Solutions for Workplace Change: Findings of Completed Projects

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Each proposal received by the WSIB Research Advisory Council is assigned a unique, 5-digit identification number.

The first two digits of the number indicate the year in which the proposal was submitted — thus RAC #02014 means the proposal was submitted in 2002. The one exception is proposals whose ID numbers begin with '98' — these were submitted in the Council's first competition in 1999.

The third digit of the ID number indicates the type of competition in which the proposal was submitted. A '0' in the third digit position indicates the proposal was submitted in the Council's main *Solutions for Workplace Change* competition. A '1' in the third digit position indicates the proposal was submitted in the Council's supplementary *Bridging the Gap* competition. The Council held its first *Bridging the Gap* competition in 2005.

The last two digits uniquely identify a proposal within a competition year and competition type. They are assigned to submissions sequentially as they are received by the Research Secretariat.

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RAC #98003
Hearing Protectors, Safety Glasses, and Respiratory Protective Equipment in Combination: Effect on Sound Attenuation

Principal Investigator(s): Sharon M. Abel (Mount Sinai Hospital)

Co-Investigator(s): Andrea Sass-Kortsak (University of Toronto)

Sponsoring Institution: Mount Sinai Hospital

Objectives
This study was designed to determine whether the hearing protection provided by earmuffs would be reduced by wearing them in combination with other safety gear also worn around the head area (e.g. hard hats, safety glasses, respirators).

Method
Seventy-two working age subjects (36 men and 36 women) were included in the study. In both groups, 12 subjects were under the age of 40 and had normal hearing. Twenty-four subjects were over the age of 40 — twelve with normal hearing and 12 with hearing loss typical of the damage caused by exposure to noise.

Two kinds of tests were performed on each subject. The ability to hear sounds was determined by measuring diffuse field hearing thresholds in quiet, and at 8 different frequencies ranging from 0.25 kHz to 8.0 kHz. The second test measured the ability to discriminate consonants in quiet and in the presence of background noise.

These two tests were performed on each subject five times:
1. with earmuffs mounted on a hard hat
2. with earmuffs on the hard hat and with safety glasses
3. with earmuffs mounted on a hard hat and with a respirator
4. with earmuffs on the hard hat with both the glasses and respirator
5. with no earmuffs, glasses or respirator.

Results
The results of this study showed that for each of five protective conditions, the noise reduction provided by earmuffs increases as frequency increases from 0.25 kHz to 1 kHz, after which there is no further increase.

The greatest noise reduction occurred with the muff on the hard hat alone, and the least noise reduction occurred with the muff on the hard hat used in combination with the safety glasses and the respirator. The difference between these two conditions was greatest at the lowest frequencies tested (0.25 and 0.5 kHz).

Generally, noise reduction was slightly greater for men than for women. All subjects had significantly poorer consonant discrimination in a noisy environment, compared to quiet, but this was worse for those subjects with an existing hearing loss. Hearing-impaired subjects also performed more poorly when wearing the muffs.

Conclusions
These results demonstrate that wearing other protective safety gear around the head can interfere with the hearing protection provided by earmuffs. They also show that for people with a hearing loss, the use of earmuffs might increase the handicap.

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RAC #98005
The Change from 8-hr to 10-hr Shifts at an Underground Mine: Identifying the Effects on Sleep, Performance, Safety, and Social Interactions, and Implementing a Workplace Health Promotion Program

Principal Investigator(s): Lawrence W. Reinish (Toronto Hospital and the University Health Network)

Co-Investigator(s): J. Beyers, L. Picard (Sudbury & District Health Unit); R.J. Heslegrave (University of Toronto and St. Michael's Hospital); C.M. Shapiro (University of Toronto and Toronto Western Hospital)

Sponsoring Institution: University Health Network

Objectives
To examine the impact of the change from an 8-hour shift schedule to a 10-hour shift schedule on underground mine workers; to better understand the types of problems facing shiftworkers; and to further intervention strategies by analysing the 1996/97 Ontario Health Survey (OHS'96) data and reviewing existing workplace health promotion intervention literature.

Method
Workers and their partners were surveyed by questionnaires before, and one month and one year after the shift schedule change implementation. A subgroup of workers was randomly selected for objective measurements of sleep and job performance one year after the change to the 10-hour shift schedule.

Results
Ten-hour day shift workers reported greater performance impairment and less sleep than eight-hour day shift workers. Ten-hour night shift workers reported fewer problems with job performance, more refreshing sleep and fewer driving difficulties than eight-hour night shift workers. On the 10-hour night shift, objective performance measures were similar or better than on the 10-hour day shift, and objective measures of sleep were equivalent, but with increased performance error rate on the night shift.

Conclusions
These data suggest that a night shift that does not encompass the entire night period may have significant benefits to shiftworkers, although possibly at a cost to subjective sleep and subjective and objective performance on the day shift of the 10-hour shift schedule.

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RAC #98007
Towards Developing Better Rehabilitation Protocols for Low Back Injured Workers

Principal Investigator(s): Stuart M. McGill (University of Waterloo)

Co-Investigator(s): Jacek Cholewicki (Yale University); Erin Harvey, Richard Preuss, Sylvain Grenier (University of Waterloo); Mickey Kerr (Institute for Work and Health)

Sponsoring Institution: University of Waterloo

Objectives
The objectives of the study were to:
- identify some physical, behavioural, and psychosocial characteristics of individuals with low back pain as compared to individuals with healthy backs
- quantify these characteristics wherever possible through the use of sophisticated measuring apparatus
- suggest changes to existing rehabilitation protocols.

Method
Some 70 workers, one-third of which had had low back pain in the previous year sufficiently severe to lose time from work, one-third low back pain not severe enough to lose time from work, and one-third no back pain in the previous year at all, performed a series of exercises and tests that allowed various physiological, biomechanical, and psychosocial parameters to be quantified.

Results
The main findings are:
- those who have a history of back troubles have a lack of muscle endurance specifically, a lack of balance in the endurance of different torso muscle groups
- absolute torso strength was not related to low back pain history but the *ratio* of flexor to extensor strength was related
- those who have a history of back troubles have a wide variety of motor control deficits including aberrant motor patterns during spine loading and challenged breathing (as would occur during challenging work), balancing, having to endure surprise loading, and other tasks
- those who have a history of low back troubles have some psychosocial markers but these do not dominate the physical characteristics that classify them as different from those with no troubles.

Conclusions
It is clear that personal, psychosocial, and biomechanical variables are associated with low back disability and are important in preventing low back injury and the ensuing chronicity collectively the evidence from several scientific perspectives is overwhelming. However, the specifics needed to establish both association and causality remain to be fully understood. Why do only some workers become patients? Some back troubles resolve, others continue along a cascade of change, pain, and ability to tolerate certain types of activity and loading. Understanding the role of personal characteristics, biomechanical parameters, psychosocial parameters, together with their interrelationships, will build the foundation for better prevention and rehabilitation approaches in the future.

Publications

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RAC #98008
Evaluation of Participatory Ergonomic Interventions in Large and Small Business

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Co-Investigator(s): Larry Brawley, Mardon Frazer, Robert Kerton, M.S. Laing, Patrick Neumann, Robert Norman, N. Theberge (University of Waterloo); Donald Cole, Mickey Kerr (Institute for Work and Health)

Sponsoring Institution: University of Waterloo

Objectives
The objectives of this study were to:
- assess the effectiveness of ergonomic changes made in an industrial workplace
- evaluate the process of ergonomic change, and find out if the changes resulting from a participatory ergonomics program lead to:
  - reduced physical loading on the body
  - reduced pain and fatigue
  - reduced injury rates
  - improved morale
  - improved productivity
  - cost justifiable benefits.

Method
A manufacturer in the auto parts sector was approached to see if interest was present in conducting a study. Their expression of interest was followed up by securing support from corporate management, plant management and plant labour representatives for conducting the study.

A "steering committee" to guide the study was formed with representatives from corporate office, plant upper management, labour and the researchers. An "Ergonomics Change Team" (ECT), consisting of labour, management and research team representatives, was formed.

Two production lines that manufactured a similar product, were selected for study. Line 1 was the Control group and Line 2 was the Intervention group. Baseline measures were made using:
- questionnaires (administered to all workers on Lines 1 and 2)
- physical loading estimates (via biomechanical modeling of all jobs on Lines 1 and 2)
- upper extremity electromyography (EMG) (from 6 randomly chosen workers on each line who were measured on each job on their respective lines).

The ECT was provided with an ergonomics training program and data from the researchers were shared with the ECT to facilitate identification and quantification of problematic jobs and to assist them in the development of possible interventions. The ECT was constrained in that the production system design could not be changed.

All measures were repeated nine months later. The process of ergonomic changes was evaluated using semi structured interviews with management, supervisory personnel, ECT members and line workers.

Results
The plant where this study was conducted now has a workable, participative process lead by an effective ergonomics change team. Twenty-one improvements with ergonomic impact were initiated and evaluated. Twenty of these improvements demonstrated positive impacts, including:
- improved muscle activity
- reduced forces on spinal structures

- improved preference ratings
- qualitative evaluation by ergonomists.

The majority of participants reported positively about the ergonomics change process: 87% felt their jobs were easier, 86% felt their jobs were safer and 77% felt their jobs were less tiring. Analysis of physical loading data from 8 workers did not demonstrate dramatic decreases in loading. This was primarily due to the dominant physical loading demands associated with the unchanged current production system.

Conclusions
Plant personnel have increased their understanding of—and have had access to—state-of-the-science ergonomics tools and knowledge. Using their training and the evidence from the pre-measure tools, the ECT has made decisions that have resulted in successful interventions.

Based upon a formal qualitative evaluation, the performance of the intervention process, and the interventions themselves, have been identified as being very effective by plant management and labour representatives.

To investigate the generalizability of the process, methods and results, multiple replications of this model are being conducted. Researchers investigating ergonomic risk factors have far greater experimental control compared to intervention research.

Specific research challenges identified in this project include sample size, worker participation, ongoing changes and variability inherent in a production facility, and potential contamination effects from the Intervention to Control Group. The array of assessment techniques, including process measures, detailed physical measures, questionnaires, self reports and interviews is one approach to addressing these challenges.

Relevance
A significant proportion of the causes of upper limb and low back pain cases—and the disability arising because of them—is considered to be related to the design of work and workplaces. Interactions among the ergonomic design of work, worker perceptions of work-related social factors, worker and management personal factors, and the organization of work, are known to influence the incidence and severity of injury, quality and productivity. Therefore, contributors to work-related musculoskeletal disorders (WMSD) are potentially preventable.

However, for any given situation, joint health and safety committees, workers, engineers, ergonomists, senior management, unions and others are faced with decisions regarding whether a particular intervention is likely to be successful and the cost effectiveness of the proposed intervention.

Future Directions
The study team has developed an approach and evaluation strategy for both outcomes and process when implementing ergonomic interventions to reduce WMSD. Its approach now is to test the generalizability of the process by utilizing new plants. The team has also been involved with the design of a new production system. It believes that the development of new tools for engineers is important for a proactive approach to the reduction of WMSDs.

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RAC #98011
CAW/McMaster Work-Related Health and Safety Risks Study

Principal Investigator(s):	Wayne Lewchuk (McMaster University); David Robertson (Canadian Auto Workers)
Co-Investigator(s):	Ted Haines (McMaster University, Occupational Health Clinics for Ontario Workers); Donald Cole (McMaster University); Mickey Kerr, Terry Sullivan (Institute for Work and Health); Paul Landsbergis (Cornell University); Peter Schnall (University of California)
Sponsoring Institution:	McMaster University

Objectives
The study had three main objectives:
- profile of work organization characteristics in the automobile industry
- profile of employee health status
- exploration of the links between work organization and health outcomes.

Method
A work organization health status survey was developed and distributed to over 1,000 autoworkers. Blood pressure readings were taken on the shop floor. A smaller sample of workers were asked to wear an ambulatory monitor for 24 hours.

Results
The study's findings were:
- The characteristics of work vary across job categories. Assembly line workers reported the least control and the highest work loads on most indicators
- Health outcomes also vary across job categories. Assembly line workers reported the poorest health status on most indicators
- The age health status was U-shaped. Initially health status deteriorated. Around age 40-45 it began to improve
- A number of our work organization indicators were correlated with a number of our health outcomes
- The incidence of hypertension in auto plants was high relative to that found in the Canadian population.

Conclusions
The study's conclusions are:
- more attention needs to be given to work organization in order to improve health outcomes
- the observation of a U-shaped health outcomes profile suggests that the regulation of the workplace, and in particular the rights associated with seniority, may play an important role in buffering workers against the worst effects of poorly organized workplaces.

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RAC #98024
Dealing with Work-Related Musculoskeletal Disorders in the Ontario Clothing Industry

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Co-Investigator(s):	Mickey Kerr, Sue Ferrier (Institute for Work & Health); Andrew King (Occupational Health Clinics for Ontario Workers); Eric Frumin, Jennifer Gunning (Union of Needletrades, Industrial and Textile Employees)
Sponsoring Institution:	Union of Needletrades, Industrial and Textile Employees

Objectives
The clothing industry is generally viewed to be relatively safe due to the low rates of traumatic industrial accidents. The major health risk in this industry, however, does not arise from immediate, potentially fatal hazards but from more subtle hazards whose effect accumulate over time into what can be very disabling musculoskeletal disorders. Research has found that the prevalence of work-related musculoskeletal disorders (WMSD) among sewing machine operators is substantially higher than other occupational groups and the prevalence of persistent neck and shoulder disorders increases with years of employment as a sewing machine operator. One study found that sewing machine operators reported as many disabling repetitive strain injuries as "data entry keyers" and "secretaries" combined. These injuries lead to long-term health effects. This is why we wanted to look at the working conditions that can lead to such high rates of disability for clothing workers.

Research has consistently found that the physical characteristics of the job are an important risk factor for muscle pain and injury. The risks for sewing machine operators have been linked to conditions such as poor workstation design and chairs, and organizational factors such as the piecework system.

Factors, such as repetition, force, posture and vibration are associated with higher rates of injury. But the workstation alone does not provide the key to understanding these injuries. There is growing evidence that other factors are linked to injuries. These include:
- high work pace
- lack of control over the job
- workload
- co-worker support
- the general work environment.

Few studies, however, have investigated physical and organizational risk factors at the same time in more than one workplace. And most studies in the clothing industry have focused only on sewing machine operators, leaving out workers in other jobs.

The purpose of this study was to document and describe the current work conditions throughout the clothing industry. The goal was to identify good practices that are currently in use in the industry, and to share these practices so that injuries can be reduced.

Method
This project was a collaborative effort by the Union of Needletrades, Industrial and Textile Employees (UNITE), the Institute for Work & Health (IWH), and the Occupational Health Clinics for Ontario Workers (OHCOW).

This research project was conducted in three phases. The first phase was a review of lost-time injury claims for the clothing industry in Ontario over a six-year period (1993-1998). The second phase was the completion of a questionnaire on work organization characteristics by one union representative and one management representative at each participating plant. The

final phase was an assessment of ergonomic conditions in the plants. Two trained ergonomists conducted assessments of jobs in the cutting, assembly, pressing and finishing departments in each plant. Twenty-nine unionized clothing manufacturers participated in the study.

Results
The results of this study indicate that:
- the combined perceptions of management and worker representatives do not correspond well to external measures of working conditions
- substantial ergonomic hazards are present throughout the clothing industry
- management and worker representatives both have positive perceptions of occupational health and safety practices in their workplace, but management representatives' perceptions are consistently more positive than worker representatives' perceptions
- in spite of the ergonomic hazards identified, the rate of accepted lost-time injuries has declined in recent years.

Positive organizational and/or physical characteristics were identified in every garment plant visited throughout the course of this study. These features ranged from open communication between workers and all levels of management, positive social environments, non-repetitive tasks, ergonomic workstation modifications, and rehabilitation teams. At the same time, however, all workplaces could improve their working conditions through both organizational and physical changes. This study identified several areas that companies of any size could target for improvement including:
- communication
- involvement of employees in decision making
- education and training of employees and management regarding work-related musculoskeletal disorders (WMSD) and ergonomics
- physical ergonomic conditions.

Conclusions
It is clear that WMSD is a major issue in the apparel industry. There is strong scientific evidence to support the work-related nature of these injuries yet individuals continue to accept their problems as a consequence of aging. Even many of those that recognize WMSD as work-related injuries accept them as "just part of the job."

We should no longer accept this consequence, with the advancements that have been made towards understanding the organizational, psychosocial and physical risk factors for these injuries. With this knowledge these injuries can be prevented. We hope that this report will be used to initiate change in the workplace towards the prevention of WMSD by creating a starting point for discussion and by stimulating ideas on how working conditions can be improved. There are many organizational and physical features of garment plants that can, and should, be targeted to reduce the risk of WMSD for garment workers.

Publications
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The study is available at *http://www.iwh.on.ca/archive/pdfs/ergohandbook.pdf.*

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RAC #98028
Assessment of a Person's Ability to Function at Work

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Co-Investigator(s):	Susan Baptiste, Donald Cole, Harry Shannon, Edward Gibson (McMaster University); Judy Clarke, Rhoda Reardon (Institute for Work and Health)
Sponsoring Institution:	McMaster University

Objectives
The objectives of this study were to:
- document a profile of the varied functional assessment (FA) practices and outcomes in Southern Ontario
- examine how employers and WSIB use FAs within in a group of workers with soft tissue injuries
- look for differences in FAs' ability to predict occupational performance and utility for vocational decision making across the range of assessments and contexts.

Method
A combined qualitative-quantitative approach gathered information from different sources, using multiple methods to generate a triangulated understanding of practice patterns and underlying factors that influence FA's utility. A cohort of 70 injured workers was followed prospectively documenting the sequence of events post-FA, the assessment's use, and FA perspectives.

The study included:
- 23 FA provider site visits and 76 assessor Interviews and questionnaires
- 70 FA report reviews
- 67 worker follow-up telephone interviews at 2 and 8 months, including SF-36
- 103 report user interviews
- 4 mixed stakeholder focus groups, each including injured workers, WSIB (adjudicators, nurse case managers, LMR providers), employers (occupational health, HR, health and safety personnel), and assessors.

Results
The study found that functional assessment (FA) providers are third party providers who operate within a range of ownership structures with variability in staff training and support, approaches and protocols.

Assessment approaches share common elements and variations that can be described along five continua:
1. nature of assessor-evaluee interactions
2. fixed or flexible protocol delivery
3. efforts to contextualize
4. perceptions and use of evidence
5. provider organizational environment.

Conclusions
The study found that FAs can be a useful information tool when making return to work and/or rehabilitation plans for workers with soft tissue injuries.

For optimal use, FAs need to be considered as one part of a complex process. This process is articulated in the "McMaster Model," developed by the research team, which depicts important considerations before, during, and after an FA.

Publications

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RAC #98033
Back Pain and Work during Pregnancy: Identification of Problems and Biomechanical Analysis

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Co-Investigator(s):	Robert Jensen, Andre Plamondon (Laurentian University); Michael McGrath, Joan Trammer (Kingston General Hospital); Caroline Weber (Queen's University)
Sponsoring Institution:	Queen's University

Objectives
The objectives of this study were:
- to identify problematic tasks experienced by pregnant women in the work place and factors associated with these problematic tasks
- to develop a biomechanical model and protocol that takes into account the changing body parameters of pregnant women to accurately evaluate loads on the lumbar spine during realistic occupational tasks
- to perform a biomechanical analysis of a few selected problematic tasks to evaluate factors associated with pregnancy (increase in body mass, posture) that increase loads on the spine.

Method
The study consists of three parts: a survey of pregnant women to identify problematic tasks, the development and validation of a biomechanical model to analyze loads on the spine during physical tasks, and a biomechanical analysis of selected tasks.

Identifying problematic tasks
Problematic tasks and influencing factors were identified through a survey of pregnant women at 20 and 34 weeks of pregnancy using three questionnaires: Initial Survey, Job Analysis Survey, and Task Description Form. Comprehensive information relevant to problematic tasks performed by pregnant women was collected and analyzed statistically. This information includes demographics from the Initial Survey, problematic tasks from the Job Analysis Survey, and details of involvement in a task (such as posture, duration, frequency, and load) from the Task Description Form. Data on back pain and discomfort in the body were also collected and analyzed.

Seventy-three subjects were surveyed in this study, of which 36 subjects completed the forms for both 20 and 34 weeks, 18 filled out only the 20 week forms and 19 only the 34 week forms. In total, 109 Initial Survey questionnaires were completed. The subjects submitted 322 reports of problematic tasks in the work place and at home, of which 105 reports of problematic work tasks were described using the Task Description Form.

The biomechanical model
An individualized link-segment biomechanical model was developed consisting of 12 segments for monitoring the whole body motion during an occupational task. The model uses kinematic data measured by an electromagnetic motion tracking system (MotionStar®) and anthropo-metric data measured by a geometric method for taking into account body changes during pregnancy. Therefore, this model is appropriate to analyze the loads on the spine of pregnant women performing complex tasks. The performance of the model was evaluated by comparing the loads at L5/S1 with the loads measured using a force plate obtained by two approaches.

Biomechanical analysis of an assigned task
A task involving lifting a file folder from a low drawer and placing it on a table was analyzed. The selection of the task was based on the considerations that it is an activity required by a wide range of occupations and that low-origin lifting tasks become increasingly difficult for pregnant women as pregnancy advances.

Two styles of lifting (freestyle lifting and squat lifting) to three orientations (0 degrees in from of the subject, 90 degrees to the right, and 90 degrees to the left) were measured. Six pregnant women and six non-pregnant women were involved in the task analysis. The pregnant subjects were tested at early and late pregnancy and postpartum. The loads at L5/S1 were analyzed.

Results
The study's findings are:

- Identifying problematic tasks: Bending, lifting, and carrying were found to be the most problematic tasks for pregnant women at work and at home. At work, the most problematic task was sitting followed by bending, lifting, and carrying. Getting tired, uncomfortable posture, and excessive time in same posture were the main factors related to problems performing the work tasks. The low back had the highest rating of discomfort in the body, which may relate to the amount of low back pain reported.
- The biomechanical model: The results showed that the model could be reliably used in biomechanical analysis of spinal loads for pregnant women and other subjects during various complex tasks.
- Biomechanical analysis of an assigned task: The results showed that body changes during pregnancy have an effect on loads at the lumbo-sacral level; in particular, the loads increase with advancing pregnancy due to the gain of upper body mass. Some women experienced loads at the lumbosacral level that were higher at postpartum than during pregnancy when they performed the same tasks, an effect that cannot be explained by changes of upper body mass. This may be related to the use of lifting strategies that are different during pregnancy than at postpartum. A more detailed analysis is needed to examine what other factors (e.g., accelerations, posture) explain these unexpected patterns. Also, more subjects are needed to confirm the generality of these patterns.

Conclusion
For future studies, it is interesting to know how the back muscles react to increased loads at the spine and whether the muscles are the cause of discomfort or even pain in the back. It is also interesting to know what strategies are required of pregnant women to cope with increased loads and body changes.

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RAC #98049
A Collaborative Investigation of the Incidence of Cancer among Workers in an Auto Parts Plant

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Co-Investigator(s):	Ted Haines (McMaster University); Paul Sampara (Occupational Health Clinics for Ontario Workers); G.Tomlinson (University of Toronto)
Sponsoring Institution:	Occupational Health Clinics for Ontario Workers

Objectives
The objectives of this study were: (a) to explore the feasibility of using the Participatory Action Research (PAR) approach including workers' satisfaction in studying a cluster of cancer cases; (b) to investigate a feasibility study on possible excess rates of brain cancer, among a group of automotive parts manufacturing plant workers; and (c) to develop workers' training materials on how to investigate cancer clusters.

Method
A participatory action research model was used with initial formation of a research advisory committee and selection of worker researchers. The training of worker researchers involved training on the basics of research methods and developing a handbook for worker researchers. Former plant workers participated in hazard mapping in a town hall meeting. The worker researchers examined old union and company records to extract information for the cohort to be followed. The cohort was matched with the cancer incidence registry at Cancer Care Ontario. An opinion survey was conducted to evaluate workers' acceptance of the study.

Results
Worker researchers were selected on the basis of their interest and knowledge of the workplace. A total of 556 records had sufficient data for matching with Cancer Care Ontario. There were 258 females and 298 males. A total of 37 incident cancers were detected. Malignant neoplasm of the brain was detected in one worker in the cohort. Among the four brain cancers one was a primary cancer, two were secondary cancers that metastasized to the brain and one was an eye cancer. Lung cancer was found in 4 workers, breast cancer in 7 workers and prostate cancer in 6 workers.

Conclusions
Occupational disease clusters may be investigated using an alternate model, the Participatory Action Research model. There was high worker acceptance of the PAR method in terms of their wish to participate and their opinion that the study was done honestly. The project has prepared a handbook, currently in final revision, that can be used to train workers in cancer cluster research. The perception of a cluster of primary brain cancer is not supported at this time. The lack of a positive association does not mean that there is an absence of cancer caused by the workplace; there are deficiencies in the cohort assembly and follow-up as well as a relatively young cohort and a short latency time. The researchers hope to match the cohort to the Ontario Cancer Care Registry and the Canadian Mortality database in five years time.

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RAC #98066
Return to Work in Small Workplaces: Sociological Perspective on Workplace Experience with Ontario's "Early and Safe" Strategy

Principal Investigator(s): Joan M. Eakin (University of Toronto)

Co-Investigator(s): Judy Clarke (Institute for Work and Health); Ellen MacEachen (University of Toronto)

Sponsoring Institution: University of Toronto

Objectives
Return to work (RTW) after work-related injury is known to be particularly challenging in small workplaces. Injured workers in small firms tend to have lower rates of reemployment, longer periods on compensation, and less access to assistance.

Little is known, however, about the actual process of RTW as it occurs in the workplace, or about the experiences of the workplace parties. We do not know how what happens in the workplace is related to the distinct nature of working life in small work settings, or how it is affected by the regulations, policies and practices of RTW. This study examined the strategy of ESRTW currently used in Ontario—an approach that emphasizes workplace "self-reliance" and "early" return to work before full recovery in "modified" jobs—and its effects on both injured workers and employers.

Method
The research was carried out using qualitative methods.

Documentary materials (regulations, policy statements, guidelines, educational materials, bureaucratic forms, Web sites) were analyzed to reveal the underlying assumptions and expectations of ESRTW. In addition, injured workers and employers were interviewed using special methods for encouraging them to recount their experience and responses in their own terms, without the researchers' prior framing of the issues.

Interviews did not use structured questionnaires; instead a "guided conversation" format was used to prompt participants to talk about their working lives and their experiences with and perspectives on injury, compensation and return to work. Interviews were taped and transformed into typed texts which were analyzed using special techniques for interpreting and explaining how the participants understood their experiences and acted upon them.

This approach attempts to uncover the meanings and "logic" underlying workers' and employers' comprehension of, and responses to, ESRTW. Their perspectives were then linked to the "structural context" in which they were located—the nature of work life in small settings, and the rules and requirements of the ESRTW system.

Participants included 17 employers and 21 injured workers from independent enterprises with fewer than 50 employees in a variety of different industrial/service sectors. Seven employers and workers were "pairs" in the same workplaces.

A sub-set of participants was re-interviewed on one or more occasions up to a year after the initial interview to cast light on the process over time. Several compensation board and rehabilitation professionals were also interviewed regarding their role in the RTW process and to explore ideas that emerged from the worker/employer data.

Participants were recruited from a number of sources, including the WSIB, government health and safety advisory agencies, community health and legal clinics, medical and chiropractic clinics, and cold calls to businesses listed in a business directory. The sample included a socially diverse set of individuals from a range of different types of workplace settings, reflecting to a fair extent the general character of the small workplace sector in the province.

Results
When delegated to the workplace, the implementation of Early, safe Return to Work (ESRTW) is superimposed on, and becomes part of, the everyday social organization, interactions and customs of the workplace ("how things are done around here"). The requirements of ESRTW are filtered through the logic of the workplace and 'adapted' to the needs and standpoints of the parties involved.

For employers, ESRTW is a business problem, with significant administrative and managerial challenges, that can draw them, often involuntarily, into the disciplinary and medical management of RTW. Compliance with ESRTW and compensation regulations can impose an administrative burden, conflict with workplace norms, undermine their managerial authority, and damage relationships with the injured worker and with other employees.

For workers, ESRTW can be a struggle to protect their personal credibility and integrity, and to reconstruct their physical and working lives within the ambiguous and contested terms of 'co-operation'. Workers suffer under what the study calls the "discourse of abuse"—persistent, pervasive imputations of fraudulence and 'overuse' of rights. Surveillance and its effects can extend into the injured workers' homes and family life.

During the vulnerable and fragile stage of bodily injury and recovery, workers confront a range of social difficulties in determining when they should return to work, in managing issues of loyalty and commitment to the firm and employers, and in engaging in modified work that can be meaningless or socially threatening.

For both employers and injured workers, damaged moral relationships and trust can trigger snowballing of social strains, induce attitudinal "hardening" and resistance, and impede the achievement of mutually acceptable solutions to the problems of injury and return to work.

Conclusions
The study has produced some important concepts and insight into the process of return to work in small workplaces which can be used to reflect on current policy and practice and to inform other research.

Findings bring into question some of the assumptions and principles of ESRTW, suggesting that the strategy might be transferring costs to workers and their families, and to employers, and that the notion of "safe" needs to include social as well as physical security. The study also points to some paradoxical perversities in the strategy of self-reliance in small workplace settings, and cautions against a one-size-fits-all approach to RTW.

Some issues—such as the disturbing implications of the discourse of abuse for the experience and disability of injured workers—transcend the matter of size and deserve consideration with respect to all workplaces and the system as a whole.

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RAC #98067
Continuous Monitoring of Diisocyanate Monomers

Principal Investigator(s): James T. Purdham (University of Toronto)

Co-Investigator(s): Susan M. Tarlo (University of Toronto)

Sponsoring Institution: University of Toronto

Objectives
Diisocyanate exposure is a very serious occupational health problem. Diisocyanates are respiratory sensitizers and one of the leading causes of occupational asthma. Accurate methods of measurement are therefore essential for these substances. Instrumental methods of measurement, to date, have been limited to colourimetric tape samplers. In this study we evaluated an infrared photoacoustic detector for its ability to measure isocyanate in workplace air and other situations.

Method
The initial work in the project was devoted to the development of a safe isocyanate vapour generation and delivery system for use in the experiments. The development of the system was a successful by-product of this research project. We were able to demonstrate that known concentrations of isocyanate can be produced and maintained at a stable level over extended periods of time.

Results
The study was able to evaluate the response of an infrared photoacoustic detector to isocyanate concentrations in a stream of nitrogen, determining the limits of detection and the precision of the measurement. Measurements were made using two different wavelength filters which produced narrow wavelength bands of infrared radiation in a region where isocyanates would give a strong response (centered on 4.5 micrometres (m) and 4.4 m). The limits of detection were found to be 40 parts per billion (ppb) and 25 ppb respectively. The relative standard deviation of measurements was found to be 3-4 percent. These findings indicated that the instrument would not be sufficiently sensitive to allow routine field measurements of exposure, although its use as a leak detection/alarm system was still a possibility as well as certain limited applications in exposure chamber work.

For the purposes of leak detection, the instrument would need to be able to make measurements in air, which contains carbon dioxide, a potentially strong interferent. The instrument has the capability of correcting for both water vapour and carbon dioxide absorption at wavelengths of interest. This correction relies upon measurement of these substances at a wavelength other than wavelength of interest and using scaling factors to determine the degree of correction required at the wavelength of interest. The instrument was calibrated to make these corrections at the isocyanate absorption wavelengths. However, it was found that the carbon dioxide absorption at the measurement wavelength was so large, that even a small error in the carbon dioxide scaling correction resulted in unacceptably large errors in the determination of isocyanate concentration.

Attempts were made to eliminate carbon dioxide and water vapour from the sample prior to entry to the measurement chamber of the instrument, using selective adsorption by molecular sieves. All attempts to do so, however, met with no success. While carbon dioxide and water vapour were successfully reduced to less than one percent of their original concentrations, the isocyanate was also completely lost. Under normal circumstances, this might be an area for further investigation, but coupled with the lack of adequate sensitivity, this would not seem warranted.

One further possible application of the instrument was investigated. In creating known concentrations of diisocyanate in human exposure facilities, diisocyanate vapour is generated by passing a stream of nitrogen through the liquid diisocyanate. Dry nitrogen rather than air is

used, because water vapour present in air will react with the liquid diisocyanate causing polymerization. This concentrated vapour is then delivered to the chamber in a stream of dilution air. The final concentration of diisocyanate in the chamber is dependent upon the flow rate of the dilution air, the concentration of toluene diisocyanate (TDI) in the delivery line, and the flow rate through the delivery line. Since the concentration of diisocyanate in the delivery line is relatively high (in the parts per million range), and it is an atmosphere free from carbon dioxide and water vapour, the infrared photoacoustic detector can reliably and accurately measure the isocyanate concentration in the delivery line and this can be used to calculate the chamber concentration. Experiments were performed to confirm this and they demonstrated a very good correlation between the level of isocyanate in the chamber predicted from photoacoustic measurements of TDI concentration in the delivery line and the actual level as determined by an MDA tape sampler. This instrument, therefore, could be a useful addition to the instrumentation used to ensure that concentrations of diisocyanate in human exposure facilities are kept within safe limits. However, since the MDA tape sampler can measure the concentration of diisocyanate directly in the chamber where the person is exposed, the role of the infrared photoacoustic detector would likely be that of backup.

Conclusions

- known concentrations of TDI can be generated by the dynamic system designed and built in our laboratory and can safely be used for isocyanate experiments
- the infrared photoacoustic detector is not sufficiently sensitive for assessment of compliance with current exposure standards, or for direct measurement of diisocyanate concentration within the human exposure challenge chamber
- the infrared photoacoustic detector is unable to reliably measure TDI concentrations in room air, because it is unable to correct with sufficient accuracy for the very large carbon dioxide absorbance at TDI responsive wavelengths
- carbon dioxide and water vapour interference with isocyanate measurements using the infrared photoacoustic detector cannot be eliminated by selective absorption using molecular sieves without loss of TDI
- the infrared photoacoustic detector can be used to measure generated TDI concentrations in nitrogen prior to dilution with air in exposure chamber applications.

The overall conclusion of the project is that the infrared photoacoustic detector is capable only of limited application in the field of diisocyanate measurement.

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RAC #98069
Evaluation of Diesel Particulate Filter Systems at Inco's Stobie Mine

Principal Investigator(s): Jozef Stachulak (Inco Limited)

Co-Investigator(s): Bruce Conard (Inco Limited)

Sponsoring Institution: Inco Limited

Objectives
The objective of this study was to test the long-term effectiveness of diesel particulate filter systems (PFSs) to reduce the concentration of diesel particulate matter (DPM) in underground environments. Of particular concern was the ability of PFSs to sustain long-term filtration efficiencies under the often harsh physical environment that exists for equipment operating in mining service. The primary reason for the past failures of PFSs in mining was recognized as being an improper matching of a PFS to the vehicle on which it was expected to perform.

Method
The study was conducted under the auspices of the Diesel Emissions Evaluation Program (DEEP) at Inco's Stobie mine from April 2000 to December 2004. Five heavy duty Load/Haul/Dump (LHD) scooptrams were selected as representing the primary heavy duty workhorse in underground mining. One of these units had a dual exhaust Deutz engine and the other four had Detroit Diesel DDEC 60 engines. Four Kubota tractors were selected as being representative of light duty vehicles, which are increasingly being used in transporting underground personnel. The duty cycles of the candidate vehicles were monitored for six months prior to selecting the PFSs for testing.

A number of different PFSs were selected for testing.

For heavy-duty LHDs:
Completely passive systems: an Oberland-Mangold PFS with a knitted glass fiber filter and a fuel-borne catalyst. An Engelhard PFS with a cordierite honeycomb filter the internal surfaces of which had been coated with a catalyst.
Completely active systems: Two from ECS/Unikat with a SiC honeycomb filter and used on-board electrical heating for regeneration; one from Arvin Meritor, with a cordierite honeycomb filter with a built in burner for regeneration.
Mixed passive-active system: a Johnson Matthey PFS with SiC or cordierite honeycomb filters. The passive part of the system used a fuel-borne catalyst and the active part used on-board electrical heaters.

For light duty tractors:
Active systems: an ECS/3M with a ceramic fiber filter medium and an on-board electrical heater; an ECS/Unikat with a SiC honeycomb filter and an on-board electrical heater; a DCL with a SiC honeycomb filter and an off-board electrical heater.

Tests on the PFSs were conducted every 250 hours of vehicle operation for heavy duty machines and monthly for light duty machines. During these routine periodic tests an ECOM instrument was used to analyze for NO, NO2, CO, CO2, and O2 and measure Bacharach smoke numbers upstream and downstream of each filter. Three more extensive periods of testing all PFSs were conducted during the summers of 2001, 2002, and 2004. These tests used three reproducible steady state engine conditions and analyzed gases and smoke numbers upstream and downstream of the filters, measured particulate concentrations using a photoelectric aerosol analyzer, measured particle size distributions using a Scanning Mobility Particle Sizer, and measure exhaust opacity.

Conclusions
- Both heavy duty and light duty vehicles in underground mining operations can be retrofitted with high efficiency Particulate Filter Systems (PFSs) for DPM removal.

However, all of the systems tested in the Stobie Project required more close attention than was desired, although there existed a wide variation in the amount of attention needed. Ideally, a PFS would be invisible to a vehicle's operator and almost invisible to the maintenance department. That is, people would go about their jobs in a conventional manner and would not need to pay attention to the filter or its regeneration. This was clearly NOT the case for any of the filters being tested in the Stobie Project and this remains a critical issue in any successful program for retrofitting or for installing PFSs as OEMs.

- Taking time to correctly match the vehicle duty with an appropriate PFS is essential for a retrofitting program to be successful.
- This matching must be done to correctly size the filter medium so that an acceptable soot collection period is obtained. Too small a filter will result in loading the filter too quickly and will negatively impact on vehicle productivity. Too large a filter will result in cramped space for the unit on the vehicle and this could negatively impact safe use of the vehicle and ease of its maintenance.
- This matching must be done to obtain the optimum method of regeneration of the filter. The optimum method of regeneration must take into account issues such as the complexity of the regeneration system, the period of time needed for regeneration, maintenance of components of the regeneration system, ease of installation and use, and cost.
- Proper communication with vehicle operators is essential. The presence of a filter on the exhaust manifold of an engine means that the filter, when working, will cause an increase in the backpressure of the engine. Operators must be attentive to non-conventional alerts and alarms for high backpressure or else serious harm could be done to the engine.
- Simple, but effective, dashboard signals of the state of the filter are needed in order to give information to the vehicle operator about the filter's effectiveness.
- The increased emission of noxious gases is often a consequence of the way in which some PFSs regenerate and these emissions, particularly NO2 must be watched carefully. While there may exist ways to control such emissions, system complexity by adding on components is undesirable.
- An emissions-based maintenance component of an overall vehicle/engine maintenance program is essential. Proper functioning of a PFS should be evaluated as part of routine maintenance. Training of maintenance personnel in the specifics of each PFS is essential.

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RAC #98070
Carpal Tunnel Syndrome—Morbidity and Management Outcomes in Ontario

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Sponsoring Institution:	Toronto General Hospital

Objectives
The objective of this study was to assess the various treatments and predictors of carpal tunnel syndrome (CTS) to help decrease the cost of this illness for the employer, and the debilitating discomfort for the worker.

Method
An analytical cross-sectional study was conducted of all Ontario workers who had a new claim registered with the Workplace Safety and Insurance Board (WSIB) in 1996, were diagnosed with carpal tunnel syndrome and had lost time off work. Clinical profile and cost were determined through WSIB claim files. The effectiveness of treatment was assessed with a four-part questionnaire.

Results
A total of 964 workers met the inclusion criteria. Three quarters of the patients had a surgical release of the carpal tunnel, most of these (93%) an open release. All of the workers had some conservative treatment, including those who eventually had surgery. However, 25% of the workers were managed with conservative treatment alone which in almost all patients consisted of splinting, medications, and work modifications.

The study was able to identify an improved clinical and return to work outcome for those workers who received surgical treatment. Yet the reasons for this were not clear as the selection criteria of patients for surgery was not available. However, the study also suggests that CTS outcomes are significantly worse if there are surgical complications. Particularly destructive is reflex sympathetic dystrophy which results in long-term disability and very poor return to work capability.

The recorded cost per patient was $8,330 for unilateral CTS, and $15,450 for bilateral CTS. The mean costs were $13,700 per worker, for a total cost to the WSIB of $13,200,000 per year. Ninety-two percent (92%) of the costs were in four categories — lost-time benefits, future economic loss, non-economic loss, and medical costs. However, since many medical costs could not be captured, the real costs are considerably higher, making CTS one of the most expensive upper extremity conditions for the WSIB.

The return on the questionnaire, administered according to the Dillman protocol, was 75%. The mean score for the symptom severity questionnaire was 2.39 for all workers; 2.25 for the group with a successful return to work; and 2.91 for the group with unsuccessful return to work. This indicates that on average there were mild to moderate symptoms still present at assessment four years after treatment.

On average workers were having mild to moderate degrees of difficulties performing sports, playing musical instruments, or engaging in crafts or hobbies. Due to hand pain, 37% of workers indicated they had moderate to severe difficulty in these activities. About 12.5% were unable to participate in any way in any of these activities. The study identifies a disturbingly high proportion of workers having persistent symptomology four years after the initiation of either conservative or surgical treatment.

In all, questionnaire scores indicate that 45% of workers have significant ongoing problems four years after treatment. Less than 30% of workers are asymptomatic, functioning without difficulty, and able to engage in their recreational activities.

Return to work was considered successful if the worker returned to work to the same job full time or the same job with some job modifications. Unsuccessful return to work occurred when the worker returned to a different job because of the CTS or was unable to work at all. Sixty-four percent (64%) of workers successfully returned to work and 36% had unsuccessful return to work outcomes.

Conclusions
This was not a controlled study so it could not assess cause and effect. The outcomes point to a large amount of pain and suffering, a large loss of work productivity, and significant financial cost as a result of an inability to prevent and adequately treat work-related CTS.

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RAC #98073
Effects of Job Strain, Hospital Organizational Factors, and Individual Characteristics on Work-Related Disability among Nurses

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Co-Investigator(s):	Mickey Kerr, Mieke Koehoorn, Sheilah Hogg-Johnson (Institute for Work & Health); Harry Shannon (McMaster University); Donna Thomson (Mount Sinai Hospital); Linda Aiken, Julie Solchoski (University of Pennsylvania)
Sponsoring Institution:	Mount Sinai Hospital

Objectives
This study examined how job strain (including staffing and workload indicators, organizational factors and individual nurse characteristics) affects the health of nurses. It did this by describing nurses' health status, examining trends in injury compensation claims and determining factors contributing to claims.

The study team also asked nurses to rank interventions aimed at improving their workplace health and safety, and gathered input from nurses and hospital stakeholders on factors related to nurse injuries, stress and absenteeism.

The study addressed the following questions:
1) What is the general self-reported health status of nurses in acute care hospitals in Ontario, and what is the prevalence of self-reported health-related work absence, burnout, back pain and neck pain?
2) What are the main trends in WSIB claims for nurses in acute care hospitals in Ontario over the past nine years?
3) To what extent can individual and job strain factors explain variation in WSIB claims rates among participating hospitals?
4) What additional factors, from the staff nurses' perspective and from an organizational perspective, should be included to develop effective workplace interventions to improve the health of nurses?

Method
This study used both quantitative and qualitative methods.

The quantitative aspects involved both cross-sectional and time-series analyses. Data from three 1998/9 Ontario data sources were linked together at the hospital-level into one database:
- a survey completed by acute-care nurses about their work life
- Ministry of Health hospital submissions
- WSIB lost-time claim rates.

WSIB claim rates were examined for a nine-year period, from 1990/1 to 1998/9.

The qualitative component involved analyses of data obtained from focus groups with nurses and interviews with hospital stakeholders at 10 Ontario hospitals. The study focused exclusively on acute care hospitals due to the availability of existing nurse survey and MoH data.

Results
The study found the following:
- Almost half of nurses (44%) reported missing work due to illness at least once in the preceding three months. High emotional exhaustion was experienced by more than 36% of nurses surveyed. A substantial number of nurses reported experiencing musculoskeletal

pain most or all of the time during the preceding week (16% for back pain and 17% for neck pain)
- Over the nine years examined, nurses had consistently higher injury claim rates compared to non-nurses. Musculoskeletal claims comprised the majority of hospital claims. Musculoskeletal injury rates dropped by only 39% for nurses, even though there was a 61% decrease in the musculoskeletal claim rate for non-nurses between 1990 and 1998
- Hospital-level regression analyses revealed that the probability of a hospital having a high RN lost-time claim rate increased when RNs worked more than one hour of overtime per week. RNs who worked more than one hour of overtime also reported more occasions of sick time than average
- The probability of a hospital having a high RN musculoskeletal lost-time claim rate decreased with improvements in nurses' relations with physicians. At the same time, the probability of a hospital having a high RN musculoskeletal lost-time claim rate increased, with RNs reporting more occasions of sick time than average
- While the majority of nurses ranked adequate staffing levels and reasonable workload as interventions that would improve their workplace health and safety, most did not believe that these variables were currently present or likely to happen in their hospital
- To reduce injuries, nurses suggested improving the physical environment. Stakeholders also suggested improving the physical work environment, and offering education to nurses. To decrease stress levels, nurses most frequently suggested improving benefits, staffing levels and respect for nurses. Stakeholders also suggested increasing respect and improving benefits
- Finally, to reduce absenteeism, nurses most often suggested improving benefits, while stakeholders offered improved benefits, changes in policy and reduced workload as potential solutions.

Conclusions
Injuries among nurses are costly to hospitals in terms of lost productivity, disruption to work flow and claims paid, as well as to nurses in terms of pain, stress and possible loss of employment.

There are further implications for the retention of qualified nursing personnel in the workforce and the delivery of quality patient care. One of the key elements of the future recruitment and retention of the nursing workforce will be protection of the health of employees from disabling injuries.

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RAC #98074
Study to Improve Diagnostic Methods for Repetitive Strain Injuries such as Carpal Tunnel Syndrome

Principal Investigator(s): Ron House (St. Michael's Hospital)

Co-Investigator(s): Michael Wills (St. Michael's Hospital)

Sponsoring Institution: St. Michael's Hospital

Objectives
The objective of the study was to determine if nerve conduction study (NCS) normal values differ between manual and non-manual workers, and, if so, whether this is an effect of anthropomorphic factors and/or subclinical pathology.

Method
Participants were initially screened by a standard questionnaire to select only those free of neurological symptoms in the upper extremities. A total of 41 manual workers and 41 non-manual workers were selected with matching for age in 10 year age intervals. Motor and sensory NCS of the upper extremities were carried out in all participants and evaluated in terms of differences related to manual vs non-manual work, various anthropomorphic measures and other factors.

Results
Some sensory NCS results differed significantly between manual and non-manual workers. This difference was explained by two factors. First, manual workers had, on average, larger hands and larger finger circumference than non-manual workers and larger finger circumference was associated with a reduction in measured sensory amplitude. In fact finger circumference was the best predictor of sensory amplitudes recorded from the hand and fingers, overshadowing the effect of any other anthropomorphic variable or age. Second, a higher incidence of subclinical median neuropathy at the wrist was found in manual workers and likely accounted for most or all of the remaining difference between manual and non-manual workers.

Conclusions
It is important to recognize the effect of hand size on the measurement of nerve function when diagnosing occupational neurological abnormalities. In particular the large, thickened hands of manual workers are associated with decreased measured sensory amplitudes that can affect the interpretation of nerve conduction studies. Specifically, it can result in false positive diagnoses of neuropathy such as carpal tunnel syndrome in manual workers. Recognition of this measurement issue should result in improved interpretation of the effect of hand size on the measurement of nerve function in manual workers and improved diagnostic accuracy. In particular, there should be a reduction in false positive diagnoses of neuropathy such as carpal tunnel syndrome and a consequent decrease in unnecessary interventions such as surgery with secondary loss of grip strength and reduction in work capability. Subclinical median neuropathy at the wrist is very common in manual workers and correlation between symptoms and nerve conduction study results is essential for accurate clinical diagnosis.

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RAC #98079
Occupational Histories of Essex County Cancer Patients

Principal Investigator(s): Kevin M. Gorey (University of Windsor)

Co-Investigator(s): James Brophy, Deborah Hellyer (Occupational Health Clinics for Ontario Workers); Margaret M. Keith (Windsor Occupational Health Information Service); Ethan Laukkanen (Windsor Regional Cancer Centre)

Sponsoring Institution: University of Windsor

Objectives
Over the past 30 years, there has been an almost 1% annual increase of breast cancer incidence in Canada. The majority of breast cancer cases cannot be explained by known risk factors. Increasing evidence suggests that synthetic chemicals may be contributing to the incidence of this disease. Although such carcinogens exist in many workplace environments, few occupational breast cancer studies have been conducted in Canada. This lack of attention to the possible occupational associations with cancer contributes to the under-reporting and minimal recognition of occupational risk factors in the etiology of breast carcinogenesis. While laboratory-based research can identify isolated carcinogenic agents, population-based studies have the advantage of being able to evaluate interactive and cumulative effects in a real world environment. Such information can advance our understanding of cancer etiology in a practical manner and may ultimately facilitate the formulation of public health interventions. The specific objective of the study was to investigate whether women who have ever engaged in farming have an increased risk of breast cancer.

Method
Over a two-and-a-half year period (2000-2002), all female patients at the Windsor Regional Cancer Centre with new incident breast cancer were invited to participate in a case-control study along with an equivalent number of randomly selected community controls. A comprehensive lifetime history questionnaire was administered to subjects by interview. Data gathered included known or suspected risk factors along with a complete occupational history of all jobs ever worked.

Results
564 female breast cancer cases and 599 female controls were enrolled in the study. Their histories were compared using logistic regression statistical techniques. After controlling for traditional risk factors and other covariates, an occupational history of farming alone produced an odds ratio (OR) = 2.8 (CI, 95%, 1.6- 4.8). Women who were employed in agriculture and were subsequently employed in auto-related industries had an odds ratio (OR) = 4.1 (CI, 95%, 1.7 - 9.9) and in health care had an odds ratio (OR) = 2.3 (CI, 95%, 1.1 - 4.6).

Conclusions
This study provides evidence of an association between farming and breast cancer risk, as well as an interactive effect between occupational farming exposures and subsequent exposures in other occupational environments. It might be extrapolated that exposure to pesticides or other farm exposures initiate the breast cancer process and subsequent exposures to agents in auto-related industry, health care or other industries act as promoters. This interactive effect requires further study and consideration. Moreover, we need a clearer understanding of the effects of farming exposures during the early periods of life when breast tissue is most vulnerable. This would fill a glaring gap in our occupational cancer knowledge base and aid our general understanding about the causes of breast cancer.

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RAC #98086
Participatory Research by Injured Workers: From Reflection to Action on Compensation and Return to Work Issues

Principal Investigator(s): Bonnie Kirsh (University of Toronto)

Co-Investigator(s): Barbara Beardwood (York University); Lynn Cockburn, Pat McKee (University of Toronto); Michael Polanyi (Institute for Work & Health); Karl Crever (Ontario Network of Injured Workers); Costanza Duran (Injured Workers' Consultants); Catherine Fenech (Injured worker); Alfred Jean-Baptiste (East End Literacy); Gerry LeBlanc (United Steelworkers of America)

Sponsoring Institution: University of Toronto

Objectives
This study explored the experiences of more than 300 injured workers living in southern Ontario. The workers were canvassed through mail-in surveys and in-depth interviews. Based on their reports, this study makes recommendations for changes to the workers' compensation system in the province.

Method
This study explored the experiences of more than 300 injured workers living in southern Ontario. The workers were canvassed through mail-in surveys and in-depth interviews.

