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Improved injury management at an Australian aluminium smelter

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Abstract. *Objective:* This longitudinal study sought to determine the effectiveness of interventions to improve injury management in an industrial setting.
Participants: Study participants were workers from three production departments of a large aluminium smelter.
Methods: The interventions introduced were to encourage active participation in rehabilitation procedures by injured workers, improve communication with all stakeholders, identify and manage psychosocial issues, and focus the workforce on occupational health and safety matters. Linear regression modelling was used to determine the effectiveness of the interventions using data collected for fourteen months before and fifteen months after the introduction of interventions. Outcomes compared were the number of injuries, number of persons on restricted duty, and lost hours per month.
Results: Modelling showed the intervention significantly reduced the number of injuries in the potrooms (from 14 to 6 per month). The number of persons on restricted duties was reduced in all departments (potrooms: from 12 to 7 persons per month, cast house: 3 to 1 person per month, carbon plant: 3 to 1 person per month). Lost hours were significantly reduced in the potrooms (from 244 to 61 hours per month).
Conclusion: These findings demonstrate the effectiveness of the revised injury management process introduced.

Keywords: Work related injuries, musculoskeletal disorders, occupational health, psycho-social factors

1. Introduction and literature review

Successful workplace injury rehabilitation relies on the input from a number of stake holders including the injured worker, the employer, the treating physician, occupational rehabilitation professionals, and insurance companies. In Australia, occupational health and safety and workplace injury management follow international best practice, with both state and federal regulations for rehabilitation dictating that an employer provide treatment and management of an injured worker's condition [15]. The Australian National Occupational Health and Safety Commission (NOHSC) developed guidelines for best practice in occupational rehabilitation, which outline the functions of first aid, treating doctors, case managers, rehabilitation coordinators/practitioners, and return to work coordinators [14]. Within the legislative framework of the Workplace Injury Management and Workers Compensation Act (New South Wales 1998) employers are required to engage occupational rehabilitation professionals to assess worker injuries and develop injury management plans that facilitate a timely return to work [16]. However, even with this structured approach, rehabilitation outcomes are often poor, with the injured worker left

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in a passive and often untenable position amongst the variety of rehabilitation professionals [11]. Additionally, supervisors are often not part of the communication process and experience difficulty in accommodating the needs of injured workers and their injury management plans which negatively affects the overall rehabilitation outcomes [8]. The stress injured workers may be subjected to stems from both the workplace and the social environments which can further exacerbate the problem [20]. Published studies show the longer assistance and treatment for an injured worker is delayed, the less likely it is to be effective [10].

Recently, a number of studies have been published reporting the benefits of multidisciplinary and active approaches to rehabilitation as opposed to passive approaches [1,5,13]. The active participation of workers along with their supervisors in developing injury prevention procedures [19] is associated with both a decrease in the incidence of musculoskeletal symptoms and an earlier return to work for those with subacute musculoskeletal injuries [12]. The benefit of including management and supervisors of injured workers in the development of injury management plans [11] has also been demonstrated. The ability of an injured worker to become involved in making informed choices during their rehabilitation increases their personal control and has been shown to improve the rehabilitation outcome whereby workers make a timely, safe and durable return to pre-injury duties [2].

Psychological stress is believed to influence health both through the generation of negative affective states, and through the disruption of endocrine functions responsible for immune and inflammatory processes [4]. A number of studies demonstrate a significant link between workplace stress and musculoskeletal injuries [3, 6,7,9,17,18]. It is proposed that identifying and managing psychosocial stress originating from both the workplace and social environments will influence rehabilitation outcomes. Additionally, the existing workplace culture can influence the rehabilitation outcome by establishing guidelines for the behaviour of management personnel, supervisors, and the injured workers [11].

This present study was designed to determine the effectiveness of an intervention program in an Australian aluminium smelter.

