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**ORIGINAL REPORT**

# OUTCOMES OF MOTOR VEHICLE CRASHES WITH FRACTURE: A PILOT STUDY OF EARLY REHABILITATION INTERVENTIONS*

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***Aim:*** **To determine the effects of early rehabilitation interventions on the physical, psychological and vocational outcomes of patients presenting to the Emergency Department with fracture resulting from a motor vehicle crash.**

***Method:*** **Prospective non-randomized cohort controlled trial. Seventy-six subjects were enrolled and formed 2 groups. The control group received usual care, and the intervention group received a consultation with a rehabilitation physician and was offered pain management, physiotherapy, psychological treatment and further specialist referrals if indicated. The battery of outcome measures covering pain, psychological assessment, return to work and return to driving was performed at the same time intervals for both cohorts.**

***Results:*** **Significant ($p < 0.05$) improvement was seen in pain levels at 12 weeks in the intervention group compared to control group. The intervention group showed a significantly better rate of return to normal work compared to the control group.**

***Conclusions:*** **Early proactive rehabilitation can benefit patients with fractures resulting from motor vehicle crashes. This pilot study suggests the need for further investigation of the recovery from fractures among such patients.**

*Key words:* rehabilitation; traffic accident; treatment outcome; bone fractures.

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## INTRODUCTION

Road crashes result in adverse outcomes in physical, psychological and societal domains. In 2001 a survey by the Australian Bureau of Statistics found that 495,300 people reported having a long-term physical impairment caused by a road crash (1). A review of the prevalence of long term disability resulting from road crashes, by Ameratunga et al. (2) described the prevalence of disability ranging from 2 to 87%.

Orthopaedic injury has been shown to have a negative impact on recovery. A non-road crash study of blunt trauma patients in Oregon, USA by Michaels et al. (3) found that those with orthopaedic injury had relatively worse recovery at 6 and 12 months as measured by the Short-Form-36 (SF-36) and Sickness Impact Profile than those without orthopaedic injury, after controlling for injury severity. In addition to serious extremity injury, Holbrook et al. (4) found depression, post-traumatic stress disorder (PTSD) and intensive care days were significantly associated with functional limitation at 12 and 18 months.

The psychological sequelae of motor vehicle crashes can be a source of disability and is unlikely to be recognised and addressed in the acute hospital setting as psychological distress frequently emerges as an issue after the person has been discharged from hospital. In a review of inpatient management of orthopaedic trauma from road crashes, Donaldson et al. (5) noted that the reported incidence of psychological distress amongst inpatients was low (11%), and was at odds with the higher levels of long term distress reported elsewhere. Read et al. (6) found levels of post-traumatic depression of about 50% at 6 months post road crash. This suggests that psychological distress is either being missed in inpatients, or alternatively becomes apparent after discharge, underlining the need for follow-up of road crash victims after hospital discharge. Fitzharris et al. (7), in a prospective cohort study of working age adults admitted to hospital following a road crash, found persistent reductions in health status at 2 and 8 months post crash. This cohort also had persistent pain at 8 months.

Social consequences of motor vehicle crashes include loss of employment. In a study of 1.2 million adults living at home with a disability resulting from a road crash, Shults et al. found that 43% were unable to return to work as a result of their injuries (8).

Suggestions that outcomes for trauma sufferers could be improved by better follow-up were noted by the authors of a

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Swedish study of outcome and quality of life 5 years after major trauma (9). In this study 205 trauma survivors were contacted 5 years post injury. Sixty percent of the sample had been injured as a result of a road crash. Nearly half of the participants felt the acute hospital could have done more to help them cope with their injury and disability. They reported a need for follow-up by trauma team and for management of persistent physical suffering. Along a similar theme, Richmond et al. (10) identified a sense of abandonment after discharge and poor pain management as factors limiting recovery from trauma.

This study, a prospective non-randomised cohort controlled trial of early rehabilitation as compared to usual care in motor vehicle crash sufferers with fracture, was conducted to determine whether early rehabilitation interventions resulted in improved short to medium term outcomes.

## METHODS

### *Design*

Adults injured in a motor vehicle crash and sustaining a fracture were identified consecutively from the emergency department information system (EDIS) (a database of all persons presenting to the emergency department), each week day from March 2005. Individuals who were not hospital inpatients at the time they were identified (i.e. had presented and been discharged overnight or on a weekend) were approached for consent by telephone. Inclusion criteria were those people who: had presented to the emergency department with a fracture due to motor vehicle trauma with an abbreviated injury score (AIS) (11) of 2 or above; were able and willing to attend follow up visits and had provided informed consent. Exclusion criteria were people who had: suffered a severe traumatic brain injury as defined by a Glasgow Coma Score (12) of 8 or below; loss of consciousness for more than 24 h or post traumatic amnesia of 7 or more days; experienced spinal cord injury with neurological deficit; poor English language skills; unwillingness or inability to attend follow-up visits.