This is the first piece of participatory research (PR) on the experiences of injured workers in Ontario. PR, a variation of what is known as action research, involves a collective approach to social and economic problems by insiders - people who are directly affected by the problem under study. Issues are collectively identified and analyzed and an action plan is created. This kind of process emphasizes alternative, non-dominant systems of producing research and knowledge.

PR was used to stimulate injured worker involvement, build injured worker understanding of their issues and increase their capacity to address these issues. The project was successful in this regard: over 70 injured workers were engaged in the process in some way, 18 were trained and actively involved as peer researchers. Ninety three per cent of peer and academic researchers involved in the project felt they had many opportunities to participate, and the same number felt helped by the project (80% learned a lot more about injured worker issues, and 73% learned a lot more about injured worker resources).

Most of the people who conducted this study are themselves injured workers. These workers, along with a handful of university academics and representatives of worker organizations, identified the key issues to be explored, and adopted a three-pronged approach to the research. First, a survey was constructed based on worker-identified issues and mailed to two groups of injured workers: a random sample of southern Ontario Workplace Safety and Insurance Board (WSIB, formerly the Workers' Compensation Board) claimants (n=165), and clients of an occupational health clinic (n=120). The purpose of the survey was to gain a broad view of characteristics of compensation and return to work experiences of injured workers. Second, in-depth interviews with a diverse sample of 17 injured workers who had experienced difficulties with their claims were conducted by trained injured workers in order to deepen our understanding of important issues faced by injured workers. Third, key documents on the experiences of injured workers in Ontario and other jurisdictions were collected and reviewed to provide a context for the project's findings.

Results
The key finding of this study is that the compensation system and return-to-work process is perceived as problematic and unsatisfactory by a large proportion of injured workers in southern Ontario. For example, less than half of injured workers in the WSIB sample (49%) were satisfied with the claims process, despite the fact that they experienced a high claims acceptance rate (78%) and returned to work promptly. A significant proportion of these workers felt they had to fight for their rights (37%) and felt stressed out by the claims process (45%). Only 32% found their benefits to be adequate to meet their family's needs. In the occupational health clinic sample of injured workers who had encountered more problems getting their claims accepted, only 14% were satisfied with the claims process, and the proportion who felt stressed by the process was very high (70%).

It is likely that these findings apply to a larger population of workers in Ontario. That means that tens of thousands of injured Ontario workers may be experiencing hardship within the system.

Data collected from injured workers indicate that this hardship has physical, psychological, financial and social dimensions. Our interviews suggest that financial strain, stigmatization, lack of support and social isolation, combined with persistent pain and functional limitations result in stress, depression, anger and despair among injured workers.

Injured workers report that their pain and other physical complaints are questioned, and an atmosphere of distrust develops between workers, the WSIB, and doctors and other health care practitioners. As a result of delays in acceptance, or refusal, of their claims, workers may be forced to live off savings or be supported by other family members as they wait for an appeal. Some have no choice but to go on social assistance. Injured workers may have difficulty accessing the right treatment because of long waiting times, complex approval processes and medical uncertainty about their condition. Employers may not always provide appropriate modified work when it is required for workers returning to work. The job retraining and vocational rehabilitation that is made available may not be suitable for the worker. Furthermore, workers whose routes to recovery are not typical or predictable find themselves within a culture that blames them for their circumstances and interprets their efforts at negotiation or control as resistance.

Conclusions
In sum, the poor treatment and stigmatization of injured workers added to the physical hardship of the injury itself seems to be leading to anger, depression and other negative life impacts for a significant group of injured workers.

The study recommends that injured workers be treated with greater respect, that their dignity be preserved, and that better support be provided for their rehabilitation and return to work. The findings of this project suggest the need to:

- improve access to information and services for injured workers (for example, increase the availability of injured worker support groups)
- increase injured worker decision-making on issues concerning their treatment, retraining and ability to return to work
- enhance injured workers' financial security by eliminating delays in payments, simplifying the claims process and monitoring employers' observance of return to work agreements
- ensure that WSIB employees receive sensitivity training and adjudicators increase their awareness of the realities of the workplace.

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RAC #98088
Outcomes in Contact Dermatitis

Principal Investigator(s): D. Linn Holness (St. Michael's Hospital)

Sponsoring Institution: St. Michael's Hospital

Objectives
There are many gaps in knowledge related to occupational disease including contact dermatitis. There is little descriptive information related to prevention, return to work and health care delivery for occupational contact dermatitis.

The objectives of the study were to: 1) describe outcome in workers with contact dermatitis over a six month period following diagnosis, 2) describe the return to work process in workers with contact dermatitis, including the roles of the injured worker, employer, health care providers and others and the modifications made to the workplace to accommodate the worker, and 3) describe workers' compensation.

Method
100 workers with hand dermatitis were enrolled and followed for 6 months post assessment at St. Michael's Hospital. Information was collected at the time of diagnosis and at 3 and 6 months. Questionnaires were administered to collect information about clinical presentation and status, quality of life, health services utilization, workplace exposures and practices, the return to work process and workers' compensation.

Results
The 100 workers were similar to our general clinic population that we have characterized previously. Two thirds of those with work-related contact dermatitis (WRCD) had had some occupational health and safety or WHMIS training in their workplace, however training related to glove use and skin care was less common.

By the time of assessment at St. Michael's Hospital, almost all the workers had seen their family doctor for their skin problem, on average 8 times, and 71% saw a dermatologist, on average 5 times. Workers reported that although the family doctors and dermatologists asked what their jobs were, they rarely asked further details about their workplace exposures and they provided minimal advice about job change or job modifications on return to work.

Six months post assessment, clinical improvement was noted in 40%. 38% were not working, almost all because of their skin problem. Of the 62% working 32% had changed job, almost all because of their skin problem. Two thirds had filed a workers' compensation claim and 70% of the claims were accepted at 6 months. 62% saw their family doctor in follow-up during the 6 months following the diagnosis but rarely was advice provided related to job change or job modification.

Conclusions
This descriptive information suggests that there are gaps in prevention and return to work programs for work-related skin disease. Research on effective strategies that are sustainable in the workplace is needed. The results also suggest that there is a need for refinement of health services delivery related to occupational disease. Design of the occupational health care delivery system to address these issues seems appropriate.

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RAC #98092
The Role of the Supervisor in Accident Prevention

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Sponsoring Institution: Laurentian University

Objectives
With the understanding that eliminating 'repeat' accidents reduces injury and provides a blueprint for prevention this project aimed to engage personnel in an evolutionary process to improve, develop, and maintain accident/incident prevention strategies and systems. The project was designed and developed to facilitate learning by researchers, managers, supervisors and workers from review of existing accident/incident reports and the related preventive responses within the organization's own database. The involvement of interested partner representatives as active participants ensured that any new practices arising as a result of this project would be relevant and feasible in the workplace. As a result, the likelihood that these practices would be applied towards obtaining the desired result of effective accident/incident prevention would increase.

Method
Based on the premise that all repeat accidents/incidents leave a 'trace,' analysis of these traces was undertaken in order to identify the factors contributing to the accidents/incidents and the fit of the preventive responses. The interplay of the two distinct processes of understanding these factors and acting upon them in an appropriate way necessarily improves understanding and enhances prevention of the accidents/incidents that recur.

With this in mind, a three stage action research model was followed. The structure of this model directed activities towards organizational change, making senior management safety intentions more explicit and aligning field personnel's actions with such intentions. The three stages were:

- making the available database useful and helping improve future databases
- using the database to capture and clearly present meaningful patterns through conventional and unconventional analyses
- involving field personnel in both the identification of contributing factors and the development of effective prevention strategies and engaging the manager as the pivot.

In line with the belief that involvement in the process of searching for and acting upon patterns in repeat accident/incident occurrence leads to improved prevention, three of our industrial partner's preventive factors were selected: Basic Cause, Risk Assessment, and Preventive Actions. Conventional and unconventional analyses of the selected preventive factors were used in order to facilitate their presentation in a form that would engage members of the organization, leading to consideration and discussion of the significance of the pattern and the appropriateness of the action responses. Subsequently, partner representatives initiated independent research into contributing and preventive factors and felt motivated towards actively improving their organization's safety management system.

Results
The action research process was designed as the critical agent of change. Working together to both identify recurring accidents/incidents and their contributing factors, and to assess the appropriateness of the preventive responses, effectively transferred successful research strategies from researcher to personnel. Ownership enabled organizational personnel to use these research strategies as an important source of improvement for the organization's safety

management system. Key lessons and outcomes arising out of the action research process include:

- repeat occurrences point to failures of the Safety Management System
- the safety intent of the manager defines the context for prevention and influences the handling and disposition of repeat occurrences
- the design of the accident investigation report may show occurrences as unique although they might be repeats
- excess information can mask patterns and conceal opportunities for prevention
- conventional statistics pinpoints focal areas, while understanding patterns leads to appropriate action
- risk assessment of all occurrences must be consistent
- safety actions must align with contributing factors and their causes
- as the driver of the Safety Management System, the manager is the pivot for change
- the 'safety intent' of the WSIB and the Ministry of Labour influence how local organizations administer their Safety Management System.

These lessons and outcomes provide evidence of how pervasively 'management human factors' influence prevention activities. This suggests that, in order to ensure that the project responds to local conditions and requirements while maintaining scientific integrity, use of an action research model must incorporate:

- willingness to adapt project design to meet local needs and conditions
- strategies for a shift in project ownership from project management team to organizational personnel
- establishment of 'stop rules' for terminating project activities.

Some challenges were faced during the course of the project. For example, re-composition of the database was a larger task then anticipated and the project had to cope with a number of key personnel changes, a period of work stoppage within the organization and a union/safety restructuring. During the span of contact of this project, the company pursued a number of other safety initiatives. Despite these challenges, the findings of this project provided the focus for the improvement of the data collection and interpretation and for the prevention initiatives that were adopted.

The project demonstrated that new opportunities for prevention exist even in the historical records of incident reports of highly competent prevention oriented organizations, such as our industrial partner. That was only possible because our Safety Association partner collects and maintains a comprehensive record of occurrence data within their industry.

That opportunities for prevention can be found in leading safety companies suggests major prevention opportunities for the industry as a whole. Revealing such opportunities may require a policy environment that motivates the Provincial Safety Associations and their industrial partners to improve the quality and collection of data, responding to the evidence of "management human factors" and exploiting the rumbles in their own data.

Lessons learned and strategies developed and applied while conducting this project are portable to other companies and industries, including the WSIB and the Ministry of Labour, who may recast their policies in support of the prevention improvement process outlined in this project. This project report provides an outline of a step by step process for the use of available data to search for patterns within the families of recurring accidents/incidents, to evaluate the related preventive responses and to engage working personnel to assist organizations in their goal of improving prevention.

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RAC #98096
Underground Mobile Trackless Equipment Visibility Investigation

Principal Investigator(s): Alan W. Salmoni (Laurentian University)

Co-Investigator(s): Jim Cluff, Tammy Eger (Mines and Aggregates Safety and Health Association); Yves Lajoie (Laurentian University)

Sponsoring Institution: Laurentian University

Objectives

The purpose of this research was to investigate visibility problems experienced by operators of underground LHD vehicles. More specifically, both assessment of potential design problems with LHD equipment and operator-reported problems with visibility were investigated.

Method

The research involved four separate parts. In Phase 1, lines of sight afforded by LHDs were physically measured and lines-of-sight diagrams were produced for 11 different LHD models. In Phase 2, a questionnaire was developed and distributed to over 100 LHD operators asking their opinions on operation visibility problems. Phase 3 studied the feasibility of using computer simulation to construct lines-of-sight diagrams. In Phase 4, simulation software was designed ("gray shade") to measure contrast sensitivity and an initial experiment was run.

Results

While all underground load-haul-dump (LHD) vehicles have restricted lines of sight resulting in blind spots, larger machines and those with cabs have a greater number of visual impairments. Machine parts most problematic include: cabs, buckets, lights, and light brackets.

Visibility was judged by operators to be "poor" (at best) under all operating conditions. Fog and dust are environmental factors identified as problematic by operators, who also suggested that improvements to safety training could be made.

Using simulation techniques, it will be possible to evaluate design modifications for visibility problems without the need to physically access the machines. The study found that physical contrast (measured by several indices), and human factors (stress and sensitivity), affected perceptual judgements of visibility in low light conditions.

Conclusions

The study found that it would be advantageous to assess lines of sight using simulation techniques, particularly during the design stages of equipment manufacture. It also reinforces the need for safety training—for operators and pedestrians—to address the severe visibility restrictions present when operating LHDs.

Publications

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RAC #00003
Development of a New Tool to Assess Disability in Cumulative Trauma Disorders

Principal Investigator(s): Brenda Brouwer (Queen's University)

Co-Investigator(s): Matt Faris (Queen's University)

Sponsoring Institution: Queen's University

Objectives
Early detection of cumulative trauma disorders (CTDs) is essential to their management but is hampered by a lack of reliable and valid evaluative tools. This study examined whether performance on a manual tracking task was reliable, sensitive, and related to self-reported disability.

Method
Two hundred and thirty seven subjects (100 controls; 137 CTD) between the ages of 18-65 years participated in at least one laboratory test session. Subjects tracked a target cursor moving in a quasi-random trajectory on a computer screen using a hand-held stylus interfaced with a digitizing tablet placed in front of them. Speed was varied between trials. The Disability of the Arm, Shoulder and Hand questionnaire was completed by all subjects; impairment was physician assessed only in those with CTD. Subsamples of 25 subjects from each group were tested on three occasions (tracking only).

Results
Test-retest reliability was excellent under all test conditions (ICC range: 0.88 to 0.96). Tracking ability was superior in control subjects ($p<0.001$) and correctly classified 78% with CTD. Tracking errors accounted for 26.4% of the variance in disability scores and when combined with impairment level 64.4% of the variance was explained.

Conclusions
The psychometric properties of the tracking task and its strong associations with impairment and disability support its utility as an evaluative tool.

Publications

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RAC #00004
Evaluation of Work-Related Symptoms, Asthma, Sensitization, and Exposures Among X-Ray Technologists

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Sponsoring Institution:	University of Toronto

Objectives
The objective of this study was to study occupational asthma in radiation technologists as a result of exposure to processing chemicals. The study explored whether radiological technologists have excess work-related respiratory, and adult onset, asthma compared to physiotherapists.

Method
This study of respiratory and other health problems among MRTs involved two components.

First Component
The first component of this study consisted of a cross-sectional mail questionnaire survey of approximately 2700 MRTs and 3000 physiotherapists in Ontario. Physiotherapists were considered an appropriate control group because they were similar to MRTs in terms of demographics and socioeconomic status, and both were from the health care sector. Moreover, the two previous studies included physiotherapists as the comparison group.

Most analyses for the first component of the study were limited to 1110 MRTs and 1523 physiotherapists who had never smoked in their lives. The response rate was 63% in each group. Because the response rate was identical, there was unlikely to be a bias due to differential response between the groups, which if present, makes the questionnaire findings hard to interpret.

Second Component
The second component of the study involved performing a series of clinical tests in a sample of MRTs and physiotherapists who responded to the questionnaire survey. The tests consisted of breathing tests to determine whether asthma was present, and induced sputum (phlegm) and blood samples to investigate the mechanism of the reported respiratory symptoms. Lastly, air samples were obtained from a sample of MRT workplaces in order to characterize chemical exposures.

A total of 25 non-smoking MRTs and 18 non-smoking physiotherapists who reported on the questionnaire symptoms of possible occupational asthma or physician-diagnosed asthma since starting work in their profession underwent a methacholine challenge, sputum induction, and provided a blood sample.

Air sampling
Air samples were obtained from 20 workplaces of symptomatic MRTs and 10 workplaces of MRTs without symptoms.

Results
The study found that Medical Radiation Technologists or MRTs (also known as radiographers or x-ray technologists) had a higher prevalence of asthma that began since starting work in the profession than the physiotherapists (6.44 versus 3.95 per cent respectively).

This difference was even more striking when the analysis was limited to males. Male MRTs had five times the prevalence of asthma that began since starting work compared to male physiotherapists. It is possible that the increased prevalence of new-onset asthma among male MRTs may be due to the manual tasks to which they were historically more frequently assigned, and which resulted in large chemical exposures. Moreover, male MRTs in the survey were significantly more likely to report conducting tasks such as freeing film jams, servicing of x-ray processors, cleaning up chemical spills, and removing used chemicals.

A questionnaire survey also found that, in the past year, MRTs were twice as likely as physiotherapists to report three or more respiratory symptoms shown to represent asthma, and were also almost four times as likely to report two or more work-related respiratory symptoms.

MRTs may develop occupational asthma and a poorly characterized condition named darkroom disease. When processing x-ray films in darkrooms, MRTs are exposed to several processing chemicals, including known respiratory irritants and sensitizers such as acetic acid, formaldehyde, glutaraldehyde, and sulfur dioxide.

The literature contains numerous case reports of occupational asthma among MRTs and other workers exposed to these chemicals. Two previous questionnaire surveys showed increased respiratory symptoms among MRTs compared to physiotherapists. There are approximately 5,000 MRTs currently working in Ontario and over 10,000 in all of Canada. Therefore, a large number of MRTs may be affected by workplace exposures.

Induced sputum results, which indicate the degree and type of airway inflammation, showed that the MRTs had significantly lower levels of sputum eosinophils compared to physiotherapists. Eosinophils are one of the cellular components responsible for the airway inflammation and wheezing due to allergy; they are usually present in increased proportions in the sputum in normal asthmatics (and in the physiotherapists with asthma in our study).

MRTs also had higher levels of sputum neutrophils compared to physiotherapists. The role of neutrophils in airway inflammation and asthma is not as well established as eosinophils; increased proportions have rarely been seen in the airways of patients with chronic asthma. Therefore, the results of the sputum induction tests showed that MRTs do not have the traditional inflammatory cell profile seen with asthma.

The lower levels of sputum eosinophils and higher levels of sputum neutrophils among MRTs may be related to their workplace exposures. The study also compared sputum samples among MRTs before and after they had been away from their workplace for at least one week. Sputum neutrophils decreased in six out of eight MRTs while they were away from work.

Sputum neutrophils also increased in two MRTs who were exposed to low levels of formaldehyde and glutaraldehyde (but greater than those measured in darkrooms) in a special exposure chamber at the Gage Occupational and Environmental Health Unit. These results, though small in number, provided further evidence for a possible association between sputum neutrophils and irritant workplace exposures.

On the other hand, the results of the blood samples showed that a test for specific antibody to glutaraldehyde, a sensitizing chemical found in x-ray film developer, was found more frequently among MRTs with respiratory symptoms, particularly those with asthma, than among MRTs without symptoms. Antibodies are special proteins produced by the body that indicate sensitization or allergy to foreign materials. This suggested a possible role for an allergic mechanism in the respiratory symptoms a subset of MRTs.

Air samplings showed the concentrations of acetic acid and sulfur dioxide (two irritant but non-sensitizing compounds present during film processing) in the workplaces of the symptomatic MRTs were significantly greater than the concentrations in the workplaces of asymptomatic MRTs. The levels of formaldehyde and glutaraldehyde were low in both categories of workplaces and no greater in the workplaces of symptomatic MRTs.

Additional analyses showed that, as compared with physiotherapists, MRTs were also more likely to report a number of work-related non-respiratory symptoms, were more likely meet a case definition of sick building syndrome, and reported more stress and burnout. However, they did not appear more likely to meet definitions of multiple chemical sensitivity than physiotherapists.

Conclusions
In summary, MRTs reported a greater prevalence of new-onset asthma, respiratory symptoms in the past year, and symptoms previously suggested to be present in "darkroom disease". The lower proportion of eosinophils and greater proportion of neutrophils in the induced sputum of MRTs with new-onset asthma compared to physiotherapists with asthma and the off-work changes in neutrophils among MRTs suggest a work-related association between exposures and respiratory irritation.

The transition from chemical x-ray processors to digital processors that is currently underway in Ontario and across Canada will likely result in lower workplace exposures and may lead to a change in the prevalence of asthma and respiratory symptoms, and provides a future research opportunity to further understand work-related respiratory symptoms among MRTs.

Publications
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Tarlo S.M., Liss G.M., Greene J.M., Purdham J., McCaskell L., Kipen H., Kerr M. (2004), "Work-Attributed Symptoms (Darkroom Disease) among Radiographers." American Journal of Industrial Medicine 45(6):513-521.

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RAC #00007
Acceptance Criteria for and Capabilities of Liners for Mitigating Ground Falls in Mines

Principal Investigator(s): James F. Archibald (Queen's University)

Co-Investigator(s): P.T. Katsabanis (Queen's University)

Sponsoring Institution: Queen's University

Objectives
The need to supply effective area ground support is important when it is realized that one third of all fatal accidents and a large proportion of serious injury incidents that occur in hard rock mines in Ontario result from falls of ground and rockbursts. One way in which injury reduction may occur will be through use of rapidly-deployable spray membrane support media, commonly designated as thin, spray-on linings (TSL's) or polymer coatings. A research effort for the Workplace Safety & Insurance Board (WSIB) has been completed to assess capabilities of innovative, spray-on polymer and like liner materials for providing satisfactory structural support for rock surfaces in underground hard rock mines. Substantial characterization work of polymer liner materials was achieved during Phase 1 laboratory trials, with systematic validation of lining performance occurring through completion of Phase 2 field scale support trials. This submission presents a summary of research which has been conducted for the second phase of this effort.

Method
In Phase 2, large scale blasting trials, to simulate rockburst events, were undertaken to test the effectiveness of spray-on liner and conventional support materials for mitigating dynamic rock ejection hazards created by such events. A total of 17 different support media types were subjected to near-identical blasting influence in a highly homogeneous rock material in order to create rock damage and support responses typical of those which would be experienced during actual, in-situ rockburst events. Direct comparison of rock and support media physical conditions was used to assess liner capacities to restrict rock movement and mitigate potential damage associated with dynamic rock failure. Blast conditions, damage yields and support agent capacities for restraint were observed photographically and by use of seismic monitoring techniques.

Reinforcement performance of the various media was assessed on the basis of support capacity to:

- provide resistance to seismic shock without losing adherence to rock surfaces onto which support material application has been made
- exhibit capabilities for undergoing significant deformation without substantial cracking, tearing or loosening of the applied substrate layer
- restrain broken surface rock fragments in place
- minimize rock displacements away from blast sources, where restraint is shown to be ineffective
- restrict the zone of surface rock damage through provision of surface confinement.

Results
All polymer and like conventional area support products, such as shotcrete and fibrecrete, tested in this Phase II study have demonstrated capabilities for generating highly effective area support potential, especially when viewed in comparison with rockbolt and bolt-and-mesh restraint, which exhibit little capacity for mitigating rockburst damage. The entire range of polymer lining types evaluated has demonstrated an ability to deform substantially, undergo minimal layer damage, and to constrain fragment or loose rock ejection created by energetic rock breakage due to blasting as a method for rockburst simulation. In so doing, these tenaciously adhering, deformable cover materials have also demonstrated an ability to substantially mitigate damage often seen to result when catastrophic unsupported rock failure occurs. Shotcrete support, while demonstrating significant capacity to restrain rock heave and fragment ejection, was noted to suffer generally greater layer damage and potential breakup than any of the spray-on polymer materials. Rockbolts and bolt-and-mesh support media

provided least effective support restraint in terms of reducing fragment ejection, restriction of the extent of the damage zone formed and prevention of damage to support materials.

Conclusions
The study results have validated the premise that new and innovative thin, spray-on lining (TSL) media may provide equivalent or substantially better rock support resistance than do conventional methods in the presence of dynamic rock failure.

Publications
Archibald J.F. (2003), "Effectiveness of Conventional Support Systems and Polymer Spray-On Liners for Reducing Hazards Associated with Rockbursting." Presented at the Mining Health and Safety Conference 2003, Sudbury, Ontario, April 22-24, 2003.

Archibald J.F., Katsabanis P.T. (2003), "Comparative Evaluation of Shotcrete, Fibrecrete and Thin, Spray-On Polymer Liners for Blast Damage Mitigation." Presented at the 105th Annual General Meeting of the Canadian Institute of Mining, Metallurgy and Petroleum, Montreal, Quebec, May 4-7, 2003.

Archibald J.F., Katsabanis P.T. (2004), "Evaluation of Liner Capacity for Blast Damage Mitigation." Journal of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM Bulletin) 97(1079):47-51.

A paper based on this research was presented by Dr. Archibald at the Mining Health and Safety Conference in 2001 and is available on the internet at *http://www.mine.queensu.ca/people/faculty/Archibald/MASHA2001paper.pdf*.

A list of Dr. Archibald's other papers that are very closely related to this research project is available at *http://www.mine.queensu.ca/people/faculty/Archibald/*

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RAC #00008
Mortality, Cancer Incidence, and Workplace Exposures Among Ontario Construction Workers

Principal Investigator(s):	Murray M. Finkelstein (McMaster University)
Co-Investigator(s):	Dave Verma (McMaster University); Dru Sahai (Construction Safety Association of Ontario); Joe DeWit (Asbestos Workers Local 95); Evelyn Stefov (Ontario Ministry of Labour)
Sponsoring Institution:	McMaster University

Objectives
Our objectives were to visit a variety of construction sites in Ontario in order to identify factors that affect occupational exposure of construction workers. This study addressed the types and levels of toxic substances to which Ontario's construction workers are exposed. Research in other jurisdictions has shown that construction workers are exposed to a variety of toxic substances including diesel exhaust, silica, lead, man-made mineral fibers, solvents, and asbestos.

Method
During the study, visits were made to a variety of construction sites in Ontario in order to identify factors that affect occupational exposure of construction workers and to conduct a range-finding exercise for common occupational contaminants by taking personal and area samples during different construction tasks. We hoped to provide industry stakeholders with sufficient information on hazardous exposures and recommended work practice changes.

Results
Our research and findings indicated that Ontario's construction workers are occupationally exposed during specific tasks to chemical substances at levels that are potentially hazardous. The most prolific contaminants are construction dust, including wood dust, concrete dust, diesel exhaust, and welding fumes. Solvents continue to be widely used in construction. Asbestos and lead are relevant mainly from a retrospective point of view (i.e., past exposures) with regards to new construction. Cross-contamination caused by industrial sources of exposures was not studied. Some construction workers may be exposed to contaminants unique to specific environments. It should be realized that our exposure study was limited in scope and as a result, our results should be viewed as preliminary rather than conclusive.

Conclusions
Construction workers are an important occupationally exposed group. Much work still remains to be done, and we are hopeful that our study's results will direct future research initiatives in the industry. More accurate determination of occupational exposure estimates for high exposure tasks and cross contamination by industrial sources of exposure is needed. Future studies in this industry should also address the effectiveness of current training programs in occupational health hazards and personal protective equipment. Other types of exposures not measured during this study, including noise, vibration, ultraviolet radiation, thermal stress, and biological hazards need to be addressed.

Publications
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Verma D.K., Kurtz L.A., Sahai D., Finkelstein M.M. (2003), "Current Chemical Exposures among Ontario Construction Workers." Applied Occupational and Environmental Hygiene 18:1031-1047.

Verma D.K., Sahai D., Kurtz L.A., Finkelstein, M.M. (2004), "Current Manmade Mineral Fibres (MMMF) Exposures Among Ontario Construction Workers." Journal of Occupational and Environmental Hygiene 1:306-318.

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Finkelstein M.M., Verma D.K., (2005), "Mortality among Ontario Members of the International Union of Bricklayers and Allied Craftworkers." American Journal of Industrial Medicine 47:4-9.

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RAC #00009
A Survey of Disability Management Approaches in Ontario Workplaces

Principal Investigator(s):	Renee Williams (McMaster University)
Co-Investigator(s):	Muriel Westmorland (McMaster University); John Lavis, Harry Shannon (McMaster University, Institute for Work & Health); Benjamin Amick (University of Texas)
Sponsoring Institution:	McMaster University

Objectives
The objectives of this study were:
- to identify the disability management (DM) approaches in education, hotel/motel, and health care workplaces in Ontario
- to investigate the relationships between DM practices and work disability
- to examine the psychometric properties of the Employer Organizational Policies and Practices (OPP) Questionnaire—the 52-item Employer OPP asks respondents to rate thee xtent to which their workplace achieves eight DM practices
- to obtain employees' perceptions of workplace DM
- to examine the psychometric properties of the Employee OPP Questionnaire—the Employee OPP is a 22-item version of the Employer OPP and asks respondents to rate the extent to which the items match the participants' experiences with workplace DM.

Method
The study was conducted in two phases: the employer survey phase and the employee phase. In the employer phase, a random sample of 1004 workplaces in education (N=333), hotel/motel (N=335), and health care (N=336) received a mailed Employer OPP. In the employee phase, 7 focus groups and 24 individual interviews with 58 employees with work-relatewd injuries or disability were cobducted to obtain employees' perceptions of workplace DM. Participants completed the Employee OPP at the end of each focus group or interview. Recruitment was carried out with the assistance of the WSIB, who mailed out 450 letters to employees in southern Ontario who had sustained a work-related injury within the past three years asking them to participate. Several union representatives and health care clinics also were approached.

Results
One hundred and fifty-seven educational workplaces (47%), 110 hotel/motel facilities (33%), and 188 health care workplaces (56%) participated. For the employer survey phase, a one-way analysis of variance for each practice showed that there were statistically significant differences between the sectors in ergonomic practices (e.g., jobs are designed to reduce heavy lifting and repetitive movement), disability case management (e.g., follow-up contacts with employees off work are made), return to work (e.g., job accommodations are made to enable return to work), and people-oriented culture (e.g., trust in employer/employee relationships). Multiple regression analyses demonstrated that safety diligence (e.g., working conditions and equipment are well maintained), people-oriented culture, and safety leadership (e.g., improving safety performance) were associated with lower claims. The Employer OPP showed good reliability between items and adequate validity in that the items correlated well with the appropriate DM practice.

Conclusions
The results indicate that the practices of safety diligence, people-oriented culture, and safety leadership are most effective in reducing injury claims. Both the Employer OPP and the Employee OPP Questionnaires seem to be promising instruments that can be used to assess and monitor workplace DM.

Employers, human resources, unions, rehabilitation providers, and policy makers need to place greater emphasis on the role of DM practices in the prevention and treatment of work-related

injuries and disability. Knowledge transfer studies to human resources and DM practitioners are necessary to enhance the implementation of best practices in DM. With improved knowledge of DM practices and collaborative work with workplace parties, human resources and DM practitioners will be better equipped to achieve the goals of workplace DM.

Publications

Williams R.M., Westmorland M.G., Shannon H.S., Rasheed F., Amick III B.C. (2005), "Disability Management Practices in Education, Hotel/Motel, and Health Care Workplaces." American Journal of Industrial Medicine 47(3):217-226.

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RAC #00011
Organizational Change and the Health and Well-Being of Home Care Workers

Principal Investigator(s): Margaret Denton (McMaster University)

Co-Investigator(s): Isik Urla Zeytinoglu, Sharon Davies (McMaster University)

Sponsoring Institution: McMaster University

Objectives
The purpose of this research program is to uncover and provide new information to improve the prevention of work-related injury and illnesses in home care work. This study focuses on home care workers, which include both visiting home care workers (personal support workers, nurses and therapists who work directly in the client/consumer's home) and office home care workers (case managers, coordinators, office staff, supervisors and managers).

Home care has recently been restructured from a non-competitive system of home health care delivery by non-profit and for-profit organizations to a system of 'managed competition' [through requests for proposals (RFP)], where both non-profit and for-profit agencies have to compete for contracts to deliver home health care services. Further, the restructuring of health care has shifted much of the burden of health care to the community sector without a corresponding shift in the level of funding for community health care agencies.

The objective of this research is to study the impact of health care restructuring and other organizational changes on the mental and physical health of home care workers. By mental health we refer to stress and burnout. By physical health we refer to occupational illnesses such as musculoskeletal disorders (MSDs) and injuries. Job satisfaction, absenteeism, job insecurity and propensity to leave are examined as individual and organizational outcomes.

Method
This study covered 11 agencies and 7 union locals. We interviewed 59 key decision-makers, 171 workers in 29 focus groups, and surveyed 1,313 workers (70% response rate). Qualitative data were analyzed for themes and quantitative data analysis consisted of descriptive statistics and associations between variables.

The research design incorporated both qualitative and quantitative data gathering. We began with 59 interviews with agency executive directors, managers and union representatives to develop an understanding of health and safety issues in their agencies. Of interest was the relationship of organizational change associated with health care restructuring in general and long-term care restructuring in particular. This was followed with a series of 29 discussion groups with employees from the participating agencies to gather their input on these issues. Information gathered through the interviews and the discussion groups, a review of current literature and knowledge gained from our earlier study informed the development of a questionnaire that was administered to all 1,949 employees of the home care agencies. In total 1,311 home care workers responded to the survey, representing a close to 70% response rate.

Results
Project results show that home care workers have high levels of stress and burnout. On the positive side, workers in all occupational groups in this sector show high levels of self-esteem and mastery. In terms of physical health problems, a number of diagnosed health problems are common among this workforce, such as back pain, arthritis and rheumatism, migraine headaches, high blood pressure, stomach and intestinal disorders, and cancer. Physical health problems among this workforce are much higher than the comparable group in the Canadian population. Another occupational health problem for this workforce is workplace harassment and violence. Taking into consideration that these workers are primarily employed in elderly or sick clients' homes, it is common for these workers to experience unacceptable racial/ethnic or sexual comments or harassment. Workers have high levels of job insecurity and are afraid of

losing their jobs or workplaces closing because of their agency not getting the contract. Still, the workers are dedicated to their agencies and show low levels of propensity to leave. However, managers and supervisors are having problems managing the increasingly stressed, dissatisfied home care workforce. Many respondents are critical of the restructuring and managed competition process.

The study shows that the restructuring and organizational change in the home care sector have contributed to the deteriorating health of workers. The business-like work environment, lack of resources in home care sector, government's budget cuts, wage inequalities, work intensification, and perceived decline in the quality of care given to clients, are all taking their toll on these workers. Their stress levels are increasing and for some, burnout is a significant problem. The restructuring and organizational change factors are also associated with increased levels of diagnosed and self-reported musculoskeletal disorders (MSDs), job dissatisfaction, absenteeism, fear of job loss, and propensity to leave the workplace. In addition, the poor physical work environment, such as safety hazards in clients' homes, repetitiveness of the job, and poor psychosocial work environment, such as lack of organizational (and supervisory) support, low co-worker support, lack of control over work, and lack of time to provide emotional support to clients, are all factors associated with increased levels of stress, burnout, MSDs, job dissatisfaction, absenteeism, feelings of job insecurity, and propensity to leave their agency.

Conclusions
The results show that occupational health problems experienced by workers in this study are preventable. It is important to acknowledge occupational stress as resulting from incremental changes in the work and external work environment, and the resulting effects on physical health, job dissatisfaction, absenteeism, and propensity to leave the workplace. Sufficient government funding to provide services, avoiding continuous changes in the work environment, and making rational restructuring decisions based on input from all stakeholders can contribute to healthier workplaces and healthy workers.

The results can assist employers, policy makers and workers in preventing work-related diseases and injuries. This research uncovered and provided new information to all stakeholders to improve the prevention of work-related injuries and illnesses. We hope our results can assist the WSIB to improve their policy and process by providing further evidence on how organizational change, restructuring, and management policy dictated by the government can affect workplaces, work practices and workers' health.

As further statistical analysis of the data is conducted and as the research is published, the researchers anticipate that the findings of this study will make significant contributions to policy formation and professional practices in Canada and elsewhere. We also hope that the results of this project can be used to influence policy formation in home care sector at the local, provincial and international levels. Agencies and unions working with the research team are anxious to assess the impact of changes made in their organizations, and of health care restructuring on the health and well-being of their employees. reform comes to the forefront of policy debates in Ontario and Canada.

Publications
Denton M., Zeytinoglu I.U. , Davies, S., Hunter D. (2006), "Where Have all the Homecare Workers Gone." In *Health Services Restructuring in Canada: New Evidence and New Directions*, Charles Beach, Richard Chaykowski, Sam Shortt, France St-Hilaire, and Arthur Sweetman (eds.). Kingston: John Deutsch Institute, Queen's University and Montreal: Institute for Research on Public Policy.

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RAC #00012
Occupational Exposure to Metalworking Fluids: An Assessment of Analytical Methods and Size Selective Air Sampling Techniques

Principal Investigator(s): Dave K. Verma (McMaster University)

Co-Investigator(s): Don Shaw, Lorraine Shaw (McMaster University)

Sponsoring Institution: McMaster University

Objectives
The objectives of this study were:
- Assess and validate analytical methods for Metalworking Fluids (MWFs) which are being used in North America and in the U.K.
- Assess various methods of sampling airborne MWFs, including size selective sampling techniques
- Collect prevailing airborne occupational MWFs exposure data in Ontario workplaces for comparison with an appropriate occupational exposure standard
- Compare and contrast Ontario exposure data to those reported elsewhere.

Method
The analytical methods routinely used in North America (NIOSH 0500 and ASTM method PS 42-97) and the Health and Safety Executive (HSE) UK MDHS 95 method were evaluated in the laboratory. Laboratory validation included evaluation of sample recovery, determination of detection limits and determination of sample stability during storage.

For the assessment of size selective air sampling methods and prevailing occupational exposure to MWFs in Ontario, large, medium and small-sized companies using MWFs were canvassed for participation in the study. Two large and two medium to small-sized companies and their Joint Occupational Health and Safety Committees (JOHSC) agreed to participate in the study. The majority of MWFs being used at these plants were semi-synthetic and synthetic MWFs with a small amount of straight mineral oil and soluble oil MWFs.

Several hundred personal and area air samples were collected using total aerosol, thoracic and inhalable samplers. A Dust-Trak (TSI Inc., MN, USA) direct reading device was used to collect real-time aerosol concentrations. A Respicon Sampler (TSI Inc., MN, USA) which simulta-neously collects respirable, thoracic and inhalable fractions of airborne MWFs was also used.

Results
- Sample analysis using HSE method MDHS 95 proved to be very problematic. No accredited laboratory in North America could be found who routinely performed this analysis. Two laboratories who agreed to try the method failed to meet the required quality control on the blind samples
- Results of MWF sample recovery by NIOSH and ASTM Methods showed good recovery. The detection limit determined was also acceptable. The sample storage study showed that the MWFs lost the most amount of weight in the first few days. MWFs samples should be analyzed as soon as possible, they should not be stored at room temperature. If samples are stored in the freezer, they should be analyzed within a week and if stored in a refrigerator, analysis should be done within two days
- The result of field sampling showed the exposure to range between 0.04 to 3.84 mg/m3 for total and thoracic aerosols
- Airborne exposure measured in Ontario plants were similar to those reported in North America.

Conclusions

- Both the NIOSH 0500 and ASTM PS 42-97methods can be used for analysis and to evaluate exposure in both oil and water-based MWFs. The HSE method MDHS 95 would require extensive validation work
- Size selective sampling using thoracic samplers is most appropriate for assessing both oil and water-based MWFs
- Airborne exposure to MWFs in Ontario is expected to exceed the NIOSH recommended exposure limit of 0.4 mg/m3 as thoracic aerosol approximately 38% of the time which is similar to what has been observed in the USA
- It appears that full worker protection would require, in addition to controlling their airborne MWFs exposure, institution of programs for fluid management and dermal exposure prevention.

Publications

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RAC #00013
Organizational Factors, Management Commitment, and Workplace Safety

Principal Investigator(s):	Harry S. Shannon (McMaster University)
Co-Investigator(s):	Lynne Lohfeld (McMaster University); John Gilbert (University of Toronto)
Sponsoring Institution:	McMaster University

Objectives
In 1990, we conducted a survey of manufacturing and retail organizations in Ontario to ask them about their policies, practices, attitudes (PPAs), including many aspects of how they deal with occupational health and safety (OH&S). We found that a number of PPAs (management commitment to OH&S, safety training, etc.) were related to lower lost-time injury rates (LTI). Since that time, injury rates in Ontario (based on claims to the WSIB) have dropped considerably. We wanted to understand if this drop might be explained by improved PPAs. As well, since management commitment is seen as crucial, we wanted to learn what senior managers view as the barriers to, and incentives for, improved OH&S.

The project therefore had three specific objectives:
- to see if possible changes in PPAs in workplaces might help to account for the drop in WSIB rates in Ontario over the last decade;
- to examine what we have defined as 'low,' 'medium,' and 'high' injury-rate workplaces to see if relationships between PPAs and current injury rates are consistent with previous research; and,
- to identify barriers to, and incentives for, increased management commitment to creating safer and healthier workplaces.

Method
This study was a follow-up to a 1990 mail survey study of approximately 1000 workplaces in Ontario. New questionnaires, mailed to companies that had participated in 1990 and to those never surveyed before, were completed by management personnel and the worker co-chair of the Joint Health and Safety Committee (JHSC). We had responses from 42% of the workplaces. In addition, a small number of interviews were conducted with senior managers from companies that provided survey data in order to learn more about management's role in promoting workplace health and safety.

Results

Comparison Over Time (1990-2001)
- In the manufacturing workplaces we re-surveyed in 2001, we looked at several variables that were known to be related to lower lost-time injury rates, and found that companies had changed in many ways:
  - an increase in safety training
  - an increase in the executive functions of the JHSC (e.g., approving new technology, rather than simply recommending it)
  - greater labour involvement in the JHSC (e.g., providing solutions)
  - greater accountability and direct involvement of upper management in health and safety (e.g., by attending meetings, conducting inspections, defining health and safety responsibilities in managers' job descriptions).

  These 'best practices' may well have played an important role in the decline in Ontario's lost-time injury rates over the last 10 years. Particularly relevant are the actions and attitudes of the most senior manager, which presumably affect a company's safety culture and help to reduce accidents.
- Some other variables previously linked to *higher* lost-time injury rates were also more prevalent in 2001:

- more work stoppages for OH&S issues
- greater perception of risk from hazards (e.g., ergonomic, housekeeping)
- a rise in workers' lobbying management for OH&S improvements.

These unexpected changes are probably caused by managements' and workers' greater awareness today of the importance of occupational OH&S issues and the need to address them. We do not think they reflect worse OH&S. Regardless, employees who speak openly and deal with potential problems may be more common in unionized workplaces than non-unionized ones, since we found that only in union sites were workers more likely to push management for OH&S improvements.

- We looked at the changes (mainly decreases) in lost-time injury rates across workplaces in our study. We wanted to see if they were related to the PPAs we measured in 1990. However, we were largely unable to predict injury rate changes based on our PPA data. We interpret this to mean that if a company makes efforts to improve their approaches to OH&S, benefits can be seen quickly; likewise, if a company stops paying attention, a good OH&S record can deteriorate rapidly.

Cross-Sectional Data (2000)

- We looked at whether the most recent injury rates were related to the latest (2001) survey of PPAs. Various factors showing management's care for its employees were related to lower injury rates, just as previous research has found:
  - low injury workplaces were more likely than high injury sites to encourage long-term career commitments from management and skilled workers
  - low injury workplaces were more likely to provide disability plans and modified work programs
  - at least in retail worksites, low injury sites had a lower turnover rate.

- Exactly how low turnover is related to safety is not clear. Employees who stay longer with a company have more experience and/or may get better OH&S training, which directly affects their behaviour; or, companies that treat workers well and retain them may be better able to maintain safer workplaces. The reverse is also possible: if workplaces are safe, workers stay.
- Claim rates were lower at less hazardous workplaces, as were perceptions of risk of lost-time accidents and environmental hazards (e.g., chemical, temperature). Also, lower injury workplaces were more likely to use computer-controlled machinery, which may be important in keeping workers out of 'harm's way' while computers control production. However, automation itself does not reduce accidents, as high injury workplaces also used automated machines and were *more* likely to have introduced new technologies in the last three years. These data caution us that workplaces intending to invest resources into machine upgrading should first evaluate the potential impact on injury rates and ensure appropriate training.
- Low injury workplaces were more likely to give worker safety awards, and were more likely to conduct OH&S measurements (e.g., employee perception surveys, lost-time statistics). Their managements more often recognized health and safety issues on the spot, implying that they go beyond formal and objective measures in determining policy. The importance of management's genuine concern for improved safety is shown by the finding that low injury sites were more likely to view OH&S as being at least as important as other aspects of the company (e.g., competitive-ness, profits). Managements also regarded worker attitude as essential.
- Greater involvement of the JHSC was related to lower injury rates. JHSCs at firms with lower injury rates more often had executive functions, rather than simply making suggestions, and were responsible for worker training.

In-Depth Interviews

- Most managers we interviewed were representatives of their JHSC in addition to receiving committee reports and authorizing health and safety expenditures.
- Managers readily described the main types of accidents that occurred in their workplace, their causes, and how to prevent them. They also said that prevention should focus on

better training and supervision of new workers and ways to change long-term workers' complacent attitudes.

- We asked managers to rank, from most to least important, 10 cards describing ways to motivate a company to promote OH&S. In general, corporate and personal values/ attitudes were the most important, whereas adverse publicity and public recognition for a poor health and safety record were least important. Some managers expressed a desire for a more positive, proactive approach in promoting OH&S, pointing to the large number of 'negative' motivators that are currently set in place (e.g., inspections by the Ministry of Labour, penalties/prosecutions for OH&S violations).
- Cost did not appear to be a major barrier to improving occupational health and safety, although many managers reported that they had limited financial resources to invest in health and safety relative to productivity and profitability.
- There was considerable difference of opinion about the utility of bonus schemes to encourage a good OH&S record. Managers in favour of bonus schemes referred to successes from other firms; those against this system pointed out the potential for workers to underreport injuries or to undergo scrutiny/hostility for reporting injuries.

Conclusions

The study's conclusions are:

- The study allowed the researchers to learn more about the various organizational factors (e.g., rise in worker safety training, greater executive functions from the health and safety committee, more involvement of upper management in OH&S issues) that the researchers think helped spur the reduction in lost-time injury rates over the past decade. We should point out that these factors may not apply to all organizations, like other sectors of the economy, recently-opened businesses, and/or smaller workplaces with no safety committee.
- The results of the study confirmed the importance of organization-level factors in dealing with health and safety. The attention given to OH&S increased during the 1990s. This helps to explain the substantial drop in injury rates in Ontario during that time. However, there are still differences between companies, even in the same type of business, and there remains a good deal of room for further improvement.
- The managers we interviewed strongly stated their desire 'do the right thing.' That is, they were keen to ensure the health and safety of their workers because it is required both morally and legally. Most managers emphasized moral and personal reasons for paying attention to health and safety. Many also reported that the corporate values of the organization emphasized the need to look after workers' health and safety. In addition, managers felt it very important that they were obeying the law, although some noted that it could be difficult to keep up with changes in relevant laws and regulations. The possibility of adverse publicity for poor safety performance or winning awards for good performance were seen as irrelevant by many of those interviewed. This seems to be the case for smaller companies, that do not have a high public profile.
- The analysis of current PPA revealed several significant associations, many of which were consistent with previous research. Our main findings indicate that both worker involvement and demonstrated concern for OH&S on the part of management and workers are characteristics of lower injury workplaces. The researchers suggest that the attitudes of management and the way those attitudes translate into actions are what contribute to safer workplaces.

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RAC #00015
Prevalence of Return to Work Programs in the Manufacturing Sector

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Sponsoring Institution: University of Toronto

Objectives
This research study is designed to describe the component parts of return to work (RTW) programmes within the Manufacturing Sector of Ontario workplaces. The main objectives of this study were to conduct focus groups and a survey of employers and workers, registered with the Workplace Safety and Insurance Board (WSIB) within the Manufacturing Sector, to describe the component parts of RTW programmes.

Method
This study used a combined qualitative and quantitative research approach. The qualitative research was in the form of focus groups, which informed the development of the quantitative component, the survey. The 8 focus groups involved representation from both the employer and worker populations to ensure all perspectives of return to work were explored. A total of 4000 surveys were distributed to 2000 employer sites targeting employers and workers through the Human Resource Managers.

Results and Conclusions
The respondents within this study were randomly selected and focused on the Manufacturing Sector, as identified by the Workplace Safety and Insurance Board of Ontario, for the purpose of restricting the study population. Both employers and workers opinions are represented in the data.

From this work it is apparent that 50% of the survey population have a RTW program in place, however, all programs seem to vary in their content and the individuals responsible for overseeing the program. It is the perception of both managers and workers that the RTW programs fall under the management of the Human Resources Department.

There is agreement amongst the managers and workers that both parties need to and for the most part are involved in the RTW process with a collaborative approach being the most effective means of attaining success. A key component of the success of modified work is ensuring that the identified work is meaningful to both the organization and the worker. When modified work is perceived to be a "make work project" the success of the RTW programs are in jeopardy.

Issues that appear to be in conflict within this study population include the perceived availability of RTW, the support shown to the injured worker by the supervisor, ongoing evaluation of the RTW programs and the ongoing communication identified as essential in the success of such programs.

The role of the WSIB in the RTW process was in question throughout the study, with specific issues being directed at the difficulty in communicating with the organization as a whole and specifically with the Claims Adjudicator and the Nurse Case Manager. It appears there is a need for clarification with respect to the role the WSIB plays in RTW.

There was concern expressed with respect to how the WSIB uses the health care information provided by the health care team, who was interpreting the information and how it was being used to make decisions. An ongoing theme in both the focus group and the survey was also

the timely access and availability to health care workers deemed appropriate by the WSIB to initiate a claim.

Overall there seems to be ongoing consistent concerns with the availability and integration of modified work and the successful implementation of RTW programs. The definition of RTW seems to be employer dependent.

Recommendations for Future Work

The study has identified some key areas that require further inquiry, specifically:

- a clear working definition of the RTW process
- the prevalence of RTW programmes within the workplaces of Ontario
- the availability and type of modified work currently available within the workplaces of Ontario
- the progression of modified work within the workplace
- RTW issues as experienced by the health care professionals when dealing with employers, workers and the WSIB.

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RAC #00017
Connecting for Change

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Sponsoring Institution:	Lakehead University

Objectives
This research project examined the use of peer support by injured workers in Northwestern Ontario. Developed by a team made up of injured workers and university-based researchers, the study looks at the extent to which injured workers help other injured workers during recovery, rehabilitation and return to work.

Method
The research team organized 12 focus group interviews in seven different communities. Between March and June 2001, a total of 54 injured workers participated in these interviews. The goal here was to interview enough injured workers in Northwestern Ontario to ensure that different experiences would be captured. The interviews included injured workers who had worked at all types of jobs, everything from labourers, truck drivers, clerks and machine operators to office managers, nurses and teachers. One focus group interview was restricted to aboriginal injured workers, and another was restricted to youth. Injured workers were asked to talk about who they turned to for help or support during their recovery, rehabilitation and return to work experiences. Participants were encouraged to elaborate on how their injuries had affected their lives, they were encouraged to speculate about what might have helped them cope better, and they were asked about contact with other injured workers.

Results
Results from this study show that injured workers face a lot of problems, including difficulties in getting their injuries recognized, difficulties with getting compensation, and difficulties with returning to work. Nearly all face financial hardships and trouble in their personal lives. Most injured workers try to get help from physicians, other rehabilitation professionals, employers, supervisors, co-workers, unions, the Office of the Worker Advisor, other professional service providers, advocates for people with disabilities, family members and/or friends, but they report varying degrees of success with finding help or support. They also turn to other injured workers, believing that their peers were the only ones able to understand what they were going through.

The data plainly show that, of all the various people that injured workers turn to for support, other injured workers consistently give the most useful help. Thus, those injured workers who are already acquainted with other injured workers generally find that it is in their casual conversations with each other that they learn the most useful information, get the most helpful advice, and find the most empathy.

The research also identified barriers to peer support, including socio-psychological barriers and practical barriers that are exacerbated by the demographic and geographic realities of the Northwestern Ontario region. That is, the region is sparsely populated, so that injured workers often live great distances from others and may not easily be able to meet face-to-face. Even when they have access to transportation, however, travel is frequently made difficult or impossible due to poor road conditions and even road closures. These realities represent barriers that injured workers in more populated areas of the province do not face on an ongoing basis. Practically speaking, it is not always possible for injured workers to get together.

