THE RELATIONSHIP BETWEEEN AN ERGONOMICS TEAM TRAINING PROGRAM AND RMI COMPRESSION IN BUS OPRATORS: A REVIEW

Chuck Sherrod, DC, MPH, CIE
California Health Consultants, Inc.
Menlo Park, CA
Abbas Moallem, Ph.D. CIE
Ergoconsult
Cupertino, CA

A study of 320 bus operators for the San Mateo County Transit District was conducted over a three-year period. In this presentation, the investigators will reveal the goals, objectives, perceived and actual barriers, methodology, worksite surveillance, training protocols, tools or instruments, as well as outcome tracking results. Also, social marketing campaign and media techniques will be revealed.

INTRODUCTION AND BACKGROUND

Repetitive Motion Injuries (RMI's), or Work-Related Musculoskeltal Disorders, (WRMSD's) are a growing problem for the US and European industries in terms of direct and indirect cost factors. From 1982 to 1994, the incidence rate of RMI's increased over 1300 % with a downturn of 24% through 1998 in the United States alone, which may reflect the proactive ergonomics efforts by many of our business communities (CTD News, 2000). The extent to which RMI's impact the US workforce is quite dramatic, according to the National Institute of Occupational Safety and Health's NORA publication, which projects the price tag for occupational injuries at $145 million dollars for both direct medical costs and indirect costs such as production losses, training and replacement of workers, administrative and legal fees (NIOSH, 1999). Actually, Heinrich documented a relationship of 1:4 for direct and indirect costs in 1941 (Heinrich, 1931). Furthermore, the Bureau of Labor and Statistics (BLS) relies exclusively on workplace injury and illness reporting data extrapolated from OSHA 200 logs by private industry, a system which OSHA suggests has inherent problems of underreporting and elimination of injury categories such as low back syndrome, the second-leading cause of MSDs. In fact, Margaret Seminario, the Occupational Health and Safety Director for the AFL-CIO, refers to myriad studies that show much larger numbers of WRMSD's than those collected by BLS, which are sequestered more specifically from workers' compensation claims and physician reports (Kale, 2000). It appears that WRMSD injury incidence rates have fallen in most industries except transportation and public utilities (1992: 9.1 and 1997: 8.4 per 200,000 hours). Truck drivers and bus operators show similar risk factor exposures.

The focus and purpose of this investigation was to explore the role and effectiveness of implementing an ergonomics team training program, the OccuCom™ System, in the modulation of RMIs, and their subsequent costs in a workforce of bus operators. It was expected that the intervention would reduce injuries and costs by at least 20%, as well as creating a mechanism for ongoing worksite epidemiologic surveillance.

METHODS

A discussion of the stepped methodology for the OccuCom™ Ergonomics Team Training Program development and assessment will include the process activities of the information-gathering phase for both passive and active epidemiologic surveillance, data analysis, integration of training materials, and evaluation.

Participants

A total of 320 bus operators for the San Mateo County Transit District (SamTrans) participated in the study. SamTrans provides public transportation (via bus) for the San Mateo County District. The operation includes 312 revenue buses with 320 operators providing their services.

The age of the operators varies from 25 to 65 years. Sixty percent of the operators are between 35 and 54, 43% are between 40 and 49, and 28% are over 50, as seen in Chart 1, which illustrates a very balanced distribution.

Age is an important factor to consider for injury analysis, design specifications, and designing training programs for several reasons. First, according to Pheasant, the normal reparative and wound healing process is slowed, as well as a steady decline in stature, and increase in weight (Pleasant, 1988). Secondly, and most importantly, the degenerative process of intervertebral discs starts at age 30, and trauma such as vibration or

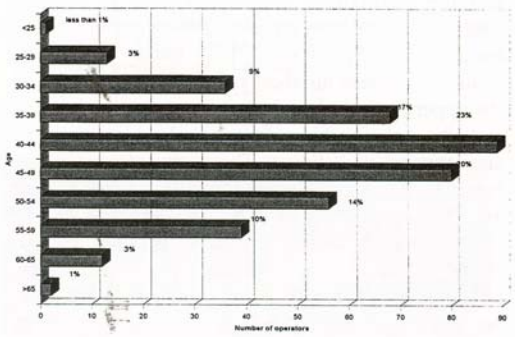


Chart 1 - Characteristics of the operators

prolonged sitting can aggravate or accelerate this process. Also, in terms of injury, individuals between the ages of 30 and 55 tend to have high incidences of chronicity and disability, and according to Bigos, workers under 25 are at greater risk of injury, but usually return to work more rapidly (Bigos, 1986).