2. Methods

2.1. Research design

A longitudinal study was undertaken to test the effectiveness of an injury management process which incorporated additional workplace communication, structured psychological services focused on occupational health and safety matters, and increased worker participation. The number of injuries and hours lost due to injuries and the number of persons on restricted duties for 14 months before the intervention and the ensuing 15 months were analysed. This study was approved by the University of Newcastle Human Research Ethics Committee.

2.2. Participants

The participants were all employees at the smelter from 1 January 2005 to 30 May 2007. The smelter consisted of four departments: three production departments (potrooms, casting and carbon plants), and the department of administration, and occupational health and safety services. Maintenance services are carried out by sub-contractors so these workers were not included in the study.

2.3. Intervention

The underlying aim of the interventions introduced in March 2006 were: to further improve communication with supervisors and management in the workplace, to enable injured workers to actively participate in injury management and rehabilitation process, to influence the workplace culture by educating the workforce about occupational health and rehabilitation matters, to identify psychosocial issues and manage these with a structured psychological employee assistance program. These activities were implemented by the on-site occupational medical doctor.

Prior to the intervention, injured workers would be seen by either their own and/or the company's doctor and referred off-site to independent rehabilitation providers which was primarily physical therapy. Communication with the workplace was maintained via official medical certificates generated by the medical practitioners and occupational rehabilitation professionals during consultations and review visits. Senior management were advised of injury management requirements and restricted duty limitations via email and site-visits from occupational rehabilitation professionals. During this process the injured worker was mainly a passive participant and the lost time was high. The progress of workers on restricted duties in graded return to pre-injury duties appeared slow. In January 2006 the injury management system was reviewed and multiple interventions described below were instituted by March 2006.

2.3.1. Improved communications

A system of direct, immediate, and ongoing emails between the physician, rehabilitation professionals, and workplace management was implemented. Workplace management included from senior management to the level of supervisors and team leaders. The content of the email messages included; the mechanism and severity of injury, treatment and management options, rehabilitation plans, restricted duties criteria, expected prognosis, goals, and scheduled reviews.

2.3.2. Active injury rehabilitation

The majority of injuries were musculoskeletal and as soon as an injury was stabilized, the worker was referred to the on-site gymnasium for exercises and rehabilitation under the supervision of a qualified therapist. This encouraged the workers to actively participate in their own rehabilitation process. Furthermore, the progressive recovery and monitoring of the injuries also served to educate employees about the mechanism of their injuries and the future prevention of similar incidents or accidents.

2.3.3. Psychological assistance program

All work place strain and sprain injuries were investigated to determine the possible association of work or non-work related psychosocial stressors. Strains and sprains are described as all painful conditions of joints, muscles, ligaments or tendons that were caused by stretching, twisting or repetitive work. A detailed psychosocial history was taken which focused on workplace disputes and grievances, personal social problems, or psychological and psychiatric problems. Psychosocial stressors were addressed by mediation and arbitration, counselling conducted on site by a Chaplain or specialized off-site psychiatric assistance was available as required.

2.3.4. Monthly educational newsletters

A monthly newsletter was introduced and distributed to educate the workforce on relevant medical matters. The newsletters cover areas of occupational health and safety including illness profiling, injury management, manual handling and ergonomics, medical administration, injury prevention, health promotion and surveillance, rehabilitation and risk management.

2.4. Data collection

Data including injuries, clinic visits, treatment, lost time (hours) and restricted duty status were recorded daily into a database maintained by the smelter health service. Monthly lost time restricted duties and treatment data were retrieved from the database for each department over the study period. Lost time was measured as the number of hours lost to injury per month. Restricted duties were measured as the number of persons on restricted duties for any part of the month. Medical treatment was measured as the number of injuries requiring medical attention beyond basic first aid. The Human Resources Department collect and report the total number of production hours worked and total overtime hours worked monthly. These were included in the analysis because the number of hours worked could influence the number of injury occurrences and the number of lost time injury hours.