A strong message to come out of the focus group data is that there is a need for information and education about peer support. In every focus group, participants talked about their hunger for information and feelings of uncertainty due to their lack of knowledge about what was possible. Several participants, who had never before talked to strangers about their situation, commented on the useful information that they were learning from each other during focus group discussions. Others, who regularly talked to friends who were also injured workers, commented on the invaluable support these informal conversations could provide. Still others, who attended peer support meetings either occasionally or regularly, commented on how much they were able to learn at these meetings, and how psychologically helpful it was to be able to talk to others in similar situations.

Conclusions

Based on the data collected in this research, the research team recommends that:

- the WSIB, employers, and unions explore options for enhancing access to peer support for injured workers
- steps be taken to ensure that funding for existing injured workers groups is maintained, and funding be made available for the creation of injured workers support groups in places where they do not currently exist
- funding be made available for a toll-free support line
- WSIB, employers, unions, and rehabilitation professionals co-operate to promote awareness of peer support, including awareness of what it is and how it can help
- information about peer support be made available in places where injured workers are likely to see it (including WSIB offices, union offices, medical and rehabilitation centres)
- funding be made available for training injured workers to offer peer support
- additional research be conducted to increase understanding of the ways the injured workers can and do help one another.

Publications

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RAC #00018
Improving Work Organization to Reduce Injury and Illness: Social Services, Stress, Violence, and Workload

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Sponsoring Institution:	McMaster University

Objectives
The objective of this study was to undertake an exploration of work organization in a subsection of the social services sector—the developmental services sector—to better understand the connections between work organization, work demands, control of work, and workplace supports.

Method
Three intensive case studies were undertaken in three very different agencies, employing a total of 219 full-time, 260 part-time and 30 casual front-line staff, and providing service to over 1150 clients. The case studies involved in-depth interviews with workers and management, on-site observations and a close review of agency documents and records pertaining to health and safety.

Results
Developmental workers face high levels of stress and violence in their jobs as well as health risks associated with heavy workloads and low control of work pace and processes. The data indicate that workload has increased in all three agencies. Managers and workers agreed that decreased funding has led to changes that have harmful health effects on everyone in the workplace—managers, workers, and clients. Changes in staffing patterns such as the increased use of part-time, split shift and casual workers rather than full-time seems to disrupt vulnerable clients and create the conditions under which violence is a likely occurrence. In addition to injuries associated with violent outbursts, workers reported stress related symptoms such as headaches, fatigue, stomach disruptions, insomnia, depression, high blood pressure and various body pains.

Consistent with studies in Europe, workplace bullying of staff by management and by other staff emerged as a central issue in one of the study sites. European studies show that bullying work environments produce more work-related stress than all other work-related stressors put together. Bullying or traumatic workplaces are costly and debilitating place to work or to provide services. Organizations can expect to lose considerable work time and compensation, management time and legal costs, as well as an increasing number of civil suits as workers experience serious health concerns such as post-traumatic stress disorder, major depression, chronic fatigue syndrome, and suicidal feelings.

Conclusions
The restructuring of services in this sector appears to have increased workloads and the health risks associated with over work and burn out. It has also exposed workers and clients to higher levels of stress and violence.

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RAC #00021
Reproductive Health Among Nickel Refinery Workers

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Sponsoring Institution:	McMaster University and the University of Tromsø, Tromsø, Norway

Objectives
To investigate whether occupational exposure to nickel compounds is causally linked to pregnancy loss, pregnancy complications, birth defects and reduced birth rate and size.

Method
The study was conducted among workers in the nickel refinery complex located at Monchegorsk in the Murmansk region of Russia. A comprehensive exposure assessment using cutting-edge personal monitors involving 350 workers was employed to construct a job exposure matrix for current and past female nickel-refinery workers. Nickel and cobalt concentrations in urine and in the water-soluble subfraction of the inhalable aerosol fraction were used for this. A birth registry was set up for Monchegorsk, including all births (24,534) from March 1973 to December 2001, inclusive. A worker questionnaire database was also constructed using personal and lifestyle information obtained in a questionnaire administered to 717 female nickel workers and 980 controls. A pilot semen quality study of 111 male workers was also completed.

Results and Conclusions
The comprehensive exposure assessments illustrated the benefit of using cutting-edge personal monitors that measure major aerosol fractions and subfractions. Categorical nickel and cobalt exposure levels of *background, low,* and *high* were assigned to all delivering women in the registry (40% of whom were employees of the nickel company). An examination of perinatal mortality and pregnancy risk factors among the delivering women illustrated the epidemiological value and power of the birth registry. There was no association between genital malformations and maternal exposure: odd ratio of 0.81 (95% CI: 0.52-1.26). Women working in jobs with solvent exposure had a non-significant two-fold risk ($p>0.05$), but actual solvent levels were not measured. Using the data in the birth registry and in the linked worker questionnaire, the following can now be investigated with minimal effort: other malformations, spontaneous abortion, pregnancy complications, and fetal development. This work is ongoing. And finally, the pilot semen quality study suggested that occupational exposure may reduce selected aspects of sperm quality, but this needs follow-up because of small study sample size.

Details
At the Fifth International Conference on Nickel Biochemistry, Toxicology and Ecologic Issues held in Sudbury, Ontario, in 1992, one of the researchers of our international team presented a paper expressing concerns about reproductive health issues among Russian female nickel-refinery workers. The raw data presented was based on female workers employed in the nickel electrorefining division of the metal-refinery complex at Monchegorsk in the Kola Peninsula of western Russia (the Murmansk region). A follow-up study of these workers and those involved in preparing the starting electrodes of impure nickel (called anodes) was conducted in 1995-1997. It concluded that a detailed epidemiologic (statistical) study was warranted because the personal exposure assessments conducted indicated high levels of nickel. Further, such a study was deemed feasible because of the availability of a favourable pool of subjects and

suitable health and occupational records. With this background, a comprehensive exposure assessment and pregnancy outcome study was launched on January 1, 2001. It was jointly funded by the Nickel Producers Environmental Research Association (NiPERA), Durham NC, USA and the Ontario Workplace Safety and Insurance Board (WSIB).

The Reproductive Health Study had three main components. First, a detailed exposure assessment using state-of-the art personal monitors and biological monitoring was carried out in the nickel- and copper-related refining operations. Based on this, the exposure ratings *background, low,* and *high* were assigned to all past and current female workers for use in the reproductive-health studies. The cutting-edge equipment employed allowed the measurement of: aerosol fractions of different size, the chemical makeup of aerosol particles, and the amount of the workplace dust which is water-soluble and thus readily taken up by the body. Our results demonstrate the benefits of measuring such aspects of worker exposure. Particle size determines where in the respiratory system aerosols deposit, and their chemical make-up helps us to understand the internal dose received and how they exert their toxic effects. Our work has shown that the personal samplers constructed with new technologies can be used routinely in the workplace, and this should be encouraged.

The second and third components of the research dealt with reproductive health of female workers and the developmental health of their babies before and just after birth. In support of these related studies, a comprehensive birth registry was set up in which extensive information is recorded for all births registered in the city of Monchegorsk during the period March 1, 1973 to December 31, 2001. In 1995, Monchegorsk had a population of 66,200. Its main employer has been the metal-refining complex, with nickel and copper as its main products. The birth registry consists of 24,534 live or still-born births, with 200 pieces of recorded information about the mother and baby. Over 40% of the delivering women were employed in some capacity by the metal-refining factory. A number of studies using the birth registry have focused on more general health issues surrounding the mothers and the babies to illustrate the quality and type of the data in the birth registry, as well as its potential use in further research. Specifically, perinatal mortality (i.e. dead at birth or death during the first 7 days) for all deliveries has been explored, as well as pregnancy risk factors for all delivering women. The first study of a series has been completed in which pregnancy outcomes and the development of babies before and just after birth are investigated in relation to occupational exposure. It is concluded that exposure to water-soluble nickel has no effect on the risk of genital malformations. However, some risk was apparent for jobs involving solvent use. This apparent effect needs further investigation as actual solvent exposures were not measured. Other neonatal outcomes among female nickel workers to be pursued using the birth registry are malformations of the skeleton and muscles, and the occurrence of newborns small for gestational age. Spontaneous abortions and pregnancy complications will also be studied in relation to working in the nickel refinery. For this, the birth registry data has been supplemented by a database of personal information obtained in a questionnaire administered to 717 current female nickel-refinery workers and 990 control subjects. The worker questionnaire is compatible with and electronically linked to the birth registry.

Further, a pilot study of semen quality was conducted among male nickel-refinery workers and suggests that exposure to nickel compounds may impair selected aspects of sperm quality. Exposure was estimated by urinary nickel concentrations. This is a tentative conclusion because too few workers were tested. Additional research is therefore recommended.

The exposure assessment component of the research described has helped to strengthen occupational hygiene practices in Russia. This discipline is not well established there. Similarly, the birth registry is the first in Russia, and has illustrated the usefulness of this tool for monitoring and standardizing medical practices in relation to pregnancy care and identifying trends in related health outcomes. The Russian Federation Ministry of Health has set out occupational health legislation to usher in personal monitoring in the workplace and has accepted, in principal, the benefits of establishing birth registries elsewhere in Russia in support of the health care system. In fact, a birth registry for medical and research use is being set up with the help of the research team for the entire Kola Peninsula. It involves all the hospitals with delivery departments, and with a central office in Murmansk.

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RAC #00022
Respiratory Disease Related to Metalworking Fluid Exposure

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Sponsoring Institution: Occupational Health Clinics for Ontario Workers

Objectives
The main purpose was to examine the association between asthma, chronic bronchitis and rhinitis and measured metalworking fluid (MWF) related exposure factors.

Method
The questionnaire was mailed to current workers. The dependent variables were asthma (Venables), chronic bronchitis and rhinitis symptoms, and methacholine challenge positive asthma. The categorical variables were gender; dust, mould or animal allergy or hayfever; cleanup tasks and MWF exposure. The continuous variables were age; seniority; calculated average and peak MWF levels and smoking. Multivariable logistic regression was used.

Results
Asthma, chronic bronchitis, and rhinitis were reported by 29%, 32%, and 39% of subjects, respectively. Eleven of the 123 methacholine challenge testing subjects were positive. Allergic status was related to asthma, chronic bronchitis and rhinitis. Smoking was associated with asthma and chronic bronchitis. Asthma, chronic bronchitis and rhinitis were associated with cleanup tasks and MWF exposure. The exploratory regression for methacholine challenge positive asthma indicated a strong association with spraying MWF. The departmental average MWF concentration was predictive of asthma and of chronic bronchitis, with an increase in the odds ratios of 1.3 and 1.6, respectively, per 0.1 mg/m^3.

Conclusions
Exposure indicators and departmental average MWF concentrations were associated with the dependent variables. Interventions as a result of this investigation included increased worker training and replacing the semi-synthetic MWF.

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RAC #00023
Dupuytren's Contracture and Occupation

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Sponsoring Institution:	McMaster University

Objectives
The main objective of this study was to examine the association between Dupuytren's Contracture (DC) and manual work, controlling for vibration exposure and potential confounding factors. As secondary objectives, the study examined the association between DC and single hand injury, and evaluated the influence of potential non-occupational risk factors.

Method
Cases with DC, and controls without DC, were selected, and information was gathered and analyzed from both groups about their handwork exposures and other factors pertinent to the study objectives.

Results
Questionnaire and interview data were gathered from 129 cases, 74 clinical controls, and 106 community controls. Logistic regression was used to evaluate handwork and nonoccupational factors. ORs related to family history and male gender were 14.1 and 4.5, respectively. Age was associated with an increase in risk of almost 3% per year. Independent of other factors, the equivalent of a year's exposure to repetitive handwork was associated with an increase in risk of about 2% per year. The results suggested that the risk becomes prominent after about 30 years of steady repetitive handwork. Independent effects of heavy handwork, vibrating tool use, and hand injury were not identified.

Conclusions
This study supports prior research indicating that repetitive handwork increases DC risk.

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RAC #00030
Prevention of WMSD in the Ontario Clothing Industry: A Focus on Small Business

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Sponsoring Institution:	University of Waterloo

Objectives
The purpose of this research project was to implement and evaluate ergonomics programs aimed at the prevention of work-related musculoskeletal disorders (WMSDs) in the Ontario clothing industry and, in particular, to compare the effectiveness of ergonomic programs that involved a partcipative as opposed to consultative approach to making ergonomic changes.

Method
Three companies were recruited. A participatory model in one plant involved management, workers, union representatives and researchers who worked as an ergonomics change team. The second plant was provided with external typical consulting advice. The third "delayed intervention" plant was used as a referent. Questionnaires were administered at baseline and at follow-up. Operations were assessed with a risk factor checklist and videotape. Interviews were conducted at the active and passive plants at the end of the study.

Results
A consistent pattern emerged among those workers who experienced ergonomic improvements compared to their coworkers who did not. They reported decreases in pain, tiredness in body parts, especially the upper extremity, effort to do their job, psychological demands and increased productivity.

Conclusions
In the two intervention companies, awareness and knowledge surrounding WMSDs was increased. Based upon results from the health questionnaires and interviews, the ergonomic interventions were effective. The participative approach was the more effective.

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RAC #00031
Exposure to Whole-Body Vibration in Mining, Transportation, and Construction

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Co-Investigator(s): Joel Andersen (Occupational Health Clinics for Ontario Workers); Tammy Eger (Mining and Aggregates Safety and Health Association); Ted Gardiner (Battle Mountrain Canada); Yves Lajoie, André Plamondon, Lloyd Reed (Laurentian University); Nancy Lightfoot (Northeastern Ontario Cancer Research Centre); Kamlesh Prajapati (Boart Longyear)

Sponsoring Institution: University of Western Ontario

Overview
While there has been a huge amount of research concerning the amount and the effects of vibration transmitted through the hands of an equipment operator, this is not the case for vibration transmitted through the body of a seated vehicle operator (e.g. a truck driver is exposed to vibration transmitted through the seat). This latter vibration is called whole-body vibration (WBV) and has been linked to such health risks as low back pain and spinal degeneration. There is a recognized need for further research in this area. The current research project studied exposure to whole-body vibration in the mining, transportation, and construction industries.

1. Operator Exposure to Whole-Body Vibration in Mining

Objectives
Compared to transportation, very little research has been conducted on whole-body vibration in mining. Because of the lack of scientific information a descriptive approach was used where many types of equipment were evaluated. This information would then be used to propose further research on selected pieces of equipment, identified as particularly problematic.

Method
Eleven different types of mining equipment including: scissor trucks, jumbo drills, LHD vehicles, underground haulage trucks, crushing plants, 150 ton trucks, surface graders, dozers, muck machines, locomotives, and cavo loaders were tested for whole-body vibration exposure. All were evaluated at two Ontario mining sites during typical operation. Operation of most equipment exposed workers to whole-body vibration via the buttock-seat interface, except for crushing plants, cavo loaders, and muck machines. These latter pieces of equipment caused us to question the ISO standards for whole-body vibration, as standing appears to be a different exposure mechanism than sitting, yet the safety guidelines do not differentiate. Vibration exposure was assessed using a triaxial accelerometer (seat pad) following the 1997 ISO 2361-1 guidelines. In the case of the standing measurements the operator stood on the pad rather than sitting on it. Vibration was assessed using 120 samples randomly selected during operation. These samples were eventually averaged together before comparing the data to the safety guidelines (ISO and ACGIH).

Results
- The dominant axis for vibration transmission was normally the z axis (vertical). Crusher plants, dozers, and scissor lifts were the exceptions (x or y axis)
- LHD vehicles, dozers, and graders were found to exceed 4-hour exposure guidelines
- Muck machines and cavo loaders (both tested with the operator standing) exceeded the 1-hour exposure guidelines
- For locomotives and jumbo drills, operators were tested in seated and standing positions because both postures are used during operation. For both pieces of equipment exposure was higher while standing. Importantly, however, neither piece of equipment or posture exceeded 8-hour limits

- For locomotives and jumbo drills, the equipment was tested while operators were standing on the platform with and without anti-fatigue matting. The vibration was somewhat attenuated by the matting (4-10 per cent).

Conclusions

- It is important to note that for all pieces of equipment tested very small samples were used. The degree to which these conditions are representative is unknown. In addition, we could find no studies with which to compare our results for most of these pieces of equipment (most of this equipment is specialized to the hard-rock mining industry). Further research is clearly warranted before firm conclusions and recommendations can be made (the recommendations made below are tentative in nature)
- The findings reported above for dozers and graders do not appear to represent significant health hazards since miners typically operate these pieces of equipment for short periods of time per day (<4 hours per day)
- In contrast, LHDs are typically used by the same operator during extended periods of time and appear to represent a significant health hazard. These results agree with a past study by Village et al. (1989). Therefore a more comprehensive study of LHDs seems warranted
- More research is clearly needed for equipment on which operators stand. In the submitted article on standing exposure we question the logic of using whole-body vibration guide-lines, which have been developed for seated operators. The vibration transmission characteristics of a standing posture are almost certainly different than that of a sitting posture. In addition to knowing little about the physics of the differences between whole-body vibration exposure when standing versus sitting, nothing is known about the potential differences in health risks to the operator
- While the amount of vibration exposure was highest for cavo loaders and muck machines (compared to the other mining equipment tested), very few miners in Ontario operate this specialized equipment and their daily use is normally limited in duration
- While our results support the use of anti-vibration mats, a large-scale study testing different mats under different work conditions seems warranted.

2. Operator Exposure to Whole-Body-Vibration in Long-Haul Trucks

Objectives

- To determine the WBV characteristics of trucks used for long-haul transportation purposes, by describing exposure to WBV using factors described by the industry and the research literature as contributory to different levels of vibration
- To determine the WBV characteristics frequently experienced in hard rock mining and in construction, by describing exposure to WBV in workplaces and under operating conditions identified by the industry as significant
- To share the results with mining, construction, and transportation stakeholders so that exposure to WBV can be eliminated or reduced, by presenting at conferences/workshops and to companies and workers, and by publishing the results and recommendations in academic journals and safety association publications.

Method

A total of 68 trucks (all from one trucking company) were tested as they travelled on one of four major Provincial highways (Hwy 144, 17W, 17E, 69S). Trips began in Sudbury and ended in Timmins, Sault Ste. Marie, Ottawa, and Toronto. Whole-body vibration exposure was measured following 1997 ISO 2631-1 standards. Using a triaxial accelerometer, vibration was measured in the x axis (forward direction of truck), y axis (sideways direction of truck), and z axis (vertical). Vibration data was collected continuously for five-minute segments randomly selected during every 30 minutes of travel time. The variables studied to investigate whether they were predictive of the quantity of vibration exposure included:

- operator experience (<2 years, >2 years)
- road conditions (rough, smooth)
- truck age/mileage (<150,000 km, >150,000 km)
- seat type (National, Bostrum)
- truck type (conventional, super truck).

Variables such as truck maintenance, driving speed, and amount of load were controlled.

After analyzing the data according to 1997 ISO 2361-1 guidelines, analyses were computed to see which variables could account for vibration differences. In addition, overall vector summed RMS values were compared to ISO 2631 guidelines and peak frequency-weighted RMS accelerations and frequency spectra were compared to the American Conference of Governmental and Industrial Hygienists (ACGIH, 2000) threshold limit values.

Results

- As a general finding, most trucks were quite safe (i.e., vibration exposure to the operator fell within the acceptable range of the 1997 ISO guidelines. Transport operators who were typically exposed to ten hours of driving did not exceed the limits suggested. However, the overall summed RMS acceleration does place them within both the health and comfort caution zone
- The major contributor to vibration exposure differences was road condition, with rough road conditions producing higher levels of vibration than smooth conditions
- The dominant axis through which vibration acted was the z axis. Neither rough nor smooth conditions exceeded the 8- or 16-hour exposure limits suggested by the ACGIH TLV guidelines
- A second difference, although small, was truck type. Super trucks exposed operators to higher levels of vibration than conventional trucks
- Seat type, driver experience, and truck age did not produce differences in vibration exposure.

Conclusions

- Even though truck age did not produce differences in vibration exposure, this result must be qualified within the context of the present study. All trucks tested were less than three years old, as the participating transport company replaces its trucks on a regular basis. Trucks older than those tested may produce greater vibration exposure
- Winter/spring driving conditions were not tested. In Northern Ontario at least, road conditions deteriorate significantly during these months. Further study of these conditions is warranted before conclusions can be drawn about (Northern Ontario) yearly exposure limits
- Government is currently debating on whether to allow truckers to spend more time per week driving. As it relates to exposure to vibration and the types of trucks tested in this study, it would appear that this would not represent a significantly increased health risk
- Road condition was the major predictor of amount of vibration exposure and this leads to two implications. First, it is important for highways to be maintained properly if exposure levels are to be minimized. For long-haul trucks the rough stretches of highway produced a significant amount of vibration and jolting. However, because these sporadic conditions were averaged over a lengthy trip, they had a minimal effect on total exposure. Second, even though short-haul trucks were not tested, it would be predicted that short-haul operators could easily be exposed to severe amounts of whole-body vibration if the route they travelled repeatedly was on a poorly maintained road. Our results also indicated these potentially dangerous roads could be effectively identified by the operators themselves
- The drivers in the present study were very capable of identifying rough road conditions. It would be very easy to compile road condition data using drivers as the source for information. A number of uses could be made of this type of data that would be valuable for good operator health and safe driving.

3. Operator Exposure to WBV in Construction

Objectives

Compared to transportation, very little research has been conducted on whole-body vibration in construction, even though there are many types of equipment for which vibration is a potential health risk. Because of the lack of scientific information a descriptive approach was used where many types of equipment were evaluated across several construction sites in the Greater Toronto Area.

Method
Whole-body vibration exposure of construction equipment including bulldozers, excavators, scrapers, graders, skid-steer vehicles, backhoes, compactors, tracked loaders, concrete trowel vehicles, zoom booms, mobile cranes, rubber tire loaders, off road dump trucks, and forklifts was measured. A wide variety of construction sites were used including residential, corporate, and public sites. In all, 67 pieces of equipment representing 14 different types were tested. Testing sessions for each piece of equipment consisted of continuous 20-minute samples (insuring that at least one complete work cycle was tested for each type of equipment). Vibration exposure was assessed using a triaxial accelerometer (seat pad) following the 1997 ISO 2361-1 guidelines. Samples from the same types of equipment were eventually averaged together before comparing the data to the safety guidelines (ISO).

Results
- Mobile equipment produced significantly more exposure to whole-body vibration than did stationary equipment; there were no differences between tire and tracked equipment
- When the weighted RMS accelerations were compared to the 1997 ISO 2631-1 standards for health caution zone, 7 of the 14 pieces of equipment exceeded the limits. The seven were tracked and rubber tire loaders, off road dump trucks, scrapers, skid-steer vehicles, backhoes, and bulldozers
- When comparing the vehicles to the ISO standards for comfort caution zone, operators of all the equipment tested, except mobile crane operators, would experience some degree of discomfort. Scraper operators were exposed to very uncomfortable whole-body-vibration levels. The rest of the equipment was rated as uncomfortable.

Conclusions
- It is important to note that for most pieces of equipment tested very small samples were used. The degree to which these conditions are representative is unknown. However, the mean RMS values found in the present research fall within the ranges reported in two other studies in the literature
- Many pieces of equipment exceeded the 8-hour limit values set out in the ISO safety standards. The operators may be uncomfortable during operation and have a greater risk of injury/negative health outcomes. A comprehensive study of these pieces of equipment is clearly warranted
- As was the case for mining, these pieces of equipment are very expensive and have a fairly slow turnover rate. This suggests that one necessary strategy, if decreasing whole-body-vibration exposure is a goal, would be to retrofit the equipment with reasonably-priced elements. Since the vibration is primarily transmitted through the buttock-seat interface, the best solution may be to redesign and then change the seats
- It would seem advisable to limit the total continuous or intermittent exposure times for operators of equipment exceeding the ISO standards (see findings). When questionable, it is relatively easy to test specific equipment on a piece-by-piece basis
- Operators should avoid rough sections whenever possible and travel at speeds appropriate for conditions
- Construction companies should purchase equipment with the best vibration dampening systems and insure that these are maintained properly.

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RAC #01005
Safe Work Limits while Wearing Firefighting Protective Clothing

Principal Investigator(s): Tom M. McLellan (Defence Research and Development Canada — Toronto)

Sponsoring Institution: Defence Research and Development Canada—Toronto

Objectives
Firefighters face a trade-off between personal protection and cardiovascular and thermal strain when performing firefighting activities. As a result, there is a requirement to develop methods for keeping firefighters' cardiovascular and thermal strain below critical levels during work in firefighting protective clothing (FPC). Although the heat-stress of wearing FPC has been described, no one has attempted to define safe work limits for firefighters in different ambient conditions.

Method
This research study was designed in conjunction with the Toronto Fire Service to establish safe work guidelines for Toronto firefighters wearing FPC and SCBA (self-contained breathing apparatus) at ambient temperatures representative ofsummer conditions in Toronto. In addition, active and passive cooling strategies combined with different levels of hydration were examined. In total, 85 medical screenings, and 339 various heat stress trials were performed during the course of the two-year grant. All heat-stress trials were conducted in the climatic facility at DRDC Toronto. In part A, three different ambient temperatures (25°C, 30°C and 35°C, 50% R.H.) were examined over four different work intensities (Heavy, Moderate, Light, and Very Light) in order to define the physiolgoical strain associated with wearing FPC and SCBA. For part B, an additional trial at 35°C was completed during each of the workloads in part A with station pants replaced with shorts. Parts C and D utilized an ambient temperature of 35°C with 50% R.H. and the Light workload defined in part A.

Results
Findings revealed significant differences in tolerance times across the various workrates and ambient temperatures. Furthermore, during recovery heart rate was not an accurate indicator of the extent of heat strain. Mathematical hyperbolic functions relating tolerance time (TT) and metabolic rate diverged at lower metabolic workrates and converged as metabolic workrates increased. These functions illustrated that even under resting conditions at 30°C and 35°C the body would continue to store heat, and thus, implementation of a work and rest schedule while remaining encapsulated would not increase work times (WT). Replacing station pants with shorts significantly reduced heat strain and increased TT during light exercise. There were no significant improvements during moderate or heavy exercise. The incorporation of active cooling during scheduled rest significantly reduced the heat strain associated with any given task. Hydration was found to play a role in reducing both the cardiovascular and thermal strain while wearing FPC and SCBA in the heat. It appears that even partial fluid replacement can have benefitial effects, increasing TT and WT. Ultimately, the implementation of active cooling (forearm submersion) and hydration strategies will help to reduce the occurrence of heat related injury and possibly myocardial infarction in active firefighters.

Publications:
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RAC #01006
Maternal Occupational Exposure to Organic Solvents during Pregnancy and Infant Visual Processing

Principal Investigator(s):	Joanne F. Rovet (University of Toronto)
Co-Investigator(s):	Carol Westall, Gideon Koren, ChristineTill (Hospital for Sick Children)
Sponsoring Institution:	University of Toronto

Objectives
The objectives of the study were:
1. to determine whether offspring of women exposed occupationally to organic solvents during pregnancy are at increased risk of visual functioning deficits
2. to compare intellectual abilities of solvent-exposed and non-exposed infants.

The rationale of the study was:
1. Despite a large body of evidence demonstrating that the visual system in an important target for organic solvent toxicity in adults, little attention has been devoted to the visual functioning of children with prenatal solvent exposure.
2. While reserach on animals and adults describes central nervous system toxicity from organic solvent exposure, studies of children exposed to organic solvents during pregnancy report inconsistent findings on intellectual functioning.

Method
To test for visual abnormalities in infants with prenatal organic solvent exposure, mothers were recruited during pregnancy through the Mothersisk Program, an antenatal counseling service in Toronto. Their infants were tested in the Visual Evoked Potential (VEP) laboratory in the Psychology Department at the Hospital for Sick Children. The sample consisted of 21 infants born to women who were occupationally exposed to solvents during pregnancy and 27 non-exposed age-matched infants recruited in a similar manner. A sweep VEP technique was used to assess contrast sensitivity and grating acuity by presenting sinusoidal gratings that 'swept' across a range of contrasts and spatial frequencies. A transient VEP technique was used to assess respones tro equiluminant chromatic- and luminance-modulated sinusoidal gratings prersented in pattern onset-offset format. Exposure level was estimated from questionnaire data obtained during pregnancy. Testers were mnasked to exposure status.

To test for intellectual deficits, 32 children (11 exposed and 21 non-exposed) were assessed at a mean age of 16.5 months using the Mullen Scales of Early Learning. All mothers had been origfinally recruited for the visual functioning portion of the study (see Objective #1).

Findings
1. Occupational exposure to organic solvents during pregnancy is associated with contrast sensitivity loss and increased risk of red-green color vision abnormalities in offspring.

2. Study results suggest that the intellectual functioning of infants whose mothers had been exposed in the workplace during pregnancy to organic solvents is in the normal range and does not differ overall in intelligence from non-exposed infants. However, exposed females showed a tendency to slightly lower scores on scales of early language skills, and language scores tended to be lower in children whose mothers had higher exposures during pregnancy.

   Due to small sample sizes, however, the data on language skills are preliminary, and larger cohorts are needed to confirm the findings.

Publications

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RAC #01008
Functional and Cellular Alterations to Work-Related Repetitive Tasks: A Feasibility Study

Principal Investigator(s): Howard J. Green (University of Waterloo)

Co-Investigator(s): Don Ranney, Rich Hughson (University of Waterloo)

Sponsoring Institution: University of Waterloo

Objectives
The overall aim of the research is to determine if a biologic pathway exists in the muscle cell to explain work-related musculoskeletal disorders such as myalgia. Given the invasive nature of the procedures necessary to secure tissue samples, financial support was provided to demonstrate that the study was feasible and that injured workers could be recruited in sufficient numbers. In addition, as part of the feasibility support, it was decided to standardize procedures and to examine reproducibilities for the non-invasive diagnosis of muscles affected by repetitive strain injury.

Method
Four different projects were addressed as part of the feasibility research. In one project, both healthy and injured volunteers were recruited and tissue samples extracted from either the trapezius muscles or the extensor carpi radialis brevis (ECRB) muscles.These tissue samples were subjected to extensive analysis to determine if abnormalities existed in the injured workers. In the other three projects, healthy volunteers were recruited and protocols standardized for the non-invasive assessment of ECRB function. One of these projects was aimed at characterizing the mechanical and fatigue properties. A second project measured blood flow via Doppler techniques, while the remaining project used 31P-NMR spectroscopy to assess muscle metabolism.

Results
For this study, a wide range of cellular properties have been measured on injured workers and healthy volunteers. These included measures of excitation-contraction coupling proteins and processes, metabolic pathways potentials and resting energy metabolism. Preliminary findings indicate deficiencies in the sacroplasmic reticulum and calcium cycling. Standardized protocols and between-day reliability estimates have been established for mechanical function, blood flow, and metabolism.

Conclusions
The work demonstrates that the research designed to investigate the cellular basis of work-related myalgia is feasible. Moreover, evidence has been provided as to a possible cause. Further work is now warranted with larger groups focussed on investigating the calcium hypothesis and whether cellular disturbances are accompanied by differences in muscle mechanics, fatigability, blood flow, and metabolism.

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RAC # 01018
Mobile Mining Equipment Operator Visibility Investigation

Principal Investigator(s): Alan W. Salmoni (Laurentian University)

Co-Investigator(s): Tammy Eger, Robert Whissell, Yves Lajoie (Laurentian University); Jim Cluff (Mining and Aggregates Safety and Health Association)

Sponsoring Institution: Laurentian University

Objectives
The objective of this research was to make design recommendations for LHDs and haul trucks used in mining that would lead to improved operator visibility and ultimately to a reduction of visibility-based accidents. The steps necessary to accomplish this general objective included:

- create 3D (AutoCad) design models of frequently used models of LHDs and haul trucks
- from previous information gathered on operator visibility problems and an understanding of the methods reported in the research literature, develop improved strategies for quantifying operator visibility
- using a (virtual) computer environment created by Jack software, test different design modifications and report which changes had the potential to improve operator visibility
- disseminate these results to manufacturers and mining companies.

Method
The goal of this research project was to identify vehicle design modifications in order to improve line of sight from the operator's position. In order to be objective a quantitative, environmentally valid methodology had to be established:

- first, 3D computer animated drawings of the mining vehicles were imported into the JACK computer environment
- second, stationary line of sight was evaluated via a "visibility audit" and lines of sight to important visual locations in the work environment were evaluated using a "target audit"
- finally, results from the visibility audit and target audit were used to identify potential LHD vehicle design modifications, including adding cameras. In addition, the impact of these design changes on the operator (postural load and angles) was assessed.

Results

<u>For LHD Vehicles</u>
Lines of sight from the following six different LHD vehicles were evaluated: TORO 011, TORO 450, Wagner St 8B, Elphinstone 1700 G, EJC 210, MTI LT350.

The design, size and placement of LHD vehicle "components" can adversely affect visibility. Visibility improvements afforded by design modifications can be determined quickly using computer simulation. The following modifications to LHD vehicles have shown promise:

- reorienting cab posts to open up visibility to the left corner
- slimming of lights and light brackets
- rounding light and light bracket design
- rounding the cylinder covering the boom and hoses
- employing cut-out machine structures that block line of sight
- lowering the height of the engine profile
- eliminating bucket teeth
- redesigning the bucket to angle away slightly at the corners
- avoiding the use of oversized buckets
- lowering the profile of the mud guards
- avoiding placing remote boxes in areas that restrict line of sight
- moving vents and cylinders that protrude from top of machine
- increasing operator sitting height in the cab when possible
- seating the operator closer to the front window

- allowing seat rotation
- installing cameras.

For Haul Trucks
Lines of sight from the following three haulage trucks were evaluated: TORO 40D, EJC 417, EJC 430. The following modifications to haulage truck vehicles have shown promise:
- lowering the profile of the front end of the truck (engine area)
- sinking the air intake cylinder and muffler
- sliming canopy posts (add more window openings)
- installing a camera at the center rear below the dump box
- reducing the profile height of the wheel well covers.

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RAC #01019
Managing the Health and Safety Interests of Young Workers in Small Business

Principal Investigator(s):	Huguette Blanco, John Lewko (Laurentian University)
Co-Investigator(s):	Rolland Le Brasseur, Kate Tilleczuk (Laurentian University); Richard Volpe (University of Toronto); Bonnie-Jean Wilson (Ontario Service Safety Alliance)
Sponsoring Institution:	Laurentian University

Objectives

The objective of this research project was to better understand how young workers and supervisors deal with each other in managing risks and advancing safety in their work places, and to assist the Ontario Service Safety Alliance (OSSA) in transferring these findings into their prevention business practices.

Method

The two-phase research project focused on young workers and supervisors from service settings. The Research Phase provided data from case studies and interviews for the Transfer Phase. Case study adhered to a multidimensional model and involved site visits, participant observations, semi-structured interviews and a review of business materials. Based on case materials, a recursive interview process was used to explore the young worker and supervisor perspectives of various work settings, issues and relationships. Cases and interviews were content-analyzed in order to identify commonalities and variations in how young workers and supervisors view work, risk, safety and the supervisory process.

Results

Research Phase Results

Cases were moved through a series of translation exercises yielding discrete outputs in the form of vignettes, scenarios and training cases, all of which became input to the transfer process. Interview content provided the raw data for extraction of themes. The data revealed a number of interesting points around areas such as risk/hazard perception, training and supervisory dynamics. Themes became a main source of results for transformation, first in Research Transfer Meetings followed by action groups.

Transfer Phase Results

The transfer process was approached at two levels: System Actions and Young Worker Focused Actions. Key transfer results include: upgrades, modifications and additions to the OSSA Continuum, enhancements to the award winning Dare to Care, tip sheets for young workers and young supervisors, and the creation of Real Life Stories. Integration of these actions will take place, immediately, intermediately (within one year), or over the long-term.

Conclusions

The research phase of this project generated key findings that indicate some cause for concern on behalf of youth at work is not unfounded. Discussion of the striking parallels between what is emerging about young workers and what is known about mature new workers was undertaken. Data collected suggests young workers often experience splinter training with an emphasis primarily on the specifics of the task. Interviews and cases revealed that young workers associate and take for granted the hazards that are in their workplace. It can be concluded that young workers and young supervisors are not trained to "think" about the need to manage risk and hazards in the workplace. The link between young worker training and increased understanding of safe work practices is tenuous at best and may be tied to the lack of specific training of management and young supervisors in this area.

The transfer phase also produced key learnings and conclusions that could be used in future studies. In order to assist a safety association in using research findings, researchers must

learn the language of the safety association and the prevention process that the association offers to clients. It was found that research results can not be simply cast into a prevention system but must be translated and transformed to align them with organizational business practices. To ensure an accurate and complete capture of knowledge transformation data, researchers must consider ways in which "meaningful data" can be moved into the field. In this project, accurate and complete capture of research results was achieved by moving data into OSSA at two levels: System Actions and Young Worker Focused Actions. Young Worker Focused Actions served as an easy insertion point as it allowed direct application to devices and tools that would affect young workers the most. System Actions will be implemented as a long-term enhancement to OSSA's unique business approach and will serve to broaden their resources to accommodate the needs of young workers and young supervisors. Transfer of research findings into the business practices of a safety association requires a considerable length of time. In the transfer to transformation process it is strategic to identify early leverage/insertion points that would come from Young Worker Focused Actions.

This research project has left numerous opportunities for future work in the area of occupational health and safety as they relate to young workers. There are certain areas that we feel require deeper investigations. An area of particular interest is the examination of training in relationship to the instruction of risk and hazard management. Another area of interest is the relationship between young workers' exposure to risk/hazards and their ability 'recognize' those exposures as risky or hazardous. Some thought should also be given to the study of young workers who find themselves working alone or with minimal supervision.

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RAC #01022
Preventing Young Worker Injuries: Methodological Feasibility Study

Principal Investigator(s): Kathryn L. Woodcock (Ryerson University)

Co-Investigator(s): Maurice Mazerolle, Carolyn Johnson (Ryerson University)

Sponsoring Institution: Ryerson University

Objectives
The objective of this study was to explore the feasibility of developing a data-based model to identify the causal pathways that differentiate injured young workers from never-injured young workers.

Method
Students were hired to administer the surveys in the Ryerson University summer session in 2002. They obtained completed surveys from 183 working students. The sample included 55% under 25 and 45% aged 25 and older, therefore it was possible to make some comparisons of the two age cohorts. As this was a pilot study, the sampling was not designed to ensure that the results would be generalizable beyond the sample, therefore the meaning of the findings should not be overstated, and may reflect only the members of this particular sample.

Results

The sample
Fifty-eight per cent of the sample were female. Most (81%) were studying Business, Information Technology Management or Computer Science courses. Over half worked in workplaces of 20 workers or more and 38% reported 100+ worker workplaces. Over 82% worked in the services sector. The primary reason for working was to pay for tuition, with the second most common reason being to get experience to compete for jobs. Student employment is no longer merely a source of discretionary income and social diversion.

Unsafe work
While 65% of the respondents denied having performed unsafe work, 32% reported that they had done so. Reasons for performing unsafe work included what we called "invincibility beliefs" (being personally lucky, or strong, quick or resistant), lack of hazard knowledge, inadequate knowledge of rights to refuse, and distrust in rights to refuse. Invincibility beliefs were cited by 31 people, while 35 lacked hazard knowledge (did not know it was unsafe, thought it was unsafe but were persuaded it was safe), 21 said that they did not know they could refuse unsafe work, and 32 expressed concerns about repercussions of refusal (either dismissal or ridicule of co-workers). Of these, four reported that they were threatened with dismissal if they refused.

Information sources
The work safety information source most often cited was someone in the workplace. Most respondents worked in non-union workplaces or were unaware of unionization in their workplace (73%); only 20 respondents were clear that they were union members. Most respondents did *not* have access to an active health and safety committee, with 32% indicating no committee existed, and 23% unsure. Counting only those who knew whether there was a safety committee, the prevalence of committees declined with workplace size. Ontario's *OHS Act* only requires committees for workplaces with more than 20 employees, therefore the existence of committees in many of these workplaces may be encouraging. At the same time, however, many large (100+ workers) workplaces either had no committee or the workers were unaware of it. Unionization increased the likelihood of safety committee access. Older workers were more likely to work where committees existed.

Hazard knowledge
The most common training received was WHMIS (hazardous material information) by 37.5% followed by safe lifting (24.3%), and fall prevention (18.2%). Twelve percent had other OHS training while 44% had received no OHS training of any kind. Over half of the respondents had not had training in OHS rights; only 31% reported this training. Students working in smaller workplaces (<20 workers) were much less likely to have safety training. In addition, unionization and OHS committees increase the chance that workers will receive training. Training was more common among older students, i.e., over time there is more chance of receiving training.

Risk perception
Those who had received OHS training were more likely to rate injury and disease "impossible". In contrast, respondents under age 25 did not give lower estimates of likelihood of injury and disease than those 25 and over. Those who expressed invincibility beliefs were less likely to rate injury and disease "impossible". The pattern of responses suggests that invincibility beliefs and risk underestimation are alternative phenomena rather than aspects of the same one.

Injury experience
Overall, 31% of the respondents reported having experienced a workplace injury. This figure is inexact because we did not stipulate the severity of "injury", and it is possible that different age groups have different definitions what constitutes "injury". Based on the reported years of experience and just one injury per respondent who indicated an injury, the injury frequency rate for the under-25 respondents was 29.1, compared with 5.0 for the older respondents. We are not prepared to conclude that younger respondents sustained more harm. We believe there are differences in definitions and the survey needs to stipulate the degree of injury.

Associations
Those who reported unsafe work experiences were significantly more likely to also report having been injured. We also saw a higher prevalence of reported work injury among those who had OHS training of any kind compared with those who had not been trained, however the sequence of training and injury could not be determined from the questions we asked. Unsafe work was not more commonly reported by the respondents under age 25. Also contrary to expectations, those citing "invincibility" beliefs were not more likely to report having done unsafe work.

Respondents in unionized workplaces and those with OHS training were more likely to indicate that they had performed unsafe work, but this could be related to improved hazard recognition. Those who would determine whether work was safe or unsafe based on whether others were doing it were more likely to acknowledge performing unsafe work.

Conclusions
Survey respondents said that work is important to students, both as a source of funding for the costs of their education, and in some cases, to support dependents, but also as experience to compete for jobs after university. Most of the pilot sample worked more weekly hours than they spent in class, but this was likely in part an effect of administering the survey in the summer session when the relative proportion of part time students increases.

Almost one-third of the sample had experienced a workplace injury at some point in their career, and half the sample had work experience of 2.5 years or less. Almost one-third acknowledged having performed unsafe work. Unsurprisingly, unsafe work and injury were strongly associated, although some of those who denied unsafe work also reported having injuries. Further research is needed to clarify the reasons for unsafe work and relative involvement of the contributing paths of the causal model.

Unfortunately, comparisons between injury experience of old and young respondents is difficult to interpret due to possibly ambiguous definitions of injury that vary by age. There seems to be a higher rate of injury among the younger students, but replication with a revised survey would be needed. The investigators did not see under-25 respondents reporting

performance of unsafe work, lower perception of injury risk in this group, nor luck or resilience ("invincibility") cited more often by younger students as the reason for unsafe work.

While workplace sources were the predominant source of task and OHS knowledge, almost two-thirds of the respondents had not received OHS training from their current employer. However, across all ages, injury rates were higher among those who had received OHS training. Further study with a revised survey is needed to determine the sequence of training and injury to clarify this relationship. It bears remembering that the approach to OHS training has changed considerably over the past 20 years, and further study of training and injury for different age groups would be interesting, as would an experimental study comparing the different approaches.

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RAC #01023
Reducing Risk of Musculoskeletal Disorders and Promoting Return-To-Work Through the Use of Rebar Tying Machines

Principal Investigator(s):	Tony Almeida (International Association of Bridge Structural & Ornamental Iron Workers, Local 721)
Co-Investigator(s):	Peter Vi, Nadine Marks (Construction Safety Association of Ontario)
Sponsoring Institution:	International Association of Bridge Structural & Ornamental Iron Workers, Local 721

Objectives
The purpose of this study was to determine the potential reduction in the risk of musculo-skeletal injuries to rodworkers when using an automatic rebar tying machine, and to determine the efficacy of the rebar tying machine as a rehabilitation device for the purpose of assisting injured workers in an early return to work program.

Method
The research project was divided into three phases. The first phase of the study was conducted in a controlled laboratory setting to investigate the biomechanical differences between manual tying and using the rebar tying machine. In the second phase of the study, a field experiment was conducted to investigate the long-term health benefits of using the rebar tying machine. The last stage of the study was also conducted in the field setting to test the efficacy of the rebar tying machine as a rehabilitation device to assist injured workers in an early return to work program.

Results
The results from the first two phases consistently showed a reduction in awkward posture of the trunk, wrist, and arms when rodworkers worked with the rebar tying machine. The reduction in awkward wrist/hand motion and static awkward trunk posture can lead to a reduction in the risk of musculoskeletal injuries. The first two phases also revealed the tying machine's ability to tie rebar of various sizes and at the same time increase tying speed when compared with traditional manual methods in some applications. Subjective inputs from experienced rodworkers indicated they preferred to work with the rebar tying machine. The perception of 'deskilling' the rebar trade when using the rebar tying machine was not found to be a factor in preventing the use of the mechanical tool.

In the third phase of the study, the tying machine was evaluated for its potential promotion of early return to work. The results from the four injured rodworkers indicated the tying machine was able to accommodate their injuries, allowing the workers to return to their pre-injury job.

Publications

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RAC #01031
HAVS Impairment and Disability Comparisons Using the DASH Questionnaire

Principal Investigator(s):	Ronald A. House (St. Michael's Hospital)
Co-Investigator(s):	Michael Wills (St. Michael's Hospital); Gary Liss, Sharon Switzer-McIntyre (University of Toronto)
Sponsoring Institution:	University of Toronto

Objectives
This study was carried out to measure upper extremity disability and quality of life in workers with Hand-arm Vibration Syndrome (HAVS) and to determine how the vascular, neurological and musculoskeletal impairments of HAVS affect these outcomes.

Method
A cross sectional design was used. Subjects were recruited from HAVS patients assessed consecutively at the Occupational Health Clinic at St Michael's Hospital over a two year period. All of the participants had detailed clinical assessment and special tests to determine the impairment associated with HAVS. Upper extremity disability was measured on the same day as clinical assessment using the Disability of the Arm, Shoulder and Hand (DASH) questionnaire and overall quality of life was assessed using the Short Form (SF) 12 questionnaire.

Results
A total of 139 HAVS patients were included in the study (98.6% participation rate). This study group had statistically significantly higher mean DASH disability scores and lower SF12 quality of life scores in comparison to population normal values. The musculoskeletal component of HAVS had the largest effect on increased upper extremity disability and diminished quality of life. The next most important component was the neurological followed by the vascular.

Conclusions
HAVS is associated with significant upper extremity disability and reduced quality of life. The musculoskeletal component of HAVS has the largest effect on disability and quality of life. Future research should focus on the nature, cause and prevention of the musculoskeletal component of HAVS.

Publications

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RAC #01041
Benefits and Costs of Ergonomic Change

Principal Investigator(s):	Richard P. Wells
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Sponsoring Institution:	University of Waterloo

Objectives
The objectives of the study were:
- to implement ergonomic interventions in Ontario workplaces using participatory processes
- to develop methods for assessing both the outcomes and the process of ergonomic intervention
- to assess the ergonomic changes made and their effects
- evaluate the process of ergonomic change.

Method
Two companies were recruited in addition to three ongoing intervention sites. "Ergonomics Change Teams" (ECT) were formed. Baseline measures were made in both intervention and comparison plants. The process of ergonomic changes was evaluated using field notes and semi-structured interviews. Measurement of leading and lagging outcomes were repeated nine to eighteen months later upon withdrawal of the university facilitation.

Results
The interviews revealed many positive features of the participatory process noted the many structural obstacles to workplace change present in their organizations. With few exceptions, workers reported that the changes made their jobs better and less risky. Measured exposures were also reduced. Reductions in perceived effort, pain and discomfort were less frequent, perhaps because of the limited intensity of the interventions made and the longer time course required for reversal of symptoms

Conclusions
Using their training and the evidence from workplace evaluations, the Ergonomics Change Teams implemented ergonomic changes in all intervention workplaces. Based upon a formal quantitative and qualitative evaluation, the performance of the intervention process, and the interventions themselves, were identified as being effective by plant management and labour representatives.

Publications
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RAC #01043
Towards Best Practices of Functional Assesment: An Innovative Model for Research Dissemination

Principal Investigator(s):	Susan A. Strong (McMaster University)
Co-Investigator(s):	Maureen Dobbins, Susan Baptiste, Marcos Costa, Edward Gibson (McMaster University); Michael Polyani, Judy Clarke (Institute for Work & Health)
Sponsoring Institution:	McMaster University

Objectives
Objectives were two-fold: first, to promote evidence-based approaches to the delivery of Functional Assessment (FA) services and use of FA findings and secondly, to evaluate an innovative method for research transfer and uptake designed to encourage reflective, research-informed practice.

Method
The methods employed were within the philosophy and principles of Participatory Action Research. This approach is distinguished by a self-help philosophy whereby participants are empowered with the knowledge and skills necessary for critical reflection, analysis, planning and action. Within this paradigm, knowledge is considered a collection of empirical data, experiences and values. Future Search is a large group change method involving a 2.5-day conference, in which diverse stakeholders establish common ground, and create a desired future together through their commitment to action. A modified Future Search Process was used as a new participatory method for research transfer and uptake involving researcher-user interaction, collective learning, and collaborative change. The focus was on practices surrounding performance-based FAs specifically, the delivery of FA services and the use of FA findings to determine an injured worker's ability to function at work. Participants were recruited for two cohorts: one to participate in the innovation, and another as a comparison group.

The project was carried out in three overlapping phases: the orientation of potential participants and development of materials; the mounting of an 87 member Future Search Conference with stakeholder representation from the whole FA system; the follow-up of action plans in seven small Action Groups with two whole group meetings and overall evaluation of the innovation. The Future Search process was enriched by providing research study findings, and augmented by the on-going support from the research team. The modified Future Search process was systematically evaluated using conference evaluation questionnaires, pre-post innovation surveys, in-depth interviews, and a comparison group.

Results
There was a clear desire for positive collaborative change among the individuals involved in this complex community and the system as a whole. Outcomes from the action groups included the development of educational and decision-making tools for use by all network partners. The types of changes that took place reflect an uptake of research findings and participation in reflective evidence-based practice. The overwhelming majority (91%) of participants exposed to the innovation believed that their involvement in the process contributed to positive changes in their FA practices. The innovation participants were two times more likely than their counterparts in the comparison group to report changes to practice. In summary, the evidence from this study suggested that a modified Future Search process was effective at facilitating knowledge transfer and uptake. In addition, there is support for a Future Search model to enable diverse stakeholders to talk and listen to each other, establish common ground, as well as to deal constructively with differing power levels amongst participants, and stimulate collaborative action.

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RAC #02001
Occupational Exposure to Chemical, Biological, and Physical Agents in Ontario Sawmills and Veneer/Plywood Plants

Principal Investigator(s): Dave K. Verma (McMaster University)

Co-Investigator(s): Murray Finkelstein (McMaster University); Cecil Demers, John Murray (Ontario Forestry Safe Workplace Association)

Sponsoring Institution: McMaster University

Objectives
The main objective of this small scale "feasibility study" was to determine whether a full two year study involving extensive sampling of airborne chemical, biological and physical agents in sawmills (2000 WSIB rate group 033) and veneer mills (2002 WSIB rate group 036) is reasonable to provide data for an industry-wide health study (e.g. epidemiological dose-response study) and directions for future initiatives in this industry.

Method
Two primary research methods were used in the study: (1) Questionnaires Survey and (2) Observational (walk-thru) Survey. Separate questionnaires were sent to selected groups including safety managers; small business operators; health and safety representative; and joint health and safety committee representatives to gather information on workplace characteristics, demographics, health and safety practices, and opinions regarding occupational health and safety practices.