Twenty-one percent of the bus operators were women, compared to 79% men. The incidence of common musculoskeletal disorders has been reported to be greater in women, with a male-to-female ratio of 1:3 according to Stevens (Stevens, 1988). However, the 21% female ratio of the bus operators may not support any gender-related injury tendency.

The level of education for the participants reflected 62% with a high school diploma, and 24% had one or more years of college. Eleven percent had completed nine to eleven years of education and only 3% below or above this level. The high level of education attained by 86% of the participants enabled them to learn the written and practical components of the training material, although the silent disability of functional illiteracy may act as a significant barrier to injury prevention efforts.

Surveillance Data Collection

The passive surveillance data collected for injuries between July 1, 1993 and June 30, 1996 revealed 103 that were musculoskeletal in nature,

and the distribution shows that 66% of injuries related to upper limb injuries (20% upper arm, 36% hand/wrist, 8% elbow, 1% lower arm, 1% shoulder). These numbers reflect the importance of the upper limbs in bus driving occupational injuries and the relationship of task behaviors such as steering and ticketing. The twenty-four percent back injury rate reveals another area of risk exposure for the operators. Although 31% of occupational injuries are due to back pain from lifting or moving heavy loads, it appears that their only exposure may be from strapping wheelchair passengers in, but more than likely also be from sitting position, duration of sitting posture, and whole body vibration (Chart 2 and 3).

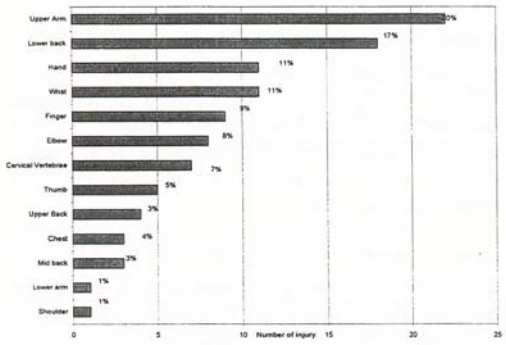


Chart 2- Type of injuries between July 1, 1993 and June 30, 1996.

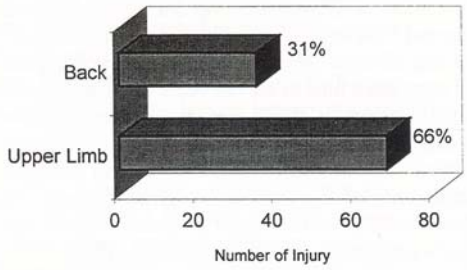


Chart 3. Injuries associated with back and upper limb in bus operator population, July 1, 1993 and June 30, 1996.

The active surveillance involved an ergonomic analysis of the activities of eight different operators who volunteered to be observed in their real work situations. In addition to informal interviews with the bus operators, direct observations, video recording, and 35 mm photography of the spontaneous behaviors of each participant at work were conducted. Before each observation session, the operator was sufficiently informed about the study purpose and observation methods, and provided a formal authorization to participate. For the scope of this investigation, our observations were focused on the vehicle conceptualization from the driver's point of view and not the passengers'.

Informal Interviews

The eight drivers were asked eight different questions about the nature of bus operator activities (Table 1), which can be defined as the mental and physical activities performed during the execution of the task.

Also, parallel activities such as record keeping and greeting customers, as well as annex activities such as taking breaks, using toilets, et cetera. A pre-test questionnaire was given to a voluntary population to identify their knowledge and skill sets in proper biomechanics and safety management. However, only eight drivers volunteered. Also, a pre-selected group of trainers from the SamTrans Training Department were available.