2.5. Data analysis

Three linear regression models were obtained: the number of injuries, the number of persons on restricted duties, and the amount of lost time per month in each department for before versus after the full implementation of the intervention. The confounding variables for all three models were intervention (dichotomous 0/1), department (included as two indicator variables), production hours and overtime hours. The number of injuries was included as an explanatory variable in the third model for lost time. Shapiro-Wilks tests were used to verify the normality of the residuals. Statistical significance was determined at the 0.05 level. All data analyses were performed using statistics/data analysis software (STATA V10, Statacorp, College Station, Texas USA).

3. Results

The participants were 636 workers employed at the smelter between January 2005 and May 2007. Only employees from the production departments of the potrooms, cast house and carbon plant were included in the statistical analysis because no lost time injury hours were recorded in the administrative department. Table 1 summarises the number of study participants through time by department of employment and mean ages. The number of employees in the potrooms, casting and carbon plant steadily declined over the 29 month follow-up period. A Kruskal-Wallis test for each year along with a Bonferroni correction for multiple comparisons showed no significant differences between workers ages across the production departments over

Table 1
Characteristics of study population

Department	Year		
	Jan 1, 2005 $n = 569$	Jan 1, 2006 $n = 530$	Jan 1, 2007 $n = 503$
Potrooms			
Employees	194	184	175
Mean age (95% C.I.)	46.4(45.1, 47.8)	47.7(46.3, 49.1)	48.2(46.8, 49.6)
Cast House			
Employees	144	126	109
Mean age (95% C.I.)	46.9(45.4, 48.3)	46.7(45.1, 48.2)	45.8(44.1, 47.4)
Carbon Plant			
Employees	94	88	76
Mean age (95% C.I.)	45.6(43.6, 47.6)	45.6(43.6, 47.6)	46.5(44.6, 48.5)

Table 2
Mean production hours per month through time, by division

Department	Year					
	2005		2006		2007	
	total	overtime	total	overtime	total	overtime
Potrooms	23,138	2,061	24,915	2,480	24,091	2,674
(95% C.I.)	(22,587, 23,687)	(1,757, 2,364)	(24,006, 25,824)	(2,105, 2,856)	(22,829, 25,353)	(2,280, 3,067)
Cast House	14,845	63	10,562	964	10,053	1,351
(95% C.I.)	(14,241, 15,450)	(10, 116)	(9,969, 11,154)	(765, 1,162)	(9,059, 11,047)	(751, 1,952)
Carbon Plant	9,145	527	8,709	508	9,341	708
(95% C.I.)	(8,918, 9,373)	(366, 688)	(8,477, 8,940)	(403, 614)	(8,891, 9,790)	(647, 769)

Table 3
Injuries, restricted duties and lost time injury hours before and after the intervention

Department	Outcome					
	Injuries		Restricted duties		Lost time	
	before	after	before	after	before	after
Potrooms	178	112	182	108	4,756	1,096
(95% C.I.)	(149, 207)	(85, 138)	(161, 203)	(82, 134)	(2,435, 7,077)	(500, 1,692)
Cast House	63	65	46	22	1,168	146
(95% C.I.)	(42, 84)	(48, 82)	(39, 53)	(13, 31)	(521, 1,815)	(0, 315)
Carbon Plant	46	45	43	17	344	284
(95% C.I.)	(35, 57)	(30, 60)	(34, 52)	(9, 25)	(0, 707)	(0, 641)

time, therefore, age was not included in any further analysis.

Table 2 summarises the mean production and overtime hours worked in each department, showing that the greatest number of hours worked was in the potrooms. A linear regression model shows a statistically significant increase in production hours in the potrooms (77.9 hours per month, p-value 0.001) and a decrease in production hours in the cast house over time (-250.1 hours per month, p-value 0.000). A similar model of overtime hours, using a square root transformation to improve fit, shows a significant increase in overtime hours in both the potrooms (23.1 hours/month in Feb 2005, p-value 0.018) and the cast house (100.2 hours per month in Jan 2007, p-value 0.000). Therefore, production and overtime hours were included as possible explanatory variables in further modelling.