Observational (walk-thru) onsite surveys were conducted by two investigators following the questionnaire survey to assess in a preliminary way prevailing occupational health hazards, consult with site-staff about occupational health and safety issues and problems, validate responses to the questionnaire, conduct preliminary measurements of dust, noise and mould and take note of other potential hazardous exposure to other contaminants.

Results
35 firms responded to the questionnaire; another 18 firms declined to complete the survey. One was returned and one reported no longer being in the business. Half of the firms completing the survey reported employing 100 or more workers. The smallest number of workers reported by a responding firm was two. Less than 10% of the firms with 5 or less workers responded to the questionnaire survey.

Approximately 55% softwood and 45% hardwood are processed in the industry. Two or three work shifts are common. On average 19% of the workers employed in the industry are under 25 years of age; 64% of workers are between 25-49 years old, 17% are 50 years and older. With respect to years of service, 17% of the workforce on average had worked for less than 2 years with their current employer, 21% had 2-5 years of service, and 62% had worked for more than 5 years for the same employer.

The responses to the questions regarding existence of occupational heath hazards indicated that most employers and employees were aware of health hazards due to exposure to wood dust, noise and mould. Both employers and employees were aware of hazard control and personal protective devices.

The result of the work-thru surveys at 22 different sites from 17 different companies for wood dust, noise and moulds shows exposure levels to be similar to what is reported in this industry in Canada and elsewhere. Airborne wood dust exposure measured ranged between 0.002mg/m^3 to 2.8 mg/m^3 as total dust. Noise exposure ranged between 55 to 106 dB(A).

Also, during the walk-thru surveys, information obtained from the questionnaire was validated and information about availability of health records of the employees was sought. Availability of health records is required for any health study (epidemiological dose response study).

Conclusions
It appears that the consistent health status (medical) record going back in time to present day is not available at the various companies and therefore an industry wide health study (epidemiological dose-response study) will likely not be possible. Such a study may be possible if limited to a few large companies who may have the required data. Historical occupational exposure data of chemicals (e.g. wood dust) for any epidemiological dose-response study will require reconstruction of past exposure and retrospective exposure assessment.

This "feasibility study" used instantaneous direct reading instruments to get an idea of range of exposures. It would appear that wood dust exposures are likely mostly below the current Ontario occupational exposure limit of 5 mg/m^3 as total dust. This, however, needs to be confirmed by long term sampling. Noise exposure at many locations are above the current and the proposed (effective as of July 2007) occupational exposure limits. Exposure to biological agents (mould and fungi) at some locations is of concern.

A comprehensive industry wide wood dust exposure study involving statistically significant numbers of both personal and area samples of both inhalable and total dusts should be conducted. Such an exposure assessment study is recommended since it would be very useful now and for future assessment of exposures in this important industry. Exposures to noise and biological agents (fungi and bacteria) are also worthy of consideration for assessment.

Publications
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RAC #02006
The Health Consequences of Underemployment and Contingent Work

Principal Investigator(s): Emile Tompa (Institute for Work & Health)

Co-Investigator(s): John Lavis, Cameron Mustard (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
The study's objective was to undertake research on the health consequences of nonstandard and contingent work experiences. There are three key elements: 1) developing a theoretical framework to describe the relationship between precarious employment experiences and health; 2) conducting empirical analyses that examine the extent to which precarious experiences give rise to adverse health outcomes, and 3) raising awareness among relevant stakeholders about the ongoing changes in the labour market and their potential adverse health consequences.

Method
The first step was to undertake a thorough literature review on constructs associated with work-related insecurity and health. The second step was to develop a conceptual framework to describe the key dimension of work experiences that can give rise to work-related precariousness, and in turn adverse health and well-being outcomes. The third step was to undertake quantitative analyses of 1) cross-sectional and longitudinal trends in non-standard work forms and arrangements and proxies of the dimensions of work-related precariousness, and 2) cohort analyses (regression modelling) of the relationship between exposure to nonstandard work and work-related precariousness and health.

Results
One product of our research was a conceptual framework that illustrates the relationship between work-related precariousness and health. Our trends analysis identified considerable increases in nonstandard work as well as work-related precariousness. In our cohort analyses we have found evidence of a relationship between certain aspects of work-related precariousness and health, as well as an indication of social patterning of exposure to work-related precariousness and adverse health outcomes.

Conclusions
There is a need to review legislation, policies and practices related to the labour-market in light of the nature of work. There is a need to further investigate the social patterning of vulnerability and exposure to work-related precariousness.

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RAC #02007
Incidence and Correlates of Lost-Time Claims among Adolescents and Young Adults in Ontario and British Columbia

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Co-Investigator(s):	Mieke Koehoorn (University of British Columbia); Cameron Mustard, Sheilah Hogg-Johnson (Institute for Work & Health)
Sponsoring Institution:	Institute for Work & Health

Objectives
The objective of the research project was to address a research gap for a significant public health concern, work injuries among adolescents and young adults. There is a body of evidence that suggests young workers are at increased risk for work injuries. However, there is preliminary evidence that the risk is not uniform across 15 to 24 year-olds, the typical Canadian definition of young worker. This suggests that the relative contributions of individual and workplace factors to compensated work injuries among young workers should be examined. This study sought to address these issues by conducting secondary data analysis on the Ontario and British Columbia workers' compensation databases, each of which contains over 100,000 lost-time claims by young workers.

Method
In order to obtain some insight into the issue, the study sought to answer the following specific questions, using both Ontario and British Columbia workers' compensation data:
1. Do 15-19 year olds sustain work injuries less often than 20-24 year-olds or adult workers? What is the relative contribution of work factors (*e.g.,* occupation, job tenure) and worker characteristics (*e.g.,* gender) in explaining this relative risk?
2. Do claim rates for young workers vary by geographic area? What community-level factors (*e.g.,* industrial mix, socio-economic status) are associated with area claim rates?
3. What is the pattern of claim rates over the 1990s for young workers? How do these trends compare across provinces and across different age groups? Are changes in workers' compensation policy associated with claim trends?

Results
Although there is much attention paid to acute injuries (*e.g.,* cuts and burns) among young workers, the study found that sprains and strains were the most frequent cause of work injuries leading to lost work days in Ontario. This pattern of injuries suggests that programs designed to prevent or minimize the impact of musculoskeletal disorders should be implemented early in work life, before these conditions become the prominent part of the adult lost-time claim and permanent impairment picture.

The study also found that across all types of injuries some young workers do sustain a permanent impairment, though at lower rates than older adults. This suggests that whether youth are at high-risk for work injury depends on the severity of the injury one is examining.

Another important finding is that *all* workers in the first month on the job are over four times more likely to have a lost-time claim than workers with over one year in their current job. The risk of injury for new workers was particularly marked among males, the goods-producing industries (*e.g.,* manufacturing, construction), and manual jobs.

The risk for new workers of all ages could be due to the lack of training or increased hazard exposure early in a job. Determining the contribution of these two factors would help target future prevention efforts. Nevertheless, this study's findings suggest that safety management systems might consider providing new workers with effective and timely training and supervision, and reduction of hazard exposure, early in a job.

The examination of claim rates in Ontario from 1990-2003 shows a 50.5% decline during that period. Although demographic shifts in age and gender of workers over time has been an explanation for this decline, this study found that the decrease in manual jobs (defined as jobs with heavy physical demands) was the only factor significantly associated with the decline in the claim rates. The role of the physical demands on the job supports the idea that economic and work safety policies that facilitate technological and safety improvements are a useful means of reducing work injuries.

Decsriptive findings showed substantial geographic variation in young worker injury rates, even afterv controlling for several job and demographic variables. Region-level characteristics such as greater residential stability were associated with low work injury rates. The non-uniform distribution of youth work injuries in a jurisdiction can aid prevention resource allocation. The association between regional level indicators and youth work injury raises two possible implications. First, it suggests that work injury prevention strategies can be integrated with other local development measures. Second, it suggests that relevant authorities might examine whether work safety measures are unevenly distributed with respect to their socio-economic environments as well.

Finally, the study developed methods to derive claim rates for Ontario and British Columbia that allow cross-provincial comparisons. Although both provinces saw declines from 1990 to 2001, the declines in Ontario were larger. Young workers showed larger absolute declines in their claim rates than the oldest age group. Being able to compare claim rates between British Columbia and Ontario is useful for prevention planning, intervention evaluation, and policy assessment.

Publications

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RAC #02014
Clinical Indicators for Tendon Injuries

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Co-Investigator(s):	Hans Uhthoff, Martin Lecompte (Ottawa Hospital General Campus); David Backman (National Research Centre)
Sponsoring Institution:	University of Ottawa

Objectives
The objective of this study was to validate the mechanical properties of tendons against clinical indicators and guide return to work after a tendon injury.

Method
In a first series of experiments, the researchers immobilized ten rabbit legs for 4 weeks and ten for 8 weeks. In a second series, the researchers created a partial tendon tear in 20 rabbits' legs. Ten each were harvested after 4 and 8 weeks. In a third series, the researchers harvested 100 human cadaver Achilles tendons and perfected double cryofixation for mechanically testing tendons in isolation. Tendons were also scanned with ultrasound (US) and magnetic resonance imaging (MRI), and calcanei X-rayed for bone mineral density (BMD).

Results
The procedures showed a weakening of tendons after immobility or partial tear. The data showed that neither MRI nor US changes correlated with the mechanical parameters, but that BMD, a relatively common and inexpensive test, did.

Conclusions
The dual cryofixation technique perfected by the research team will advance the study of tendon pathologies, a pre-requisite to the rehabilitation of work-related tendon injuries. In addition, BMD may be the best predictor of the readiness of tendons to resume work after injury. Clinicians can now benefit from evidence on which to investigate and manage the rehabilitation of workers after a tendon injury.

Publications
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RAC #02015
Preventing Chronic Disability: A Subacute Cognitive-Behavioural Disability Management Program for Occupational Injuries of the Lower Back

Principal Investigator(s):	Dean Tripp (Queen's University)
Co-Investigator(s):	Joan Stevenson, Matthew Faris, Wilma Hopman (Queen's University); Anne Symes, Nomusa Mngoma (Providence Continuing Care Centre)
Sponsoring Institution:	Queen's University

Objectives
The goal of this study was to examine the impact of a physiotherapist delivered cognitive/behavioral disability management program (CBDMP) for subacute low back injured workers targeting psychosocial risk factors of chronic pain (i.e., fear of reinjury, catastrophizing, perceptions of disability, depressed mood).

Method
This study used a randomized controlled parallel design with a treatment group and a "time matched" control. The initial sample consisted of 81 subacute low back injured workers (men= 38; women=43; mean age=39, SD=9.5). The randomization schedule placed 44 of these participants in the treatment group and 37 in the control. In the treatment group 21/44 (48%) participants finished the CBDMP providing complete data while 12/37 (33%) did so in the control. Contrasts of baseline data found no significant differences between those who completed the CBDMP and those who did not. Further, differences on these measures by the total number of sessions completed (e.g., 1-5) was not significant and those who had completed by group were no different on all baseline measures. Based on these results, subsequent analyses used completers only.

Results
Regressions showed that baseline pain (beta=.52, p.<.001) and fear avoidance beliefs (beta=.24, p.=.01) best predicted baseline disability and that catastrophizing (beta=.28, p.=.05) and fear avoidance beliefs (beta=.33, p.=.03) best predicted baseline pain report. Comparing across time and treatment group, catastrophizing was reduced with a two-fold change in noted in the treatment group (p.<.001; treatment scores dropping 60%; control 31%). Pain was equally reduced in both groups (p=.001; treatment 60%; control 55%). Disability was equally reduced across group (p.<.001; treatment 53%; control 54%). Fear of reinjury reduction showed a three-fold change in the treatment group (p=.003; treatment 27%; control 10%). Depressed mood dropped (p=.001) with a two-fold change in the treatment group (treatment 56%; control 22%). Fear Avoidance Beliefs were significantly reduced over time (p.<.001) but not differentially across groups (treatment 76%; control 73%). RTW logistic regressions indicate that baseline pain and changes in disability over the course of therapy were significantly associated with return to work following completion of the study treatment phase for both groups.

Conclusions
Differences were noted in risk factor reduction over the course of the physiotherapist delivered 5-week CBDMP. Greatest changes were shown for fear of reinjury, catastrophizing, and depressed mood, suggesting that cognitive behavioral interventions can reduce risk factors during the subacute phase of a low back injury for workers. These findings have practical treatment implications for reducing psychosocial risk factors during rehabilitation suggesting that CBDMP training by physiotherapists may lead to better risk profiles during the subacute phase of low back injury. Further data is required to examine long-term outcomes of a CBDMP intervention.

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RAC #02031
Occupational Exposure to Ultrafine Particles and the Relationship to Early Indicators of Cardiopulmonary Effects

Principal Investigator(s): James T. Purdham (University of Toronto)

Co-Investigator(s): Andrea Sass-Kortsak, Susan Tarlo, Gary Liss, Frances Silverman (University of Toronto)

Sponsoring Institution: University of Toronto

Objectives
The objectives of this project were to determine if there are associations between exposure to particulates in the workplace and biochemical markers of inflammation and coagulation, and if associations are related to particle size, type and/or confounding exposures.

Method
Subjects were recruited from workplaces with exposure to ultrafine particles (UFPs). It was necessary to augment the workplace subjects with welding students and apprentices. A small group of low exposure workers were also included. Evaluations took place on the first day of the work-week, and the work-day on which 30 hours of work was accumulated. Exposure to particulates and confounders was measured on both days. Lung function variables were measured and blood samples taken at the beginning and end of the first day and at the end of the second day. Blood samples were analyzed for selected cytokines and other indicators of inflammation, fibrinogen and endothelins. Standard statistical analysis techniques (analysis of variance (ANOVA) & regression) were used to examine associations between exposure measures and changes in biochemical marker levels, across-shift and across-week.

Results
Exposure of welding students and industrial workers to particulate matter was significantly greater than controls for all particulate fractions. There were no significant associations between any exposure variable and changes in lung-function variables, endothelins, and fibrinogen. Of the ten cytokines, significant associations were found only for IL-4, IL-6, and GM-CSF, although the relationship with IL-6 became non-significant when smoking was taken into account. In industrial workers, increases in IL-4 levels across-shift were significantly associated with exposure to fine and coarse particles, while increases in GM-CSF levels across-week were significantly associated with exposure to UFPs. There was also a decrease in circulating monocytes significantly associated with cross-shift exposure to UFPs for all subjects.

Conclusions
Workers in this study were exposed to significantly higher levels of UFPs than found in office environments or in the ambient environment. The study lends modest support for the hypothesis that exposure to particulate matter results in inflammatory processes, but there are some limitations to the study.

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RAC #02032
Barriers to Diagnosis of Work-Related Asthma

Principal Investigator(s): Susan Tarlo (University of Toronto)

Co-Investigator(s): Gary Liss (University of Toronto)

Sponsoring Institution: University of Toronto

Objectives
Work-related asthma includes both occupational asthma (OA), caused by the workplace environment, and work-aggravated asthma (WAA), which is asthma not caused by work but transiently aggravated by workplace exposures. Delays in the recognition and appropriate management of work-related asthma can increase the need for asthma medication, emergency visits and hospital admissions for asthma. Such delays may result from worker-related factors or factors associated with their workplace as well as potential delays from under-recognition by the attending physician. Several studies have shown that a significant period of time exists between symptom onset and the investigation and diagnosis of OA. Continued exposure and, longer duration of symptoms have been associated with a worse prognosis. This study was designed to identify the various individual and work-related factors associated with time to first physician visit after onset of work symptoms.

Method
One hundred patients with suspected work-related asthma were identified from an Occupational Lung Disease Clinic and 100 claimants to the Ontario Workplace Safety and Insurance Board (WSIB). A questionnaire was administered by one of the investigators to the clinic patients at the time of a clinic visit; this was conducted by telephone interview for the WSIB patients. It included questions to record demographic, work-related factors and time to first physician visit. Chart reviews were also undertaken of those patients who gave their consent for review of clinic files or WSIB files as appropriate; data extracted included medical investigations in order to classify the participants into diagnostic categories.

Results
Among the 200 participants, 80 (40%) had sensitizer-induced OA and eighty seven (44%) WAA. The remaining patients with irritant-induced asthma (4) or unrelated asthma, were excluded from further analyses. In the OA group, risk factors for delay in a diagnostic milestone after developing symptoms included male sex ($p=0.001$), being unmarried (0.05), low education and lack of awareness of the possible association of symptoms with work. Factors associated with other longer diagnostic milestones (time from the onset of symptoms to first physician visit, time to physician recognition of work-relatedness, or time to OA diagnosis) were older age, lack of knowledge of WHMIS programs and lack of knowledge that a workplace agent could cause asthma. For those with WAA the presence of Health and Safety Programs at work significantly reduced the time to diagnostic milestones, as did awareness of OA and of agents at work which could affect asthma. Similar to those with OA, a lower household income and lower education were associated with longer diagnostic milestones.

Conclusions
The associations found in this study suggest the potential for intervention with programs to better educate workers at risk of OA from exposure to workplace sensitizers, and WAA among asthmatics exposed to workplace irritants. It also illustrates the need for better primary care physician education on work-related asthma since only 60% asked about a work-relationship of symptoms. Future research directions could include assessment of programs introduced to improve worker and physician knowledge of work-related asthma to determine whether these will facilitate earlier diagnosis and improved outcome.

Publications

Santos M., Jung H., Peyrovi J., Obadia M., Lou W., Liss G.M., Tarlo S.M. (2005), "Work-Related Asthma: Factors Associated With Time To First Physician Visit." Proceedings of the American Thoracic Society 2:A442.

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RAC #02033
Defining the Role of Electrodiagnostic Testing in the Evaluation of Carpal Tunnel Syndrome

Principal Investigator(s): Brent Graham (University Health Network)

Co-Investigator(s): Peter Ashby (University Health Network)

Sponsoring Institution: University Health Network

Objectives
Electrodiagnostic testing is widely used in the diagnosis of carpal tunnel syndrome (CTS) although the extent to which the diagnosis is made more definitive by this investigation is unknown. The objective of this study was to determine the post-test probability of CTS in comparison to the probability of CTS prior to testing established on a clinical evaluation alone.

Method
A prospective, double-blinded study was conducted in the electrodiagnostic lab of a university teaching hospital. All patients referred for electrodiagnostic testing for any peripheral nerve diagnosis were evaluated using the CTS-7, a validated clinical diagnostic aid that estimates the probability of CTS on the basis of the presence or absence of seven clinical findings from the history and physical examination. The evaluation was carried out by a hand therapist blinded to the reason for referral to the lab. The CTS-7 was used to establish the pre-test probability of CTS. All patients then underwent a standard electrodiagnostic evaluation of the median nerve by a neurologist blind to the result of the CTS-7 evaluation. The sensory nerve conduction velocity (SYNC) was used to classify the result of testing for carpal tunnel syndrome as either positive or negative using two different electrodiagnostic criteria from the literature, one a stringent, the other a lax definition.

Results
A total of 143 patients were recruited into the study. The pre-test probability of CTS, estimated by the CTS-7, ranged from 0.105 to 0.998 (mean 0.81, SD 0.22). Seventy-three percent of the patients had a pre-test probability of at least 0.80. The average change in probability for these patients was -0.02 by the stringent criterion and -0.06 by the lax criterion. In 59% the pre-test probability of CTS was greater than 0.90, and the change in post-test probability was even lower (-0.02 and -0.01). With either electrodiagnostic criterion for CTS, the majority of the large changes in probability occurred in patients in whom the pre-test probability was 0.50 or less. In most of these cases, the probability of CTS was lowered further.

Conclusions
In the majority of cases of CTS diagnosed on the basis of history and physical examination alone electrodiagnostic tests do not change the probability of CTS to an extent that is clinically significant. Where large changes in post-test probability occur, they are generally to further lower an already small probability of the diagnosis. The optimal role of electrodiagnostic testing is in studying cases where the clinical evaluation indicates an intermediate probability of CTS.

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RAC #02034
Ergonomic and Hygiene Interventions to Improve the Health and Safety of Drywall Finishing Workers

Principal Investigator(s):	Greg Smith (International Union of Painters & Allied Trades, D.C. 46)
Co-Investigator(s):	Hugh Laird (Interior Systems Contractors Association of Ontario); Peter Vi, Dru Sahai (Construction Safety Association of Ontario)
Sponsoring Institution:	International Union of Painters & Allied Trades, D.C. 46

Objectives
This study had three objectives:
1) determine the potential reduction in the risk of musculoskeletal injuries to drywall finishing workers when using a pneumatic drywall finishing system
2) determine the potential reduction in dust exposure when using a powered drywall sanding system
3) determine the potential reduction in ergonomic-related hazards when using a drywall sanding machine.

Method

Methods for Objective 1: Reducing physical load and work time using a pneumatic drywall finishing machine
Seven drywall-finishing journeymen and three apprentices participated in this experiment. To evaluate the biomechanic loads, participants performed simulated drywall plastering tasks. All experiments were conducted in a newly constructed home at the Interior Finishing Systems Training Center in Toronto. A 582 ft^2 (54 m^2) master bedroom was used to conduct the experiment. All participants were asked to apply drywall compound onto the flat and corner joints using both the manual method and using the pneumatic finishing machine. While the participants were performing the experimental tasks, videotapes of the participants' working postures were recorded. Muscle activities (EMG) were also collected at the same time. Participants were also asked to fill out a usability questionnaire after each experimental trial.

Methods for Objective 2: Reducing Dust Exposures in Drywall Finishing Using a Shrouded Ventilated Rotary Sander (SVRS)
Eleven subjects—seven journeymen and four apprentices from the International Brotherhood of Painters and Allied Trades, District Council 46—were selected to participate in this research study. This research study was conducted in a newly constructed home at the Interior Finishing Systems Training Center in Toronto, Ontario. Two very similar rooms were selected for comparing dust concentrations generated by traditional pole sanding with those generated by an SVRS, which uses a portable vacuum system attached to a sanding head which removes dust at the source. Subjects were instructed to sand as they would normally on the job. For each subject, two test runs were conducted: 1) for the respirable fraction using the pole sander in one room; 2) for the respirable fraction using the SVRS in the other room. A TSI, model AM510, SidePak™ in conjunction with a Dorr-Oliver cyclone was used to measure respirable dust concentrations for each test run. After the comparison testing involving the eleven subjects was completed, air sampling for respirable dust was conducted while sanding with the SVRS at various speed control settings (one through five). Bulk (dry) and drywall dust samples were taken to determine silica content and particle size distribution.

Methods for Objective 3: Ergonomic evaluation of drywall sanding tasks using a drywall sanding machine
Seven drywall-finishing journeymen and three apprentices participated in this experiment, thanks to the International Union of Painters & Allied trades. To evaluate the biomechanic loads, participants performed simulated drywall sanding tasks. All experiments were

conducted in a newly constructed home at the Interior Finishing Systems Training Center (IFTC) in Toronto, Ontario. Using two separate rooms, participants sanded the joint compound using both the manual method and the SVRS. To investigate drywall sanding tasks for potential reduction in risk of injury, electromyography (EMG) were applied on the skin surface above the following four muscles: (1) left and (2) right upper trapezius, and (3) left and (4) right flexor digitorum superficialis to estimate muscle loads on the shoulders and forearm.

Results

Results for Objective 1: Reducing physical load and work time using a pneumatic drywall finishing machine

- On average, using the traditional method (i.e., using a hawk and trowel), the participants finished with an average total time period of 31.62 minutes to apply joint compound. Using the Apla-Tech pneumatic drywall system, the participants finished with a total time of 11.05 minutes—a decrease of 65% in comparison with the traditional method.
- There were no significant differences observed in the duration and frequency of gaps (an activity gap was defined as a period of at least 0.2 seconds during which muscle activity remains below 0.5% maximum voluntary conraction [MVC]) for the left and right trapezius muscles, and the right flexor muscles when comparing between the two plastering methods. Significantly ($p<0.05$) higher muscular rest and rest frequency were observed, however, for the left forearm flexor muscles when the participants used the Apla-Tech pneumatic finishing tools.
- When comparing between the traditional method and using the Apla-Tech, significant lower static load level was observed for the left forearm flexor muscles when the participants used the Apla-Tech method. Unlike the left forearm flexor muscles, the right forearm flexor muscles were exposed to a significantly higher median load level when the participants used the Apla-Tech pneumatic tools.
- Significantly ($p<0.05$) higher peak load level in the left and right forearm flexor muscles were observed when participants used the pneumatic drywall finishing tools.
- Generally, working with the Apla-Tech pneumatic tool was the preferred work method when comparing to the manual method on several items on the questionnaire.

Results for Objective 2: Reducing Dust Exposures in Drywall Finishing Using a Shrouded Ventilated Rotary Sander (SVRS)

- The data indicate that the SVRS was very effective in capturing most of the respirable airborne dust. When using the SVRS, the eleven subjects reduced their respirable dust exposures by an average 96%, compared to exposures during conventional pole sanding.
- As the speed of the sanding disc increased, personal exposure levels increased, except at the highest setting. Even though exposure levels generally increased with disc speed, the sanding process was still very well controlled.
- Analysis by infrared spectrophotometry for silica in various bulk and dust samples revealed an average concentration of over 5%. For the dust generated during SVRS sanding, particle sizing by optical light microscopy revealed that particles less than 5 ìm (projected area diameter) were about 81% of the inhalable mass, of which 52% was less than 1 ìm in diameter. Almost the same particle size distribution was noted for the dust generated during pole sanding, except that 41% of the particles were less than 1 ìm in diameter.

Results for Objective 3: Ergonomic evaluation of drywall sanding tasks using a drywall sanding machine

- Generally, the SVRS sanding trial requires less muscular activity in the shoulder and forearm muscles.
- Significantly higher muscular rest duration were observed for the right and left trapezius muscles, and the left forearm flexor muscles in the SVRS sanding trial when compared to the manual sanding condition. For the rest frequency variable, only the right trapezius muscle was found to be significantly higher when working with the SVRS.
- Working with the SVRS was found to require significantly less static load levels in the left and right trapezius muscles, and the right forearm flexor when compared to manual pole sanding. The median load level (dynamic work) was also found to involve significantly less

muscle activity in the left and right trapezius muscles, and in the right forearm flexor muscle when working with the SVRS.

Conclusions

Conclusions for Objective 1: Reducing physical load and work time using a pneumatic drywall finishing machine

- Productivity, as measured by the time required to plaster 582 ft^2, was very much dependent on the type of work method used. In this study, the Apla-Tech pneumatic tool was found to be a superior tool for apply joint compound than the traditional hand method using a hawk and trowel. The increase in productivity when using the pneumatic tool is positive because it allows more rest period between work task, which in turn can decrease risks of musculoskeletal disorders.
- Working with the pneumatic drywall finishing system resulted in a significantly higher muscular rest period (average accumulated EMG gap time) for the left forearm flexor muscle. Significant increase in frequency and duration of gap period would indicate the reduction in risk of injury for the left forearm when working with the Apla-Tech pneumatic tool.
- The static load level of the left forearm flexor muscle was found to be significantly lower when working with the pneumatic drywall finishing tool. This study found an average static load level of 2.23% MVC and 0.75% MVC when work with the traditional manual method and pneumatic tool, respectively. The large differences in the static load level may be due to the constant holding of the drywall hawk. The high static load level in the left flexor muscles when using the manual plastering method can put workers at risk of upper limb musculoskeletal disorders.
- The median load level for the right forearm flexor muscles were found to be significantly higher when working with the pneumatic tool. Average median load level for the right forearm flexor muscle while working with the Apla-Tech was 11.2% MVC. The increase in median load level in the right forearm flexor muscles is significant because the EMG load level was well above the recommended level of 10% MVC suggested by Johnson (1982).
- The peak load level in the right and left forearm flexor muscles were found significantly ($p<0.05$) higher when working with the Apla-Tech pneumatic tools. The large differences in peak load level may due to the heavy weight of the Apla-Tech tool (15 lb with full drywall compound). Although there was an increase in peak load level, the risk of injury however, remains low because it is well below the recommend load level of 90% MVC suggested by Johnson (1982).
- Majority of the items on the usability questionnaires were found to be significantly in favor of the Apla-Tech pneumatic drywall finishing tool. Although the majority of the workers prefer to work with the pneumatic tool, some workers felt uneasiness about the speed of the tool and the "deskilling" of the plastering trade when working with the tool, which they believe can lead to a loss of jobs.
- Working with the pneumatic tool can prevent fall related injuries because the use of ladders, scaffolds and benches can be reduced. However, this hypothesis should be further studied to confirm the findings.
- Based on the EMG measures, tool preference, productivity and reduction of risk of traumatic slips and falls, it is concluded that the pneumatic tool is an effective tool for applying compound onto drywall joints.
- Further studies in the field setting to verify the effectiveness of the pneumatic tool should be conducted.

Conclusions for Objective 2: Reducing Dust Exposures in Drywall Finishing Using a Shrouded Ventilated Rotary Sander (SVRS)

Traditional Pole sanding creates high dust levels. This dust can contain silica in significant concentrations as a natural ingredient. Usually drywall joint compound manufacturers recommend that workers wear respirators in dusty areas. Unfortunately, respiratory protection can be ineffective even when worn, if training on how to properly select, care or fit is inadequate. A far more efficient means of control is to utilize a vacuum sanding system such

as the SVRS. The SVRS has many occupational health and safety benefits over pole sanding including the following:

- For sanders and nearby workers the SVRS significantly reduces exposure to drywall dust. Thus workers are much less likely to suffer adverse health effects.
- It greatly reduces the need for respiratory protection.
- Because it controls drywall dust so well, it can significantly reduce cleanup time.
- It is easy to use and not likely to cause musculoskeletal problems.
- It is ideal for situations where creating dust is a problem, for example, renovations where the building is occupied, new construction when other trades are in the area, hospital work where patients must be protected, work around dust-sensitive electronic equipment such as computers.

Conclusions for Objective 3: Ergonomic evaluation of drywall sanding tasks using a drywall sanding machine

- Despite the large difference in total weight between the SVRS (8 lbs) and the pole sanding tool (2 lbs), working with the SVRS generally requires less muscular activity in the upper extremity. The high muscular effort in manual pole sanding may result from the forceful and repetitive movement of the upper extremity in order to create a high friction force between the sandpaper and the wall. In the SVRS sanding condition, however, little muscular effort is required because majority of the sanding force was generated by the sanding machine.
- For manual pole sanding, the loads on the lower arm muscles were found to be at most risk for musculoskeletal injuries. The risk for musculoskeletal injuries at the trapezius muscles was found to be lower than the forearm muscles. The higher risk of injuries in the lower arm when compared to the shoulder area corresponds well with the WSIB lost-time injury (LTI) data.
- The static and median load level for the right and left trapezius muscle, and the right forearm flexor muscles were found to be significantly lower when using the SVRS. The decrease in muscular exertion can reduce the risk of musculoskeletal injuries. The reduction of risk of musculoskeletal injuries was found to be the most significant on the forearm flexor muscles.
- Working with the SVRS resulted in a significantly higher muscular rest period for the left and right trapezius muscles, and for the left forearm flexor muscle. Past studies have found a correlation between muscular rest periods and reporting of shoulder pain. Higher frequency and duration of rest periods when performing physical activities can allow improvement of blood flow, calcium re-absorption into the sarcoplasmatic reticulum, and the reduction of the extra-cellular efflux of potassium. All these factors have been found to be correlated with reduction in pain sensation.
- Based on the biomechanical measures, we conclude that using the SVRS is an effective method for drywall sanding.
- Further studies should be conducted in the field setting to verify the benefits of using the sanding machine to decrease risk of musculoskeletal disorders.

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RAC #02036
Physician Occupational Disease Practice Survey

Principal Investigator(s):	D. Linn Holness (St. Michael's Hospital)
Co-Investigator(s):	Susan Tarlo (St. Michael's Hospital); Gary Liss, Frances Silverman (University of Toronto)
Sponsoring Institution:	St. Michael's Hospital

Objectives
Physicians have a key role in recognition of occupational diseases. For occupational asthma and contact dermatitis (OA, OCD), the longer the duration of symptoms before diagnosis, the poorer the outcome. Our objective was to understand practice patterns, knowledge, barriers and needs for early diagnosis of occupational lung and skin disease for family physicians, respirologists and dermatologists.

Method
Following focus groups and interviews, a survey was developed and sent to all dermatologists, respirologists and a random sample of 400 family physicians in Ontario.

Results
Most physicians see less than 20 patients a year with OA or OCD. The majority report taking a work history and providing advice on exposures. Barriers include time constraints and lack of knowledge. Reasons for referral to specialists include a lack of expertise, testing facilities and knowledge about WSIB, time constraints and inadequate re-imbursement, while lack of access to specialists is a barrier for referral. Most physicians identify a need for further education. Barriers to this include a low volume of patients and time constraints. Important information sources are continuing education events, journals and specialist reports.

Conclusions
Opportunities are identified to improve educational initiatives and health services delivery for occupational disease, with approaches tailored to each particular physician group.

Publications

Tabassum S., Tarlo S., Liss G., Silverman, F., and Holness, D.L. (2005), "Practice Patterns and Educational Assessment of Ontario Respirologists (RPs) for Occupational Lung Disease." Proceedings of the American Thoracic Society 2:A443.

Tabassum S., Wasserstein D., Santos M., Urch B., Liss G., Tarlo S., Silverman F., Holness D.L. (2005), "Assessing Self-Rated Knowledge of Indoor and Outdoor Air Pollution among General Practitioners (GPs) and Respirologists (RPs) in Ontario." Proceedings of the American Thoracic Society 2:A443.

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RAC #02039
The Validation of a Classification System for Work-Related Disorders of the Shoulder and Elbow

Principal Investigator(s):	Dorcas E. Beaton (St. Michael's Hospital)
Co-Investigator(s):	Robin Richards (Sunnybrook and Women's College Health Sciences Centre); Sheilah Hogg-Johnson (Institute for Work & Health)
Sponsoring Institution:	St. Michael's Hospital

Objectives
This project aimed to further develop and study a classification system for work-related musculoskeletal disorders of the shoulder and elbow that has been previously established with patients who consulted in a specialty clinic at St. Michael's Hospital in Toronto.

There were four specific objectives:
1. Compare numbers, costs, and duration of lost time for workers who attended the Shoulder and Elbow Clinic in the calendar year 2001 with all comparable workers in Ontario with a lost-time claim
2. Describe the long-term (2-3 year) outcomes of workers who attended the clinic in the 2001 calendar year to assess the ability of the sub-groups to predict long-term outcomes
3. Assess the robustness of the classification system by repeating the analysis using identical data gathered from the first 200 workers attending the clinic after March 2004, along with the workers who attended in 2001
4. Revise the methods used for routine data collection in the clinic in order to allow the team access to information used to classify workers prior to their assessment.

Method
Objective 1
Billing codes in the WSIB database were used to identify clinic attendees and to extract information on these clinics attendees from the WSIB database. In total, 391 injured workers who attended the Shoulder and Elbow Clinic in 2001 were identified.

Objective 2
Workers were contacted by telephone 2-3 years after their clinic attendance and administered a follow-up survey.

Objective 3
Cluster analysis was used to identify sub-groups of patients that were similar to each other and different from other sub-groups according to pre-defined variables. The variables chosen were self-reported measures of pain intensity, level of disability, and extent of pain. K means cluster analysis was conducted.

Objective 4
'Brown bag' sessions were held with the clinical team to develop a method for reporting results of the surveys to the clinicians in a useful way. Feedback was sought on design, layout, and content. IT specialists were then called in to design easy-to-use interfaces with one-button report printing.

Results
Objective 1
There was a significant difference in the total wage replacement from accident date to March 1, 2004 between the clinic attendees and the non-attendees. The median cost was $29,343 for attendees and $841 for non-attendees. The median cumulative duration on benefits within 365 days from the first day of wage replacement was 305 days for the clinic attendees and 15 days for the non-attendees.

Objective 2
188 injured workers were reached. The average age was 45.3 years, 48% were male, and the average duration of time off work until the date of the clinic visit was 24.3 months. Information collected through the questionnaire provided a range of predictors that could be considered for the predictive models.

Objective 3
The best solution had three sub-groups defined, very similar to the sub-groups expected, confirming the robustness of the classification system.

Objective 4
With high quality equipment capable of managing the heavy flow of people through the clinic and entering in a 28-page questionnaire, the total process now takes 3 minutes. A verifying function set at a very low tolerance error is in place to maximize data quality.

Conclusions
The classification system produced in previous work was verified by reproducing it successfully and reliably in two additional data sets. This seems to indicate that the three patterns of workers persist over time, even given the shifting demographics of the clinics.

The cluster groups had construct validity, in relation to pain, and other indicators of the impact of the condition. The study also provided evidence of the predictive validity of the cluster groups against two of three outcomes: work status at 2-3 years and disability at 2-3 years after visit. Cluster group was not predictive of after-clinic wage replacement benefits.

The study also established a 'just in time' reporting system that the clinicians can use to have access to scored surveys in a user-friendly format. The use of these forms has continued beyond the study and they are still in use on a regular basis.

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RAC #02041
Paternal Exposure to Ionizing Radiation in Ontario Uranium Miners and Risk of Congenital Anomaly in Offspring: A Record-Linkage Case-Control Study

Principal Investigator(s):	Loraine Marrett (Cancer Care Ontario)
Co-Investigator(s):	John McLaughlin (Samuel Lunenfeld Research Institute); Douglas Chambers (SENES Consultants Ltd.)
Sponsoring Institution:	Cancer Care Ontario

Objectives
The objective of the study was to determine if pre-conceptional exposure to ionizing radiation as a uranium miner increases the risk of congenital anomalies in offspring.

Method
A population-based matched case-control study was employed. Cases: Ontario infants with congenital anomalies from the Canadian Congenital Anomalies Surveillance System, 1979-1986. Controls: normal live born infants selected from Ontario Birth Certificates over the same period (case-control file [CCF]).

The CCF was linked to uranium miners in the Mining Master File (MMF) or the National Dose Registry (NDR), 1952-1986, to identify cases and controls whose fathers were miners prior to their conception.

Results
There were 28,992 uranium miners in the combined MMF-NDR file, and 42,446 case-control pairs. Linkage of CCF and MMF-NDR produced 449 links.

Overall, there was no increased risk of having a child with a congenital anomaly if the father was a uranium miner or exposed to radon before the conception. There was no increased risk of having any specific anomaly or any category of anomaly according to ICD-9 categorical or hierarchical etiological groupings. Risk has not yet been examined in relation to dose of gamma radiation exposure, or in relation to radiation exposure during specific windows of time pre-conception.

Conclusions
Preliminary results suggest that the children of Ontario uranium miners do not have increased risk of having congenital anomalies.

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RAC #02051
The Development of a Reliable and Valid Measure of Acute and Chronic Stressors in Policing

Principal Investigator(s):	Donald R. McCreary (Defence Research & Development Canada)
Co-Investigator(s):	Megan M. Thompson (Defence Research & Development Canada)
Sponsoring Institution:	Defence Research & Development Canada

Objectives
The goal of the present research was to develop a reliable and valid measure (or measures) of police stress: the Police Stress Questionnaire (PSQ). This measure should be short in length so as to minimize as much survey burden as possible amongst respondents. It also should contain no terminology specific to the Canadian police culture in the hopes that it will be adopted in other countries. The benefit to this latter goal is that, by using a common instrument, differences in policing-related stress between officers in different countries can be explored.

Method

Phase 1: Item Selection and Assessment of Applicability
The first phase of the research involved eliciting the items for a short, reliable, and valid self-report measure of stressors applicable to the policing environment. This was achieved through a series of focus groups conducted with active-duty members of the Ontario Provincial Police (OPP). Transcripts of the focus groups from Study 1 were reviewed for common themes and these commonalities served as the basis for an initial set of questionnaire items. In Study 2, the initial draft of the questionnaire was then given to a small group of OPP officers for their comments on wording and applicability.

Phase 2: Questionnaire Reliability and Validity
In the second phase of the research, the new measure's psychometric reliability and validity was assessed. In Study 3, the questionnaire was given alongside generic measures of perceived stress, daily hassles (i.e., a measure of generic chronic stressors), and negative life events (i.e., a generic measure of acute stressors). This study assessed discriminant validity. In Study 4, the questionnaire was given alongside measures of people's job satisfaction and emotional responses to their work to assess the concurrent validity of the two Police Stress Questionnaires.

Results
- The results of the focus groups confirmed that police officers appear to make an important distinction between operational stress (i.e., stressors associated with doing the job) and organizational stress (i.e., stressors associated with the organization and organizational culture within which one works). It was with this distinction in mind that we created two separate PSQs: the PSQ-Op and the PSQ-Org.
- Three separate studies demonstrated the reliability of the PSQ-Op and PSQ-Org. This is important because it means that the 20 items in each questionnaire form two coherent wholes, one measuring Operational Stress associated with policing, the other measuring Organizational Stress associated with policing. Without evidence of the two scales' reliability, researchers would not be able to use these scales with confidence.
- Study 2 demonstrated construct validity by showing that the stress ratings of the PSQ items were positively correlated with their frequency (i.e., the more frequently they occur, the more stressful they are perceived).
- Study 3 demonstrated discriminant validity by showing that the PSQ-Op and PSQ-Org were only partially correlated with self-perceptions of general stress, daily hassles, and

negative life events. These moderate correlations suggest that work-related and non-work-related stress co-occurs.
- Study 4 demonstrated concurrent validity. The PSQ-Op and PSQ-Org were correlated with lower levels of job satisfaction and more negative (and fewer positive) emotions about one's job. While the correlations with poor job satisfaction are statistically significant for both the PSQ-Op and PSQ-Org scales, the correlations are stronger for the PSQ-Org, suggesting that this factor is more important to job satisfaction in these police officers.

Conclusions
- The PSQ-Op and PSQ-Org are reliable and valid measures of two conceptually distinct, albeit correlated, aspects of occupational stress in policing (i.e., Operational and Organization stressors).
- Stress associated with policing is relatively independent of general life stressors and needs to be assessed separately.
- Those experiencing higher levels of policing-related stress are less satisfied with all aspects of their jobs (Overall Job Satisfaction, Satisfaction with Pay, Satisfaction with Promotion Opportunities, Satisfaction with Immediate Supervisor, Satisfaction with Fringe Benefits, Satisfaction with Contingent Rewards, Satisfaction with Operating Policies and Procedures, Satisfaction with Co-workers, Satisfaction with the Nature of the Work, and Satisfaction with Communication within the Organization).
- Organizational stress appears to be more strongly associated with lower levels of job satisfaction.
- Those experiencing higher levels of policing-related stress have more negative, and fewer positive, feelings about their jobs.
- Future research needs to explore the association between these job-related stressors and the health and well-being of officers. The rationale for this comes from the well-documented relationship between stress and poor health and well-being. Strategies for reducing police-related stress can then be determined and implemented.

Publications
McCreary D.R., Thompson M.M. (2006), "Development of Two Reliable and Valid Measures of Stressors in Policing: The Operational and Organizational Police Stress Questionnaires." International Journal of Stress Management 13(4):494-518.

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RAC #03003
Driving Pedal Reaction Times Following Traumatic Right Below Knee Amputations

Principal Investigator(s):	Benjamin Meikle (St. John's Rehabilitation Hospital); Michael Devlin (West Park Healthcare Centre)
Co-Investigator(s):	Christos Boulias (West Park Healthcare Centre)
Sponsoring Institution:	WestPark Healthcare Centre

Objectives
Driving represents a major achievement in the rehabilitation of traumatic lower extremity amputees as it allows increased mobility and freedom, and it is often necessary in order to return to work. Although it is generally accepted that persons with right leg amputations can return to driving following an amputation, it is unclear how they should drive. Many experts recommend that all right leg amputees who drive require their car to be modified to have either a left foot accelerator or hand controls. However, a recent survey has shown that the majority of right leg amputees who returned to driving did so without modifying their vehicles, and many of them used their prosthesis on the foot pedals. Unfortunately, research in this field is lacking and there is no available evidence to indicate how a right below knee amputee should drive. It is not known if an amputee can safely operate foot pedals with their prosthesis, and it is not known if they can safely operate manual transmission automobiles (which require the use of both feet on the pedals). This study was designed to be a preliminary investigation of the following 2 questions: Can right below knee amputees safely operate vehicle foot pedals with their prosthesis? What technique of operating the foot pedals is associated with the fastest reaction times?

Method
This study measured the driving brake pedal reaction times of right below knee amputees while using four different techniques of operating the foot pedals, including the following:
1. Right sided accelerator with prosthesis operating accelerator and brake
2. Right sided accelerator with prosthesis operating accelerator and left foot operating brake
3. Right sided accelerator with left foot operating accelerator and brake
4. Left sided accelerator with left foot operating accelerator and brake

A total of 10 right below knee amputees participated in this study. They were tested in a controlled setting using an electronic device that simulated driving position. Individuals depressed the accelerator pedal, and a random visual stimulus signalled them to rapidly release the accelerator and depress the brake fully.

Results
The reaction times were the fastest with the left foot operating a conventional automobile setup (a right sided accelerator). There were slightly slower but still acceptable response times with the prosthetic operation of a right sided accelerator pedal setup, as well as with left footed operation of a left sided accelerator setup. The slowest reaction times were using the two footed technique.

Conclusions
This study would suggest that many right below knee amputees have the potential to safely operate driving pedals with their prosthesis. In addition, this study suggests that right below knee amputees should be instructed not to drive with a two-footed technique, and they may benefit from using a left-foot cross-over technique. Given these findings, many amputees should have the potential to return to driving manual transmission vehicles, which may be vital for a return to work. Further research is recommended in order to develop clear guidelines regarding return to driving following amputation.

Publications

Meikle B., Devlin M., Pauley T. (2006), "Driving Pedal Reaction Times After Right Transtibial Amputations." Archives of Physical and Medical Rehabilitation 87(3):390-394.

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RAC #03007
Physician-Diagnosed Asthma, Respiratory and Cutaneous Symptoms, Immunologic Sensitization, and Exposures among Cleaners

Principal Investigator(s): Susan M. Tarlo, Gary M. Liss (University of Toronto)

Co-Investigator(s): James Purdham, Andrea Sass-Kortsak (University of Toronto); D. Linn Holness (St. Michael Hospital)

Sponsoring Institution: University of Toronto

Objectives
Cleaners have been reported to have increased risk for work-related asthma symptoms (WRAS). This study aimed 1) to compare WRAS among cleaners and other building workers (OBWs) and assess the relationship of these symptoms to the frequency of performance of various cleaning tasks, 2) to clinically characterize a subset of cleaners with respiratory symptoms to assess the likely diagnoses and relationships of respiratory disease to the workplace, 3) to characterize exposures of cleaners.

Method
School and racetrack workers in Ontario, Canada, who were mainly men, completed a questionnaire to determine the prevalence of physician-diagnosed asthma (PDA), new-onset asthma (NOA), respiratory symptoms, and WRAS. A subset of cleaners underwent clinical assessment and assessment of exposures. Workplace exposure was performed among university building cleaners.

Results
Overall, cleaners and OBW had a similar prevalence of these variables, but female cleaners reported significantly more WRAS than female OBWs, suggesting work-exacerbated asthma, which was also supported from clinical evaluations. Men who waxed and wax-stripped floors, spot-cleaned carpets, and cleaned tile and grout more frequently reported more WRAS. The cleaning chemicals included agents previously associated with work-related asthma but measured concentrations were low.

Conclusions
Findings suggest work-exacerbated asthma among those who clean buildings and associations with some specific tasks.

Publications

Lynde C.B., Obadia M., Liss G.M., Ribeiro M., Holness D.L., Tarlo S.M. (2009), "Cutaneous and Respiratory Symptoms among Professional Cleaners." Occupational Medicine 59:249-254.

Obadia M., Liss G.M., Lou W., Purdham J., Tarlo S.M. (2009), "Relationships between Asthma and Work Exposures among Non-Domestic Cleaners in Ontario." American Journal of Industrial Medicine 52:716-723.

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RAC #03010
Ground Fall Mitigation Capability and Enhanced Testing for Rockburst Susceptibility of Rock Liners

Principal Investigator(s): James Archibald (Queen's University)

Co-Investigator(s): P.D. Katsabanis (Queen's University)

Sponsoring Institution: Queen's University

Objectives
Because future mining development in this province is expected to take place at greater depths than presently mined, the incidence of rock falls and rockbursts, and thus worker injuries, is projected to increase. The objective of this study was to build on previous RAC-funded research to assess further the capabilities of conventional forms of mine reinforcement media and new thin, spray-on linings (TSL's) to provide effective structural support for rock excavations in underground mines.

Method
A systematic process of material characterization that had been developed in earlier research was rigorously carried out to permit side-by-side comparison of TSL characteristics for seven new products and eleven TSL products in total. Blasting trials were conducted upon exposed rock in a surface site where damage effects were monitored using high-speed digital and other photographic analytical techniques. Ground vibration conditions (notably particle velocity characteristics of ground motion) were also monitored at each detonation site using multiple sensors to insure that systematic and repeatable test conditions were maintained for all support materials. Each test site occupied a zone of outcrop sized at 4 metres by 5 metres in plan. Measured ground displacement, velocity, and acceleration characteristics resulting from each blast provided information to permit comparison of support effectiveness between sites. Post-blast damage assessment was also conducted through systematic analyses of digital blast images, ground motion data, extent of fracture zone created, and conditions of support media damage. Ground motion and outcrop fracture incidence were uniformly maintained between successive tests by rigorous adherence to fixed explosives loading geometry conditions.

Results
The results obtained from this research effort have validated the assumption that this new and innovative support technique may be equivalent to or substantially better than conventional support methods in providing safe, capable and sustainable support in the event of dynamic rock failure. The entire range of TSL types evaluated has demonstrated an ability to deform substantially and to therefore constrain fragment or loose rock ejection created by energetic and natural rock breakage. By so doing, these tenaciously-adhering, deformable cover materials have also demonstrated an ability to substantially mitigate damage often seen to result when catastrophic unsupported rock failure occurs.

Conclusions
The wide-ranging series of tests completed have verified that spray-on forms of area support, including conventional concrete materials such as shotcrete and fibrecrete linings, innovative TSL's, and combinations of both forms of sprayable support agents (designated as "Superliners") all demonstrate significant and positive support benefit and abilities to resist rockburst-induced damage relative to conventional support media. Significant worker hazards are known to currently exist in Ontario mines where use of conventional support measures is the norm. Implementation of new support technologies may therefore realize reduction of worker hazards in current operating mines and help to prevent escalation of hazards when future deep mining occurs. The relative merits of a variety of forms of spray-on lining support materials (conventional and TSL types) for mitigating rockburst damage have been effectively demonstrated through the course of this research effort. Many of the spray-on products appear to be viable for rock support use, and should therefore be contemplated for systematic underground application trials by industry.

The results of laboratory tests have identified several promising TSL agent materials that may be potentially very effective in mitigating rockburst damage to both the support materials and rock surfaces onto which the materials were placed. TSL support technology appears to be viable for reducing rockburst hazards associated with rock fracturing, fragment ejection and loss of support capacity, as was noted to occur for conventional rock support media. For these benefits alone, the application of TSL support technologies would be very beneficial for reducing worker hazards in underground rockburst-prone environments. Safety benefits have been shown where TSL media have been tested under highly dynamic failure conditions. It would also be anticipated that such support measures would realize significant support restraint in lower stress environments, where worker injury from falls of loose ground are also common.

Publications

Archibald J.F., Dirige A.P., Katsabanis P.T. (2005), "Evaluation of New and Combined Area Support Systems for Rockburst Damage Mitigation." Presentation at the 20th Symposium on Ground Control: The Impact of Ground Control on the Success of Mining Operations, Quebec Mining Association, Val d'Or, Quebec, March 22-24, 2005. CD-ROM publication (21 pages).