Analysis

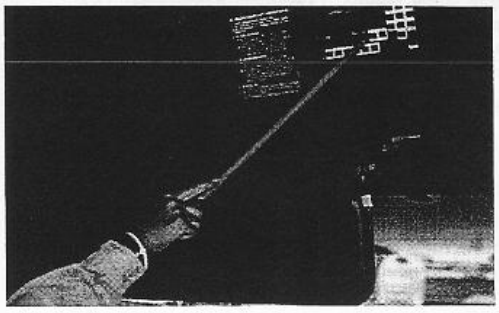
The data analysis phase of the project was conducted offsite and involved both developing a Task Analysis Report, including recommendations for work practice design modifications (Pictures 1 & 2), administrative changes, engineering controls, and equipment such as phasing in newer, more adjustable mirrors and bus seats with capacity to absorb vibration and provide back support, as well as training and retraining design. In this paper we are going to review only the results on training program. After a pre-implementation conference with the SamTrans project manager, designed to get an agreement to proceed, we began integration of data into the OccuCom™ Ergonomic Team Training Program.

Training Implementation

The third phase activity is the implementation of the training. This was conducted on-site in their North Bast South San Francisco training facility with their pre-selected group of professional trainers, who were also trained as bus operators. The OccuCom™ System is a four-hour train-the-trainer format that is further divided into four learning modules. The materials consisted of a training binder for each trainer (four trainers), with a 30-page training manual and pocket-sized laminated stretching and strengthening cards for each trainee, two sets of 11-inch x 14-inch all posters for recreation room bulletin boards, two Lift Alert 2000s, a fully scripted slide narrative for 20+ slides, a 5-minute post-test and evaluation forms, and selected videos.

Evaluation and Outcome Tracking

The fourth phase or activity was evaluation and outcome tracking. The evaluation was to determine program effectiveness. Trainer and trainee post-test results and evaluation form feedback, as well as development of the Haddon Injury Prevention Matrix (Table 2) to assess work behaviors, environmental and social factors of bus operators and forecasted changes. Outcome tracking at 9-, 12-, and 18-month intervals for RMI incidence rates, compression of RMI morbidity and risk factors.



Picture 1- The commands to change head signs are located in the front side of the front window. To reach this command some operators prefer to do this task with a stick.

Picture 2- Opening the driver's side window seems to be a real problem for shorter operator. This indicate a real design problem

Training Procedure

The early stages of the implementation rollout involved the participation of the safety director, training manager, California Health Consultants, Inc. (CHC) senior ergonomics consulting team in terms of developing operational logistics and project timelines. It was decided to first train the trainers about the 3 ½ hour session in an expanded 5 hour version, and then demonstrate to this same group the 3 ½ hour protocol for the trainer participants. Therefore, the trainer-to-trainee ratio ran 1:8 for the entire bus operator population, which require 12 weeks (January to March 1998). A practiced task, which required that participants to transfer a wheelchair into position and strap in passengers in the correct biomechanical posture without eliciting a sensory sound from the Lift Alert 2000 monitor.

Later, the participants were debriefed, took a post-test, filled out evaluation forms, and were thanked.

Table 1. Responses of bus operators to eight questions.

N	Question	Op#1	Op#2	Op#3	Op#4	Op#5	Op#6	Op#7	Op#8
1	Do you perform stretching exercises during your breaks?	No (1)	No	Yes	No	No	Not really	No	No
2	What activities of your job do you feel put you at most risk for an injury?	People (2)		Sitting	Sitting people (6)	Sitting & Stress	Sitting	Sitting (9)	People
3	Do you feel your level of physical fitness is adequate for your current job?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	What part of your workstation needs to be improved?	Seat	Seat	Seat (4)	Seat steer. Wheel	Seat	Seat	Nothing	Sea (12)t
5	Do you think you have enough training for your safety at work?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	Do you feel any pain after a work day ?	No(3)	No	Yes (5)*	No	Yes (8)	Yes	Yes (10)	No (13)
7	Do you think you have enough breaks during your workday?	Yes	Yes	Yes	Yes (7)	Yes	No (11)	Yes	No
8	What is the hardest part of your work?	Stress & People	Stress	Sitting position	Sitting position	Sitting & people	Sitting	Nothing	People & Neck move-ment

Comments

(1) Not really I have some physical activity with my other job.
(2) Stress: dealing with people in the bus and watching for them outside the bus when I drive. Stress of being on time
(3) Sometimes arm pain
(4) I hate the 800 bus because of their seat (An injured worker who stayed 3 years on rehabilitation)
(5) But I have learned to live with it (an injured operator)
(6) Sitting too long and dealing with people
(7) I have three hours break its too long
(8) Neck and shoulder
(9) Being seated too long
(10) low back pain
(11) I often can not take my recovery time
(12) If the seat could go further backwards it would be better
(13) last year I had neck problems, Personal trainer told me it 's because of my sitting position.