Lost time injuries occurred in three of the four departments evaluated as shown in Table 3. Despite the increase in production hours in the potrooms during the study period, the number of injuries and the lost time hours all decrease after intervention. In addition, the number of persons on restricted duties decreased, indicating that the decrease in lost time hours was not simply achieved by a reclassification of workers to restricted duties.

Table 4 shows the regression tables from the three multiple regression analyses. Interaction variables (i.e., products of explanatory variables) were included, if significant, to allow the effect of the intervention to vary by department. Not including significant interactions means the model pools the interaction effect over department, possibly reducing and/or increasing the estimated effect in some departments. Some estimates pre-

Table 4
Regression results for injuries, number of restricted duties and lost time injury hours

Response variables	# Injuries/month		# Restricted duties		Lost time injury hours/month	
response transform			square root		square root	
R-squared	70%		84%		54%	
Explanatory variables	coef.	p-value	coef.	p-value	coef.	p-value
Intervention	−7.75	0.000	−0.803	0.000	−0.248	0.000
Potroom (reference population)						
Casting	32.46	0.009	0.293	0.870	−0.566	0.000
Carbon plant	18.92	0.198	4.41	0.063	−0.671	0.000
Intervention*casting §	4.36	0.038			0.149	0.035
Intervention*carbon plant§	7.47	0.000			0.246	0.005
Production hours	1.26	0.011	0.070	0.293		
Production hours* casting§	−2.08	0.001	−0.073	0.400		
Production hours*carbon plant§	−1.19	0.305	−0.549	0.008		
Overtime hours					−0.141	0.004
# Injuries/month			0.042	0.021		
Constant	−16.21	0.147	1.40	0.379	0.824	0.000

§ Indicates an Interaction between intervention and work division
Note: Empty cells indicate the variable was not significant and so was removed from the model.

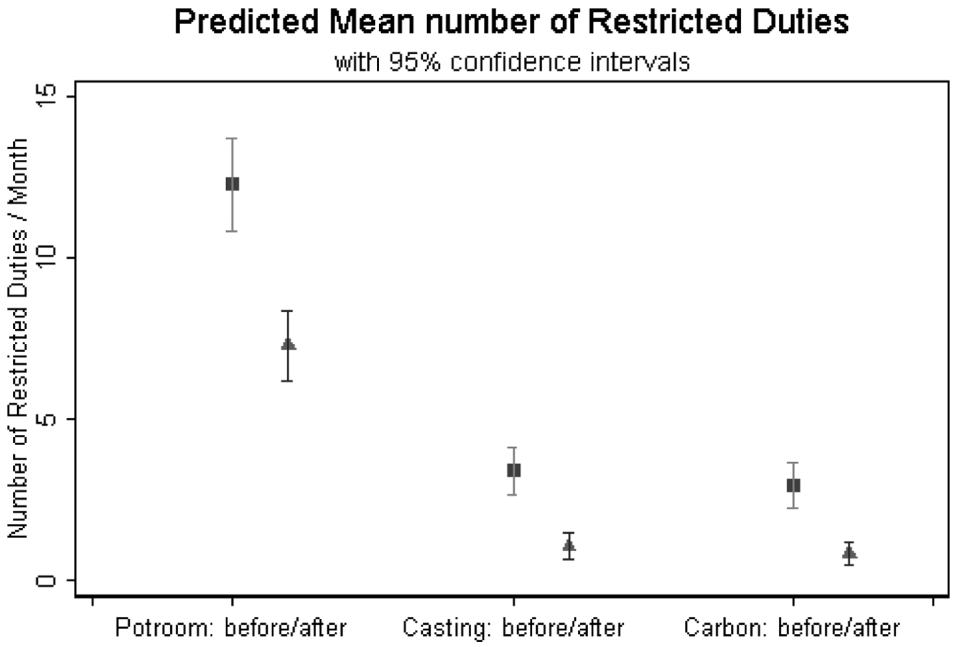

Fig. 1. Predicted Effectiveness of the Intervention on Number of Employess on Restricted Duties per month.

dicted by the model at average production and overtime hours in each department (see Figs 1 and 2).