Archibald J.F., Dirige A.P., Katsabanis P.T. (2005), "Update on WSIB Research Into Testing of New Spray-On Liner and Composite 'Superliner' Area Supports." Presentation at the Mining Health and Safety Conference 2005, Mines and Aggregates Health and Safety Association of Ontario, Sudbury, Ontario, April 12-14, 2005. CD-ROM publication (23 pages).

Archibald J.F., Dirige A.P. (2005), "Spray-On Lining Innovation for Support in Burst-Prone Mine Environments and Tunnel Coatings in Civil Engineering Use." Presentation at the 40th U. S. Rock Mechanics Symposium, Fairbanks, Alaska, June 2005.

Dirige A.P., Archibald J.F. (2005), "Simulation of Pull-Tests for Thin Spray-on Liners." Presentation at the 40th U. S. Rock Mechanics Symposium, Fairbanks, Alaska, June 2005.

Archibald J.F., Dirige A.P. (2005), "Use of Spray-On Linings for Effective Structural Support in Civil and Mining Applications." Presentation at the K. Y. Lo Symposium, University of Western Ontario, July 2005.

Archibald J.F., Dirige A.P. (2006), "Safety Considerations Associated with Thin., Spray-On Liners Used for Mining and Civil Engineering Applications." Presentation at MASHA Mining Health and Safety Conference, Sudbury, Ontario, April 2006.

Archibald J.F., Dirige A.P. (2006), "Development Status of Thin, Spray-On Liners for Mining and Civil Engineering Applications." Presentation at the Annual General Meeting of the Canadian Institute of Mining, Metallurgy and Petroleum, Vancouver, British Columbia, May 13-17, 2006.

Archibald J.F., Dirige P.A. (2006), "Thin, Spray-On Lining Applications for Rockburst, Blast and Fire Damage Mitigation." Presentation at the 41st Symposium of the United States Rock Mechanics Society (ARMA/USRMS 06-1005), Golden, Colorado, June 17-21, 2006.

Archibald J.F., Dirige P.A. (2006), "Development of Thin, Spray-On Liner and Composite Superliner Area Supports for Damage Mitigation in Blast-and Rockburst-Induced Rock Failure Events." Presentation at the 9th International Conference on Structures Under Shock and Impact (SUSI 2006), Liverpool, UK, July 1-6, 2006.

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RAC #03019
Line-of-Sight Issues with Tele-Remote and Conventional Load Haul Dump Vehicles

Principal Investigator(s): Paul Dunn (Laurentian University)

Co-Investigator(s): Tammy Eger, Sylvain Grenier (Laurentian University)

Sponsoring Institution: Laurentian University

Objectives
This project set out to create the CAD (Computer Aided Design) underground environment and mobile equipment profiles in Laurentian University's state-of-the-art 3D stereo immersive environment, such that line of sight issues could be analysed and transferred to appropriate industry, government and research personnel.

Method
The project demonstrated the value of using virtual reality (VR) with stereo immersion capability in enhancing safety analyses, and as such, models obtained in previous WSIB projects were further developed into fully interactive VR models. A new laser scanning method was compared to the light filament technique for visibility assessment. In addition a computer simulation method was used in evaluating visibility information.

Results
The usefulness of 3D stereo to examine line of sight was demonstrated as well as the benefit of different stakeholders collaborating within an immersive environment. A laser scanning method was developed to examine line of sight and compared to computer based visibility assessment methods. An evaluation of laser scanner and computer simulation methods for collecting line of sight data was made and the results lead to the proposed CLOSE (computer-based line of sight evaluation) method for line of sight assessment. A mine visibility training module was also created to enhance the knowledge transfer of projects results.

Conclusions
This research has developed new methods for collecting visibility information in the field and for evaluating and standardizing the presentation of line of sight information for mobile equipment. The project has also demonstrated the use of stereo immersive VR technology for transferring the research results to advisory committee members and other interested parties. A visibility training module is also being released from the research which will help transfer the research findings to a wider audience. It is hoped that through improved visibility collection and analyses techniques and the improved knowledge transfer of these research findings to the mining and wider community that a reduction in mobile equipment accidents will be achieved.

Publications

Bhattacherya I., Dunn P.G., Eger T. (2006), "Development of a New Operator Visibility Assessment Technique for Mobile Equipment." Journal of the South African Institute of Mining and Metallurgy 106(2):87-92

Eger T., Jeffkins A., Dunn P., Bhattacherya I., Djivre M. (2005), "Benefits of Assessing LHD Vehicle Visibility in a Virtual Environment." CIM Bulletin Volume 98 No. 1089

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RAC #03022
Stress, Trauma, and Recovery in the Workplace: Early Stage Studies

Principal Investigator(s):	Ruth A. Lanius (University of Western Ontario)
Co-Investigator(s):	Peter C. Williamson, Richard W.J. Neufeld (University of Western Ontario); Nicholas J. Coupland, Kathleen M. Hegadoren, Brian H. Rowe (University of Alberta); Ravi Menon (Robarts Research Institute)
Sponsoring Institution:	University of Western Ontario

Objectives
The goal of this study was to investigate the relationship between default mode network connectivity and the severity of Post-traumatic Stress Disorder (PTSD) symptoms in a sample of subjects recently exposed to a traumatic event.

Method
This prospective study included eleven subjects who presented to the Emergency Department after they had been involved in a motor vehicle crash (n=8) or workplace accident (n=3). Subjects were followed from presentation in the Emergency Department for three months. Nine subjects were scanned at six weeks, and two were scanned at twelve weeks post-accident. Participants underwent a 5.5 minute resting functional magnetic resonance imaging (fMRI) scan with their eyes closed. Areas of the brain whose activity positively correlated with that of the posterior cingulate/precuneus were assessed. In order to assess the relationship between severity of PTSD symptoms and posterior cingulate/precuneus connectivity, the contrast image representing areas positively correlated with the seed region was correlated with the subjects' Clinician Administered PTSD Scale (CAPS) scores.

Results
Results show that resting state connectivity of the posterior cingulate cortex/precuneus with the subgenual anterior cingulate cortex and the right amygdala is associated with current PTSD symptoms and that correlation with the right amygdala predicts future PTSD symptoms, as measured by the CAPS, in a sample of subjects who had experienced an acute traumatic event six to twelve weeks prior to the fMRI scan.

Conclusions
These results may contribute to the development of prognostic tools to distinguish between those who will and those who will not develop PTSD subsequent to exposure to a traumatic event.

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RAC #03026
Attitudes and Incident Causal Modeling for Construction

Principal Investigator(s):	Brenda McCabe (University of Toronto)
Co-Investigator(s):	Douglas Hyatt, Catherine Loughlin (University of Toronto); Susan Tighe (University of Waterloo)
Sponsoring Institution:	University of Toronto

Objectives
The objectives of this project were to:
- document attitudes toward safety and safety incidents on construction sites
- collect detailed information about events and conditions leading to injury and non-injury incidents
- develop a probabilistic model of workplace safety.

Method
Data collection was achieved with 911 self-administered questionnaires. Non-parametric statistical analysis methods were used as most variables were not normally distributed.

Results
Ninety percent of the workers surveyed had had at least one incident in the previous three months. Workers with more physical symptoms were younger, had greater mobility, increased work pressure, lower perception of job safety, and less job involvement. Workers with psychological symptoms had more interpersonal conflict. Role overload and psychological symptoms were highest among supervisors. Those who experienced an accident in the previous 3 months felt more work pressure and had less confidence in the safety of their work.

Conclusions
This study suggests that mobility plays a more significant role in safety performance than the nature of the work. The industry may consider establishing common safety and prevention programs amongst contractors. Consistent safety cultures across firms may provide the same benefits as long term employment with one firm. In the union sector, this might be accomplished through stronger partnering between the unions and employers.

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RAC #03046
A Study of the Hands-Free Technique's Effectiveness in Reducing Operating Room Percutaneous Injuries and Contaminations and the Effectiveness of an Educational Video

Principal Investigator(s): Bernadette Stringer (University of Western Ontario)

Co-Investigator(s): Ted Haines, Jennifer Blythe, Ved Tandan (McMaster University); Kenneth Harris, Francine Lortie-Monette (University of Western Ontario); Ramon Berguer (University of California Davis School of Medicine); Charlie Goldsmith (Centre for Evaluation of Medicines)

Sponsoring Institution: University of Western Ontario

Objectives
The objectives of this studt were to develop a training video/DVD based on surgeon and nurse interviews about the hands-free technique (HFT); and to evaluate whether the video/DVD increased HFT use and whether HFT use reduces injury, glove tear, and contamination.

Method
Semi-structured telephone interviews followed by the development of the video/DVD in collaboration with a professional filmmaker, allowed the primary research to begin.

Operating room nurses completed questionnaires at the end of about 500 surgeries/site in 2 control and 4 intervention hospitals during baseline Period 1. Then, intervention nurses attended educationals and viewed the video/DVD during a week and subsequently, both groups completed 500 questionnaires during two periods, 3 to 4 months apart.

Results
Interviews with Canadian and U.S. surgeons (11), and OR nurses (9), successfully informed the development of the 20-minute HFT video/DVD encouraging HFT use. Based on 10,596 surgery questionnaires from control and intervention hospitals, the video/DVD was found to increase HFT use to 75% or more in significant numbers of surgeries immediately and again 3 to 4 months later, and HFT use of 75% or more during surgery, significantly reduced injury, glove tear and contamination by 35%.

Conclusions
When the HFT is used most of the time during surgery, risk is reduced, and the HFT video/DVD can increase short and longer term HFT use.

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RAC #03049
Evaluation of Whole-Body Vibration, Seat Design and Performance, and Sitting Posture in Large Mobile Equipment

Principal Investigator(s):	Alan Salmoni (University of Western Ontario); Tammy Eger (Laurentian University); Paul-Émile Boileau (Institut de recherche en santé et en sécurité du travail du Québec)
Co-Investigator(s):	André Plamondon, Alain Delisle (Institut de recherche en santé et en sécurité du travail du Québec); Joan Stevenson (Queen's University); Christian LaRiviere (PRIVICAP); Peter Vi (Construction Safety Association of Ontario); Sylvain Grenier (Laurentian University/Occupational Health Clinics for Ontario Workers)
Sponsoring Institution:	University of Western Ontario

Objectives
This study was an extension of previous RAC-funded research. In that study, pieces of equipment—including load-haul-dump (LHD) vehicles, haulage trucks and scrapers—were found to expose the operators to whole-body vibration (WBV) levels above the health guidance caution zone defined in the ISO 2631-1 standard. The purpose of this study was to carry out a more comprehensive investigation on the pieces of equipment in mining and construction that appeared to expose the operators to WBV levels above the ISO 2631-1 health guidance caution zone. The study had three broad objectives:

- To investigate comprehensively LHD vehicles, haulage trucks and scrapers identified in the first study as causing unsafe exposure levels (Phase 1).
- One of the primary manifestations resulting from unsafe exposure to WBV is lower back problems. Sitting posture can also cause lower back problems as well as affect the level of exposure to vibration. Thus, the second broad objective of the present research was to assess the sitting postures and comfort of LHD vehicle drivers when operating under typical working conditions (Phase 2).
- The third broad objective was to investigate seat design characteristics that might be employed to minimize exposure to WBV (using Phase 1 data to simulate the vibration exposure for LHD vehicles) during LHD vehicle operation. Since the seat on which the operator sits represents the transmission point between the vibrating equipment and the person, proper seat design has the potential to play a major role in minimizing exposure to WBV (Phase 3).

Method
In Phase 1, 17 LHD vehicles (8 small & 9 large), 6 haulage trucks (3 small & 3 large) and 34 scraper vehicles were evaluated. Vibration signals were collected at both the seat-vehicle (this data was used in phase 3) and the operator-seat interfaces. In Phase 2, sitting postures were assessed during the operation of a sub-sample of LHD vehicles. In Phase 3, the acceleration vibration response of the LHD vehicle category corresponding to the mean and upper bound spectra were determined from the Phase 1 data. These vibration spectral class characteristics were reproduced on a WBV vehicular simulator to study the biomechanical response of subjects submitted to vibration on a currently-used seat and to identify subject response characteristics to the WBV.

Results
In Phase 1 it was found that many of the vehicles exposed operators to potentially harmful levels of vibration, particularly in the vertical axis. This conclusion was consistent no matter if the ISO or European Union safety standards are applied to the data. Clearly action is warranted. Since it is very difficult to change the work structure (i.e., shift length, breaks, etc.), one of the most promising protective strategies is to design seats that can be installed in these vehicles that will minimize the magnitude of the vibration exposures. In Phase 3 seat characteristics were identified, which if used during seat design and seat installation could help

reduce vibration exposure significantly. Cooperation with vehicle and seat manufacturers is necessary for this to be implemented.

In Phase 2 the postures of the LHD operators, many of which were quite awkward, were identified so they could be used in the laboratory testing to be carried out in Phase 3. A major portion of the time spent in Phase 3 was spent attempting to identify the correct protocol to use to test the body's biomechanical response to vibration. This proved to be challenging. At the time of writing this report study 3, which was to assess the biomechanical response using various postures was not completed. This work will, however, be finished over the next few months.

Conclusions

The conclusions of this study are:

- The present research (Phase 1 field testing) has confirmed that the seats being manufactured and used in the LHDs and scrapers are not effective in decreasing WBV exposure (many are in fact amplifying the vibration as found in both Phase 1 and 3). This is not surprising since vibration dampening has not been one of the major criteria used when purchasing seats for these vehicles. Two issues make an immediate fix unlikely. First, the seats are often purchased separately from the vehicles. Second, a solution would need full cooperation of the manufacturers. If the latter condition could be met, there would almost certainly be increased costs passed on to the purchaser. An immediate solution for existing vehicles is not obvious.
- Phase 2 was designed to study the working postures used by LHD operators. While this work is potentially very useful for WBV exposure research, it is also very important for all types of musculoskeletal injuries. The LHD cab environment is an incredibly challenging one in which to gather work posture data—simply collecting the data took months of discussion and preparation; this knowledge, however, can now be transferred to other projects.
- The research conducted in Phase 3 to measure the biomechanical response to WBV proved to be very challenging. Through the laboratory testing, the reliability of the measurement techniques was determined, but significant biomechanical responses to 60 minutes of vibration exposure in the vertical axis were not detected. Further research in this area should consider the limitations mentioned above. This line of research is very important if the human body (biomechanical) response to WBV is to be understood more clearly.
- The spectral analysis and seat testing conducted at the IRSST in Montreal as part of Phase 3, confirmed the findings reported above for Phase 1. It is only by pursuing this line of research can we begin to understand optimal seat design. Much more work will need to be completed (and it is noted that WSIB is currently funding the VibRG to do more of this research) in this area. A strong recommendation would be for WSIB to help in finding a manufacturing partner for this very important work. Seats with vibration damping capabilities will need to be built into the design and installation stages.
- Since this was a jointly funded research project (WSIB and IRSST) between Ontario-based researchers and researchers based in Montreal at the IRSST, it is important to comment on the efficacy of this strategy. From the perspective of the researchers this strategy was incredibly valuable. The research team's strong recommendation is for WSIB to continue facilitating such partnerships. Much is to be gained, not least of which are research cost efficiencies (the work done in Montreal could not be done in Ontario) and the expansion of expertise to address an important worker safety issue. The skills, workplace access, and knowledge of the combined team of researchers are quite impressive and in the area of WBV, matched in few other places in the world. Ten researchers and six graduate students played a significant role in the research program, including the reporting of the results and submission of research articles.

Publications

Salmoni A., Cann A., Gillin K. (2010), "Exposure to Whole-Body Vibration and Seat Transmissibility in a Large Sample of Earth Scrapers." Work 35:63-75.

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RAC #04003
Employment Strain: The Hidden Costs of Precarious Employment

Principal Investigator(s): Wayne Lewchuk (McMaster University)

Co-Investigator(s): Andrew King (United Steel Workers of America); Michael Quinlan (University of New South Wales); Leah Vosko (York University)

Sponsoring Institution: McMaster University

Objectives
The study aimed to explore the health effects of precarious employment relationships in Ontario, and understand how various forms of support shape health.

Method
Three measures make up our "Employment Strain" model: employment relationship uncertainty; employment relationship effort; and, employment relationship support. This new framework was used to measure the characteristics of precarious employment and their effect on health using data from a structured, self-administered, population-based survey completed by 3,244 workers, and 82 semi-structured interviews using a stratified sampling technique to select participants.

Results
Precarious employment has negative health consequences for many workers. However, the relationship between precarious employment and health is complex, whereby the characteristics of the employment relationship and levels of support determine health outcomes. Using the "Employment Strain" framework, we found that workers exposed to High Employment Strain – workers with high levels of employment relationship uncertainty and high levels of employment relationship effort – have poorer health. Importantly, support does shape health and can help to buffer the health risks associated with precarious employment.

Conclusions
Precarious work is not sustainable for most workers, and carries serious health and social consequences. Limited and eroding levels of support compound the health-risks of non-permanent employment.

Publications:

Clarke M., Lewchuk W., de Wolff A., King A. (2007), "'This just isn't sustainable': Precarious Employment, Stress and Workers' Health." International Journal of Law and Psychiatry 30(4-5):311-326.

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RAC #04008
The Logic of Practice: An Ethnographic Study of Front-Line Service Work with Small Businesses in Ontario's Workplace Health Insurance Agency

Principal Investigator(s): Joan M. Eakin (University of Toronto)

Co-Investigator(s): Ellen MacEachen, Judy Clarke (Institute for Work & Health)

Sponsoring Institution: University of Toronto

Objectives
To characterize the nature of work at the front-lines of Ontario's WSIB, specifically the work of adjudicators, nurse case managers and customer service representatives servicing small businesses. The study aimed to describe and account for the 'logic' and social relations of front-line work in relation to the institutional context.

Method
Individual interviews with front-line staff, 'go-along' observations of routine work activities, and documentary materials (e.g. electronic forms, performance tools) were collected at two WSIB offices (urban /regional) during 2005-2007. Qualitative methods were used to analyze the data.

Results
The WSIB has deep set contradictory institutional accountabilities that frame work at the front-lines. Front-line work is a 'professional assembly line', judgment and flexibility superimposed on bureaucratic process. Strategic discursive and discretionary practices are required to meet conflicting job expectations. Work with small businesses has distinctive form within an administrative system and mind-set designed for larger organizations, and reflects the marginal, oft-changing status of small business within the operations of the WSIB.

Conclusions
Front-line staff mediate the conflicting objectives of the WSIB and manage a delicate set of relations with involuntary clients in a context of limited, uncertain, and changing rules, policies and resources. The complexity and contradictions of front-line work may be invisible to, and misinterpreted by WSIB clients and administrators, even by front-line staff themselves.

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RAC #04010
Determinants of Return-To-Work: Applying the Readiness for Change Model

Principal Investigator(s): Renée-Louise Franche (Institute for Work & Health)

Co-Investigator(s): Gail Hepburn, Curtis Breslin, Cameron Mustard, Sheilah Hogg-Johnson, John Frank, Pierre Coté (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives

The main objectives of this prospective study were the following:

1. To develop and validate an instrument to assist healthcare, insurance, and human resource personnel in assessing injured workers' stage of readiness to return to work
2. To describe the health statuis and work limitations in injured workers with musculoskeletal disorders at one month post-injury, startified by return-to-work status, and to document their return-to-work trajectories six months post-injury
3. To estimate the prevalence, incidence, and course of depressive symproms and to estimate the prevalence of mental healtrh treatment use in workers foloowing a workplace musculoskeletal injury of the back or upper extremity
4. To examine the longitudinal relationship between six early return-to-work disability management strategies and work absence duration in a cohort of injured workers with lost-time, work-related musculoskeletal disorders. Secondary objectives were to compare findings of analyses conducted with both administrative and self-reported outcomes of work absence duration, and to evaluate findings with those of a recent systematic literature review on the effectiveness of workplace-based return-to-work interventions.

Methods

Development and validation of the Readiness Staging Scale

An exploratory factor analysis was first conducted with one sample, followed by a subsequent confirmatory factor analysis, with a different sample. An initial pool of 34 questionnaire items was developed by 6 occupational health experts to assess stage of readiness for return to work, based on previous pilot work. Twenty-two items assessing Precontemplation, Contemplation, and Preparation for Action were administered by telephone to 299 lost-time claimants who had not returned to work. Ten items assessing Action and Maintenance were administered to 333 lost-time claimants who were back at work. Participants were recruited approximately one month after a work-related musculoskeletal injury through the Ontario Workplace Safety & Insurance Board.

Health status, work limitations and RTW trajectories

A sample of 632 workers with a back or upper extremity musculoskeletal disorder, who filed a Workplace Safety and Insurance Board lost-time claim injury, participated in this prospective study. Participants were assessed at baseline (1 month post-injury) and at 6 months follow-up.

The course and correlates of depressive symptomatology in workers following a workplace injury

This was a prospective cohort study of 632 workers filing a new lost-time workers' compensation claim for a work-related MSK disorder of the back or upper extremity. Of these, 446 completed the six-month follow-up interview. A high level of depressive symptoms was defined using the previously validated cutoff score of 16 or higher on the Center for Epidemiologic Studies Depression Scale (CES-D), indicative of a high likelihood of clinical depression.

The impact of early workplace-based return-to-work strategies on work absence duration

Using a cohort of 632 claimants with work-related musculoskeletal injuries, Cox proportional hazard analyses were performed with six RTW strategies measured one month post-injury as predictors: (1) early contact with the worker by the workplace, (2) work accommodation offer and acceptance, (3) contact between healthcare provider (HCP) and the workplace, (4) advice

from HCP to the workplace on how to prevent re-injury or recurrence, (5) ergonomic worksite visits, and (6) presence of a RTW coordinator. Outcomes were 6-month self-reported work absence duration and time receiving wage replacement benefits from an administrative database.

Results

Development and validation of the Readiness Staging Scale
Exploratory factor analyses were carried out on the two first subsamples ('not working' sample=149, 'working' sample=166). For the 'not working' sample, 60% of the variance was explained by four factors: Prepared for Action (Self-Evaluative), Contemplation, Precontemplation, and Prepared for Action (Behavioural). For the 'working' sample, 58% of the variance was explained by two factors: Uncertain Maintenance and Proactive Maintenance. Confirmatory factor analyses were then carried out on the second subsamples ('not working' sample=150, 'working' sample=167), using the same3 items stemming from thee xploratory analyses, and all fit indices were satisfactory. Convergent validity of the scale was examined with three approaches: (1) by using factorially-derived readiness dimensions, (2) by creating one overall readiness scale score for each participant, and (3) by categorizing participants in one readiness stage group. The relationship of readiness with the following theoretically derived constructs was examined: Depressive Symptoms, Self-Efficacy, Fear Avoidance, Pain, and General Health. Relationships were generally in the direction expected.

The project validated the Readiness Staging Scale developed to assist healthcare, insurance, and human resource personnel in assessing injured workers' stage of readiness for return-to-work. The findings suggest that this newly developed instrument has good psychometric properties — that is, it measures what it intends to measure in a reliable way. This suggests that the Readiness for Change model, as applied to return to work, is relevant to work disability research. In practice, the instrument may help those in the RTW process offer stage-specific services tailored to injured workers' needs, and it can be used to evaluate RTW interventions. This research will be useful to workers, employers, healthcare providers and insurers in furthering their understanding of their role in the RTW process.

Health status, work limitations and RTW trajectories
One month post-injury, poor physical health, high levels of depressive symptoms, and high work limitations are prevalent in workers, including in those with a sustained first return to work. Workers with a sustained first return to work report a better health status and fewer work limitations than those who experienced a recurrence of work absence or who never returned to work. Six months post-injury, the rate of recurrence of work absence in the trajectories of injured workers who have made at least one return to work attempt is high (38%), including the rate for workers with an initial sustained first return to work (27%).

The results suggest that workers whose return to work was sustained report a better health status and fewer work limitations than those who either had a recurrence after returning to work, or those who did not return to work. However, the research also shows that a sustained return does not equal a complete recovery from musculoskeletal disorders. Workers back at work still reported meaningful health limitations, compared to the general population, and significant work limitations. These findings highlight the importance of considering multiple factors, including depressive symptoms and work limitations, when studying the complex process of return to work and when developing RTW interventions and disability management strategies. In the future, it is suggested 12-month follow-up data are used to enable the examination of multiple recurrences and their effects on health outcomes and work limitations over a longer period. Moreover, future research should identify early predictive factors of the course of RTW, particularly focusing on the "problematic" paths of recurrences and persistent work absence. This will provide guidance for an optimal reintegration or for preventing recurrence.

The course and correlates of depressive symptomatology in workers following a workplace injury

The prevalence of high levels of depressive symptoms one month and six months post-injury were 44.6% (95% confidence interval 40.7% to 48.5%) and 27.6% (23.5% to 31.8%), respectively. Their incidence was 11.3% (7.5% to 15.2%) between one and six months post-injury, and 49.7% (42.6% to 56.9%) of participants reporting high levels of depressive symptoms at one month post-injury experienced a persistence of symptoms at the six-month follow-up. At the six-month follow-up, only 12.9% (5.8% to 20.1%) of participants with persistently high levels of depressive symptoms reported a depression diagnosis since injury and 30.1% (20.8% to 39.4%) reported currently receiving depression treatment.

The project addressed an important gap in the literature with regards to documenting the prevalence, course, and treatment of depressive symptoms in workers following a workplace injury. The findings not only show the pervasiveness of depressive symptoms in injured workers, but suggest that persistently high levels of symptoms are undiagnosed and under-treated. These findings make a case for directing clinicians' and policy-makers' attention towards the mental health of injured workers. Consistent with previous research examining the impact of depressive symptoms on work absence duration following a workplace injury, the results suggest that injured workers who have a problematic return to work may be more likely to present with high levels of depressive symptoms than those who remain at work after their first RTW attempt. It is hoped these findings will increase physician awareness of the persistence of symptoms. This may lead to more accurate identification of workers who would benefit from further assessment and intervention. In addition, factors facilitating resolution of depressive symptoms in injured workers should be investigated.

The impact of early workplace-based return-to-work strategies on work absence duration

Work Accommodation Offer/Acceptance and Advice From Healthcare Provider To The Work-place On Re-Injury Prevention were significant predictors of shorter work absence duration indexed by both self-report and administrative data. Receiving an ergonomic visit was a significant predictor of shorter duration receiving benefits only. Hazard rate ratios remained stable when comparing crude to adjusted models, suggesting that there was little residual confounding after adjusting for known confounders.

The project examined the relationship between six early workplace-based disability management strategies and how they predict work absence duration in our cohort. The study built on existing research and compared its findings with both administrative and self-reported outcomes of work absence duration. It also evaluated its findings with those of a recent systematic literature review on the effectiveness of workplace-based RTW interventions. The project's findings suggest that the following two elements are critical in a workplace-based RTW intervention program during the first month following injury: (1) receipt and acceptance of a work accommodation offer, and (2) healthcare provider advice to the workplace on how to prevent re-injury. The study is directly relevant to clinicians and employers as it highlights the importance of communication between healthcare providers and employers on re-injury prevention. It also highlights the importance of not only the offer of a work accommodation, but also of its acceptance. Future research should seek to develop processes and tools to provide more acceptable work accommodation offers. Research should also focus on assessing optimal timing of RTW strategies, and on assessing if particular groups of workers are more likely to derive greater benefit from those strategies.

Conclusions

Development and validation of the Readiness Staging Scale

Psychometric properties of the newly developed instrument suggest that the application of the Readiness for Change model to returning to work is relevant to work disability research. The instrument may facilitate the offer of stage-specific services tailored to injured workers' needs and could be used to evaluate return-to-work intervenmtions.

Health status, work limitations and RTW trajectories
There are return-to-work status specific health outcomes in injured workers. A sustained first return to work is not equivalent to a complete recovery from musculoskeletal disorders.

The course and correlates of depressive symptomatology in workers following a workplace injury
Depressive symptoms are pervasive in workers with work-related MSK injuries, particularly in the immediate weeks post-injury. Few of those afflicted with persistent depressive symptoms receive diagnosis or treatment.

The impact of early workplace-based return-to-work strategies on work absence duration
Analyses using administrative and self-reported indices of work absence generally converged, and were consistent with the findings of the systematic literature review. Work accommodation and targeted healthcare practitioner communication with the workplace are critical elements in an early workplace-based return-to-work intervention program during the first month following an injury.

Publications
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Franche R-L., Corbière M., Lee H., Breslin F.C., Hepburn C.G. (2007), "The Readiness for Return-to-Work (RRTW) Scale: Development and Validation of a Self-Report Staging Scale in List-Time Claimants with Musculoskeletal Disorders." Journal of Occupational Rehabilitation 17:450-472.

Franche R-L., Severin C.N., Hogg-Johnson S., Côté P., Vidmar M., Lee H. (2007), "The Impact of Early Workplace-Based Return-to-Work Strategies on Work Absence Duration: A 6-Month Longitudinal Study Following an Occupational Musculoskeletal Injury." Journal of Occupational and Environmental Medicine 49(9):960-974.

Bültmann U., Franche R-L., Hogg-Johnson S., Côté P., Lee H., Severin C., Vidmar M., Carnide N. (2007), "Health Status, Work Limitations, and Return-to-Work Trajectories in Injured Workers with Musculoskeletal Disorders." Quality of Life Research 16:1167-1178.

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RAC #04012
Implementing Mechanical Devices in the Drywall Finishing Trade to Prevent Falls, Musculoskeletal Disorders, and Occupational Disease

Principal Investigator(s): Greg Smith (International Union of Painters & Allied Trades, D.C. 46)

Co-Investigator(s): Hugh Laird (Interior Systems Contractors Association of Ontario); Peter Vi, Dru Sahai, Lawrence Kurtz (Construction Safety Association of Ontario)

Sponsoring Institution: International Union of Painters & Allied Trades D.C. 46

Objectives

This study is an extension of an earlier RAC funded project (#02034). Past studies conducted in a controlled setting found hygiene and ergonomic benefits of using two alternative drywall finishing systems. In the current study, a field study is performed to evaluate the following:

1. Determine the potential reduction in the risk of musculoskeletal disorders and fall-related injuries to drywall finishing workers when using a mechanical drywall finishing system (A study of drywall plastering task using mechanical tools and traditional hawk and trowel methods).
2. Verify the reduction in dust exposure and ergonomic-related hazards while using a drywall sanding system in the field (Effectiveness of a drywall sanding machine (DSM) in reducing forceful exertions, repetitive motion, and drywall dust).

Method

Objective 1: A study of drywall plastering task using mechanical tools and traditional hawk and trowel methods

In total fourteen (14) plasterers were asked to participate in this study. Participants were selected from a list of experienced plasterers who are currently members of Local 1891. Seven workers currently using the mechanical drywall tools were assigned into the intervention group. For the control group, seven workers using the traditional hand trowel method were selected for this group. Before conducting the study, all participants' employers were contacted to explain the purpose of the study and obtain their signed consent. While the participants were performing their work tasks, a videotape of all plastering task was recorded. Information on muscle activities (EMG), and trunk and arm repetitive motion (MTx sensors) were also collected at the same time. Data collection time for each participant varied between 3 and 5 hours.

Objective 2: Effectiveness of a drywall sanding machine (DSM) in reducing forceful exertions, repetitive motion, and drywall dust

Selection of participants was obtained from a list of experienced plasterers currently members of Local 1891. For the EMG and Gyro analysis, twelve (12) plasterers were asked to participate in this study. Six workers were asked to use the drywall sanding machine (intervention group) while performing their rough sanding task. The participants in the intervention group were allowed a half hour practice with the sanding machine before data collection was commenced. For the control group, six workers using the traditional pole-sanding techniques were selected. Before conducting the study, all participants' employers were contacted to explain the purpose of the study and obtain their signed consent. While the participants were performing their work tasks, a videotape of all sanding task was recorded. Information on muscle activities (EMG), and trunk and arm repetitive motion (MTx sensors) were also collected at the same time. Data collection time for each participant varies between 45 minutes and 2 hours. For the airborne dust analysis, 17 workers were asked to wear the SidePak aerosol monitor while using the pole sander. Eight (8) workers were asked to wear the SidePak monitor while using the sanding machine. Some of these workers also wore the respirable and total dust samplers (for the side-by-side assessment). The SidePak was turned on and set to log the data only

during times when workers were sanding. Breaks and other periods of downtime were excluded from the dataset.

Results

Objective 1: A study of drywall plastering task using mechanical tools and traditional hawk and trowel methods

1. Comparing to plastering with the hawk and trowel method (control group), the mechanical work tool group (intervention) had a significantly ($p<0.05$) higher median and peak load levels in the left middle deltoid muscle. No significant ($p>0.05$) differences in all three APDF load levels (static, median, and peak) was observed for the right deltoid muscles when comparing between the manual and machine compound application condition.
2. For the forearm flexor muscles, both of the median and peak load level was found to be significantly greater in the mechanical work tool condition when comparing to manual plastering.
3. Comparing the kinematics data between manual and machine compound applications showed that median acceleration rate of the trunk flexion/extension plane was significantly ($p<0.05$) higher when workers used the mechanical tool. For the dominant upper arm side, no significant ($p>0.05$) differences between the control and intervention group was observed for the median acceleration rate of the flexion/extension plane and the abduction/adduction plane.
4. A measurement of productivity for the two methods of compound application was performed. The average speed of compound application by manual tools was found to be 1.31 metre per minute, while the average speed using the machine was 3.90 m/min—about three times faster than the manual compound application.

Objective 2: Effectiveness of a drywall sanding machine (DSM) in reducing forceful exertions, repetitive motion, and drywall dust

1. Significantly higher levels of mean and peak trunk acceleration were found in the flexion/extension (f/e) plane when participants used the sanding pole.
2. The upper arm acceleration in the f/e plane and in the lateral plane was found to be significantly ($p<0.05$) lower in the DSM group versus the pole sanding group.
3. Significantly ($p<0.05$) higher middle deltoid muscle activities were found when participants used the pole sanding tool versus the DSM.
4. For the pole sanding group, the static, median, and peak APDF levels were significantly ($p<0.05$) higher on the right middle deltoid muscles when compared to the left muscles. For the DSM group, no significant difference was found between the right and left middle deltoid activities.
5. For the respirable dust exposure, the results for the pole sanding samples were compared to the machine sanding samples and they were found to be statistically significant ($p<0.0005$). To eliminate the possibility that the greater proportion of final sanding samples in the pole sanding data subset influenced this result – the sample means were compared again – using only rough sanding pole samples compared to all machine sanding samples (rough and final). The sample distributions were again found to be statistically significant ($p<0.005$).

Conclusions

Objective 1: A study of drywall plastering task using mechanical tools and traditional hawk and trowel methods

1. The increase in muscular exertion when using the mechanical drywall tools was mainly due to the heavier weight of the work tool. The combined weight of the mechanical work tools and the drywall compound is approximately 7.73 kg, whereas the total weight of the drywall compound and the hawk and trowel method was found to be less than 2.27 kg.
2. The acceleration of the upper arm was not found to be a contributing factor in the increase in forceful exertion when workers used the mechanical application tools. Therefore, the main contributing factor for the increase in forceful exertion in the upper extremities was mainly due to the increase in the weight of the mechanical work tool and not the acceleration of the upper arm (i.e. $F = m * a$).

3. From the trunk kinematics data, there was significant higher trunk acceleration in the flexion/extension plane when workers worked with the mechanical compound application tools. In combination with the higher acceleration and the heavier weight of the mechanical tool, working with the mechanical tool may increase the muscular loads on the lower back. This study did not measure the trunk load and therefore further study should be conducted in order to confirm this finding.
4. The significant increase in muscular exertion in the forearm muscles when using the mechanical drywall application tools is consistent with earlier findings. Unlike the previous study, this study also found a significant increase in muscular loading in the shoulder area, as measured by the middle deltoid muscles. Despite an increase in muscular exertion of the upper extremities when using the mechanical application tools, none of the three APDF load levels measured for the forearm and deltoid muscles exceed Jonsson's guideline .
5. Even though the overall average of all the three APDF load levels were not found to be higher than Jonsson's guideline, a caution should be taken into consideration for individual variation (i.e. strength level, anthropometry, differences in work technique) which can result in an increase in muscular exertion above the Jonsson's guideline. For example, this study did observed some individuals surpassing the recommended muscular load level which can put these workers at risk of muscular fatigue and injury even though the overall group averages were below the Jonsson's guideline. Therefore, assuming that all workers will be at a low risk of muscular fatigue and injury when working with the mechanical tools should be assessed with caution.
6. In this study, working with the mechanical drywall application tool can prevent fallrelated injuries because the use of ladders, scaffolds and benches can be reduced. When working with the hawk and trowel method, workers have to use benches or scaffolds in order to reach the ceilings and upper vertical walls. Observations of the use of work benches or scaffolds were reduced when workers performed plastering task using the mechanical drywall finishing tools. This finding is consistent with previous study.
7. The drywall mechanical tool was found to be a superior tool for applying drywall joint compound. On average, a three-fold increase in productivity was found when using the mechanical tool. The large difference in productivity was consistent with findings of the previous study. The increase in productivity when using the mechanical tool is positive because it allows more rest periods between work tasks, which in turn can decrease fatigue and risk of musculoskeletal disorders.

Objective 2: Effectiveness of a drywall sanding machine (DSM) in reducing forceful exertions, repetitive motion, and drywall dust

1. Despite the large difference in weight between the DSM (3.64 kg) and the pole sanding tool (0.91 kg), the DSM required significantly less shoulder muscle activities. This lower muscle activity may be due to the lower acceleration of the upper arm when using the DSM (i.e. Force = mass X acceleration). Similar findings were also found for the trunk.
2. Due to the mechanical design of the DSM, workers do not need to perform high energy consuming activities when sanding; they only need to grip and direct the DSM handle. The DSM also promotes equal generation of forces on the left and right shoulders, where pole sanding tool generates significantly higher forces on the side of the dominant hand.
3. When working with the DSM, a reduction in dust exposure was observed. The DSM has many occupational health and safety benefits over pole sanding including the following:
    - For sanders and nearby workers the DSM significantly reduces exposure to drywall dust. Thus workers are much less likely to suffer adverse health effects.
    - It greatly reduces the need for respiratory protection.
    - It can significantly reduce cleanup time.
    - It is ideal for situations where dust is problematic, such as renovations in occupied buildings, hospitals where patients must be protected, or work near dust-sensitive electronic equipment such as computers.
4. The study recommends the drywall sanding machine for rough sanding tasks because it reduces musculoskeletal exertion, repetitive motions, and drywall dust exposure.

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RAC #04016
Workplace Incivility and Other Work Factors: Effects on Psychological Distress and Health

Principal Investigator(s): Harry S. Shannon (McMaster University)

Co-Investigator(s): Ted Haines (McMaster University); Lilia Cortina (University of Michigan)

Sponsoring Institution: McMaster University

Objectives
The study aim was to examine the level of workplace incivility and its effects of on psychological distress and health in postal workers. This was the first such study in postal workers.

Method
A survey of members of the Canadian Union of Postal Workers (CUPW) was conducted. The questionnaire included items on incivility, other aspects of work such as job control and social support, and health-related measures (including psychological distress). The relationship between the level of incivility and the health-related measures was examined, taking account of the other work factors.

Results
Half of the sample of CUPW members completed the survey, providing 950 valid questionnaires. At least some incivility at work in the previous year was experienced by 85% of respondents. Supervisor incivility was a little more common than incivility from co-workers. Greater incivility was related to poorer health and greater psychological distress, even after accounting for other features of work including social support.

Conclusions
Incivility was quite common in these workers and it was related to health and psychological outcomes. Further research is recommended to establish that incivility precedes the outcomes, and also to confirm the relationships in other occupations.

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RAC #04018
Functional and Cellular Alterations in Work-Related Muscle Pain

Principal Investigator(s): Howard J. Green (University of Waterloo)

Co-Investigator(s): Don A. Ranney, A. Russell Tupling (University of Waterloo)

Sponsoring Institution: University of Waterloo

Objectives
The overall aim was to determine the mechanisms and functional consequences underlying work-related or occupational myalgia (OM) which results in discomfort and pain specific to the extensor carpi radialis brevis (ECRB) and trapezius (TRAP) muscles.

Method
Female workers with clinically diagnosed OM in ECRB or TRAP and healthy (H) controls were recruited for the study. Tissue samples were obtained from ECRB and TRAP and analyzed for histochemical, biochemical and molecular properties. In addition, mechanical function and fatiguability (ECRB, TRAP) blood flow (ECRB) and energy metabolism (ECRB) were assessed in response to a protocol involving repetitive muscle contractions.

Results
For both ECRB and TRAP, a lower ($p<0.05$) maximal contractile force (MVC) was observed in OM compared to H. Force-induced by electrical stimulation in TRAP was also observed to be lower (0.05) in OM at low frequencies (10 Hz and 20 Hz) as was the maximal rate of force development. Few differences existed between groups in fatiguability for either ECRB and TRAP. Forearm blood low in response to a standardized task as assessed by non-invasive infrared spectroscopy, indicated reduction ($p<0.05$) in recovery in OM in the absence of differences in either the non-steady state or steady state phases. Muscle metabolism (ECRB), measured with ^{31}P-NMR techniques, revealed a greater disturbance ($p<0.05$) in energy metabolism in OM type distribution and capillarization was not different between groups for either ECRB and TRAP. A trend was evident towards lower sarcoplasmic reticulum Ca^{2+}-handling in OM as suggested by the lower Ca^{2+}-ATPase activity and Ca^{2+}-uptake.

Conclusions
This study clearly indicates that biological differences exist between OM and H which could have implications to the pain and discomfort observed in OM.

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RAC #04019
Using Virtual Reality in Mine Rescue Operations

Principal Investigator(s): Paul G. Dunn (Laurentian University)

Co-Investigator(s): Tammy Eger (Laurentiian University)

Sponsoring Institution: Laurentian University

Objectives
The goal in this development project was to provide a demonstration model which would allow the environmental conditions to be adjusted, mine layout to be selected and would highlight the potential of VR for Mines Rescue Control Group (MRCG) training and integration of available data. The configuration would be established by the MRCG demonstration model in order to challenge teams or individuals in making good decisions in emergency situations. The three objectives for the MRCG development project were:

1. To conduct a review of the full capability required for the VR model. This would include the detailing of communication and data requirements for control groups during emergency situations. The Mines and Aggregates Safety and Health Association (MASHA) would provide guidance in this task.
2. To build a mine model for evaluation for mines rescue control group training. This would be used to determine the current capability and research required to produce a fully functional control group training environment. The MASHA Mines Rescue Advisory Group would provide feedback in the generation of this model and in identifying control group training requirements.
3. To transfer knowledge on current VR safety capability with mine rescue interest groups, to get as much feedback as possible before the full proposal is written in 2005.

Method
The research design was focused on delivering the above objectives through the following:

1. Detailed review of control group training functions and meeting with mine rescue personnel to define the full scope and capability requirements for the VR model.
2. Build a VR model of a pre-determined mine site already used for control group training. Incorporate current capability into the VR model to show what is possible currently. Identify the research required to produce a fully functional control group VR training model.
3. Conduct workshops, with invited mine rescue groups, in the Virtual Reality Laboratory (VRL) with the demonstration VR model produced to obtain feedback on what is required eventually for control group training.

Results
A 3D mine model was created from the 2D plans currently used in the mines rescue control group training exercises (Figures 1-6 in Appendix A). This model of the "Regional Mine" consists of an adit, a single shaft, 1 level consisting of an east and west drift, and a surface area with various buildings. The 3D model is viewable from all sides by manipulating a camera which can rotate around the mine model, allowing a control group to view the whole mine from any side or angle at any time. For the demonstration project, it was decided that a fire emergency scenario would be used with 2 randomly spawning fire locations so that it could be shown that the mine emergency can be different with each successive restart of the simulation. The Regional Mine documentation was added such that a review of procedures and available equipment could be accessed at any time during the simulation. While the simulation is running and once the emergency is conveyed to the user, options are presented to simulate the decision making process of the control group who would be in charge of managing the mine emergency.

Using a tree structure of successive decisions for prompts, the user of the mine simulation is guided through the necessary decisions needed to properly instruct the mine rescue team through the emergency. With each step, the mine rescue team can be located in real time

within the mine model as to their position. At pre-set checkpoints, the camera jumps into the model simulating the environment inside the mine, with textured drift walls, a 5-man rescue team, and relevant emergency simulations, such as smoke in the case of the fire emergency in this development project. These checkpoints for the mines rescue team were based upon MASHA's recommendations from their own mines rescue training meetings using the regional mine model. It was also decided that rather than use a scoring system, the penalty for making wrong or less correct decisions would only be added time for the mine rescue team to travel to different checkpoints in the regional mine.

Conclusions

This development project was able to provide a MRCG simulation based on a relatively simple mine layout. It created a sample mine VR model which has demonstrated the potential of using a VR environment for MRCG training. This has been reviewed by the MASHA Mines Rescue Advisory Committee and the feedback on the capability so far has been of very strong support for the developments. The main feedback from the advisory committee has been that site specific training would be a major step forward in terms of MRCGT.

The Regional Mine model was created in 3D from 2D plans and was used to determine capability and research required to produce a fully functional control group training environment. Communication and data requirements were incorporated into the VR model allowing for effective training for control groups during an emergency fire situation.

The research in this demonstration project not only developed a technology that can enhance training, but will also be useful in helping mine rescue teams deal with emergency situations in a VR environment. VRLs have also proven themselves to be excellent knowledge transfer and data comprehension facilities, where the impact of emergency situations on mine worker health and safety can be better understood and transferred efficiently to relevant industry and government personnel. The models developed certainly assist in lifting the awareness of emergency response situations to people outside of mine rescue operations.

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RAC #04020
A Comparison of Posture and Back and Upper Extremity Muscle Activity during Standardized Computer Work between Pregnant and Non-Pregnant Women

Principal Investigator(s): Geneviève A. Dumas (Queen's University)

Co-Investigator(s): Andrew B. Leger (Queen's University); Michael McGrath (Kingston General Hospital); André Plamondon, Alain Delisle (Institut de recherche en santé et en sécurité du travail)

Sponsoring Institution: Queen's University

Objectives
The objective of this study was to evaluate the effect of a "desk board" designed to provide arm support during computer work on the back and upper extremity of pregnant and non-pregnant women.

Method
Twelve pregnant and 18 non-pregnant participants were monitored while performing standardized computer tasks on a conventional desk and with the desk board, presented in randomized order. Posture (wrist, elbow, shoulder, neck, and back) was evaluated using an optoelectic method while muscular activity of eight selected arm, shoulder and back muscles was monitored by surface EMG.

Results
The desk board increased muscle activity in the extensor digitorum and right trapezius, likely due to an increase in wrist extension and elbow flexion. For the back, the desk board seemed to have a positive effect on both the control and pregnant group by slightly reducing muscular activity in some of the muscles monitored. The desk board tended to reduce perceived discomfort and tension in the left upper limb and the lower back for the control group.

Conclusions
The desk board had a positive effect on the back, but not on the upper extremities. The results for the two groups were generally similar, but there were some discrepancies.

Publications

Slot T., Charpentier K., Dumas G., Delisle A., Leger A., Plamondon A. (2009), "Evaluation of Forearm Support Provided by the Workplace Board on Perceived Tension, Comfort and Productivity in Pregnanat and Non-Pregnant Computer Users." Work 34:67-77.

Dumas G.A., Upjohn T.R., Leger A., Delisle A., Charpentier K., Plamondon A., Salazar E. (2008), "Effect of a Desk Attachment Board on Posture and Muscle Activity in Women during Computer Work." Ergonomics 51(11):1735-1756.

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RAC #04023
Evaluation and Sustainability of Ergonomic Interventions

Principal Investigator(s):	Richard P. Wells (University of Waterloo)
Co-Investigator(s):	Donald Cole, Emile Tompa, Dee Kramer (Institute for Work & Health); Syed Naqvi (Occupational Health Clinics for Ontario Workers); Mardon Frazer, Nancy Theberge (University of Waterloo)
Sponsoring Institution:	University of Waterloo

Objectives
Interventions utilizing principles of participative ergonomics are frequently performed to prevent musculoskeletal disorders (MSD), however factors contributing to their success or failure are needed to inform and improve current practice.

Method
Participative ergonomics interventions in three companies were monitored. Outcomes included changes made, exposure changes, perceived efforts, pain and discomfort, and costs and resources utilized. Processes were monitored by an observer in the plants using interviews, field notes and meeting observations.

Results
Each site was successful in forming participative change teams. The teams identified high priority tasks and processes and all of them instituted multiple changes. In most cases the changes only affected a small number of people or resulted in small reductions in exposure. There were only small changes in pain and discomfort and effort ratings relative to the comparison plants. All sites struggled to sustain the change teams.

Conclusions
Participative ergonomics appeared to be a feasible and appropriate approach for reducing risk factors for MSD. However, the scope of the teams' activities and the difficulty in sustaining the teams' activities reduced their ability to reduce MSD risk factors and improve musculoskeletal health outcomes.

Publications

Tompa E., Dolinschi R., Laing A. (2009), "An Economic Evaluation of a Participatory Ergonomics Process in an Auto Parts Manufacturer." Journal of Safety Research 40:41-47.

Wells R., Laing A., Cole D. (2009), "Characterizing the Intensity of Changes Made to Reduce Mechanical Exposure." Work 34:179-193.

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RAC #04024
Physiological Demands of Firefighter Candidate Recruitment Test and Relationship to Firefighting

Principal Investigator(s): Richard L. Hughson (University of Waterloo)

Co-Investigator(s): Michael T. Sharratt (University of Waterloo)

Sponsoring Institution: University of Waterloo

Objectives
The objective of the study was to monitor the energy requirements of the Candidate Physical Abilities Test (CPAT), a bona fide occupational requirement for entry into the profession of firefighting, and to quantify the physiological demands of firefighting tasks by measurement of oxygen uptake, carbon dioxide output, ventilatory patterns, and heart rate.

Method
Completion time for the CPAT was compared to physiological performance indicators obtained from standard laboratory tests. Incumbent firefighters were tested during a simulation of high-rise search. Thirty-four men and 23 women participated in the CPAT study and 10 firefighters took part in the simulation. A portable breath-by-breath gas collection system measured oxygen uptake during tests and during incremental treadmill running to observe maximal oxygen uptake (VO_2max).

Results
Thirty-one men and 4 women completed the CPAT under the 10-minute, 20-second criterion time; two men and eight women stopped during the circuit due to fatigue. Regression analysis of the data revealed that the completion time could be predicted by the single variable of absolute VO_2max expressed without consideration of body mass with all the other variables dropped from the model (r^2=0.650). VO_2max expressed relative to body mass was a poor indicator (r^2=0.134) of performance time. Firefighter performance was similar to that of the CPAT.

Conclusions
The results demonstrate the feasibility of the CPAT to evaluate the physical capabilities of individuals to meet the task-specific demands of firefighting. The findings show the importance of high levels of physical fitness as expressed by maximal oxygen uptake in combination with muscle strength and power to meet the demands of the bona fide occupational requirement for this demanding profession.

A major advance of the research was the development of the necessary hardware to directly measure energy expenditure during the performance of work tasks while wearing self-contained breathing apparatus. The results show that energy expenditure rises very rapidly during a stair climb, that it is reduced only slightly during a systematic room search, and that it rises again during a simulated victim rescue. This technology will allow direct measurement under various firefighting conditions and will give us greater understanding of the true demands of firefighting.

Publications

Williams-Bell F.M., Villar R., Sharratt M.T., Hughson R.L. (2009), "Physiological Demands of the Firefighter Candidate Physical Ability Test." Medicine & Science in Sports & Exercise 41(3):653-662.

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RAC #04027
Spinal Cord Injury: Determining Rehabilitation Costs and Employability in Non-Medicare Benefits Programs

Principal Investigator(s):	Molly Verrier, Viivi Riis (University of Toronto)
Co-Investigator(s):	Susan Jaglal (University of Toronto); Jan Walker (West Park Health Centre); Emil Tompa (Institute for Work & Health)
Sponsoring Institution:	University of Toronto

Objectives
Canadian data for payment of outpatient spinal cord injury (SCI) rehabilitation and the relationship to employment status is sparse. For the purposes of comparison, we explored the feasibility of claim file audit as a method to retrieve data about outpatient rehabilitation and employment status from the Workplace Safety and Insurance Board of Ontario (WSIB) and accident benefits paid by auto insurers.