Table 2. Haddon Injury Prevention Matrix based on task analysis data from SamTrans bus operators, 1994-1999.

	Host	Agent	Environmental and Social Factors
Pre-event	Fatigue, stress, force, repetitive motion and prolonged sitting	Bus seat with poor adjustability and no lumbar support	Compliance with General Safety Order 5110
Event	RMI or WRMSD	Steering wheel, seated posture, wheelchair manipulation	OccuCom™ Ergonomic Team Training
Post-event	Loss days, disability	Fitness program, new bus seats	Newsletter, annual training refresher

RESULTS

Planned comparisons of Questionnaire #1 pre-test and Questionnaire #2 post-test did not occur, due to lack of volunteers. However, the post-test scores and obstacle course ratings were all within criteria limits (75% or better). The outcome tracking of RMI injury rates through the 18-month post-training period showed a 13.5% decrease in RMIs, after correcting for lacerations, dog bites, et cetera. Moreover, we will compare the original 24-month incidence rates, as given earlier, with post-intervention rates when available, to enhance external validity.

DISCUSSION

The study provides evidence, in terms of face value, that the OccuCom™ Ergonomics Team Training Program was effective in decreasing RMIs for the bus operator population, although short of the anticipated 20%. As of the date of this paper, most of the design and work practice modification recommendations and training procedures have been implemented or are in progress. This includes both parallel and annex activities. Since we know from the National Safety Council's research study of 1997 that 88% of MSDs are due to unsafe behavior, 10% due to unsafe environment, and 2% unknown, a behavior-based training program such as the OccuCom™ system was an appropriate intervention. However, the work practices and equipment and ergonomic design modifications must complement the behavior-based OccuCom™ system in order to maximize the total effect of an ergonomics program.

As mentioned earlier from OSHA's admonition regarding the state of our injury reporting system, it would be a reasonable assumption that the number of claims for both the pre- and post- intervention period do not necessarily reflect the actual number of bus operators suffering from pain related to their jobs. In fact, a 1996 study led by Charles Dillon at the University of Connecticut found that the number of actual MSDs far exceed the number of reported MSDs, with only 10% of respondents filing worker's compensation claims (Dillon, 1996).

ACKNOWLEDGMENTS

We appreciate the efforts of the senior consulting staff of California Health Consultants and NetErgonomics for their contributions, as well as Susan Ashcraft for editorial contributions. We are indebted to Chrisman and Associates and samTrans Human Resource Department for the provision of database queries, and, of course, the bus operator trainee and trainer participants.

REFERENCES

Bigos, S.J., D.M. Spengler, N.A. Martin, *et al.* (1986). Back injuries in industry: A retrospective study III, Employees related factors, Spine: 113: 252-256.

Dillon, C. (1996). Upper Extremity Repetitive Strain Injuries in Connecticut in 1996, Extent and Cost. CTD News 9:2-10.

Heinrich, H.W. (1931). *Industrial Accident Prevention.* New York: McGraw, Hill and Book Company.

Kale, A. (2000). They're falling. Safety and Health 181:30-31.

National Institute of Safety and Health (1997). In: NIOSH/NORA FY 1999 Update/Background – An Agenda for the 21st Century. Website www.cdc.gov/niosh/nora9904.html.

Pleasant, S. (1988) *Body Space, Anthropometry, Ertonmics and the Design Work.* Second Edition, London: Taylor and Francis.

Stevens, J.C. (1988). Carpal Tunnel Syndrome in Rochester, Minnesota, 1961 to 1980. Neura: 38: 137-8.

US Bureau of Labor and Statistics (1999). In: CTD News (2000). Repeated trauma disorders fall for fourth year in a row in 1998. CTD News: 9(1): 1,8.