Statistically significant reduction in injuries, persons performing restricted duties and lost time injury hours as a result of the intervention were seen in the potrooms. The cast house and carbon plant saw statistically significant reductions in the restricted duties as a result of the intervention. These differences are seen by the non-overlapping 95% confidence intervals.

4. Discussion

The significant decrease in reported injuries, persons on restricted duties, and lost time hours at work demonstrate the positive effect of the interventions. An effective and immediate electronic communications system negates the need for queries and delays in allocating rehabilitation, restricted/suitable duties, and appropriate compensation. Furthermore, it enables efficient information exchange for designing return to work plans,

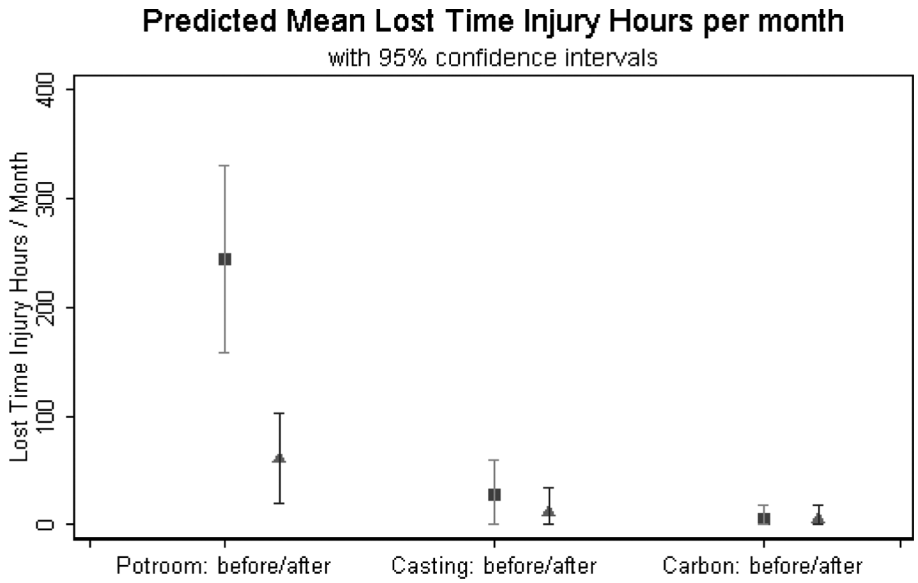

Fig. 2. Predicted Effectiveness of the Intervention on Lost Time Injury Hours per month.

arrangements for the follow up consultations, and affords documented evidence of the procedures. There are now fewer misunderstandings. The system creates employee ownership of the return to work procedures. Active participation in exercise appears to be more beneficial than passive approaches such as rest. By attending on-site exercise and rehabilitation programs, employees increased their awareness of their rehabilitation process, became actively involved, and became interested in contributing to their own recovery. This is opposed to attending off-site rehabilitation procedures where the employees may become passive observers with limited involvement in the rehabilitation process. It appears beneficial to identify and manage background psychosocial issues, both work and non-work related sources, as part of the rehabilitation process. Efforts to reduce the psychological stressors appear to improve both the physiological ability to heal and promote a positive sense of well-being.

Finally, regular newsletters serve to educate all employees regarding current occupational health and safety issues in the work place and promote awareness of the need and procedures of evidence-based medical and rehabilitation modalities.

The interventions undertaken in this study resulted in superior rehabilitation outcomes for the injured employees. The proportional effects of individual components of the intervention were not identified. Further studies within the overall workplace and the injury management culture of an organisation are required to clearly define the benefits of improved communications, worker autonomy participation, and psychological stress management.

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