Method
Twenty-eight WSIB claim files, representing workers injured between January 1996 and December 2000 were reviewed. After implementing multiple strategies, access to only one auto insurance claim file was obtained across the same time period making comparison of funding groups impossible.

Results
The data available through chart audit of WSIB claims do not align with the available literature on SCI and suggests that this method does not yield data that reflect all data about the sample's rehabilitation payments and employment outcome. A claim file audit is therefore not a feasible method to compare data about outpatient rehabilitation and employment status from the Workplace Safety and Insurance Board of Ontario (WSIB) and accident benefits paid by auto insurers.

Conclusions
For meaningful analysis of relationships between outpatient rehabilitation payments and employment status, along with standard data quality practices, a theoretical framework outlining the determinants of rehabilitation that affect employability needs to be in place to guide with data abstraction.

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RAC #04028
What Are the Key Modifiable Personal and Environmental Factors that Prevent Disability in People with Back Pain? A Consensus using the Delphi and Q-Card Methodologies

Principal Investigator(s):	Jaime Guzman (Institute for Work & Health)
Co-Investigator(s):	John Frank (University of Toronto); Jill Hayden, Andrea Furlan, John Francis Flannery (Institute for Work & Health); David Cassidy (Toronto Western Hospital Research Institute); Patrick Loisel (Université de Sherbrooke)
Sponsoring Institution:	Institute for Work & Health

Objectives
The objective of this project was to reach expert consensus on the relative impact and modifiability of personal and environmental factors that prevent participation restrictions in people with back pain (as per the International Classification of Functioning Disability and Health (ICF)).

Method
Evidence-based summaries for 32 modifiable factors were used by 33 experts (researchers, care providers, patient representatives, employers, insurers) in a three-round Delphi process to reach consensus on the factors' relative impact (expected improvement in participation if the factor could be modified for a usual population of people with back pain) and modifiability (amount of time and resources required to change the factor). Consensus was strong, moderate, or low (greater than 85%, 50%-84%, and 33%-49% of experts respectively).

Results
Judging from ICF, available research is 'unbalanced' toward return to work, with little attention to other disability outcomes. It is also 'patchy', with some factors ignored and others partially studied. Despite clear definitions and evidence summaries, there was substantial disagreement. After three rounds, there was strong consensus that Care Provider Reassurance had a high impact. There was moderate consensus that Expectation of Recovery and Decreased Fears had a high impact, and that Back Supports, Care Provider Reassurance, and Patient Knowledge were relatively easy to change. There was low consensus that Patient Knowledge and Appropriate Care had a high impact and that Temporary Duties were easy to change. Some experts would still rank the following factors at the top, despite majority decision to drop them: Amount of Pain, Job Satisfaction, Fitness, Function, Lifting Devices, Workstation Design, and Physical Workload.

Conclusions
Existing evidence on the factors was limited and there was substantial disagreement as to their relative impact and modifiability. Interventions could focus on Care Provider Reassurance, or be multifaceted to address several factors supported by different stakeholders. Panel findings should help define priorities for intervention and research.

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RAC #04031
Rotator Cuff Repair Failures: Causes and Solutions

Principal Investigator(s):	Guy Trudel (University of Ottawa)
Co-Investigator(s):	Hans Unthoff (University of Ottawa); David S. Backman (Institute for Aerospace Research, National Research Council); Martin Lecompte (The Ottawa Hospital)
Sponsoring Institution:	University of Ottawa

Objectives
This research project had two objectives:
1. to correlate the mechanical strength of the supraspinatus (SSP) tendon with the area of tendon remodeling at the surgical site for the 12 weeks following rotator cuff repair in a rabbit model
2. to correlate extra- and intra-muscular fat content of the SSP muscle at the time of rotator cuff repair with the mechanical strength of the tendon 12 weeks after surgery in a rabbit model.

Method
The research team used a well-established rabbit model of supraspinatus tear with surgical repair, which the team had used extensively in the past. For objective 1, four groups of 10 rabbits underwent complete supraspinatus tendon tear and repair unilaterally. They were sacrificed at 0, 2, 6, or 12 weeks. Both shoulder joints were removed en bloc. Standardized tendon histology assessed the area of tendon remodeling and mechanical testing to failure assessed tensile strength. For objective 2, three groups of 20 rabbits underwent complete tendon tear unilaterally. In half, the SSP was repaired either at 4, 8, or 12 weeks later. Fat has accumulated to different extents in the three groups. In the other half, the researchers quantified extra- and intramuscular fat content at 4, 8, and 12 weeks using high resolution CT scan and histological measurements. In the attached group, 12 weeks after repair, both shoulder joints were mechanically tested.

Results
The results indicate a steady increase in mechanical strength of the experimental tendons from 0 weeks to 2 weeks post surgery. At these time points, all contralateral tendons exhibit significantly higher mechanical strength than the operated tendons. Interestingly, the results show the contralateral tendon mechanical strength to be higher than that of aged matched control tendons. Stiffness values show similar trends in the supraspinatus tendons.

Conclusions
Mechanical recovery of supraspinatus tendons after re-attachment to bone proceeded positively with increased force in tension after 0, 1, and 2 weeks in tendons surgically attached immediately after rupture. More results on radiological correlation, histology, and in delayed surgical reattachment will complete the clinical picture. Clinicians will then benefit from evidence on which to investigate and manage the rehabilitation of workers after a tendon injury.

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RAC #04032
Toward Reducing Injuries in Lift Trucks: Understanding Eye Movement, and Line-of-Sight Impairments Due to Postural Constraints Imposed by Lift Truck Operation

Principal Investigator(s): Sylvain G. Grenier (Laurentian University)

Co-Investigator(s): Tammy R. Eger (Laurentian University); Jonathan Tyson (Pulp and Paper Health & Safety Association); Lori Ann Vallis (University of Guelph)

Sponsoring Institution: Laurentian University

Objectives
The study intended to quantify postures and determine where operators are looking relative to the line of sight on selected machines in the field. This data was then used to estimate joint loads imposed by the adopted postures and to assess preliminary design modifications that might reduce these loads and improve LOS and vision.

Method
An arena in Sudbury was rented and a "lift truck rodeo" course was constructed under the guidance of Jonathon Tyson from PPHSA. The course consisted of six stations that simulated commonly encountered tasks. Equipment world donated a lift truck for the three day testing session and eight drivers were recruited to drive the course. Motion capture data was recorded and so was eye gaze over the six tasks. Based on these outcomes, in the second year of the project data was collected at a mine smelter in Sudbury and at a pulp and paper mill in Sault St. Marie.

All the data was processed with 3DMatch posture matching software. This software also estimated musculoskeletal loading. The eye tracking data was coded, using custom software, on a grid superimposed over the field of view. The location of the crosshairs, or point of regard was of interest here.

Results
The study has quantified the postures and the associated musculoskeletal loads. The study has determined where operators are looking during the operation of the machines and has detailed the LOS on three different types of machines. The investigators have attempted to superimpose operator LOS choices over available LOS. The investigators have also attempted to determine what visual information operators were seeking when they adopted awkward postures.

Conclusions
It appears that drivers do not always look in the direction of travel. The investigators have successfully modified the lift truck CAD to improve LOS but have not yet determined the musculoskeletal loading impacts. Driver behaviour may be due to a desire to minimize musculoskeletal loads in the back neck and shoulders. In more complex maneuvers loading of joints, the low back in particular, may be higher than expected. Although not dangerously high at any given time, from a cumulative standpoint it does not seem to be safe. However, there are indications that for males in particular a significant unloading occurs when using the steering wheel.

Publications

Eger T.R., Godwin A.A., Hennry D.J., Grenier S.G., Callaghan J., Demerchant A. (2010), "Why Vehicle Design Matters: Exploring the Link between Line-of-Sight, Driving Posture, and Risk Factors for Injury." Work 35:27-37.

For more information:

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RAC #04036
The Electrophysiological Characterization of Muscles Affected by Repetitive Strain Injury

Principal Investigator(s): Linda B. McLean (Queen's University)

Co-Investigator(s): Daniel W. Stashuk (University of Waterloo); Timothy Doherty (St. Joseph's Health Care)

Sponsoring Institution: Queen's University

Objectives
The purpose of this study was to determine: (i) if motor unit morphology and firing statistics recorded from the affected muscle in patients with non-specific arm pain (NSAP) are different from individuals with lateral epicondylitis (LE) and/or control and at-risk subjects, and (ii) if these quantitative electromyography (EMG) parameters suggest that the underlying pathophysiology in NSAP is either myopathic or neuropathic in nature.

Method
Sixteen subjects with NSAP, 11 subjects with LE, 8 subjects at risk of developing NSAP, and 37 control subjects participated. Needle and surface-detected EMG signals from low-level isometric contractions of the extensor carpi radialis brevis (ECRB) muscle were decomposed into constituent motor unit potential (MUP) trains. The morphology of surface and needle-detected MUPs and motor unit firing rates were compared among the four groups.

Results
Patients with NSAP had smaller MUP amplitudes compared to the control and LE groups ($p<0.006$). MUP duration in the control subjects was significantly shorter than that in the other groups ($p<0.006$). NSAP, LE and at-risk subjects had lower mean MU firing rates than the control subjects ($p<0.006$).

Conclusions
Smaller MUPs are often associated with myopathic conditions, and may be indicative of fiber loss within affected motor units in patients with NSAP.

Publications

Calder K.M., Agnew M.J., Stashuk D.W., McLean L. (2008), "Reliability of quantitative EMG analysis of the extensor carpi radialis muscle." Journal of Neuroscience Methods 168(2):483-493.

Calder K.M., Stashuk D., McLean L. (2008), "Physiological characteristics of motor units in the brachioradialis muscle during fatiguing isometric contractions." Journal of Electromyography and Kinesiology, 18(1):2-15.

For more information:

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RAC #04038
Predictors of the Incidence of Disability Income Insurance among Ontario Labour Force Participants, 1994-2004

Principal Investigator(s): Cameron A. Mustard (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
The objective of this paper is to describe the sources and amount of income security benefits received by disabled working age Canadians. Income security benefits for labour market earning losses arising from disability in working-age populations in Canada are provided by four primary sources: 1) the federal Canada Pension Plan's disability benefit program, financed by employer and employee compulsory payroll taxes, 2) provincial worker's compensation agencies, funded by premiums paid by employers, 3) provincial social assistance programs, funded by general tax sources, and 4) employment-based (and typically employee-funded) long-term disability plans.

Method
Estimates of the number of disability income beneficiaries and benefit amounts were obtained from two representative samples of Canadians: the Survey of Labour and Income Dynamics (2001) and the Participation and Activity Limitation Survey.

Results
In 2001, 5.1% of Canadians aged 15-64 received disability benefits. CPP(D) provided $2.4 billion in benefits to 279,000 beneficiaries, provincial social assistance programs provided $3.4 billion in benefits to 351,000 beneficiaries, provincial workers' compensation agencies provided $2.3 billion in benefits to 130,000 beneficiaries and employment-based long-term disability plans provided $4.4 billion in benefits to 166,000 beneficiaries. At ages 55-64, approximately 11% of working age Canadian were receiving a disability benefit. In addition, approximately 386,000 working age Canadians with disability were not participating in the labour force and were not receiving disability benefits.

Conclusions
In 2001, disabled Canadians received a total of $12.7 billion in income security benefits. The Canadian disability benefit system combines contributory schemes based on labour force participation with non-contributory mean-tested disability income security programs. Benefit amounts differ substantially between programs and there appear to be significant inconsistencies in program coverage.

Publications
Mustard, Cameron A., Dickie, Caroline, Chan, Stella (2007). "Disability Income Security Benefits for Working-Age Canadians." Institute for Work & Health, Working Paper #339.

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RAC #05001
Stepping into Health: the Search for a More Effective Worksite Physical Activity Intervention

Principal Investigator(s):	Tanya R. Berry (University of Alberta)
Co-Investigator(s):	Jill Tracey, Kimberley A. Dawson, Marilyn Jacobs, Kathryn Zettel, Stephanie Kibbie (Wilfrid Laurier University)
Sponsoring Institution:	Wilfrid Laurier University

Objectives
The purpose of the research was to compare the efficacy of a traditional meeting physical activity intervention with an internet physical activity intervention. Additional objectives were to determine if one type of intervention was more desirable and to compare intervention group participants with employees who chose not to participate.

Method
Employees at one university completed pretest questionnaires prior to voluntary enrollment in ten-week physical activity interventions based on social cognitive theory and stages of change. Employees also completed post-test questionnaires and focus groups were conducted with intervention participants. Quantitative and qualitative data were triangulated to determine outcomes.

Results
Although the internet intervention attracted more participants, results showed significant increases in coping self-efficacy and ability to overcome barriers in the traditional group only. Qualitative data indicated that this was due to the social support provided by this format. Both groups showed significant increases in walking behaviour. The internet group participants were significantly lower than either the traditional or nonintervention groups in life and job satisfaction.

Conclusions
It is important to have individual contact when attempting to increase physical activity. It is also important to consider who is attracted to a particular intervention as internet employees may fall into an 'unhappy employee' category.

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RAC #05005
Optimal Installation of Auditory Warning Devices to Improve Safety in the Workplace

Principal Investigator(s): Christian Giguère (University of Ottawa)

Co-Investigator(s): Chantal Laroche (University of Ottawa)

Sponsoring Institution: University of Ottawa

Objectives
The goal of this project was to validate a set of tools to guide the installation of warning devices in the workplace, taking into account the hearing status of workers, the noise field, the use of hearing protectors, and the sound propagation in industrial rooms.

Method
Two software tools were validated during laboratory and field experiments; the first tool (Detectsound) produces warning sound targets at each workstation; the other tool (AlarmLocator) identifies the minimum number of warning devices required in the work area, the optimal placement of the devices and their sound power level.

Results
Detectsound was tuned in the laboratory using 36 subjects to accurately predict the perception of warning sound components under the presence of continuous and impact noises. AlarmLocator was developed to accurately predict the sound propagation from warning devices to workstations in the work area. During field validation, Detectsound and AlarmLocator were shown to have good predictive validity.

Conclusions
These new tools aim at decreasing the risk of accidents due to failure to react to danger situations in the noisy workplace and contribute to improved practices in the installation of warning devices, which will be directly relevant to industrial hygienists, device manufacturers and standardization organizations.

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RAC #05008
Powerline Maintainer's Gloves: Approaches to Reducing Hand Loading, Improving Performance, and Reducing Musculoskeletal Disorder Risk Factors

Principal Investigator(s): Richard P. Wells (University of Waterloo)

Co-Investigator(s): Mardon Frazer, Heather Carnahan (University of Waterloo); Shannon J. Maracle, Wendy K. Dunk (Electrical & Utilities Safety Association)

Sponsoring Institution: University of Waterloo

Objectives
Insulated rubber gloves protect powerline maintainers from electrical hazards. The wearing of the gloves interferes with manual work. The objective of the study was to describe the effect of different gloves on performance and effort and recommend ways to reduce loading on the upper limbs.

Method
Five classes of gloves, three sizes, and gloves from two manufacturers and three cover manufacturers were tested. A lab and a field study were performed. Twenty students performed seven tasks while the electrical activity of their forearm muscles and ratings of effort were measured. Twenty four current powerline maintainers performed three tasks Ratings of effort, performance times and ratings of comfort, fit and dexterity were performed and comments regarding the gloves solicited.

Results
Effort to exert forces and manipulate objects was substantial. As glove class increased, performance decreased, effort increased and self rated comfort and fit decreased. Substantial reductions of effort were apparent when using a class one instead of a class 2 glove. Negligible differences were seen between the gloves or covers tested.

Conclusions
Use class 1 or class 0 instead of class 2 when safety permits. Gloves and covers can be purchased from any of the manufacturer tested.

Publications

Willms K., Wells R. (2009), "Glove Attributes and their Contribution to Force Decrement and Increased Effort in Power Grip." Human Factors 51(6):797-812.

For more information:

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RAC #05009
Multi-Task Jobs and Rotation

Principal Investigator(s):	Richard P. Wells (University of Waterloo)
Co-Investigator(s):	James Potvin, Peter Keir (McMaster University); Clark R. Dickerson, Mardon Frazer, Heather Carnahan (University of Waterloo); Anne E. Moore (York University)
Sponsoring Institution:	University of Waterloo

Objectives
Questions about job rotation are commonly asked by workplace parties. Variety in jobs is generally considered to aid in the prevention of musculoskeletal disorders (MSD). The project's objectives were to develop a method to test whether task variation provided benefits and to use the approach in three different body regions.

Method
Fatigue, as measured by changes in the electrical activity of muscles or a reduction in maximum hand-grip strength, was compared using simple tasks in the laboratory while participants performed four conditions; two conditions that used the same task throughout and two that alternated between the two tasks. A field study of rotation duration was also performed.

Results
The projects demonstrated a benefit resulting from task rotation in terms of less fatigue or discomfort and maintenance of maximal force production compared to tasks with no variation.

Conclusions
Task variety can be beneficial from the viewpoint of reducing fatigue, increasing work capacity and potentially preventing MSDs. Future work will include testing these findings in occupational settings.

Publications

Wells R., McFall K., Dickerson C.R. (2010), "Task Selection for Increased Mechanical Exposure Variation: Relevance to Job Rotation." Ergonomics 53(3):314-323.

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RAC #05025
Occupational Exposures of Six Degree-of-Freedom (Multi-Axis) Whole-Body Vibration: Relationship Between Exposures and Comfort

Principal Investigator(s): James P. Dickey (University of Guelph)

Co-Investigator(s): Tammy Eger (Laurentian University); Sylvain G. Grenier (Laurentian University/Occupational Health Clinics for Ontario Workers); Michele L. Oliver (University of Guelph); Paul-Émile Boileau (Institut de recherche Robert Sauvé en santé et en sécurité du travail); Alan Salmoni (University of Western Ontario); Peter Vi (Construction Safety Association of Ontario)

Sponsoring Institution: University of Guelph

Objectives
The objective of the study was to evaluate the complex interplay between multi-axis whole-body vibration exposures, seating, and operator comfort.

Method
This study has been performed as a 3 phase study involving both field- and laboratory-based studies. Phase 1 involved field measurements of chassis and seatpan accelerations from specific vehicles in the forestry (skidders), mining (load-haul-dump vehicles), and construction (scrapers) sectors. Phase 2 involved evaluating the contribution of translational, rotational, and combined/complex vibrations on perceived comfort. Phase 3 involved a laboratory-based evaluation of perceived discomfort from actual vibrations measured in the field (Phase 1).

Results
High levels of vibration were observed in all of the field data. The field exposures included large translational and rotational components. A comparison between two standards for assessing health effects (ISO 2631-1 and 2631-5) revealed significant differences. The laboratory testing has revealed that the severity of the vibration, as calculated using the Vibration Total Value parameter, was not strongly correlated to measures of perceived discomfort for multi-axis sinusoidal and field exposure vibrations.

Conclusions
The current international standards for evaluating exposures (ISO 2631-1 and 2631-5) do not adequately assess multi-axis vibrations. Studies are underway to develop a framework for assessing multi-axis vibrations, and are planned to assess options for industrial seating.

Publications

Smets M.P.H., Eger T.R., Grenier S.G. (2010), "Whole-Body Vibration Experienced by Haulage Truck Operators in Surface Mining Operations: A Comparison of Various Analysis Methods Utilized in the Prediction of Health Risks." Applied Ergonomics 41:763-770.

Jack R.J., Oliver M., Dickey J.P, Cation S., Hayward G., Lee-Shee N. (2010), "Six-Degree-of-Freedom Whole-Body Vibration Exposure Levels during Routine Skidder Operations." Ergonomics 53(5):696-715.

Grenier S.G., Eger T.R., Dickey J.P. (2010), "Predicting Discomfort Scores Reported by LHD Operators using Whole-Body Vibration Exposure Values and Musculoskeletal Pain Scores." Work 35:49-62.

Dickey J.P., Eger T.R., Oliver M.L., Boileau P-E., Trick L.M., Edwards A.M. (2007). "Multi-axis sinusoidal whole-body vibrations: Part II — Relationship between Vibration Total Value and discomfort varies between vibration axes." Journal of Low Frequency Noise, Vibration and Active Control 26:195-204.

Dickey J., Oliver M., Boileau P-E., Eger T., Trick L., Edwards M. (2006). "Multi-axis sinusoidal whole-body vibrations: Part I — How long should the vibration and rest exposures be for reliable discomfort measures?" Journal of Low Frequency Noise, Vibration and Active Control 25(3):175-184.

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RAC #05027
Validation of a New Strategy to Acquire On-Line Peak and Cumulative Loading for Manual Handling Tasks in Industrial Settings

Principal Investigator(s): Joan M. Stevenson (Queen's University)

Co-Investigator(s): Nicholas Troje, Evelyn L. Morin, J. Timothy Bryant (Queen's University); Tammy Eger (Laurentian University)

Sponsoring Institution: Queen's University

Objectives
The objective was to develop a wireless data acquisition system that could be used in field trials for assessment of cumulative joint moments and forces.

Method
The Xsens® mobile data acquisition system was acquired and a series of static and dynamic accuracy tests were completed. A linked-segment model and strategies to measure the load-in-hands were developed. Then, in two field trials, upper body joint orientations and accelerations were analyzed.

Results
On the principal axes, the Xsens® system was accurate and precise. However, off-axes motions resulted in unacceptable errors of joint displacements and lumbar moments. In terms hand forces, the biceps showed the most promise but can be improved if combined with other measures (e.g., wrist or trunk motion). In field trials for body armor and forest tree planting, the Xsens® performance was acceptable but data must be interpreted with caution.

Conclusions
Now that Xsens® has improved its hardware and software (in 2008), the current LSM model should be revalidated. In addition, current data should be reanalyzed after selecting the optimal combination of 'load-in-hands' algorithm. Once these steps have been taken, we feel confident that the XSens® wireless system can be used successfully in assessing cumulative loads in industrial settings.

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RAC #05028
Managing the 'Tail of the Curve': the Course, Predictive Factors, and Work-Related Outcomes of Injured Workers One Year after Attending the WSIB Specialty Clinics for Upper Limb Disorders

Principal Investigator(s): Dorcas E. Beaton (St. Michael's Hospital)

Co-Investigator(s): Joy MacDermid (McMaster University); Robin Richards (Sunnybrook & Women's College Health Sciences Centre); Renee Louise Franche, Pierre Cote, Sheilah Hogg-Johnson, Claire Bombardier (Institute for Work & Health); Sonia Pagura (Orthopaedic & Arthritic Institute)

Sponsoring Institution: St. Michael's Hospital

Objectives
To describe the course and outcomes of persons attending a WSIB shoulder and elbow specialty clinic and to evaluate prognostic factors associated with more successful outcomes.

Method
A prospective cohort study was conducted at two WSIB specialty clinics (Toronto and London). Self-report variables on work status, work disability, physical functioning and perception of recovery were assessed at clinic attendance and 3, 6, and 12-months post visit. At baseline, more than 30 known predictors of return-to-work (RTW) outcomes were fielded. Cluster analyses and structural equation modeling techniques were applied to examine the longitudinal variability in the course of recovery, and the factors that predicted specific courses.

Results
41.4% of injured workers (*n*=254 of 614) were not working at initial assessment. After 12 months, 16.7% of them had returned to work. Injured workers had different courses of recovery – typically described as belonging to one of four sets of trajectories. Pain, physical function, and mental health at the time of clinic attendance stood out as strong predictors of either return to work or at-work ability. Workplace factors were more predictive of only RTW with the exception of work flexibility and supportive policies.

Conclusions
This research is the first to describe the course after specialty clinic attendance, and to identify these prognostic factors. Future work can now aim at modifying these factors and testing these interventions.

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RAC #05029
Development of Permeation Passive Samplers for Occupational Exposure Monitoring of Complex Mixtures of Volatile Organic Compounds

Principal Investigator(s): Tadeusz Górecki (University of Waterloo)

Sponsoring Institution: University of Waterloo

Objectives
Passive air samplers used at workplace atmospheres have at least some of the following disadvantages: sensitivity to moisture, temperature, and air velocity around the sampler, and the requirement of the sampler to be calibrated for each and every pollutant of concern prior to its deployment in the field. The objective of this project was to develop a sampler and calibration procedure to address all these issues.

Method
A permeation passive sampler equipped with a polydimethylsiloxane (PDMS) membrane was designed. An apparatus was built to generate standard test atmospheres of various groups of chemical compounds, and the calibration constants were determined experimentally at different temperatures. Gas chromatographic retention indices were determined for all the analytes using PDMS-coated capillary columns. Correlation between the calibration constants of the samplers towards various chemicals and the corresponding retention index values were determined. The correlations can be used to estimate the calibration constants for unknown analytes.

Results
Excellent correlations between the calibration constants and the respective gas chromatographic retention indices were observed. Within the temperature range of workplace atmospheres, no significant effect of temperature on the uptake rate was noticed. PDMS is highly hydrophobic, therefore the effect of humidity on sampling rate is expected to be minimal.

Conclusions
The newly designed passive sampler is very simple and inexpensive. The method for the estimation of the calibration constants based on the gas chromatographic retention properties of the analytes makes it possible to deploy the sampler in the same fashion in which conventional active sampling is deployed, without the need to know the identities of the analytes beforehand. The samplers are simple, inexpensive, and unobtrusive, which should help in their acceptance in the are of occupational hygiene.

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RAC #05037
An Ethnographic Study of Injured Workers' Complex Claims Experience

Principal Investigator(s): Ellen MacEachen (Institute for Work & Health)

Co-Investigator(s): Sue Ferrier, Donald C. Cole (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
Most workers who incur an injury on the job resulting in a compensation claim follow a relatively straightforward path to recovery and return to work. However, a minority of compensation claims are prolonged. To date, only a vague picture exists of why and how these claims are problematic. This study was conducted in order to gain an understanding of systematic, process-related problems affecting injured workers who had failed to return to work as expected.

Method
In-depth interviews were conducted with 48 injured workers and 21 service providers. A purposive sampling approach was used to achieve maximum variation across Ontario and a relatively even representation of men and women. Participants were recruited for their experience with and knowledge of problems and situations that injured workers can have with long term and prolonged workers' compensation claims. Interviews normally lasted 60 to 90 minutes; they were audio-recorded and transcribed verbatim. The interview questions and analysis focused on administrative, workplace, and health-related roadblocks encountered by workers during the claims process. The analytic focus of the research was on systemic (rather than individual) determinants of prolonged claims as these may be amenable to administrative and policy intervention. The investigators' method of constant comparison directed them to repeated themes and their consequences.

Results
Workers become 'stuck' on workers' compensation when a series of seemingly mundane problems added up and became a paralyzing "toxic dose" that prevents sustainable return to work. Problems related to power relations (workers afraid to complain about problems, bosses don't want injury costs), evidence rules (immediate reporting of injuries, clear work-related health evidence), and communication (by paper, telephone, among strangers) can create a multitude of harms for an injured worker. Underlying these situations are impractical policy assumptions that workplaces provide a safe and nurturing environment for injured recovering workers. The investigators find that idealistic policies and workers' compensation adjudicators who have the latitude to interpret situations are key parts of prolonged claims.

The study provides a detailed account of problematic return to work process and their effects on injured workers. Part 1 focuses on return to work problems associated with *workplaces*. The investigators find that return to work policy does not always fit easily with business logic and practices. Conditions for modified work can cause physical and mental strain for workers who become re-injured, or experience social harassment. "Over compliant" workers who brave difficult workplace situations because they fear loss of income may be particularly exposed to re-injury. Part 2 examines problems in the *labour market re-entry* process that can affect successful re-employment of workers. Training programs may not accommodate workers' ongoing health needs and older, inexperienced, disabled workers can be particularly disadvantaged in competitive job markets. Part 3 describes how *health care providers* can be reluctant to engage with WSIB because of poor compensation, excessive paperwork requirements, and the experience of having their assessments overlooked or overturned. Health care system problems such as physician shortages also affect the amount and quality of care to workers. Part 4 examines problems related to the way *WSIB interacts with workers*. A lack of direct contact between workers and their claims' decision-makers—adjudicators—can affect the quality of decisions being made about claims, particularly in situations with complex or ambiguous circumstances. Lack of accessibility, transparency and accountability for system

processes were implicated in problematic processes. Part 5 describes key effects of these process problems: worker re-injury, poverty and mental health problems.

Conclusions
An understanding of prolonged workers compensation claims requires consideration of the broader systems—workers' compensation, healthcare, workplace-- that workers must navigate following an injury. This study finds that injured workers can become caught in webs of relationships and procedures over which they have little control, and that idealist return to work policies help to set the stage for these problems. The investigators find that communication breakdowns and misunderstandings underlie many of return to work process problems. Interventions must focus on informed and realistic policy assumptions about real workplace social conditions and health care provision, and on enhanced communication and understanding between injured workers and workers compensation adjudicators.

Publications
Kosny A., MacEachen E., Ferrier S., Chambers L. (2011). "The Role of Health Care Providers in Long Term and Complicated Worekrs' Compensation Claims." Journal of Occupational Rehabilitation 21:582-590.

MacEachen E., Kosny A., Ferrier S., Chambers L. (2010). "The 'Toxic Dose' of System Problems: Why Some Injured Workers Don't Return to Work as Expected." Journal of Occupational Rehabilitation 20:349-366.

MacEachen E., Ferrier S., Kosny A., Chambers L. (2007). "A Deliberation on 'Hurt versus Harm' Logic in Early-Return-to-Work Policy." Policy and Practice in Health and Safety 5(2):41-62.

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RAC #05040
Evaluation of HSA-Initiated Collaborative Partnership to Implement Participatory Ergonomic Programs

Principal Investigator(s): Philip L. Bigelow (Institute for Work & Health)

Co-Investigator(s): Donald Cole, Sue Ferrier, Renee-Louise Franche, Desre Kramer, Dov Zohar (Institute for Work & Health); Mardon Frazer, Nancy Theberge, Richard Wells (University of Waterloo); Wendy Lee, Shannon Maracle (Electrical & Utilities Safety Association)

Sponsoring Institution: Institute for Work & Health

Objectives
The objectives of the project were to: develop an understanding of the facilitators and barriers to the implementation of participatory ergonomic programs through a collaborative partnership that had been initiated by a Health and Safety Association (HSA); conduct an evaluation of the overall program; and assess the quality of relationships developed through the partnership.

Method
The methods involved multiple data sources and incorporated a theoretical framework that focused on readiness for organizational change and safety climate as antecedents. Over 1100 employees in six participating utilities completed questionnaires at baseline, nine, and eighteen months post-implementation.

Results
The results provided evidence that the theoretical model was appropriate and the program had positive impacts. A new measure of readiness for organizational change for participatory ergonomics had good psychometric properties and was a facilitating factor related to employee participation in the program. Although a number of exposures to psychosocial risk factors for musculoskeletal disorders (MSDs) declined over the program period, reported physical effort and MSDs did not significantly decline. A number of measures of pain significantly declined and the patterns were constant across the utilities.

Conclusions
It was concluded that, although the collaboration was not without challenges, overall findings were positive and there was evidence that the HSA played a key role both in terms of providing expertise but also in facilitating communications and building relationships.

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RAC #05102
Numerical Model Development of a Heavy Mining Vehicle Multipiece Rim and Wheel Assembly for Structural Analysis

Principal Investigator(s): William J. Altenhof (University of Windsor)

Sponsoring Institution: University of Windsor

Objectives
The objective of this research project was to conduct a thorough literature review dealing with topics associated with failure of mining wheels, rationale for injury or death of operating and/or maintenance personnel resulting from these failures, and the current state of application of engineering tools in the design of mining wheels. Experimental structural testing of a multipiece mining wheel was to be conducted to understand the mechanical performance of the mining vehicle wheel and to provide data for computer model validation. Using the validated numerical model a fatigue analysis of the multipiece wheel assembly was to be conducted.

Method
Experimental testing of the multipiece mining wheel was conducted at the structural laboratory at the University of Windsor. Strain gauges were adhered to the mining wheel and a hydraulic loading cylinder was used to apply a bending moment load to the apparatus containing the multipiece wheel, adaptor plate and shaft. A data acquisition system was used to record observations from the strain gauges, load cells, and linear voltage differential transformers at a rate of 1 Hz.

A numerical model of the multipiece wheel assembly was generated using Finite Element Model Builder (FEMB) for simulation in LS-DYNA an explicit and implicit large deformation finite element code. Fatigue simulations were conducted after model validation was completed. Fatigue analyses were completed on software developed at the University of Windsor.

Results
An analysis of the data obtained from the literature review indicated that typically the specific type of wheel associated with a mechanical failure (and resulting injury or death) was generally not referenced in reporting documentation. It was noted that in situations where specific reference to the type of wheel was made in an injury report that three piece mining vehicle wheels were most common in accidents.

For the laboratory controlled testing of the mining wheel, strain values were typically within the range of -61με to 100με with maximum values occurring at positions around the mounting ring. Predictions of the finite element model were in good agreement to the experimental findings with percentage errors typically in the range of 10% to 20% removing any experimental data well outside the expected results.

Results from the numerical fatigue analysis indicated that the mining wheel exhibited an infinite fatigue life. The lowest factors of safety were observed to be 1.73 utilizing a von Mises method to assess fatigue behaviour in the multi-axial loading condition.

Conclusions
The majority of injuries and/or deaths related to mining vehicle wheels can be attributed to operator/maintenance personnel error and/or failure to follow and/or compile, on an individual or institutional basis,specific guidelines and/or rules.

Based upon the experimental structural testing completed on the three piece mining wheel strains typically ranged from approximately -61με to 100με on the mining wheel. Strains on the mounting ring where observed to be greatest in magnitude in both compressive and tensile conditions. On the mounting ring, the largest tensile strain was observed to be 104.25με and the largest compressive strain was observed to be -61.25με. The wheel base

position illustrated the largest tensile strain of 29με, the other location of strain measurement on the wheel base illustrated a negligible strain. The removable flange illustrated minor strains with values ranging from -4.75με to 3.25με. The results of the experimental testing were typically consistent through the four tests completed. The numerical model was generally able to predict strain values within 10% to 20%.

Based upon the von Mises and Sines methods of multi-axial fatigue assessment, the minimum factors of safety for an infinite fatigue life were calculated to be 1.73 and 1.81 respectively. It was noted that a lower value of the factor of safety was observed for the locking ring when applying the von Mises fatigue method. Potential damage and/or misalignment to the locking ring will reduce this factor of safety.

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RAC #05106
Development of Products to Transfer Line of Sight and Mobile Equipment Knowledge to Industry and Educational Institutions

Principal Investigator(s): Ann L. Pegoraro (Laurentian University)

Co-Investigator(s): Paul Dunn, Tammy Eger, Sylvain Grenier, Michel Larivière (Laurentian University); Shawn Allenby (Ottawa-Carleton District School Board); Yi Huang (Northern College); Rick Banting (Mines and Aggregates Safety and Health Association)

Sponsoring Institution: Laurentian University

Objectives
The research team has been conducting line-of-sight research on mobile mining equipment (such as load-haul-dump vehicles) since 1999. During this period a considerable amount of knowledge has been produced. There is now a need to transfer this knowledge to workers in the mining industry, to students who are currently in educational institutions and who likely will soon be working in the mining industry, and to manufacturers of mobile mining equipment.

Method
The project proceded in three distinct phases. Phase one involved training new personnel and researchers on the key project tools — JACK and Blender. In the second phase, a new version of the mining training module (ITMO) was produced and tested for usability. The third phase of the project involved the creation of the following training modules:

- A 'How to Measure Line-of-Sight' Guide
- Line-of-Sight General Awareness Modules
- Line-of-Sight Interactive Training Module – ITMo

Results
For this knowledge transfer project, the research team developed a training module that can be played on a PC (ITMO), and user guides on the various methods of evaluating line of sight. These tools will serve to educate current workers and increase the profile of workplace safety among young workers. Small pilot tests and general usability evaluations were conducted to ensure the products meet the learning needs of the stakeholder groups and that they are easy to use.

Conclusions
The grant enabled the production of several products for the mining industry that relate to line-of-sight issues in mobile mining equipment such as load-haul-dump vehicles. The grant allowed for a health and safety association partner, MASHA, as well as the mining industry, to benefit directly from academic research through the production of useful and relevant training products. The partnership with MASHA was key in this project as the association provided access to the industry, periodic feedback during the project, and will be a beneficiary of the products produced. The integration of these products into MASHA training sessions and materials will greatly increase their uptake by industry. The various demonstrations to industry have lead to numerous industry inquiries into the availability of ITM) and the other training modules on line-of-sight.

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RAC #05107
Development of a Mover's Pack: A Specialized Backpack for the Moving Industry

Principal Investigator(s): Joan M. Stevenson (Queen's University)

Co-Investigator(s): Bill Ostrom (Ostrom Outdoors); J. Timothy Byrant (Queen's University)

Sponsoring Institution: Queen's University

Objectives
The objectives of this project were two-fold: (1) to assess the biomechanical differences between hand-held anterior (AC) and posterior (PC) load carriage; and, (2) to determine if an assistive load carriage device could reduce muscle effort while carrying loads either anterior or posterior loads.

Method
A field study was conducted to determine the main sources of musculoskeletal injury in the professional moving population. A treadmill simulation of load carrying techniques used by professional movers was employed to compare electromyographic (EMG) signals from the AC and PC carrying postures. A similar EMG analysis was conducted while subject carried the loads manually or with the assistance of the moving device in either the AC or PC load arrangement.

Results
The PC manual carrying method significantly ($p<0.05$) reduced back muscle activity (>50% reduction) in comparison to AC method. The assistive device did not significantly alter back muscle activity; however, it significantly reduced handgrip muscle activity (>40% reduction) and anterior shoulder muscle activity (>75% reduction).

Conclusions
The large reductions in back muscle activity during PC suggests that the muscular compression forces on the spine may also be significantly reduced, a factor that may help to decrease back injury in the moving industry. Although it did not alter back muscle activity, the assistive moving device was an effective ergonomic tool to alleviate grip effort and shoulder activity in both AC and PC conditions; furthermore, improving the ease of use of the PC method.

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RAC #05108
Guidelines for the Development of Re-Entry Protocols in Seismically Active Mines

Principal Investigator(s): Stephen D. McKinnon (Queen's University)

Sponsoring Institution: Queen's University

Objectives
The objective of this short-term research project was to produce practical guidelines for the development of re-entry protocols for seismically active mines, based on a synthesis and analysis of currently used protocols, including advice on instrumentation, data analysis, and final protocol development.

Method
The methodology of this preliminary project has been to develop a detailed questionnaire, with assistance from the Mines and Aggregates Safety and Health Association (MASHA) Ground Control Committee, to collect data from seismically active mines in a standardized format. Based on the analysis of survey and mine site visits, improvements, concerns, requirements, and limitations of current re-entry practices were identified and used to elaborate guidelines for the development of re-entry protocols.

Results

Analysis and evaluation of current re-entry practices

- A wide variety of re-entry protocols are used in practice, many being specific to particular activities such as mining through dykes, crown blasts, or mining around identified hazardous zones. Most re-entry decisions are made on a case-by-case basis, with no recognized standards for the determination of the re-entry time period/exclusion zone
- There is no generic re-entry period that covers all situations; re-entry time periods can vary from hours to days
- Re-entry protocols cannot be generalized or directly adapted from other mines. A policy can have success in one environment but can be of questionable value in others. Re-entry protocols must be compatible with rock mass behaviour in a particular geological/mining environment based on observations of seismicity patterns, and in some cases are tailored to account for the limitations of the seismic monitoring system in place
- The most common monitored seismic source patterns are event frequency, seismic energy, and seismic moment
- The logic involved in re-entering a zone affected by blasts or large seismic events is when the seismic data (seismic source parameters) has returned to background levels plus a prescribed background time window
- The following factors were reported to be important in the development of re-entry protocols (not in order of significance):
  - *in situ* stresses/depth
  - type of rock and failure mechanism
  - presence of certain geological structures (faults, shear, dykes, contact zones)
  - highly stressed zones of the mine such as pillars, abutments, or remnants
  - history of instability in the area
  - induced stress level (mining sequence, extraction)
  - layout geometry
  - size of blast
  - seismic monitoring system coverage
- At the surveyed mines the re-entry protocol is often in writing but it is not generally a Standard Operating Procedure
- The Ground Control personnel are generally responsible for developing and placing re-entry restrictions as they have access to the seismic data and experience to interpret it. With appropriate training, mine operators can place restrictions until reported to and inspected by Ground Control personnel
- The communication of the re-entry protocol to workers is mostly verbal

- There are generally no formal review procedures, or review by the Joint Health and Safety Committee.

The guidelines
The following empirical guidelines were established based on the most commonplace re-entry practices at the surveyed mines and provide advice on the development of re-entry protocols without sufficient seismic data:

- Trigger of re-entry incidences:
  - 90% of re-entry incidences are triggered within time periods and zones relative to blasts, making the re-entry protocol for blast-related events the most fundamental one
  - the most common distance from active mining that seismic events can occur and trigger re-entry restrictions is 50-100 m.
- Many protocols recognize the following sensitive seismic sources/zones:
  - certain geologic structures (faults, shear, dykes, and contact zones)
  - highly stressed zones of the mine such as pillars or remnants
  - zones with significant contrast in rock mass properties
  - local brittle rock mass failure, either self-initiated or triggered by remote sources
- Re-entry time periods:
  - for blasts or large seismic events in sensitive zones a standard re-entry period of 12 hours following the blast/event can be used before re-entering the area for inspection
  - for zones where anomalous seismicity has occurred causing damage, an extended re-entry period of 24 hours is recommended
- Exclusion zone:
  - for mines and zones with without a large history of seismic events a minimum exclusion zone radius between 50-100 m. from the potential source including as a minimum the levels immediately above and below is recommended for open stope mining
- Recommended parameters to monitor:
  - it is recommended that both the number of events and their associated magnitude or strength release per hour be monitored to determine re-entry time
- Background time window
  - re-entry should be delayed for a minimum time window of two consecutive hours of background levels of seismic activity.

In addition, a full set of guidelines for the development of a site-specific re-entry protocol was produced, which emphasizes the use of procedures to develop re-entry protocols based on the analysis of locally observed seismicity. The objective of these guidelines is to provide a standard procedure for developing protocols appropriate to the seismic characteristics of any mine, including specification of the following:

- seismic monitoring system requirements
- list of data that needs to be collected
- how the data should be analyzed, including information on the presentation and interpretation of the collected data using techniques developed during this study
- how to develop the re-entry protocol following data analysis.

Conclusions
Preliminary guidelines for the development of re-entry protocols in seismically active mines have been developed. Work with industrial partners has allowed researchers to determine the needs and method to improve the reliability of these guidelines.

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RAC #05111
Simultaneous Exposure Measurement of Noise, Hand-Arm Vibration, and Musculoskeletal Loads in Boilermakers

Principal Investigator(s): Alan Salmoni (University of Western Ontario)

Co-Investigator(s): Philip Bigelow (Institute for Work & Health); Peter Vi, Dru Sahai (Construction Safety Association of Ontario); Margaret Cheesman (University of Western Ontario)

Sponsoring Institution: University of Western Ontario

Objectives
The objective of this project was to measure the muscular loads, hand-arm vibration exposure, and noise level exposure of boilermakers working in different industries in Ontario.

Method
Boilermakers (N = 16) from the nuclear power and petro chemical industries, and the Toronto school board were assessed while performing tasks using different kinds of tools. Forearm muscle EMGs were used to measure muscular load and accelerometers were attached to the tools being held to assess HAV exposure. Noise dosimeters were also worn by the workers.

Results
Across all workers tested median muscular loads varied from 2-4% of maximal voluntary contraction (MVC) and peaks were from 14-20% for the four forearm muscles measured. The dose values for noise exposure projected over an 8-hr day were very high with an average dose of 172% of the daily recommended value. Across all tools tested the HAV exposure was moderate: 50% (8 out of 16) of the workers had A(8) values <2.5 m/s^2 (<action value), 31% (5 of 16) had values between 2.5 and 5.0 m/s^2 (<limit value), and 19% (3 out of 16) had A(8) values >5.0 m/s^2 (over the exposure limit).

Conclusions
Whereas muscular loads were moderate in value, several limitations in the sampling and measurement used make it impossible and invalid to generalize the results to all settings. More testing is needed before firm conclusions can be made.

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RAC #05114
Evaluation of the Impact of a Participatory Ergonomics Intervention in a Medium Size Facility

Principal Investigator(s):	David Mijatovic (Occupational Health Clinics for Ontario Workers)
Co-Investigator(s):	Richard P. Wells (University of Waterloo); Donald C. Cole (Institute for Work and Health); Syed Naqvi (Occupational Health Clinics for Ontario Workers)
Sponsoring Institution:	Occupational Health Clinics for Ontario Workers

Objectives
The first objective of this project was to use the background research on participatory ergonomics and apply it to the development of an ergonomic committee within a medium-sized automotive parts manufacturing facility.

The second objective of this project was to develop a participatory ergonomics handbook based on this research.

Method
A workplace was recruited. A participatory ergonomics approach was initiated through an ergonomic committee. The ergonomic committee involved management, workers, union representatives, engineering staff, and the principal investigator. Questionnaires were administered at beginning and end of the project. Operations were assessed with videotape analysis. Interviews were conducted with key individuals.

Results
Thirteen changes were made during the intervention period. Workers generally rated the changes as having made the work "better than before". Workers perceived the intervention to have "made work easier, safer, and less tiring" without affecting the pace at which work was completed. Strains and sprains recorded at the facility for all of 2007 were noticeably less than each of the previous three years. The number of grievances (all types) at the facility noticeably dropped during the study period and for the remaining months of 2007.

Conclusions
The participatory ergonomics approach was effective in identifying hazards and implementing improvements in the workplace.

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RAC #05115
Identifying the Barriers and Facilitators to the Adoption of Ergonomic Innovations in the Construction Sector

Principal Investigator(s): Philip L. Bigelow (Institute for Work & Health)

Co-Investigator(s): Desre M. Kramer, Richard P. Wells (University of Waterloo); Enzo Garritano, Peter Vi (Construction Safety Association of Ontario)

Sponsoring Institution: Institute for Work & Health

Objectives
This study used a 'diffusion of innovation' framework to explore the adoption of ergonomic innovations in the construction sector.

Method
A hydraulic ladder lift, an innovation, believed to reduce musculoskeletal injuries, was identified by the Construction Safety Association of Ontario (CSAO). Thirty-three firms identified as opinion leaders were offered this innovation at no cost. Thirteen companies committed to use the innovation and report on its characteristics that led them to accept or reject it. Managers and operators were interviewed and surveyed.

Results
Thirteen companies, with five to 900 employees participated. Researchers shared information about an innovation, which was previously unknown to 80% of the participants. The operators informed workmates not employed by their companies but who worked on the same site about the intervention. The opinion leaders informed decision-makers within their companies and gave presentations at prearranged meetings. They shared knowledge of the innovation to 32 more companies and potentially several thousand other employees.

Conclusions
A significant barrier to adoption of ergonomic innovations may be at lack of awareness of and ability to manage musculoskeletal disorders. The researchers developed relationships with construction employers, all of whom expressed willingness to participate in a similar project in the future. This bridge enhanced awareness.

Publications

Kramer D., Bigelow P., Vi P., Garritano E., Carlan N., Wells R. (2009), "Spreading Good Ideas: A Case Study of the Adoption of an Innovation in the Construction Sector." Applied Ergonomics 40:826-832.

For more information:

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RAC #05116
Developing Standardized Metrics for Work Disability Management Benchmarking

Principal Investigator(s): Donald C. Cole (Institute for Work & Health)

Co-Investigator(s): Liz Scott (Organizational Solutions); Andrew Clarke (Clarke, Brown & Associates); Sheilah Hogg-Johnson (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives

The objective of this study was to conduct a proof of concept demonstration for a benchmarking collaborative that would standardize recording and reporting of work disability management metrics. The objective was to assess the feasibility of different components of the system, and to examine how well the benchmarking system can provide reports useful to workplace parties.

Method

Three organizations funded by the grant, as well as eight privately funded (financial services) companies, participated in the pilot. In phase 1, organizations reviewed 265 metrics. Metrics assigned high utility and ease of provision proceeded to phase 2, self-assessment, where organizations provided values for the metrics. During the final phase of the study, research team members visited the participating organizations to review the processes used to calculate the values of the metrics supplied in the self-assessment.

Results

Organizations see high utility in disability management processes and outcome metrics. The ability to provide values for the data varied across sectors. Since outcomes and processes differ across companies and over time, an opportunity exists to benchmark performance as appropriate standards are achieved.

Conclusions

The pilot provided the groundwork for a benchmarking collaborative that would standardize work disability management information in a way that is useful to the long-term goal of improving work disability management practices.

Publications

Busse J.W., Dolinschi R., Clarke A., Scott L., Hogg-Johnson S., Amick III B.C., Rivilis I., Cole D. (2011), "Attitudes toward Disability Management: A Survey of Employers Returning to Work and Their Supervisors." Work 40:143-151.

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RAC #05123
Musculoskeletal Injury Prevention for Sign Language Interpreters

Principal Investigator(s): Kathryn L. Woodcock (Ryerson University)

Sponsoring Institution: Ryerson University

Objectives
Occupational health education is essential for professionals in training, to avoid early attrition from practice. The Association for Visual Language Interpreters of Canada (AVLIC) identified a need to revise and update the *Repetitive Strain Injury (RSI) Resource Guide for Sign Language Interpreters* (AVLIC 1995). Recognizing the critically limited resources of the AVLIC volunteers led to this joint proposal (Ryerson, AVLIC and the Ontario Association of Sign Language Interpreters (OASLI)) to the WSIB Research Advisory Council "Bridging the Gap" program for knowledge transfer. *Occupational Health and Safety for Sign Language Interpreters* is intended for working interpreters, interpreting students and educators, and those who employ or purchase the services of interpreters.

Method
The research literature was amassed several ways, including keyword searches for publications about injury and sign language interpreting, papers previously compiled by the partners, papers referred by other researchers through personal contact, and papers cited as sources in the compiled materials. Literature about musculoskeletal disorders (MSDs) not specifically related to sign language interpreting was retrieved from the resources of the Centre of Research Expertise for the Prevention of Musculoskeletal Disorders (CRE-MSD). In the first year of the project, it became apparent that the research literature lacked information on the prevalence of RSIs among Canadian interpreters. As a result, the research group expanded its project to collect data using a Ryerson Research Ethics Board approved survey of AVLIC members. The research group also sought information on various potential risk factors. Although a high prevalence of RSIs appeared to exist among respondents, little information was provided on specific risk factors. Specimens of sign techniques referenced in the guide were developed using SignLink Studio using the services of Ryerson's Centre for Learning Technologies, and the assistance of a deaf PhD candidate. Peer-reviewed input was solicited from an expert panel of four reviewers of whom one declined and one did not respond. Two helpful reviews were received and their suggestions incorporated. At several points in the process, the AVLIC steering committee provided input in person and by email.

Results
The project produced a guide for release and proposed endorsement at the 2008 AVLIC conference and SignLinked materials to be launched online at the time of release. As well, developing new information for this project also produced scientific data which was reported.

Conclusions
There is considerable interest among end-users – interpreters, their employers, insurers, and medical professionals – for evidence-based guidance related to sign language interpreters. Some of the areas where end-users wanted guidance could not be substantiated with research evidence, therefore further research is needed. However the integrated model and extensive literature review has enhanced the resources available to end-users.

Publications
Occupational Health and Safety for Sign Language Interpreters is available on the internet at http://www.ryerson.ca/woodcock/pdfs/OHSforSLI.pdf

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RAC #05124
Pilot Study of Manganese Accumulation in Ontario Welders

Principal Investigator(s): Ana Pejović-Milić (Ryerson University)

Co-Investigator(s): David Chettle, Ted Haines (McMaster University); John Oudyk, Michael W. Pysklywec (OHCOW-Hamilton Clinic); Harry A. Roels (Université catholique de Louvain)

Sponsoring Institution: Ryerson University

Objectives
Excessive, prolonged exposure to manganese (Mn) is known to be neurotoxic and has resulted in cases of occupational manganism, a Parkinson's disease like syndrome, in some jurisdictions outside Ontario. Exposure to Mn at low levels for a prolonged period of time can result in milder neurological symptoms than those seen in manganism: including memory deficit, loss of motor control and reduction in the refinement of certain bodily motions. However, the link between this condition and Mn exposure is not easy to identify unambiguously, particularly months to years after the main exposure has ceased. The ability to put subtle changes in neurological function of occupationally exposed individuals in the context of objective measure of cumulative Mn exposure is lacking. Therefore, there is a need for a new diagnostic tool with ability to measure the cumulative exposure to Mn in workplace.

Based on the animal studies, it is plausible that measuring bone Mn levels with *In Vivo* Neutron Activation Analysis could serve as a biomarker of past exposure, and hence, would act as a means of monitoring exposed subjects and the population. In this pilot project bone, blood and urine Mn levels of welders occupationally exposed to Mn in Hamilton, Ontario were measured and compared to the levels found in subjects without any history of occupational exposure to Mn.

The project described here investigated: 1) whether the bone Mn levels in humans can be reliably measured with a novel diagnostic tool – *In Vivo* Neutron Activation Analysis, 2) whether this diagnostic tool can distinguish between the exposed and non-exposed subjects and 3) whether bone Mn levels do reflect differences in long-term occupational exposure.

Method
Forty subjects (thirty welders occupationally exposed to Mn and ten controls) from Hamilton, ON were participating in this study. An occupational history was obtained to qualify/quantify past working history and Mn exposures. All subjects underwent bone Mn measurement along with blood, serum, plasma and urine analysis on Mn concentrations. In addition a complete blood count was determined for each subject, including erythrocyte indices, white blood cell indices and platelets. To evaluate inter-laboratory reproducibility, multiple samples of each biological measure were obtained.

Results
Bone Mn concentrations can be measured *in vivo* using the developed diagnostic tool – bone Mn *in vivo* Neutron Activation Analysis. Also, bone Mn levels are statistically different on the group bases between the occupationally exposed population (welders) and the members of population living in southern Ontario. It appears furthermore that *in vivo* bone Mn levels do reflect differences in cumulative occupational exposures. In the two populations participating in this study the mean bone Mn levels were (2.89 ± 0.38) μg Mn/g Ca for workers occupationally exposed to Mn and (0.12 ± 0.68) μg Mn/g Ca for population living in Hamilton region. Furthermore, it appears that bone Mn levels do reflect differences in the occupational exposure of welders (p = 0.01); however a larger study (utilizing a better sensitivity of IVNAA) would be needed to fully address these biomarkers in occupational settings.

Whole blood Mn appeared as the most reliable biomarker of all typical biomarkers considered in this study, being most strongly associated with cumulative exposure. Whole blood Mn results were reproduced by the two laboratories, unlike urine, serum and plasma Mn concentrations. It was interesting to note that red blood cell indices seem to have a significant effect on this relationship suggesting the need to include this covariate in future considerations of blood Mn. While urine Mn was somewhat associated with cumulative exposure, the vast majority of results were at the extreme low end of the reference ranges, making it difficult to endorse urine Mn as a useful biomarker. Serum and particularly plasma are viewed as unreliable biomarkers of Mn exposure.

Conclusions

This project, the first of its kind in the world, successfully evaluated the use of IVNAA technique to measure bone Mn in human hand bone. In the two populations participating in this study, the mean bone Mn levels were significantly different and furthermore, it appears that bone and whole blood Mn levels do reveal differences in the long-term, occupational exposure of welders; however a larger study would be needed to fully address this finding. The investigators propose use of whole blood Mn along with bone Mn to explore relationships between the cumulative exposure to this element and clinical outcomes.

Publications

Pejović-Milić A., Aslam, Chettle D.R., Oudyk J., Pysklywec M.W., Haines T. (2009), "Bone Manganese as a Biomarker of Manganese Exposure: A Feasibility Study." American Journal of Industrial Medicine 52:742-750.

For more information:

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RAC #05125
Evaluating 'Mental Health Works': A Feasibility Study

Principal Investigator(s): Bernadette Stringer (McMaster University)

Co-Investigator(s): Ted Haines, Andrea Baumann, Ron Goeree, Nick Kates, Wayne Lewchuk, Harriett MacMillan, Harry S. Shannon (McMaster University); Martin Shain (Center for Addiction and Mental Health); Victor Catano, Mark Fleming, Lori Frances (St. Mary's University); Bonnie Kirsh (University of Toronto); Terry Krupa (Queens University); Donna Lero (University of Guelph); Chantal Viens (Universite Laval)

Sponsoring Institution: McMaster University

Objectives

Work-related mental health problems cause significant suffering, disability and cost. Knowledge about the effectiveness of mental health interventions directed at managers and organizations is limited. A feasibility study was conducted to enhance the likelihood of success of a large scale, future study. This was done by: 1) identifying questionnaires or sections of questionnaires measuring mental health related issues; 2) using data from a pilot intervention study in two companies to carry out baseline and pre/post intervention analyses; and 3) assessing accessibility to and type and quality of mental health outcome data collected by each company, and how such data should be aggregated for confidentiality purposes in future research studies.

Method

Step 1: Research team members assembled whole instruments and sections of instruments to ensure inclusion of important mental health related themes, prior to focus groups.

Step 2: Focus groups were held with corporate and senior level managers from a financial institution (FI) and lower level managers and union representatives from a government institution (GI) to explore perceptions of occupational stress and mental illness. Other issues discussed were how workload and decision latitude affected stress/mental health, the effectiveness of current approaches identifying/accommodating mentally ill employees, nature and degree of stigmatization etc. Participants also provided feedback on the themes selected for the study questionnaire, commented on its length, and recommended the mode of administration for good response rates.

Step 3: To meet federal government English/French requirements, one of the investigators translated the questionnaire into French and it was reviewed by a professional translator from the GI. Next, the questionnaire was back-translated into English and then pilot tested among nine researchers, managers and workers.

At the FI, where paper questionnaires were distributed, eligible managers (would attend an intervention workshop) handed out sealed envelopes addressed to each employee, each time documents were distributed, for confidentiality reasons. Initially, a letter of information, questionnaire, and stamped envelope addressed to the principal investigator were distributed in a sealed envelope addressed to each employee. Two weeks later, a note thanking responders and encouraging non-responders to respond was also distributed. Two weeks after that, another thank-you note was sent to responders and another reminder note was sent to non-responders. Two weeks after that, a thank-you note wrapped in an extra sheet of paper was sent to responders, and a letter to non-responders explaining how their views were essential to ensure unbiased results was sent with a replacement questionnaire and self-addressed, stamped envelope. Then two weeks later, another one page thank-you note was sent to responders and a final letter was sent to non-responders. Approximately three weeks later, non-responders were excluded.

Eligible GI employees accessed the questionnaire through a URL provided in a personalized email; upon clicking on the URL, they were directed to the Survey Monkey website where the English/French questionnaire could be completed. Non-respondents received up to five e-mail messages including thank-you notes, reminders and letters of encouragement at approximately the same intervals as those used for the FI, and were excluded approximately three weeks after the final contact if they did not respond.

Step 4: The availability, completeness, and abstractability of disability/work absence/EAP (employee assistance program) data for use in subsequent effectiveness studies were assessed through site visits and conference calls.

Results

The Occupational Stress and Mental Health Questionnaire, to be completed over 15 minutes, was developed. It consisted of ten dimensions from the Copenhagen Psychosocial Questionnaire, four Return to Work Perception Survey dimensions, two Work Productivity and Activity Impairment Scale dimensions, two Supervisor as Voice Manager Questionnaire dimensions, and the Stigma Scale for Receiving Psychological Help.

Baseline response by GI and FI employees was 75% and 60%, respectively. Post intervention the response was 57% by GI employees and 59% by FI employees. While all 44 GI employees who completed baseline questionnaires were still employed post intervention, only 61 of 98 FI employees were still employed.

On average, GI employees were 48 years old, FI non-call center (NCC) employees were 45 years old, and FI call center (CC) workers were 34 years old. Eighty-two percent of GI workers were female compared to 65% of NCC employees and 46% of CC employees. Compared to all GI and 94% of NCC workers who worked fulltime, only 48% of CC employees worked full time.

Using linear regression to adjust for age, gender and work experience, GI employees reported better general health than both groups of FI (CC and NCC) employees, although they did not report better mental health. GI and the NCC employees also reported higher quantitative demands compared to CC employees. In addition, GI employees reported greater cognitive demands compared to both FI groups. While GI employees reported more work related influence than both NCC and CC employees, NCC employees also reported more influence at work compared to CC employees.

Although cross sectional regression analyses showed important differences between GI, NCC and CC employees' perceptions regarding workload, health, and other outcomes, no significant difference between each group's baseline and post intervention scores were found.

Mental illness data being collected by the GI and FI was not available to be assessed by the investigators.

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RAC #06005
Exposure Limits for Work Performed in Deep Mechanized Mines

Principal Investigator(s): Glen P. Kenny (University of Ottawa)

Co-Investigator(s): Ollie Jay (University of Ottawa); Stephen Hardcastle (Resources Canada)

Sponsoring Institution: University of Ottawa

Objectives
Using direct calorimetry, the investigators evaluated the dynamics of human heat balance during work in hot environments. Further, the investigators examined the effects of both environmental and non-environmental factors on the development of heat stress in man.

Method
In conjunction with the concurrent physiological monitoring of core and skin temperatures, hemodynamic measures, skin blood flow and local sweat rate, whole-body calorimetry was employed to accurately measure the rates of whole-body evaporative and dry heat exchange as well as the change in body heat content.

Results
The main findings are that for day-to-day mining tasks requiring low energy expenditure: 1) physically fit middle-aged adults appear to cope with the heat stress as effectively as the younger participants and, 2) in a range of ambient conditions from 30^{o}C to 45^{o}C there were no differences in total heat loss and therefore net body heat storage with core temperatures did not exceed the operational work threshold limit of 38.0^{o}C. For intermittent work separated by short bouts of rest, the cumulative increase in body heat storage and core temperature increases with successive exercise bouts, however the magnitude of increase became progressively smaller. Different work/rest intervals influence the change in body heat content for a similar work volume and therefore the time required to reach a core temperature work threshold limit of 38.0^{o}C.

Conclusions
Using appropriately scheduled rest intervals reduces the heat strain on the worker and lengthens the time he/she is able to perform their job in a hot environment. Thermal tolerance may be less a function of chronological age than of functional capacity and physiological health status.

Publications

Kenny G.P., Dorman L.E., Webb P., Ducharme M.B., Gagnon D., Reardon F.D., Hardcastle S.G., Jay O. (2009), "Heat balance and cumulative heat storage during intermittent bouts of exercise." Medicine and Science in Sports and Exercise 41(3):588-596.

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RAC #06007
The Etiology and Reduction of Role Overload

Principal Investigator(s): Linda E. Duxbury (Carleton University)

Co-Investigator(s): Christopher A. Higgins (University of Western Ontario); Sean T. Lyons (St. Francis Xavier University)

Sponsoring Institution: Carleton University

Objectives
This study seeks to increase our understanding of the etiology of role overload (having too many responsibilities and too little time in which to attend to them) and to identify mechanisms by which role overload can be reduced or prevented.

Method
The study was undertaken at four Ottawa hospitals. A multi-method research approach (focus groups (n = 6), surveys (n = 1396), interviews (150)) was used.

Results
What causes overload at work?
- a lack of time (too many commitments, time constraints, and unrealistic work deadlines and work expectations)
- multiple competing priorities
- a lack of help and support
- understaffing
- an inability to control the situation
- a non-supportive organizational culture.

What causes overload at home?
- expectations at work
- a lack of time
- competing demands and priorities
- a lack of help and support
- life cycle stage (eldercare, children at a difficult age)
- an inability to control the situation.

This study links higher levels of role overload with negative emotions, poorer physical and mental health, increased work-life conflict, poorer relationships at work and at home, greater intent to turnover, increased absenteeism, greater use of employee assistance programs, lower commitment and productivity.

The study found that Canadian hospital workers employ a myriad of strategies to cope with role overload but Canadian hospitals provide employees with few supports to help them cope.

What helps prevent overload from occurring?
- supportive management
- being prepared emotionally
- having a plan
- setting priorities
- having a good support team and access to help.

What strategies can health care workers and organizations employ to mitigate the negative impacts of role overload on individual and organizational well-being? Organizations should address the conditions that cause overload at work (the culture, understaffing, complexity of work). Employees who wish to improve their mental and physical health need to make an effort to get enough sleep, put their family first, seek social support from colleagues at work and friends and reduce their use of alcohol and over-the-counter medication.

Conclusions
High levels of role overload are prevalent in Canadian hospitals. High levels of overload engender a number of negative consequences for employers and employees. This study gives employers and employees an incentive to address issues associated with overload and directions on how best to proceed.

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RAC #06008
Exploring the Role and Strategies for Knowledge Exchange and Translation by Injured Worker Groups

Principal Investigator(s): Lynn E. Shaw (University of Western Ontario)

Co-Investigator(s): Joy C. MacDermid (McMaster University); Anita Kothari (University of Western Ontario); Andrea Duncan (Workplace Safety & Insurance Board)

Sponsoring Institution: University of Western Ontario

Objectives
The aim of this study was to understand the barriers and facilitators of knowledge exchange and transfer experienced by Injured Worker Groups (IWGs) and Health Care Professionals (HCPs) in facilitating and brokering knowledge to help injured workers make informed decisions about recovery and return to work.

Method
A participatory action research process guided this exploratory study. A purposeful sampling strategy was used to elicit insights from 63 IWG members, 43 HCPs, and two professional knowledge brokers. Data was collected using informal and formal qualitative methods, such as focus groups, interviews, document reviews and consultations. Data was analyzed using thematic and grounded theory methods.

Results
Barriers in transferring knowledge included system barriers, a lack of information accessibility, and problems with variations in injured worker capacity and experience with using information. In addition, participants indicated they lacked expertise in knowledge transfer. Findings also revealed an interactive knowledge transfer process that synthesized all actions and efforts of participants in helping injured workers understand and use information.

Conclusions
Future steps required to improve knowledge transfer to injured workers include the development of a sustainable knowledge transfer community of practice, a best practice guide for knowledge brokers, and a process for ongoing assessment and evaluation of information needs.

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RAC #06011
Human Factors and Engineering Design Tool Use among Professional Ergonomists and Engineers

Principal Investigator(s): W. Patrick Neumann (Ryerson University)

Co-Investigator(s): Richard Wells, Nancy Theberge (University of Waterloo); Saeed Zolfaghari (Ryerson University); Jonas Laring (Swedish National Institute for Working Life)

Sponsoring Institution: Ryerson University

Objectives
This study investigated the tools and routines used in the daily practice of Canadian ergonomists and industrial engineers. Understanding these two groups is an important step in closing the gap between the practice of engineering and the application of ergonomics in workplaces.

Method
Semi-structured interviews were conducted with 20 Canadian ergonomists and 19 industrial engineers. Interviews were audio recorded, transcribed and thematically coded before analysis was conducted in a research team setting.

Results
Important findings are that ergonomists are heavily engaged in 'organizational work' that extends far beyond the use of standard ergonomics methods. Ergonomists use a broad range of tools, but almost all begin with qualitative assessment using imaging and interviews, with more detailed quantification being used more to convince stakeholders of the need for change than for the identification of solution opportunities per se. Industrial engineers and ergonomists have many similarities, including the need to navigate their organizations to achieve project implementation and the routine inclusion of workers in the development of solutions.

Conclusions
In many cases, the use of exposure quantification tools appears to be unnecessary for the identification of improvement options, but remains helpful to convince skeptical stakeholders of the need for change. Good potential for collaboration between ergonomists and industrial engineers exists, but remains underutilized.

Publications

Theberge N., Neumann W.P. (2010), "Doing 'Organizational Work': Expanding the Concpetion of Professional Practice in Ergonomics." Applied Ergonomics 42:76-84.

For more information:

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RAC #06014
Developing Facilitation for Primary Occupational Health Care

Principal Investigator(s): Grant M. Russell (University of Ottawa, C.T. Lamont Centre)

Co-Investigator(s): William E. Hogg (C.T. Lamont Centre); Jacques Lemelin (University of Ottawa, C.T. Lamont Centre)

Sponsoring Institution: University of Ottawa

Objectives
The objective of the project was to develop a protocol to test the effectiveness of outreach facilitation on improving occupational health outcomes in primary care.

Method
This developmental study was conducted in conjunction with a project advisory board representing key stakeholders in occupational health. The project team reviewed and collated recent literature concerning practice improvement strategies and occupational health care. Study materials were prepared following a literature review. These included: a) a regionally orientated, evidence based primary care resource guide b) a curriculum for outreach facilitator training, and c) an instrument for assessing occupational health needs within primary care practices. These materials were used in the piloting of an outreach facilitation program aimed to optimise the delivery of occupational care in the primary care setting. An evaluation of the pilot study informed the subsequent preparation of a protocol for a randomised trial of facilitation, the main output of the project.

Results
A protocol titled: "A Cluster Randomised Trial of the Effectiveness of Outreach Facilitation on Improving Occupational Health Outcomes in Primary Care" was completed. The protocol is suitable for subsequent presentation to a funding agency. The secondary output, the Resource Guide, designed both to support primary care practices and to act as a supplement to the Outreach Facilitator Training Manual was produced in paper and electronic format. Insights from the project advisory board and findings from the pilot study confirm the importance of further work in this area.

Conclusions
Outreach facilitators, in addition to providing tailored support to practices also have the potential to improve communication between stakeholders. The protocol is designed to test whether this potential translates into measurable reductions in lost time from work.

For more information:

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RAC #06019
Ergonomics in the Transportation Sector: The Development of Best Practices in MSD-Reduction Strategies

Principal Investigator(s): Richard P. Wells (University of Waterloo)

Co-Investigator(s): Mark J. Diacur (Transportation Health & Safety Association of Ontario); Desre M. Kramer (University of Waterloo); Philip Bigelow (Institute for Work & Health)

Sponsoring Institution: University of Waterloo

Objectives
This collaborative project with the Transportation Health and Safety Association of Ontario (THSAO) had as its objective the development of feasible and effective interventions to prevent musculoskeletal disorders (MSDs) in the transportation sector.

Method
Using workshops and cross-functional teams in six participating companies (courier, long haul and less-than-truckload (LTL), flat bed and waste subsectors) detailed task analyses were performed. High demand tasks were identified and prioritized in a cross-company workshop and a wide range of interventions were developed. The process was book-ended by two conferences, each with international speakers.

Results
Potential interventions and guidance were described in a series of tip sheets. This information can be found on the Centre of Research Expertise for the Prevention of Musculoskeletal Disorders (CRE-MSD) website under the "Transportation" tab located in the "Research to Practice" section of the website (www.cre-msd.uwaterloo.ca).

Conclusions
The participatory approach allowed the identification of a large number of higher demand tasks that could increase the risk of developing MSDs. The involvement of the transportation companies allowed the identification of countermeasures that had a high likelihood of reducing MSD risk and were feasible for the sector.

Publications

Kramer D.M., Wells R.P., Bigelow P.I., Carlan N., Cole D.C., Hepburn C.G. (2010), "Dancing the two-step: Collaborating with intermediary organizations as research partners to help implement workplace health and safety interventions." Work 36(3):321-322.

Marshall J., Wells R. (2011), "Evaluating the Physical Demands of Three Tarping Systems for Flatbed Transport Trailers." Work 39:125-140.

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RAC #06025
A Pilot Study towards a Virtual Workspace Design Tool for Ergonomic Assessment of Vision and Arm Function

Principal Investigator(s): Farrokh Janabi-Sharifi (Ryerson University)

Co-Investigator(s): Patrick Neumann (Ryerson University); Anne Moore (York University)

Sponsoring Institution: Ryerson University

Objectives
The *long-term objective* of this research is to develop an ergonomic evaluation tool addressing the arm, neck and visual systems jointly. The *short-term objectives* included enabling the researchers to build industrial partnerships and conduct pilot work to ensure the compatibility of the methods and conceptual models that will be required in a full project.

Method
Pilot-studies were conducted to investigate the feasibility of integrating human kinematic data in simulated assembly work with preliminary visual system models.

Results
Worker's head location was shifted to maintain a 25 degree gaze angle with respect to the plane of the active forearm. The trade off between head postures required to maintain adequate visual line of sight and the shoulder postures required to reach a point on the workspace were simultaneously determined in order to highlight places within the workspace that minimize postural loads while maintaining visual performance. An industry partner was found who will integrate the proposed model into their digital human software making the research results readily accessible to Ontario workplaces.

Conclusions
This pilot work confirms that the proposed R/D program to develop an integrated model of vision /arm function is realistic and feasible. This tool will help designers optimize performance while minimizing health risk to Ontario workers.

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RAC #06026
An Examination of the Working Conditions and Risk Factors for Work-Related Injuries among Immigrant Workers in Ontario

Principal Investigator(s): Peter M. Smith (Institute for Work & Health)

Co-Investigator(s): Cameron Mustard (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
The aims of this research project were to:
- describe the labour market experiences of immigrant workers in Ontario and Canada;
- examine if recent immigrants were at higher risk of work-injury than Canadian-born workers; and
- examine if immigrants were less likely to receive compensation after a work-related injury.

Method
To examine these questions we utilized numerous secondary data sources collected by Statistics Canada. These included the Survey of Labour and Income Dynamics (SLID); the Canadian Community Health Survey (CCHS), and the Longitudinal Survey of Immigrants to Canada (LSIC). We also examined numerous outcomes related to work conditions, work injury and compensation after injury. These were:
1. underemployment – related to hours worked per week, weeks worked per year, and education utilized in their current occupation;
2. work-related occupational health and safety risk factors – membership in a union or collective bargaining agreement; employment in physically demanding occupations; employment in a workplace with less than 20 employees; regular shift work; irregular shift work and having non-permanent employment;
3. risk of an activity limiting workplace injury in the previous 12 months;
4. not receiving any type of wage replacement after a work-related absence of seven or more days; and
5. movement into an occupation with greater physical demands after arrival in Canada compared to the job in which the respondent had their previous non-Canadian experience.

For the first four outcomes immigrants were compared to the Canadian-born labour market participants. For the fifth outcome (movement into an occupation with greater physical demands) we examined probabilities of this movement for different sub-groups within a cohort of recent immigrants to Canada.

Results
We found that compared to Canadian-born workers, recent immigrants to Canada were at increased risk for all types of underemployment that we examined. Of the six occupational health and safety risks that we examined we found that our main independent variables describing aspects of immigration status were associated with five; the exception being regular shift work. Recent immigrant men had almost twice the risk of an activity limiting work-related injury that required medical attention, compared to Canadian-born men. Surprisingly this risk was driven by the very high percentage of immigrant men who required medical attention for their work injuries. No excess risk was found among female immigrants compared to Canadian-born female labour market participants. The probability of not receiving employer or workers' compensation benefits was higher among women, immigrants in their first 10 years in Canada, younger workers, respondents who were in their first year of a job, those who were not members of a union or collective bargaining agreement, and part time workers. And finally, in the cohort of recent immigrants (the LSIC) we found that respondents with poorer language skills and lower levels of education, and family class or refugee applicants were the most likely to be employed in occupations with higher physical demands at both two- and four-years post arrival in Canada.

Conclusions
This investigation is one of the first to examine the labour market conditions (outside of income) among immigrants to Canada, compared to Canadian-born workers. In particular we are not aware of any studies that have documented various occupational health and safety risk factors among immigrants to Canada. We found that recent immigrants to Canada are faced with a number of occupational health and safety risks which, based on our analysis of the CCHS, put them at increased risk of work-related injuries that require medical attention. In addition, recent immigrants were at an increased risk for not receiving any compensation following a work-related absence of 7 days or longer. However, there are still considerable gaps in our knowledge about immigrant workers. The SLID and the CCHS were not designed to specifically examine immigrant labour market experiences. As such in each study the sample of immigrants was quite small. In addition, based on the responses to injury questions in the CCHS we have reservations about this data source's ability to accurately estimate the burden of injuries among recent immigrants to Canada. We recommend an increase in the surveillance of both immigrant occupational health and safety risks and in accurately estimating the burden of injury, and its consequences, among recent immigrants to Canada. Given the occupational health and safety risks we have documented among immigrants, we also recommend that the timely provision of information on occupational health and safety to immigrants before they start working should be a priority to help protect the health of immigrants as they integrate into the Canadian labour force.

Publications
Smith P.M., Mustard C.A. (2009), "Comparing the risk of work-related injuries between immigrants to Canada and Canadian-born labour market participants." Occupational and Environmental Medicine 66(6):361-367.

Smith P.M., Mustard C.A. (2010), "The unequal distribution of occupational health and safety risks among immigrants to Canada compared to Canadian-born labour market participants: 1993-2005." Safety Science 48:1296-1303.

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RAC #06031
Key Exposures Causing Work-Related Allergic Contact Dermatitis and Evidence for Dual Causation of Occupational Asthma

Principal Investigator(s): D Linn Holness, Gary M. Liss (St. Michael's Hospital)

Co-Investigator(s): Susan M. Tarlo, Irena Kudla (St. Michael's Hospital); Melanie Pratt (University of Ottawa); Denis Sasseville (McGill University)

Sponsoring Institution: St. Michael's Hospital

Objectives
The objectives of this study were to investigate the most common occupational contact allergens (OCA) and determine whether these agents caused occupational asthma (OA).

Method
Patch test data for 3676 patients from two Canadian centres from 2001 to 2006 were analyzed. Once the 10 most common occupational allergens were identified, the occupational asthma literature was searched to determine if the agent was associated with OA. Results were discussed with stakeholders and researchers.

Results
The ten most common OCA were: epoxy resin, thiuram, carba mix, nickel sulfate, cobalt chloride, potassium dichromate, glyceryl thioglycolate, pphenylenediamine, formaldehyde and glutaraldehyde. The seven of these that were associated with OA were components of epoxy resin systems, nickel sulfate, cobalt chloride, potassium dichromate, p-phenylenediamine, formaldehyde, and glutaraldehyde.

Conclusions
Unrecognized or uncontrolled exposure to these agents through either dermal or inhalation routes of exposure may lead to work-related allergic disease. Awareness of these associations may result in opportunities for recognition and prevention. Workplace stakeholders felt that there may a lack of recognition that both skin and lung exposure routes were possible routes of exposure to these occupational agents. Researchers thought that over time the data may be useful for identifying common or emerging occupational contact allergens.

Publications

Arrandale V.H., Liss G.M., Tarlo S.M., Pratt M.D., Sasseville D., Kudla I., Holness D.L. (2012), "Occupational Contact Allergens: Are They Also Associated with Occupational Asthma?" American Journal of Industrial Medicine 55:353-360.

For more information:

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RAC #06032
Prostate Cancer and Occupational Whole-Body Vibration Exposure

Principal Investigator(s): James T. Purdham (University of Toronto)

Co-Investigator(s): Alan W. Salmoni (University of Western Ontario); Nancy Kreiger (Cancer Care Ontario); Andrea M. Sass-Kortsak (University of Toronto); Marie-Elise Parent (Institut National de la Recherche Scientifique/Université de Quebec); Jack Siemiatycki (University of Montreal)

Sponsoring Institution: University of Toronto

Objectives
The aim of the study was to determine whether whole body vibration (WBV) exposure in the workplace is a risk factor for prostate cancer.

Method
Existing data were used from a Montreal population-based case-control study which included 449 incident male cases (or proxies) and 533 population controls. Face-to-face interviews had been used to collect data for a detailed job description for each job held, tasks completed, and type of equipment used. From this data, an expert assessment was made of the intensity of WBV exposure and its daily duration for every job held by each subject. Prior to the full exposure assessment, trials of inter-rater agreement were conducted between the two expert assessors, with the degree of agreement determined by the κ statistic. The data were then analyzed using logistic regression models to explore the relationship between WBV exposure and prostate cancer incidence. A variety of exposure variables were examined based on combinations of intensity, daily duration and years of exposure, and allowing for a number of potential confounders.

Results
Inter-rater agreement on WBV exposure was excellent with κ statistics in trials ranging from 0.83–0.94. Occupations with exposure to WBV showed increased risk, but do not reach significance (OR = 1.44, CI = 0.99–2.09). The risk is significantly elevated for work in transport equipment operation (OR = 1.90, CI = 1.07–3.39). None of the derived WBV exposure variables was significantly associated with prostate cancer, nor was there any evidence for a dose-response relationship. The limitations of the study were evaluated.

Conclusions
These results, together with findings from an earlier study, suggest that workers involved in heavy equipment and transport equipment operation are at an increased risk of prostate cancer. Further investigation is warranted, which should include WBV exposure assessment, but take into account of the frequency of vibration.

Publications

Young E., Kreiger N., Purdham J., Sass-Kortsak A. (2009), "Prostate cancer and driving occupations: Could whole body vibration play a role?" International Archives of Occupational and Environmental Health 82(5):551-556.

For more information:

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RAC #06104
Developing a Tool for Engineering Design That Will Predict the Effort Required by the Hand and Wrist during Manual Work

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Co-Investigator(s): Desre M. Kramer, Clark Dickerson (University of Waterloo); Carolin Bart (Daimler Chrysler); Wyatt Clark (Canadian Auto Workers)

Sponsoring Institution: University of Waterloo

Objectives
Hand force is the dominant risk factor for fatigue and musculoskeletal disorders of the hand and wrist. It is also challenging to measure hand force or predict it for most tasks, e.g., inserting a part. Therefore, the objective of the project is to develop a software tool that can be used during design and provide engineers and others with information on the strength of the hand and forearm required to perform a particular task when the design specifications are known. Along with this, the use of manual task simulations to estimate the demand of a more realistic task will be investigated. In addition, the ability of tabulated measures of hand strength to predict the demands on workers' hands is assessed. Such an approach could also be used to assess existing tasks either on the assembly line or from a simulated task.

Method
Two questions were addressed:
1) How to estimate the demand of work tasks based upon a large database of efforts previously collected and
2) Determine how well laboratory strength data can be transferred to work tasks and studying how different ways of simulating tasks affects the estimated demand.

Results
From the two parts of the project:
- Software to perform the modelling of the laboratory exertions was specifically written and was used to predict perceived exertion and muscle activity for different percentiles of men and women.
- The simulation study identified a number of aspects of the simulations that significantly affected the measured demands. Also of interest was that perceived exertion and grip force matching were most consistent across the different simulations but was highly variable between people, thereby requiring multiple people to rate a task.
- A set of recommendations for practitioners was created.

Conclusions
- The software tool developed can successfully estimate hand demands without the necessity of measuring grip force.
- It was found that normative strength data collected in the laboratory, as well as task simulation can be successfully transferred to work tasks but typically underestimate demand.
- Once hand force is known, it can be input into a variety of risk assessment methods.

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RAC #06106
Assessment Tools for Non-Fixed Work

Principal Investigator(s): Anne E. Moore (York University)

Co-Investigator(s): Peter Vi, Enzo Garritano (Construction Safety Association of Ontario); Richard P. Wells (University of Waterloo)

Sponsoring Institution: York University

Objectives
The goal of this study was to compare the ability of a range of ergonomic assessment tools and ratings of perceived exertion to distinguish between tasks performed in a non-fixed environment.

Method
Postural data of the trunk and upper limb were collected from fourteen male rod workers from five different sites for an average of six hours each. For each task performed, weights of tools/parts touched, environmental conditions, perceptual ratings of discomfort of the low back and wrist and exertion of lifting and grasping were recorded. For the seven most commonly performed tasks, post hoc analysis included Strain Index (SI), Rapid Upper Limb Assessment (RULA), Rapid Entire Body Assessment (REBA), National Institute for Occupational Safety and Health Lifting Equation (NIOSH LE) and Liberty Mutual tables.

Results
SI, Snook Maximum Acceptable Weight of Lift (MAWL), NIOSH LE and the four perceptual scales distinguished between tasks. Tying on slab had the highest SI, Ratings of Perceived Exertion (RPE) grasping, Ratings of Perceived Discomfort (RPD) wrist and RPD low back. SI ranked tasks similar to RPD wrist and RPE grasping. NIOSH LE reflected load lifted and Snook MAWL distinguished lifting conditions used.

Conclusions
In future studies assessing risk of non-fixed work, particularly in work involving both heavy lifting and forceful hand tasks, RPE, RPD, NIOSH LE, Snook MAWL and SI show the greatest ability to differentiate between tasks in a manner consistent with work-related musculoskeletal disorder risks.

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RAC #06107
Hand and Upper Extremity Function in Workers with Occupational Contact Dermatitis

Principal Investigator(s): Sharon L. Switzer-McIntyre (University of Toronto)

Co-Investigator(s): D. Linn Holness, Dorcas Beaton (St. Michael's Hospital); Rosemary Nixon (Occupational Dermatology Research and Education Centre)

Sponsoring Institution: University of Toronto

Objectives
The objectives of this project were to:
- describe upper extremity (UE) musculoskeletal findings and health-related quality of life, UE function, and ability to work among individuals with hand dermatitis
- determine factors associated with work productivity.

Method
Data were obtained for 62 participants from a musculoskeletal examination and a patient-reported survey which included the following questionnaires: Short Form (36) Health Survey (SF-36); Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH); Work Instability Scale; and Work Limitations Questionnaire. Variables most strongly associated with productivity were identified using multiple regression.

Results
Finger joint restrictions and numbness were moderate-to-severe in 30.0% and 28.6% of subjects, respectively. Positive Tinel's and/or Phalen's Tests occurred in 24.6% of participants. The study found that 15.8% of subjects had a SF-36 Mental Component Summary score of less than 30. The mean QuickDASH score was 30.2. Among subjects, 47.5% reported moderate-to-high work instability and 31.4% reported a greater than 10% decrease in productivity. Among participants, 19.2% missed more than 5 weeks of work in the past year; 28.1% of subjects were doing a different job (19.3%) or not working (8.8%). Worse UE function and mental health were associated with reduced productivity (r = 75.6%).

Conclusions
Hand dermatitis is associated with musculoskeletal findings in the hand and wrist and decreased mental health, UE function, and ability to work. Assessment should include more than the severity of skin changes.

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RAC #06108
Why Is Occupational Disease Under-Reported?

Principal Investigator(s): Ronald A. House, Joan Eakin (St. Michael's Hospital)

Co-Investigator(s): D. Linn Holness (St. Michael's Hospital)

Sponsoring Institution: St. Michael's Hospital

Objectives
This pilot study was carried out to explore the conceptual basis and substantive issues influencing recognition and reporting of occupational disease.

Method
The study used a qualitative design with seven focus groups selected to represent key stakeholders in occupational health and safety. The focus groups included Ontario Workplace Safety and Insurance Board (WSIB) front line occupational disease team members, WSIB front line operations team members, WSIB directors, health care professionals, union/worker representatives, employers and ill and/or injured workers.

Results
The evaluation of core concepts indicated that some factors such as (1) recognition and reporting and (2) disease and injury need to be considered as separate phenomena with potentially different determinants. The main new unit of analysis identified was stakeholder location and, in particular to whom stakeholders are accountable, which may be associated with different perspectives within and between stakeholder groups. Three main determinants of recognition and reporting were identified including: (1) psycho-social factors, (2) workplace cultural factors, and (3) systemic and structural factors.

Conclusions
This qualitative pilot study has identified key concepts, units of analysis and determinants of recognition and reporting that should be considered in future research.

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RAC #06109
Economic Perspectives on Workplace in a Return to Work Program

Principal Investigator(s): J. David Cassidy (University Health Network)

Co-Investigator(s): Eleanor Boyle, Sylvia Boddener (University Health Network); Emile Tompa, Sheilah Hogg-Johnson (Institute for Work & Health); Michel Schofield (Workplace Safety & Insurance Board)

Sponsoring Institution: University Health Network

Objectives
Although workplace return-to-work (RTW) interventions have been shown to be cost effective, previous economic analyses have focused on the insurer's perspective. Employers can also incur costs when supporting the RTW of their employees. The overall purpose of this study was to develop an instrument for identifying and measuring costs incurred by employers when injured workers are involved in a RTW program. The objectives of this project were to identify a key set of items for estimating the costs of RTW interventions from the employer's perspective, and to identify and value the costs and consequences of a RTW intervention.

Method
The investigators conducted a survey of 10 workplaces with RTW programs. The survey consisted of semi-structured interviews with a human resources or occupational health and safety representative from each enrolled workplace.

Results
The investigators identified key items for estimating the costs of RTW interventions from the employer's perspective. Employers' identified the following items: medical, equipment, training and education, wage replacement and productivity, and claims administration costs when assisting an employee's RTW.

Conclusions
Even in a jurisdiction with workers' compensation insurance, employers incur costs associated with RTW programs. It is important to consider these costs, from the perspective of the employer, when studying the cost-effectiveness of RTW interventions or programs.

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RAC #06110
What Workplace Characteristics Have an Impact on an Injured Worker's Return to Work? A Qualitative Study

Principal Investigator(s): Eleanor E.W.G. Boyle (University Health Network)

Co-Investigator(s): Ivan A. Steenstra (Institute for Work & Health); Jill Hayden, J. David Cassidy, Stephanie Wyeld (University Health Network); Richard Wells (University of Waterloo)

Sponsoring Institution: University Health Network

Objectives
Previous research which has attempted to predict the reasons that delay or encourage early and safe return to work from musculoskeletal injuries, has identified factors associated with the injury, the worker, and the work. However, it has been found that these factors are not able to fully explain the pathways to successful return to work of an injured worker. It was thought that specific information on the interactions in the workplace among the stakeholders involved including organizational policies would further assist in explaining the return to work outcome. Therefore, the objective of this study was to determine what workplace factors and organizational factors may have an influence in the return to work process.

Method
Focus groups were conducted with the individuals who are considered to be the stakeholders involved with returning an injured nurse back to work. There were a total of nine focus groups conducted. Three focus groups were comprised of nurses who received a work-related injury, two focus groups involved nursing managers who had experiences with returning an injured nurse back to work, and one focus group involved each of the following groups of individuals: return-to-work coordinators, WSIB mediators and WSIB ergonomists, Ontario Nursing Association (ONA) union representatives, and occupational health nurses who were responsible for returning injured nurses back to work. Various recruitment strategies were used for the focus group assembly which involved invitation letters, presentations to stakeholders and key informants. Each focus group lasted for one hour, were audio-recorded and transcribed verbatim.

Results
Three major themes, with various sub-themes, emerged from the analysis as challenges and facilitators for returning an injured nurse back to work as follows: organizational factors, communication factors, and personal belief factors.

The organizational-related factors are considered to be issues that can only be changed at the organizational level. The injured nurses and nursing managers discussed their concerns with the equipment, lack of continual safety education, and suggested a need for ergonomic education. Some of the injured nurses were unaware of the process of reporting their injury and to which WSIB benefits they were entitled. Participants from all focus groups discussed the challenges of finding suitable modified work on the unit where the nurse was injured. The uncertainty of the patient load, the physical nature of the job at the bedside, and the staff ratio of nurses on modified duties were factors that hampered the offer of modified duties on the unit. It was also noted that not all of the nurses may have all the necessary qualifications which would allow them to be assigned to another role which is less physical in nature. There were suggestions on how these challenges could be improved by each stakeholder group. Some of these suggestions included the re-training of the injured nurses to different occupations that align with their interests or offering the 80/20 system to the injured nurses where 20% of their time is off of the unit. Another suggestion involved creating a job listing of the available 'short-term' jobs.

The communication-related factors encompass the interactions the injured nurse has with each stakeholder involved with returning himself/herself to work. There was a lot of

miscommunication among the stakeholders. Therefore, it would be helpful to inform everyone of the roles and responsibilities of each group involved in the process, namely the nurses, the nursing managers, the occupational health nurses, the ONA and the WSIB, in order to clarify the process of communication. Although this information is presented during the orientation sessions, it can be easily forgotten. The injured nurses, the ONA representatives, and the nursing managers suggested that it might be helpful if the work restrictions of the injured nurse were posted so that everyone would be aware of his/her physical abilities while on modified duties. This would improve the communication among the staff on the unit on all shifts because then everyone would know why a certain individual was not being assigned any "heavy" patients.

The injured nurses' perceptions of how they were treated comprised the personal belief factor. Some of the injured nurses expressed they were not feeling useful to the organization. The injured nurses also had feelings they were being pressured to retire early or were labelled as "damaged goods".

Conclusions
The injured nurses did encounter problems during the return-to-work process. These problems were acknowledged by the injured nurses, the nursing managers, the ONA, the WSIB, and the occupational health nurses. Overall, there is a basic underlying understanding of the problems each stakeholder faces in returning an injured nurse back to work successfully. The key factor is communicating any problems that may arise to the appropriate stakeholder in order to assure a successful return to work for an injured nurse.

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RAC #06112
Prevention System OHS Management Audit Tools: Description, Content Validation and an Assessment of the Feasibility of Measurement Research

Principal Investigator(s): Lynda Robson (Institute for Work & Health)

Co-Investigator(s): Philip L. Bigelow, Dwayne Van Eerd, Garry Gray (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
1. Describe the audit methods of the Ontario Prevention System.
2. Examine their content validity.
3. Determine the feasibility of further study of reliability and validity

Method
Data were collected through interviews, review of documents and observations of audits. Features of audit methods and their associated programs were described and compared. A content validity analysis compared the content of methods with CSA Z1000, an OHS management system standard.

Results
Seventeen audit methods from the Ontario Prevention System were studied. Similarities and differences among methods and their associated programs were found on aspects such as the structure of the auditing function in the auditing organization, the recruitment and training of auditors, quality control practices, sampling, and the judgment of audit evidence against audit criteria. On average the methods represented 74% of the CSA Z1000 content partially or fully.

Conclusions
1. A wide variety of audit methods are used in the Ontario Prevention System.
2. The more comprehensive audit methods represent the content of the recent Canadian OHS management system standard CSA Z1000 well overall. Management elements that are more characteristic of system approaches to OHS management are represented more weakly.
3. Further measurement studies of Prevention System audits are feasible.

Publications

Robson L.S., Macdonald S., Van Eerd D.L., Gray G.C., Bigelow P.L. (2010), "Something Might Be Missing from Occupational Health and Safety Audits: Findings from a Content Validity Analysis of Five Audit Instruments." Journal of Occupational and Environmental Medicine 52(5):536-543.

Robson L.S., MacDonald S., Gray G.C., Van Eerd D.L., Bigelow P. (2012), "A Descriptive Study of the OHS Management Auditing Methods Used by Public Sector Organizations Conducting Audits of Workplaces: Implications for Audit Reliability and Validity." Safety Science 50:181-189.

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RAC #06116
Design Guidelines for Dynamic Behaviour of Ground Support Tendons

Principal Investigator(s): Chantale Doucet (Natural Resources Canada)

Sponsoring Institution: Natural Resources Canada

Objectives
The objectives of the first phase of the project were: (1) to produce technical information data sheets for each support element, which will be used as guidelines and data input for design, and (2) to identify the gaps in the existing knowledge to orientate the future research and testing. The ultimate objective of the project is to produce documented standards and functional support assemblies (and systems) for the reinforcement of rock mass excavations under dynamic loading, and methods to estimate their strength and predict their behaviour.

Method
A general review of literature and technical data released on the subject over the last two decades was carried out, along with a gap analysis.

Results
Technical information data sheets were prepared for most ground support elements used in Ontario mines. However, only ground support elements specifically designed for use in dynamic conditions have been tested until now to determine their behaviour under such conditions. Gaps and future research directions were identified.

Conclusions
The compilation and analysis of the available data were used to define a road map for the next phases of the project. Most of the gaps identified should be addressed within the second phase of the project.

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RAC #07006
Development and Evaluation of a Novel Shoulder Occupational Exposure Analysis Tool

Principal Investigator(s): Clark R. Dickerson (University of Waterloo)

Co-Investigator(s): Jack P. Callaghan (University of Waterloo); Richard Wotherspoon (Cooper Standard Automotive)

Sponsoring Institution: University of Waterloo

Objectives
The objective of this project was to provide ergonomists with access to more detailed biomechanical evaluations of shoulder occupational tasks. This access was envisioned as a stand-alone tool that provides insight into both cumulative and acute stressors to the musculoskeletal elements of the shoulder.

Method
Five major steps achieved the tool: 1) biomechanical metrics were extracted from a known industrial exposure set; 2) these metrics were correlated with self-reported discomfort and injury data; 3) a reduced set of influential biomechanical factors were extracted; 4) a model and graphical user interface for converting field exposure data into biomechanical exposure data were generated; and 5) the tool was pilot evaluated by practicing ergonomists.

Results
A preliminary tool, named the STAR (Shoulder Task Analysis and Redesign) Tool has been created that relies on modest inputs and produces an overall estimate of shoulder exposure. The model has been partially vetted with industrial parties.

Conclusions
A body of work has enabled the development of a novel analysis tool for shoulder exposures. This sets the stage for further integration and beta testing of the tool with practicing ergonomists. The eventual goal is to create a practical, informative, widely available tool for implementation across occupational sectors.

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RAC #07007
Guidelines for the Development of Re-Entry Protocols in Seismically Active Mines

Principal Investigator(s): Stephen D. McKinnon (Queen's University)

Co-Investigator(s): Kristy Tiampo (University of Western Ontario)

Sponsoring Institution: Queen's University

Objectives
Following a large seismic event in hard rock mines, there is a short-term increase in aftershock activity, which over time decays to background levels. During this time of elevated seismic activity the risk of aftershocks with sufficiently high magnitude to cause damage is high. Workers are therefore restricted from re-entering affected areas for a specified time period. This is the re-entry protocol. The overall goal of the project was to produce reliable practical guidelines for the development of re-entry protocols in seismically active mines for the range of mining conditions found in Ontario.

Method
The first phase of the project involved a review of current re-entry. The second phase focused on a detailed statistical analysis of 252 aftershock sequences from seven different mines, representing a wide range of geological and mining conditions.

Results
For mines with a significant seismic database, a probabilistic approach for presenting and analyzing seismicity data in real time was developed. For mines with limited historical seismicity, generic guidelines were developed.

Conclusions
Re-entry protocols used previously were largely based on empirical experience at particular mine sites. The current methodology presents a uniform approach, including the capability to quantify the degree of confidence in real-time.

Publications
Cho N., Tiampo K.F., McKinnon S., Vallejos J., Klein W. (2010), "A simple metric to quantify seismicity clustering." Nonlinear Processes in Geophysics; Special Issue on Geocomplexity: Novel Approaches to Understanding Geosystems 17:293-302.

Vallejos J.A., McKinnon S.M. (2010), "Omori's law applied to mining-induced seismicity and re-entry protocol development." Pure and Applied Geophysics 167(1):91-106.

Vallejos J.A., McKinnon S.M. (2011), "Correlations between mining and seismicity for re-entry protocol development." International Journal of Rock Mechanics and Mining Sciences 48(4):616-625.

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RAC #07014
An Ethnographic Study of Process and Experience with Labour Market Re-Entry

Principal Investigator(s): Ellen MacEachen (Institute for Work & Health)

Co-Investigator(s): Agnieszka Kosny, Renee-Louise Franche (Institute for Work & Health); Katherine Lippel (University of Ottawa)

Sponsoring Institution: Institute for Work & Health

Objectives
In research on return to work following a work injury, relatively little attention is paid to the situation of workers who cannot return to their pre-injury employer. This study examined how a vocational rehabilitation program for workers' compensation claimants was organized and functioned and some of the challenges related to design and implementation of the program.

Method
A qualitative, exploratory approach was used to gain an understanding of the functioning of Ontario's Labour Market Re-Entry (LMR) program. Workers enter this program if they cannot return to work with their pre-injury employer, usually because a permanent injury has changed their ability to continue in that form of employment. The study design was informed by institutional ethnography, discourse analysis, and grounded theory. Data consists of 71 interviews with key LMR program actors and documents that provided procedural, legal and financial context.

Results
The analysis identifies a contradiction between the LMR program design and ongoing worker health problems. The LMR program cast worker injury as an accommodated issue that did not interfere with vocational rehabilitation. However, workers and providers regularly faced retraining problems because of workers' unstable and ongoing health problems. Explanations for the problem of worker ill health in the retraining program were found in three key areas. First, employers had incentives to send unhealthy workers to the program; second, workers were conceptualized as at a health 'plateau'; and third, communication barriers existed among different system parties. In the end, workers who completed the LMR program were deemed employable but were actually in a vulnerable and uncompetitive position in the labour market.

Conclusions
This examination of the micro-dynamics of a vocational retraining program sheds light on some mechanisms behind costs and outcomes for workers in the role of system design and process. Discourse, or terminology, frames thinking about issues and can conceal or open up new avenues for vocational rehabilitation. Worker-focused interventions should include individual, social and environmental issues related to the worker's situation but their viability requires attention to financial and power relations within organizational processes.

Publications

MacEachen E., Kosny A., Ferrier S., Lippel K., Neilson C., Franche R.L., Pugliese D. (2012), "The 'Ability' Paradigm in Vocational Rehabilitation: Challenges in an Ontario Injured Worker Retraining Program." Journal of Occupational Rehabilitation 22:105-117.

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RAC #07015
Immigrant Workers' Experiences after Work-Related Injury and Illness

Principal Investigator(s): Agnieszka Kosny (Institute for Work & Health)

Co-Investigator(s): Ellen MacEachen, Peter Smith (Institute for Work & Health); John Shields (Ryerson University)

Sponsoring Institution: Institute for Work & Health

Objectives
Immigrants often come to Canada for the purpose of employment and make up a large proportion of our labour force. Yet, these workers' labour market experience may not always be positive – new immigrant workers can have difficulties finding a job in their field and may end up working in "survival jobs" that expose them to workplace hazards. Workers who are new to Canada may not be familiar with legislation designed to protect them at work or with social programs that can help after a work-related injury. This study sought to explore the experiences of new immigrants after they were injured on the job, including workers' knowledge of their rights, encounters with employers and health care providers, and experiences with injury-reporting and claim filing.

Method
During this study in-depth interviews were conducted with service providers (n=14) who worked closely with new immigrant workers. These included physicians, settlement workers, workers' compensation employees, and legal representatives. New immigrants (n=28) who had experienced a work-related injury were also interviewed. Most of the workers who were interviewed came from Asia and arrived after 1996. Eight of the 28 workers interviewed had not filed a workers' compensation claim after their injury.

Results
The analysis revealed that at the time of their injury many workers were in manual, "survival jobs" and had not received job or occupational health and safety training. Many did not speak the English language well and did not know very much about their rights. While workers often felt trepidation about reporting their injury, most told a health care provider or employer that they were injured or in pain. This, however, rarely led to timely or appropriate claim filing. Workers were often discouraged from filing a claim, misinformed about their rights or offered "time off work" in lieu of reporting the injury to WSIB. In instances where a claim was filed, communication problems were common and led to mistakes being made on forms and misunderstandings with the adjudicator and employer. Interpretation services were not always offered consistently or at the correct time in the compensation process.

Conclusions
Efforts must be made to systematically inform new immigrants of their health and safety rights, responsibilities and entitlements as they are entering the labour market. Systems must also be put in place to ensure that new immigrants can successfully access the compensation system in the event of a work-related injury and that employers and health care providers fulfill their reporting responsibilities.

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RAC #07016
Examining Changes in Injuries Submitted as No-Lost-Time Claims in Ontario between 1991 and 2005

Principal Investigator(s): Peter M. Smith (Institute for Work & Health)

Co-Investigator(s): Cameron A. Mustard, Sheilah Hogg-Johnson (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
The objective of this project was to conduct the first trend analysis of the rates and associated health care costs of no-lost-time claims (NLTCs) in Ontario between 1991 and 2006. Further, it sought to extract detailed injury information, which is collected, but not stored or reported, for approximately 9,250 NLTCs, to examine changes in the types of injuries submitted as no-lost-time claims during the implementation of the New Experimental Experience Rating (NEER) program.

Method
The first section of this project utilized administrative information on NLTCs and lost-time claims reported over the same period, together with labour force survey estimates, to examine trends in lost-time and no-lost-time claim rates across various labour force sub-groups between 1991 and 2006. The second section of the project examined health care use (cost and duration) associated with no-lost-time claims between 1991 and 2006. This section used multiple regression modelling techniques to examine yearly trends in no-lost-time claim health care costs, while accounting for industrial and demographic labour market changes. The third section examined differences in the nature and events related with no-lost-time claims over the period 1991 to 2006, focusing on differences across firms with different premium payments and workplace size. This section of the project extracted injury information (nature of injury and event leading to injury) from 9,250 allowed no-lost-time claims with an accident date in 1991, 1996, 2000 and 2005 from firms covered under the NEER experience rating program. These years were selected as they refer to the time periods before the NEER program became mandatory (1991), after the NEER program became mandatory (1996), after the introduction of legislation in 1997-1998 to promote early return to work (2000) and a more recent accident year (2005). The final section, using administrative data only, examined differences in no-lost-time and lost-time claim reporting before and after changes to day-light savings (DST) in Ontario in the years 1993 to 2006.

Independent variables in all sections of the project included the accident year, the age and gender of the claimant and the industry in which the claimant's workplace operates. In addition, for sections two and three, information was also included on the payroll reported by their employer to the WSIB (estimated as full-time equivalents of payroll – grouped into four different payroll sizes).

Results
The first section of the project found that the factors associated with no-lost-time claims and lost-time claims differed, with differences in associations found between models examining no-lost-time claims and lost-time claims present among all independent variables used. Noteworthy differences were those observed among industry groups. In the fully adjusted models – relative to the reference industry of retail trade – mining and utilities and the construction industries were associated with an increased probability of reporting no-lost-time claims, but a decreased probability of reporting lost-time claims. Differences in probability estimates for lost-time and no-lost-time claims were also observed across gender and age groups.

Focusing on health care expenditures for no-lost-time claims between 1991 and 2006, the second section reported a decline in health care expenditures between 1991 and 1997,

followed by an increase in health care expenditures between 1998 and 2006. These trends were generally similar across demographic and industrial subgroups. In addition, this study found that the probability of receiving subsequent health care also increased over time, as did the probability of receiving health care between 31 and 180 days after the injury.

The results of the third section suggest that there have been surprisingly limited changes in the types of injuries (using event and nature of injury) that are submitted as no-lost-time claims across the years 1991, 1996, 2000 and 2005. While systemic diseases and trauma to muscles, tendons and ligaments caused through repetitive events increased across survey years, almost 60% of no-lost-time claims remained in one of three groups: traumatic injuries to muscles, tendons and ligaments caused through contact with equipment; surface wounds or open wounds caused through contact with equipment; or body reaction and overexertion claims.

The results of the final section showed no significant effects of daylight savings time (DST) on the incidence of work injury claims (no-lost-time and lost-time); either for the loss of one hour sleep in the spring transition, or the gain of one hour sleep in the fall transition period. Also, no differential effects were found of DST on work injury claims across industry, age, gender and job tenure groups.

Conclusions

The results of this project provide the first detailed examination of no-lost-time claims in Ontario. The results suggest – given differences in the factors association with lost-time and no-lost-time claim rates – the preferential use of lost-time claims in determining occupational health and safety performance may be misleading across industrial and demographic labour market sub-groups. As such, the investigators recommend that both no-lost-time and lost-time claims be included in assessing trends in occupational health and safety outcomes, and targeting particular groups for more intensive work injury prevention, when using compensation data. The analyses of health care data suggest that, generally speaking, the major driver of the relatively stable rate of no-lost-time claims has been workplace accommodation, given the increasing health care costs associated with no-lost-time claims since 1998. The analysis of the nature of injury and events leading to injury for no-lost-time claims over four different years (1991, 1996, 2000 and 2005) demonstrates an increase in the percentage of no-lost-time claims that are repetitive movement injuries. However, contrary to a hypothesis of claim management, the investigators found no increases in claims where the nature of the injury would make workplace accommodation unlikely to be possible. Specifically, multiple traumatic and intracranial injuries, both due to contact with equipment and objects or falls, did not increase substantially with the introduction of the NEER program (although these injuries still did represent 8% of all no-lost-time claims in our sample). Finally, it appears that the transition to daylight savings, in particular waking up an hour earlier, does not have an impact on no-lost-time or lost-time claim incidence.

Publications

Smith P., Chen C., Hogg-Johnson S., Mustard C., Tompa E. (2011), "Trends in the Health Care Use and Expenditures Associated with No-Lost-Time Claims in Ontario: 1991 to 2006." Journal of Occupational and Environmental Medicine 53(2):211-217.

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RAC #07021
Biodynamic Response of Human Subjects Exposed to Complex Multi-axis Vibration

Principal Investigator(s): Dickey, James P. (University of Guelph)

Co-Investigator(s): Tammy Eger, Sylvain Grenier (Laurentian University); Paul-Emile Boileau (Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRRST)); Michele Oliver, Peter Kim (University of Guelph); Subhash Rakheja (Concordia University)

Sponsoring Institution: University of Guelph

Objectives
The study had two main objectives: (i) to measure human responses to multi-axis vibrations, and (ii) to perform analyses with several biodynamic measures to identify those that are most important for evaluating operator responses and health risks.

Method
Phase 1 involved laboratory-based testing, exposing human subjects to vibrations using a unique robotic platform. Vibration profiles were developed based on our previous field measurements and broadband random vibrations. Testing evaluated three different industrial seats using nine combinations of subject postures. Phase 2 involved developing a biodynamic tool for evaluating the performance of seats as well as evaluating operator responses and health risks to multi-axis vibration. Seat transmission characteristics were calculated.

Results
The investigators tested 9 subjects (6 male/3 female) with the vehicular vibration profiles, and an additional 29 subjects (16 male/13 female) with the broad-band random vibration profiles. The non-stationary nature of the measured vehicular vibration data and limited spectrum of the signals resulted in a low partial coherence of the vibration input and force/acceleration output. The analysis of the broadband random vibration profiles showed high coherences for the vertical and the yaw components, but low coherence for the other components.

Tools for evaluating the performance of seats: The investigators assessed the transmissibility between the platform and the seatpan. Statistically significant differences between the different seats, but not between the different postures, were observed.

Tools for evaluating the operator response: The investigators assessed the transmissibility between the seatpan and the subject's heads. Considerable variability and low coherence between these signals was observed; differences between different postures did not reach a level of statistical significance.

Conclusions
Analysis of the signals with low coherence continues. Seat transmission parameters showed statistically significant differences between seats, but not between different postures; this may be a useful for assessing seat performance independent of driver posture.

Publications

Jack R.J., Oliver M. (2008), "A Review of Factors Influencing Whole-Body Vibration Injuries in Forestry Mobile Machine Operators." International Journal of Forest Engineering 19(1):50-64.

For more information:

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RAC #07023
A Biomechanical Comparison of Floor and Overhead Lifts Using One or Two Caregivers for Patient Transfers

Principal Investigator(s): Geoffrey R. Fernie (Toronto Rehabilitation Institute)

Sponsoring Institution: Toronto Rehabilitation Institute

Objectives
The objectives of this project were to compare the loads generated at the low back during floor and overhead lift maneuvering with one and two caregivers and to determine the effect of patient weight and caregiver experience.

Method
Twenty-one caregivers were asked to maneuver floor and overhead lifts with a 90kg surrogate patient working alone as well as with the help of a second caregiver. A subset of five caregivers repeated the lift maneuvering tasks with 115kg and 135kg surrogate patients. Ground reaction forces, motion capture data, and ratings of perceived exertion were recorded. Caregivers were also surveyed on their opinions regarding overhead versus floor lifts.

Results
Use of overhead lifts result in significantly lower back loads than floor lifts. Having two caregivers working together with a floor lift did not reduce loads on the primary caregiver compared to the single-caregiver case. In contrast, two-caregiver operation of an overhead lift did result in reduced loads compared to the single-caregiver case. Loads were also found to be higher with heavier patients and with inexperienced caregivers.

Conclusions
Overhead lifts result in lower loads on caregivers compared to floor lifts and should be used wherever possible to reduce the risk of back injury to caregivers. The use of two caregivers does not significantly compensate for the poorer performance of floor lifts.

Publications
Dutta T., Holliday P.J., Gorski S.M., Baharvandy M.S., Fernie G.R. (2012), "A Biomechanical Assessment of Floor and Overhead Lifts Using One or Two Caregivers for Patient Transfers." Applied Ergonomics 43:521-531.

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RAC #07025
The Organizational, Environmental, and Individual Factors that Influence Nurses' Decisions to Use Facial Protection to Prevent Occupational Transmission of Communicable Respiratory Illness in Acute Care Hospitals

Principal Investigator(s): D Linn Holness, Kathryn Nichol (St. Michael's Hospital)

Co-Investigator(s): Allison McGeer (Mount Sinai Hospital); Linda O'Brien-Pallas (University of Toronto); Philip Bigelow (Institute for Work & Health)

Sponsoring Institution: St. Michael's Hospital

Objectives
To describe nurses' adherence to recommended use of facial protective equipment (FPE) and to identify the factors that influence adherence.

Method
A two-phase study was conducted: a cross-sectional survey of nurses in selected units of six acute care hospitals in Toronto and an observational cohort of critical care nurses.

Results
Of the 1074 nurses who completed surveys (82% response rate), 44% reported adherence to recommended use of FPE. Multivariate analysis revealed five predictors of adherence: unit type, FPE availability, training and fit testing, organizational support for health and safety, and good communication. Following the survey, 112 observations in 14 intensive care units were conducted that showed a 44% competence rate with proper use of disposable N95 respirators. Multivariate analysis revealed knowledge of recommended use of FPE as a significant predictor of competence.

Conclusions
Despite recent investment in our public health system, nurses' adherence to recommended use of FPE and competence in effective use of N95 respirators remains suboptimal. To improve adherence, organizational leaders should focus on FPE availability, training and fit testing, organizational support for health and safety, and positive communication. To improve competence in effective use of N95 respirators, strategies to increase knowledge should be implemented.

Publications

Nichol K., Bigelow P., O'Brien-Pallas L., McGeer A., Manno M., Holness D.L. (2008), "The individual, environmental and organizational factors that influence nurses' use of facial protection to prevent occupational transmission of communicable respiratory illness in acute care hospitals." American Journal of Infection Control 36(7):481-487.

For more information:

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RAC #07103
In Search of Innovations: Identifying New Tools and Processes to Prevent MSDs in the Construction Sector

Principal Investigator(s):	Desre M. Kramer (University of Waterloo), Philip Bigelow (Institute for Work & Health)
Co-Investigator(s):	Peter Vi, Enzo Garritano (Construction Safety Association of Ontario); Richard P. Wells (University of Waterloo)
Sponsoring Institution:	University of Waterloo

Objectives
This study's objective was to identify innovations that were presently being used in the workplace, that could potentially reduce musculoskeletal disorders (MSDs) in the construction sector in Ontario.

Method
The investigators identified a potential database of 125 innovations in trade magazines and additional innovations by visiting construction sites. Focus was placed on 24 innovations, which included tools and organizational processes that represented a variety of trades and were used in different sectors of the industry. Information about the innovations was gathered by observing workers, surveying workers and construction-safety consultants, and interviewing company managers. The investigators analyzed the characteristics of the innovations and the extent of penetration by coding and reviewing the taped interviews, analyzing the survey data and merging the multiple sources of data.

Results
All the innovations had a positive effect on production or quality of work. They had the complementary effect of limiting musculoskeletal strain. Companies which adopted innovations had relatively stable workforces and had been in business for more than 5 years.

Conclusions
The innovations that were adopted were usually selected for multiple advantages, only one of which was MSD prevention. The innovations were relatively non-complex, adaptable, and their benefits could be observed. The major barriers for adoption were the traditional culture of the construction sector rather than financial ones.

Publications

Kramer D.M., Bigelow P.L., Carlan N., Wells, R.P., Garritano E., Vi P., Plawinski M. (2010), "Searching for Needles in a Haystack: Identifying Innovations to Prevent MSDs in the Construction Sector." Applied Ergonomics 41:577-584.

For more information:

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RAC #07104
Evaluating the Effects of Cold and Glove Use on Manual Dexterity and Performance and the Testing of Potential Solutions

Principal Investigator(s): Richard Wells (University of Waterloo)

Co-Investigator(s): Shannon J. Maracle, Electrical & Utilities Safety Association)

Sponsoring Institution: University of Waterloo

Objectives
Electric utility workers in Canada must frequently work in the cold. They must wear thick rubber gloves to protect themselves when working on live high-voltage conductors which, even in warm conditions, can result in rapid fatigue and reduced performance. The purpose of the study was therefore to document the challenge of working in the cold wearing the standard five-finger rubber gloves and covers and compare them to two equipment options, mitten style gloves or a prototype wool liner, and two heating options, glove (H-Warmer) or torso (T-Warmer) heating.

Method
The dependant measures were grip force, temperature, dexterity, finger sensitivity and thermal sensation. Thermistors were used to measure skin temperature and were placed on the back of the 3rd and 5th digits, the back of the hand, the back of the forearm, the big toe and the sternum. The participants filled out a rating of perceived effort. Dexterity was measured using a modified Purdue pegboard test. A Von Frey hair test was also administered. The study population consisted of ten experienced male utility workers from three local utility companies; the working environment was a controlled temperature walk-in chamber. The chamber controls were set at -20 degrees Celsius. They performed simulated utility work for 45 minutes with interspersed test batteries every 15 minutes.

Results
The mitten style glove and woollen liner in a standard glove reduced the effects of working in the cold compared to the standard five-fingered variety with a thin cotton liner. We found that the mitten style glove showed lesser drops in skin temperature for the 3rd and 5th digits than the other conditions ($p < 0.05$). There were neither statistically significant effects nor any apparent trends in skin temperatures or performance for either heating condition.

Conclusions
The woollen glove and the mitten glove offered less of a drop in finger temperature than the standard glove and the heating conditions. The woollen under-glove appears to combine better comfort and little interference with performance, with less of a decrease in finger temperature.

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RAC #07110
Identification of Biomechanical Risk Factors Responsible for Musculoskeletal Disorders in the Northern Ontario Tree Planting Population

Principal Investigator(s): Genevieve A. Dumas (Queen's University)

Co-Investigator(s): Peter J. Keir (McMaster University)

Sponsoring Institution: Queen's University

Objectives
To evaluate posture and joint loading in tree planters during three tree-unloading strategies:
1. load evenly distributed to the right and left sides of the body – *evenly loaded*
2. load entirely on the right side – *right loaded* and
3. load entirely on the left side – *left loaded*.

Method
Field Study: Upper body posture (trunk, elbow, wrist) of 20 tree planters was recorded in the field with inertial motion sensors during the three unloading conditions while workers performed their regular planting tasks. *Lab Study:* The tree planting task was simulated in a lab setting and subjects performed the planting task 10 times during each unloading condition. Joint loading in the ankles, knees, hips and trunk was recorded with two force plates and postures were captured by two Optotrak bars.

Results
Field study: Asymmetrical tree unloading resulted in more neutral postures in the upper body than symmetrical tree unloading (decreased forearm pronation and trunk flexion). These results were supported by significantly lower pain scores reported by participants who used asymmetric tree unloading as their preferred technique throughout the planting season. *Lab Study:* Greatest joint loading and non-neutral postures occur when the tree is inserted in the ground, therefore this posture should be assumed for as little time as possible during the task. Right-loaded planting bags seemed to produce the most differences in posture and joint loading, suggesting that it is worse to carry the load on the right side of the body than the left side of the body or evenly across the body. Axial forces were greater in the right leg than the left leg throughout the planting cycle regardless of loading condition.

Conclusions
Regardless of unloading strategy, the point at which the tree is planted in the ground (maximum trunk flexion) produced greater joint loading and non-neutral postures in both the upper and lower body than any other point in the planting cycle. This posture should be assumed for as little time as possible to decrease risk for injury.

Publications
Slot T.R., Dumas G.A. (2010), "Musculoskeletal Symptoms in Tree Planters in Ontario, Canada." Work 36:67-75.

Slot T., Shackles E., Dumas G.A. (2010), "Upper Limb and Trunk Kinematics in Planters during Three Load Carriage Conditions." Occupational ergonomics 9:169-182.

For more information:
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RAC #07112
Development of Rapid Techniques for the Identification of Asbestos Fibres in Floor Tiles using Fourier Transform Infrared Spectophotometry (FT-IR) and Two-Dimensional Powder X-Ray Diffraction (XRD2) Methods

Principal Investigator(s): Brian E. McCarry (McMaster University)

Co-Investigator(s): James Britten, Lorraine Shaw (McMaster University)

Sponsoring Institution: McMaster University

Objectives
This study was undertaken to develop and evaluate the suitability of Fourier Transform Infrared Spectrophotometry (FT-IR) and Two Dimensional X-Ray Diffraction (XRD2) for the rapid determination of asbestos in floor tiles. A comparison of approved methods for the determination of asbestos in bulk materials was performed which includes Polarized Light Microscopy (PLM), X-Ray Powder Diffraction (XRD) and Analytical Electron Microscopy (AEM).

Method
Fifty floor tile samples and five quality control samples were randomly selected for the study. Not all floor tiles contained asbestos.

Results
FT-IR and XRD2 were able to qualitatively determine asbestos in floor tiles. Quantitative analysis was performed by FT-IR, but not XRD2, due to difficulties in preparing a calibration curve in a suitable matrix. The FT-IR detection limit was determined to be 0.5% chrysotile for a 2 mg bulk sample.

Conclusions
Both techniques were acceptable for the analysis of chrysotile asbestos in floor tiles. XRD2 had the fastest sample preparation and analysis time of five minutes, but at the present time only gives a qualitative analysis. FT-IR has a moderate sample preparation time, fast analysis time of thirty minutes and can quantify the percent of chrysotile in the sample.

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RAC #07114
Economic Evaluation Workbook for Workplace Partners and Systems Partners

Principal Investigator(s): Emile Tompa (Institute for Work & Health)

Co-Investigator(s): Benjamin Amick III, Kiera Keown, Anita Dubey, Emma Irvin (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
This project aims to assist workplace decision makers in Ontario with allocating limited resources to the best health and safety interventions by developing a tool that they can use to undertake occupational health and safety (OHS) economic evaluations. The tool is targeted at small and medium sized workplaces within the Ontario manufacturing and service sectors.

Method
A team of researchers at the Institute for Work and Health worked with partners from the Industrial Accident Prevention Association, the Ontario Service Safety Alliance and the Workplace Safety & Insurance Board to develop the workbook tool. The team drew upon existing tools, research undertaken on the economic evaluation of health and safety interventions, a methods text for occupational health and safety researchers, and economic evaluations of workplace interventions. Prototypes of the workbook were evaluated to ensure usability at team meetings, in focus groups, and through field testing.

Results and Conclusions
The workbook software provides an invaluable tool for workplaces interested in estimating the financial implications of OHS interventions while upholding rigorous economic evaluation methods principles. Extensive evaluation of the workbook has ensured the software is user friendly.

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RAC #07115
Bridging the Safety Gap for Vulnerable Young Workers using Employment Centres

Principal Investigator(s): Curtis F. Breslin (Institute for Work & Health)

Co-Investigator(s): Matt Wood (Ontario Association of Youth Employment Centres); Cameron Mustard (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
Young people aged 16 to 24 years who are out of school (especially those with less than a high school diploma) are at a particularly elevated risk of work injury. We sought to determine the optimal way to improve occupational health and safety (OHS) for this "high risk" subgroup of young workers who use employment centres.

Method
Information on these issues was obtained by implementing an online survey in youth employment centres across Ontario, through a collaboration between the Institute for Work & Health and the Ontario Association of Youth Employment Centres (OAYEC).

Results
The key results were as follows:
- 1886 people meeting the study criteria provided responses to the survey.
- These young workers are exposed to several types of unsafe work conditions such as dust/particles, trip hazards and heavy lifting.
- These young workers do not always receive workplace-specific training, and when they do, it is often video-based.

Conclusions
Conclusions of this project include:
- Workplace parties should place a priority on reducing unsafe work conditions such as trip/fall hazards, dust/air particles and heavy lifting.
- Employers should provide orientation and training to maximize information and skill acquisition/retention about health and safety (e.g., one-to-one training on the job).

For more information:

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RAC #07117
User-Acceptability and Effectiveness of a Personal Lift Assist Device (PLAD) in an Automotive Industrial Setting

Principal Investigator(s): Joan M. Stevenson (Queen's University)

Co-Investigator(s): Mohammad Abdoli-Eramaki (Ryerson University); Alison Godwin (Laurentian University); Michael Agnew (Virginia Polytechnic Institute and State University)

Sponsoring Institution: Queen's University

Objectives
The objectives of the project were two-fold: (1) to finalize the personal lift assist device (PLAD) design features and develop a method of controlling how much support the PLAD provides wearers, and 2) to test the PLAD's effectiveness and user acceptability during two repetitive automotive manufacturing tasks; one of which contained extensive static holding in a forward inclined posture and the other that was primarily a lifting task at different heights.

Method
A laboratory study was conducted to develop a computerized model that calculated the required spring stiffness to offset a proportion of a wearers' L4/L5 bending moment based on anthropometry and posture. The effectiveness and user acceptability of the PLAD were then tested using a combination of trunk electromyography, ratings of perceived exertion (RPE), and subjective survey responses.

Results
The model for determining spring stiffness was successfully developed and used to provide each automotive worker in study two with a 20% reduction in their low back moment. During the static holding task the PLAD significantly reduced the thoracic and lumbar erector spinae activity ($p \leq 0.05$) and predicted-compression ($p \leq 0.05$) by approximately 20%. RPE were found to be significantly lower when wearing the PLAD ($p=0.006$), and 80% of subjects tested indicated they would wear the device every day. During the repetitive lifting task, low back muscular activity was also 20% lower when wearing the PLAD and 60% of subjects said they would wear the PLAD every day.

Conclusions
The PLAD appears to be very beneficial during lifting and forward bending industrial tasks, but slightly awkward and restrictive during reaching and walking tasks. With slight adjustments, it could be very comfortable and beneficial during many assembly tasks.

Publications

Graham R.B., Agnew M.J., Stevenson J.M. (2009), "Effectiveness of an On-Body Lifting Aid at Reducing Low-Back Physical Demands During an Automotive Assembly Task: Assessment of EMG Response and User Acceptability." Applied Ergonomics 40(5):936-942.

For more information:

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RAC #07120
Optimizing Seat Selection to Minimize Six Degree-of-Freedom Whole-Body Vibration in Integrated Steel Manufacturing Mobile Machinery

Principal Investigator(s): Michele L. Oliver (University of Guelph)

Co-Investigator(s): James Dickey (University of Guelph); Tammy Eger (Laurentian University); Patricia Hope (Algoma Steel)

Sponsoring Institution: University of Guelph

Objectives
The first objective of this research was to quantify chassis six degree-of-freedom (6-DOF) accelerations according to methods outlined in ISO 2631-1 (1997) during normal field operations of five common types of mobile machines used in integrated steel manufacturing operations. The second objective was to assess how well three selected heavy equipment seats attenuate field vibration obtained from the integrated steel manufacturing machine with the highest vibration data.

Method
Using 3-DOF (seat) and 6-DOF (chassis) sensors, exposures were quantified using unweighted as well as ISO 2631-1:1997 standard weighted accelerations while potential health risks and comfort ratings were predicted using ISO 2631-1:1997. Based upon these measures, of the five machine types tested, the Pot Hauler was identified to have the most elevated levels of whole-body vibration (WBV). From the Pot Hauler data, six representative acceleration profiles were compiled from the field vibration data. These profiles were used as inputs to a 6-DOF robot which assessed how well three selected heavy equipment seats attenuated field-based vibration. Sixteen unskilled (eight males, eight females) and four skilled operators sat in each of three seats while being vibrated on the robot.

Results
Based upon the tri-axial seat-pad accelerometer at the operator/seat interface, the calculated 8-hour daily equivalent vibration dose value placed all pot haulers and one heavy lift transport, one hoist and one loader above the health guidance caution zone. The 6-DOF chassis vibration total values were elevated for all five mobile machine types tested resulting in ISO 2631-1 (1997) comfort predictions ranging from Uncomfortable to Extremely Uncomfortable. Elevated values were also observed at the chassis for crest factors and peak running root mean squared accelerations. Vibration dominant frequencies were generally between 1 and 8Hz, which is within the range known to be harmful for humans. Effects from the engine idling or running at low speeds were observed for each vehicle in almost all axes, occurring at approximately 27Hz, which is a frequency that has the potential to produce negative heath effects. Based upon these results, the Pot Hauler was found to have the most elevated WBV levels.

In the laboratory study, the Pot Hauler field vibration profiles revealed no significant differences between the three chairs for Vibration Total Value, ISO 2631-1 Predicted Comfort, Operator Reported Comfort or Seat Effective Amplitude Transmissibility. There were, however, a number of the significant interactions between chair and acceleration profile suggesting that a single seat may not be best for all vibration profiles found in routine daily operation of mobile machines within the steel making industry. While the authors acknowledge that the lack of a ‘clear cut’ seat choice could result from the selection of high end seats used within the study, a significant three way interaction between sex, chair and profile suggest that operator sex, as well as vibration profile may also have an influence. This is demonstrated further by the significant interactions between chair and profile, indicating that there may not be a single best seat to retrofit existing machines.

Conclusions
Both 6-DOF chassis and 3-DOF seat vibration total values were elevated for five mobile machines used in steel making suggesting that appropriate seat retrofitting might be in order to help reduce worker vibration exposure. Results of the laboratory study indicate that one seat may not be best for all vibrations encountered daily by mobile machine operators, and that operator sex, as well as vibration profile, will affect the best seat selection. These results have provided the steel industry with information which will allow them to more efficiently retrofit existing machines which workers report to be particularly uncomfortable to ride in, and which may be related to a substantial number of lost time claim days due to ailments associated with WBV exposure.

Publications
Cation S., Oliver M., Jack R.J., Dickey J., Lee Shee N. (2011), "Whole-body vibration sensor calibration using a six-degree of freedom robot." Advances in Acoustics and Vibration, Volume 2011, Article ID 276898, 7 pages doi:10.1155/2011/276898. [Open Access: http://www.hindawi.com/journals/aav/2011/276898/]

Dickey J.P., Eger T., Oliver M. (2010), "A systematic approach to simulating field-based occupational whole-body vibration exposure in the lab using a 6df robot." Work 35(1):15-26.

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RAC #07127
Development of a Green Light and Red Flag Toolkit for Persistent Claims

Principal Investigator(s): Ellen MacEachen (Institute for Work & Health)

Co-Investigator(s): Agneiczka Kosny (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
A problem facing WSIB and system partners is the growing number of "persistent," or long-term, workers' compensation claims. This problem could be reduced if key return-to-work (RTW) decision-makers were able to identify situations when workers may be at particular risk of not being able to complete their expected RTW trajectory, and consider ways of managing those situations.

Method
A team of researchers, knowledge transfer and communication experts transformed findings from a the richly detailed, qualitative "complex claims" study into a set of "red flags", or warning signs of RTW problems, and "green lights", or suggestions for optimal RTW management. Workshops were then conducted with RTW experts across Ontario in order to generate "green lights" for RTW problems, review the structure of the guide, consider dissemination strategies, and target audiences. An Advisory Committee provided overall guidance on the goals and design of this project and the final content of this guide.

Results
A guide was developed entitled "Red Flags/Green Lights: A guide to identifying and solving return-to-work problems". This guide supports optimal quality in the disability management process.

Conclusions
This guide translates findings from a research study into a product that can provide advice about how to manage challenging return-to-work (RTW) situations.

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RAC #07129
Involving Stakeholders in the Planning of a Workplace Intervention to Improve Return to Work: Putting What We Know into Action Using an Intervention Mapping Approach

Principal Investigator(s):	Carlo Ammendolia (Centre of Research Expertise for Improved Disability Outcomes (CREIDO)/University Health Network)
Co-Investigator(s):	J. David Cassidy, Eleanor Boyle, Pierre Cote, Monique Gignac (University Health Network); Ivan Steenstra, Claire Bombardier (Institute for Work & Health); Patrick Loisel (University of Sherbrooke)
Sponsoring Institution:	University Health Network

Objectives
1) To obtain feedback from stakeholders on a Return to Work (RTW) program based on RTW coordination and propose a conceptual framework for RTW coordination
2) To gather insight on potential psychosocial determinants of RTW from stakeholders
3) To use the information obtained from the first and second objectives to further refine a RTW program.

Method
Qualitative methods in the form of focus groups were used. An intervention mapping approach was used to design the RTW program incorporating findings from the focus groups.

Results
RTW coordination should incorporate the elements of trust, shared decision making, tailoring to the needs of injured worker and workplace, meaningful accommodation and ongoing support following RTW. Stakeholders describe how the culture of a community can mediate psychosocial factors that negatively impact RTW. The compensation system, negative voices and conflicting information from employers, health care providers, employers, union representatives, and family can produce feelings of resentment and depression in the injured worker and consequently negatively impacts RTW.

Conclusions
A conceptual model of RTW coordination is proposed based on stakeholder feedback. Upstream organization-system factors may contribute to "psychosocial traits" that often are associated with delays in RTW.

Publications

Ammendolia C., Cassidy D., Steenstra I., Soklaridis S., Boyle E., Eng S., Howard H., Bhupinder B., Côté P. (2009), "Designing a workplace return-to-work program for occupational low back pain: an intervention mapping approach." BMC Musculoskeletal Disorders 10(65).

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RAC #07131
Development of a Measure of Social Support for Workplace-Based Disability Management

Principal Investigator(s):	Rosemary M. Lysaght (Queen's University)
Co-Investigator(s):	Sherrey L. Larmour-Trode (Limestone Health Consultants, Inc.); Mary Ann McColl, Leandre Fabrigar (Queen's University); Margaret Friesen (University of Manitoba)
Sponsoring Institution:	Queen's University

Objectives
The primary goal of this project was to validate a multi-faceted measure of perceived social support for the disability management context and to collect descriptive data concerning worker support in a variety of work contexts.

Method
A support measure prototype was tested with 101 workers in accommodated work situations. Four validation tools contributed to assessment of criterion validity. Factor analysis was used to validate the content structure and reduce the total number of response items. Secondary analysis was conducted to explore the nature of supports in the workplace.

Results
The total number of items was reduced through inspection of item properties, and through factor analytic procedures. A multi-factor structure was identified for each of four primary sources of support within which items were organized in the instrument: supervisors, coworkers, the work organization, and family and friends. The criterion validity of the scale was established through examination of correlations with corresponding measures of support. Preliminary testing of the predictive validity of the tool revealed that the instrument may be able to distinguish between levels of support provided to individuals based on their unique disability characteristics.

Conclusions
Continued testing of this measure will further establish reliability and validity. The instrument provides a validated measure of workplace disability support for future intervention studies, and will also contribute as a quality management tool for human resource professionals.

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RAC #08023
Multimorbidity, Depression, and Pain in the Workplace: Potential Risk Factors for Work Absence and Work Limitations in Canadian Nurses

Principal Investigator(s): Renée-Louise Franche (Institute for Work & Health)

Co-Investigator(s): Cameron Mustard, Selahadin Ibrahim, Peter Smith (Institute for Work & Health); Pierre Côté (University Health Network); Jaime Guzman (Occupational Health & Safety Agency for Healthcare in British Columbia); Mieke Koehoorn (University of British Columbia)

Sponsoring Institution: Institute for Work & Health

Objectives
To examine the effects of worker health and workplace factors: (1) on work absence duration due to physical and mental conditions, (2) on work absence duration due to work-related musculoskeletal (MSK) injuries, and (3) on work limitations.

Method
The study involved an analysis of Statistics Canada's 2005 National Survey of the Work and Health of Nurses, using structural equation modeling (objectives 1 & 2), and probit regression (objective 3). Objective 1 analyses included all female, direct care nurses (n=11,762). Objective 2 (n=941) and 3 (n=915) analyses focused on those reporting a time-loss work-related MSK injury.

Results
Key factors associated with work absence due to all conditions were pain and pain-related work interference, depression, workplace respect/support, multimorbidity, violence, and organizational culture.

The effects of all factors associated with absence due to MSK injury - depression, back pain, age, unionization, physical demands and job control - were mediated by work-related pain and pain-related work interference.

Pain-related work interference, role overload, nurse-physician relationships and job control/demands were associated with work limitations.

Conclusions
Pain and pain-related work interference are key factors associated with work absence and work limitations. Workplace social environments and workplace respect and support are also important.

Publications

Franche R-L., Murray E., Ibrahim S., Smith P., Carnide N., Côté P., Gibson J., Koehoorn M. (2011), "Examining the Impact of Worker and Workplace Factors on Prolonged Work Absences among Canadian Nurses." Journal of Occupational and Environmental Medicine 53(8):919-927.

For more information:

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RAC #08027
The Problem of Claims Persistency: What Is Driving Increases in Persistent and Locked-In Claims?

Principal Investigator(s): Sheilah A. Hogg-Johnson (Institute for Work & Health)

Co-Investigator(s): Emile Tompa, Benjamin Amick III (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
Claims that continue to receive wage-replacement benefits for a prolonged time is a significant issue at the WSIB. The objectives of this project were to identify how persistency distributed across the course of claims, whether attributes of the worker or injury accounted for increasing persistency and to investigate whether introduction of Bill 99 contributed by examining claims milestones.

Method
A random sample of 10% of lost time claimants to the WSIB between 1990 and 2001 were included. Different measures of duration were examined by year of injury to examine trends over time. Regression models were fit to estimate variation by year controlling for baseline factors. Claim milestones were examined to determine: whether they changed over time, whether they accounted for variation in duration, and whether they predicted duration.

Results
Claims persistency was increasing. It accrued from the later part of claims and increases were concurrent with the policy change in 1998. Increases in persistency were not explained by changing worker demographics (e.g. older workers) nor by changes in injury type. Second Injury Enhancement Fund (SIEF) and firm size relationships point to employers as key drivers of persistency.

Conclusions
Unintended consequences of occupational health and safety policy must be considered in policy development. A study of claims milestones over time points to employers as a key driver of claim persistency.

For more information:
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RAC #08031
Development of an Ontario-Wide Survey to Study Factors Impacting the Health and Safety of Truck Drivers in Ontario

Principal Investigator(s): Philip L. Bigelow (University of Waterloo)

Co-Investigator(s): Sheilah Hogg-Johnson, Benjamin Amick III (Institute for Work & Health); Karl Sieber (US Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health); Mark Skinner (Transportation Health and Safety Association of Ontario)

Sponsoring Institution: University of Waterloo

Objectives
The objectives of the study were to gather information from stakeholders regarding the feasibility and the key content of a national survey that would address the surveillance needs of organizations charged with improving the health, safety and wellness of truck drivers.

Method
Study methods included semi-structured interviews with drivers and health and safety professionals, development and pilot testing of a questionnaire, and administration of the questionnaire to 107 drivers visiting two truckstops in Southern Ontario.

Results
Key informant interviews indicated that although safety professionals were aware of more of the risk factors appearing in the literature, drivers were able to provide rich and detailed information about hazards and potential solutions. Interviews with drivers informed the content of the final questionnaire which could be completed in 30 minutes. Results from the survey showed that the drivers reported more chronic disease risk factors as well as factors that would put them at risk for collisions as compared to the general population.

Conclusions
Truck drivers in Ontario are a vulnerable population in terms of risk factors for collisions and chronic disease. Stakeholders felt that data from baseline and routine driver health, safety, and wellness surveys would help them improve their programs.

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RAC #08035
A Randomized Controlled Study of Targeted Occupational Health and Safety Consultation in Ontario

Principal Investigator(s): Sheilah A. Hogg-Johnson (Institute for Work & Health)

Co-Investigator(s): Lynda Robson, Benjamin C. Amick, Peter Smith, Emile Tompa, Cameron A. Mustard (Institute for Work & Health); Donald C. Cole (Institute for Work & Health, University of Toronto)

Sponsoring Institution: Institute for Work & Health

Objectives
The Ontario High Risk Firm Initiative ran from 2004 to 2008. It involved targeting high risk firms with intensive inspection of workplaces or offers of Occupational Health & Safety (OHS) consultation. In 2006, firms from two sectors, Service and Manufacturing, were randomized into three groups to receive OHS consultation services (provided by sector-specific Health and Safety Associations), Ministry of Labour inspections, or left to business as usual. We sought to describe the interventions as delivered and to evaluate the impact of these two components.

Method
The study sample consisted of all manufacturing and service firms ranked between the 2nd and 10th percentile of worst performing firms for 2006. Yearly work injury claims counts from 2002 to 2008 and firm attributes were obtained from administrative data sources. Negative binomial models were used to model claim and disability day rates by study arm and year.

Results
There were 1459 service sector and 2153 manufacturing sector firms in the study. Firms were similar across the three study arms prior to intervention. There were no significant differences in claim rates or disability day rates between firms in the intervention groups and firms in the control group in the two years following the intervention.

Conclusions
Following the random allocation of firms to two intervention groups, this study found no difference in OHS outcomes between the intervention groups and a control group in the two years after the intervention. The absence of an intervention effect could have been due to problems with the method used to select firms, the impact of the interventions, or the outcomes available for evaluation.

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RAC #09020
Development of Valid and Reliable Physical Exposure Measures for Users of Hand-Held Mobile Communication Devices

Principal Investigator(s): Richard P. Wells (University of Waterloo)

Co-Investigator(s): Benjamin Amick III, Ivan Steenstra (Institute for Work & Health)

Sponsoring Institution: University of Waterloo

Objectives
To understand the use of mobile technology, and determine its relationships to any musculoskeletal health effects, accurate measures of how these devices are used is required. A previous study developed a questionnaire for self-reporting device use. There is little knowledge, however, of the questionnaire's usability, or of the agreement between measures of device use collected by it and more direct measures.

The purpose of this study was to: 1) examine agreement between self-reports collected by the questionnaire and direct measurements produced by a custom application logging software and 2) examine the usability of the questionnaire by conducting interviews and better understand how respondents think about their device use.

Method
Custom software to record the applications used was written for phones using the Android operating system and debugged. To protect participant's privacy, the application did not collect details of the keystrokes made, phone numbers called or texted or websites visited for example. Twenty-five people were recruited from a Canadian university to participate. Participants visited the laboratory on two occasions. On their first visit they downloaded the custom application logging software onto their mobile phone/device. On their second visit, one week later, they uploaded the week's data log and filled out the previously developed questionnaire. A subgroup of respondents, 17 out of 25, participated in an interview.

Average daily usage was compared with self-reported usage for each of six categories of device use identified in the questionnaire. Bland-Altman plots were used to examine the agreement between logged and self-reported usage. A preliminary coding scheme of major themes brought forward in interviews was developed by two people reading through all interviews once; this coding scheme was confirmed upon detailed examination of each interview.

Results
The mean active time per day from data logs was approximately 113.3 minutes (range from 17.2 to 482.5 minutes), and the mean number of text messages sent per day was 37 (range from 2 to 160) and received per day was 24 (range from 1 to 77). Bland-Altman plots showed that, generally speaking, participants' self-reports overestimated their logged use Overestimates tended to be low at low mean usage times, and became more variable as mean usage time increased.

A total of six themes were identified from interviews: 1) concepts of a mobile hand-held device, 2) tasks attributed to categories of device use, 3) thought process to arrive at self-reported usage, 4) ease of reporting usage, 5) physical interaction with device, and 6) completeness of list of categories of device use. These themes were useful in identifying possible reasons for inconsistencies between logged and self-reported usage.

Conclusions
The preliminary findings indicate it may be challenging for respondents to provide good self-reports. The root of this challenge does not appear to lie with the design of the questionnaire. Rather, it may be attributed to the respondents' difficulty in estimating usage, likely due to the variability of device use both within a day and a week. Going forward, research investigating

the relationship between device use and musculoskeletal symptoms may want to consider using a logging application to examine exposure in addition to questionnaires.

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RAC #09025
Measurement Accuracy and Precision of Short-Period Air Sampling by Direct-Reading Instruments

Principal Investigator(s): Ian Drummond (University of Toronto)

Co-Investigator(s): Paul Bozek (University of Toronto)

Sponsoring Institution: University of Toronto

Objectives
Electronic instruments have the ability to measure worker exposure continuously during a shift, helping to identify tasks that cause exposure, and making it cheaper and easier to meet exposure standards. The instruments are not widely used for several reasons. People are reluctant to change from the traditional air sample and laboratory analysis method because they don't know if the instruments work as well, and because there are not standard instructions and computer programs on how to use the instruments and interpret the results.

The objectives of this project were to reduce the barriers to short-period air sampling by direct-reading instruments (DRIs) by:
1) Measuring the accuracy and precision of the DRIs in comparison to charcoal tubes, using a response factor derived from a long-term charcoal tube sample.
2) Documenting a procedure to simplify and standardize collection and analysis of the data, taking the fast response time of the PIDs into account.

Method
An area air-sampling station was constructed consisting of a sequential short term charcoal tube sampler, two ToxiRae photoionization detectors (PIDs), two MiniRae PIDs, and two charcoal-tube air samplers. The station was used to measure styrene in two locations: in a calibration chamber and in a plastics factory over a two hour period. The air concentrations measured by the PID units were compared to the charcoal tube results for each 15-minute period.

Results
A PID response factor was calculated from the simultaneous long-term charcoal tube measurements, hence called the C-tube correction. In the laboratory, the relative accuracy of both models of PID was 1.02, and the standard deviation was 0.022 (N=128), making the results with the C-tube correction of the same accuracy and precision as the traditional charcoal tube method.

In the plastics factory, where the concentrations fluctuated widely, and acetone was present as an interference, the C-tube correction method gave a relative accuracy of 1.01 and a standard deviation of 0.207 (N=397).

A spreadsheet called DirectEvaluation.xls was written to automate the analysis of the PID raw data for compliance with short-term exposure limits (STEL), excursion or ceiling limits.

Conclusions
Short-period air sampling using the C-tube correction method is a promising, straight-forward way to obtain full-shift, representative information, of comparable accuracy and precision to the charcoal tube method. This work indicates that instruments can be used in the workplace with confidence that the results will be comparable to the older standard method using air samples and laboratory analysis. A further advantage is that people responsible for measuring worker exposure will have access to a cheaper, easier tool to use. This may result in better information on workplace exposures, and how worker exposure might be reduced.

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RAC #09035
Integrating OHS into Operations Research Models for Long-Term Work System Performance Evaluation

Principal Investigator(s): W. Patrick Neumann (Ryerson University)

Co-Investigator(s): Mohamed Wahab Mohamed Ismail (Ryerson University); Linda M.O. Rose (KTH, The Royal Institute of Technology)

Sponsoring Institution: Ryerson University

Objectives
This seed grant had the primary objective of establishing a modelling framework by which occupational health and safety (OHS) aspects can be integrated into dynamic models of the economic performance of operations. A secondary objective was to establish a functioning team for a full grant proposal to apply and test this modelling framework.

Method
The model was developed by applying available dose-response-recovery evidence from the scientific literature in a stochastic model of system performance with three interacting levels: the human health-state and performance sub-model, the workstation performance sub-model, and the system model of interacting workstations which contains as well the cost model for the operations in question.

Results
A modelling framework was developed and implemented in a small test program that can predict changes in employee health status based on known risk levels. A full proposal to the Workplace Safety & Insurance Board Research Advisory Council was successful and corporate partners are keen to engage in the future field tests.

Conclusions
The modelling framework has been developed and a proof of principle test was made in a small hypothetical test case. The next steps of field applicability and managerial utility are being initiated.

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RAC #09104
Bridging the Safety Gap for Postsecondary Workers

Principal Investigator(s): Cindy L. Hunt (Humber College Institute of Technology & Advanced Learning)

Co-Investigator(s): F. Curtis Breslin (Institute for Work & Health)

Sponsoring Institution: Humber College Institute of Technology & Advanced Learning

Objectives
Young workers are at risk for occupation-related injuries, yet many do not receive education early in their working life concerning injury prevention and risk mitigation in the workplace. For this reason, targeting students with focused education regarding occupational health and safety (OHS) is important to support early prevention of injuries. In this study the investigators established baseline data on the current nature of work and safety training for employed young adults in college and evaluated one online instruction program designed to improve safety knowledge, attitudes and beliefs.

Method
Students involved in the Ontario Work Study program at one college in southern Ontario were recruited to participate in a longitudinal study. The control group completed the required program on OHS provided by the college (i.e. classroom training). The intervention group completed the college's OHS program as well as an online learning module to supplement the learning. Upon completion and three months post programs, students completed an online survey investigating their knowledge, attitudes and beliefs regarding workplace safety.

Results
The study examined 132 work study students in college. There was no statistical difference in the outcome measures between the control (classroom training) and the intervention group (classroom and online training) at the end of the program or at the three month follow-up.

Conclusions
Further refinement and testing of the survey instrument is needed. It is possible that the generic nature of the online and classroom training may have minimized any statistical differences in the study groups. More research is needed on the amount and type of OHS training young workers receive from their immediate supervisor in their "job-specific" work environment.

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RAC #09106
Red Flags/Green Lights: A Multiple Stakeholder Evaluation of the Uses of a Return-to-Work Problems Guide

Principal Investigator(s): Ellen MacEachen (Institute for Work & Health)

Co-Investigator(s): Agnieszka Kosny, Elizabeth Mansfield, Keira Keown (Institute for Work & Health)

Sponsoring Institution: Institute for Work & Health

Objectives
Return-to-work (RTW) is a complex process and dependent on the coordination of different stakeholders. In May 2009, the investigators developed "Red Flags/Green Lights: A Guide to Identifying and Solving Return-to-Work Problems" to help decision-makers to identify and manage RTW problems. The purpose of this project was to evaluate the implementation process of this Guide among different kinds of RTW stakeholders.

Method
A utilization evaluation approach was used. Twenty-four RTW decision-makers from the eight partner organizations participated in the study. Two-hour workshops and follow up interviews three and six months later were was conducted with two workplaces, two health care clinics, one union, two injured worker representative groups, and one workers' compensation board.

Results
The Guide was useful to a range of different RTW decision-makers, but in different ways. The 'Work' and 'Health' sections of the Guide were most helpful. All partners used the Guide as a resource, and most as a problem-solving tool to increase communication and reduce formal conflicts. Information needed but not in the Guide was legal and policy detail, workers' exercising their rights, and employer business concerns. A party deriving least use from the Guide was workplaces, mostly because they encountered RTW as a business rather than a communication problem.

Conclusions
This utilization evaluation showed how different RTW partners encounter RTW problems in different ways. A clear function of the Guide is its use as a communication opener.

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RAC #09117
Physiological and Psychological Strain of Firefighters during Emergency Response Scenarios: Field Validation of the Toronto Heat Study

Principal Investigator(s): Stephen S. Cheung (Brock University)

Co-Investigator(s): Tom M. McLellan (DRDC-Toronto); Timothy Metcalfe (Toronto Fire Service)

Sponsoring Institution: Brock University

Objectives
Firefighting is an occupation in which individuals are exposed to excessive cardiovascular and thermoregulatory strain. To date, there is no real-life data which examines the thermoregulatory strain, sympathetic adrenal medullary system (SAS) and hypothalamic pituitary axis (HPA) responses concurrent to the cardiovascular strain associated with real-life emergency responses. The primary objective of this study was to perform field monitoring of firefighters in a natural setting, during real-life emergency response scenarios.

Method
Twelve 24-hour firefighter shifts were monitored that included 43 firefighters (Age: 41.9 ± 1.2 years; Years on Force: 15.3 ± 1.3 years; Height: 178.5 ± 1.1cm; Mass: 89.2 ± 1.7 kg; Body Mass Index (BMI): 28.0 ± 0.5 $kg \cdot m^{-2}$; VO_{2max} (Maximum oxygen consumption): 53.4 ± 1.4 $mL \cdot kg^{-1} \cdot min^{-1}$; Body Fat: 19.6 ± 0.7%). Each was tested one time during the summer months while on active duty in Toronto, Ontario (27.5 ± 0.2ºC and 53 ± 11% relative humidity (RH)). Both core temperature (T_c), measured using radio telemetry, and heart rate (HR) were logged continuously during each shift. Salivary cortisol and alpha amylase, as well as perceptual and psychological indices, were collected pre/post shift and during various call scenarios. In addition, urine samples were collected and pooled for pre, 12-hour and 24-hour pooled determinations of urine cytokines – Tumour Necrosis Factor-α (TNF-α), Interleukin-6 (IL-6) and Interleukin-10 (IL-10). Spot and pooled urine samples were also used to monitor urine specific gravity (USG).

Results
A total of 98 alarm responses were observed during call monitoring (7.6 ± 1.6 $calls \cdot shift^{-1}$, 52% classified as Active), with calls classified as Fire (self-contained breathing apparatus (SCBA) and non-SCBA, n = 47), Medical (n = 29), Auto extrication (AutoX, n = 11), Elevator (n = 6) and Other (n = 5). Findings showed that Active Fire SCBA and AutoX calls lasted significantly longer and produced higher peak heart rate, core temperature, and physiological strain compared to other call types (Fire non-SCBA, Medical, Elevator and Other). As a predictor of physiological strain, the Perceptual Strain Index generally underestimated physiological strain. However, as the level of encapsulation increased, such as with Fire and/or AutoX, the perceptual strain index became a more reliable predictor of physiological strain. Although we did not obtain data with active cooling, passive cooling proved to be a mildly effective cooling strategy when combined with fluid replacement and ambient temperatures at or below 30°C. Finally, significant alterations in the circadian cortisol cycle were observed as well as changes in inflammatory cytokines over the course of the 24-hr shift. This study is the first to report both physiological, psychological and biochemical responses in real-life call scenarios across different call types. Further, it suggests that AutoX may be equal to or more stressful than classic fire calls in some cases and that AutoX requires due consideration in standard rehabilitation guidelines.

Conclusions
These findings suggest that emotional stress associated with alarm calls and accentuated by an altered SAS activation, heighted the degree of firefighters' cardiovascular strain experienced by firefighters arriving at the emergency scene. Furthermore, both specific hydration strategies and the implementation of active rehabilitation are needed during additional call types, such as AutoX, not just traditional fire suppression. As well, the

incorporation of alternative methods to aid in the prediction of physiological strain, such as the Perceptual Strain Index, are needed during real-life emergency call responses.

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RAC #09118
User Trials and Possible Risks of Wearing an On-Body Personal Lift Assistive Device (PLAD)

Principal Investigator(s): Joan M. Stevenson (Queen's University)

Co-Investigator(s): Linda McLean, Patrick Costigan (Queen's University); Mohammad Abdoli-Eramaki (Ryerson University)

Sponsoring Institution: Queen's University

Objectives
The objectives of this research were to determine if there were added risk factors when wearing the Personal Lift Assistive Device (PLAD) due to: lifting technique, dynamic spinal stability, and energy demand; and to determine user-acceptability of the PLAD across a number of industrial jobs.

Method
Laboratory lifting studies 1 and 2 involved collecting three dimensional kinematic data using an Optotrak whereas laboratory study 3 involved electromyography and a portable oxygen analyzer. Field study 4 involved testing different PLAD prototypes in four industries using subjective questionnaires.

Results
Results revealed that the PLAD caused: 1) lifting technique be significantly altered to a straighter back and greater hip bend; 2) dynamic spinal stability to be significantly increased when lifting heavier loads; and, 3) energy demand to be unchanged when wearing the PLAD. Industrial workers perceived the PLAD to be effective, would be worn 70-80% of the time but required further design improvements to be fully accepted.

Conclusions
The PLAD did not increase the risk factors during lifting tasks based on technique, dynamic spinal stability or energy demand. Based on field trials, the PLAD was effective and would be worn by most workers for specific lifting and forward bending jobs, especially with some additional design changes.

Publications

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