The first 40 patients enrolled formed the control group, while the next 40 formed the intervention group. A sequential rather than randomized study design was chosen to avoid the contamination of control group by intervention group strategies which may have been adopted by treating teams if the 2 groups were concurrent.

Followed-up of patients occurred at or as close as possible to day 10, week 6, week 12 and week 18 post injury. All patients had the following data collected: demographic data; pain levels using a 10-cm visual analogue scale (VAS) (13), psychological well-being measures including Depression Anxiety and Stress Scale (DASS) (14) and Trauma Screening Questionnaire (TSQ) (15); return to driving, and return to any work and to normal work. The DASS is a self-report scale of 42 items in each of the areas of depression, anxiety and stress. Subjects are asked to report the extent to which they have experienced each state over the past week using a 4 point scale. Recommended cut-offs for normal, moderate and severe scores are given based on normative Australian data. The TSQ is a 10 point self-report scale covering re-arousal and re-experiencing when thinking of the traumatic event, with a person scoring 6 or more considered to be at risk of PTSD. The tools for psychological assessment were administered by the rehabilitation physician and research nurse and scored by the research nurse.

### *The intervention*

Both groups received the usual hospital and primary care for their injury, for example admission under the orthopaedic team for fracture fixation, with advice to attend their primary care physician for analgesia review post discharge, and were reviewed in the outpatient fracture clinic at 6 weeks to assess fracture healing. At this point physiotherapy may have been arranged. A rehabilitation consultation was not typically part of early usual care. The intervention group also received a consultation with a rehabilitation physician at each time point. The rehabilitation consultation focussed on the activity limitations and participation restrictions resulting from the fracture. The treatments offered to the intervention group were individualized and evidence based where evidence existed. Further referrals for investigation, psychological intervention and physiotherapy, if required, were made during the intervention consultation by the rehabilitation physician. Medications were adjusted and general advice regarding recovery timeframes for the patient's injury was given during the intervention group consultation. Intervention group patients were discussed in a case conference with a multidisciplinary team and therapy goals were set. Psychological intervention was offered to those patients in the intervention group who scored at least moderate depression, anxiety or stress on the DASS, or who had experienced more than 6 arousal events on the TSQ.

### *Recruitment and retention in the study*

Over the 18-month recruitment period 536 persons presented with a fracture following a motor vehicle crash. Of these, 200 were eligible, 80 patients initially consented to the study, but 76 completed the first assessment. Table I shows the retention of patients in the study over time.

### *Data analysis*

Baseline differences between groups were assessed using Pearson Chisquare for categorical data (e.g. work status) and analysis of variance (ANOVA) for continuous data (e.g. age), with $p$ set at 0.05. For continuous outcome data collected over time (i.e. VAS for pain), repeat-measures ANOVA was used to compare means between groups over time, with important covariates incorporated where appropriate. Where data distributions were highly skewed (i.e. DASS and TSQ scores), the non-parametric Sign Test for related samples was used to assess within subject changes over time and the Mann-Whitney $U$ was used to assess between group differences. To allow maximum use of the existing data after loss to follow up, a series of analyses were undertaken to compare each successive time point to the first time point for each measure. To control for these 3 multiple comparisons, $p$ was adjusted to 0.017 (i.e. 0.05/3).

For categorical outcome data, Cox regression for survival functions was used to assess the impact of the intervention over time on percentage of patients returning to driving, to any work and to normal work, while controlling for other relevant covariates. Return to driving, any work and normal work were classified as 'terminal' events for the purposes of analysis. Cases lost to follow up were analysed on an intention-to-treat basis, such that the last available information was retained for the remainder of the study (e.g. if not driving at week 6 and lost to follow up, then continued in analysis as not driving). The loss to follow up does not advantage the intervention group in this analysis.

Data was analysed using IBM SPSS Professional Version 19 (IBM SPSS, 2012). Sample size calculation was conducted prior to the study, identifying the need for 64 patients in each study group in order to provide 80% power to detect a 0.5 standard deviation difference in means with a $p < 0.05$ using VAS pain scores. Unfortunately, our rate of recruitment fell below expectations and available study funding. Approval was granted from the St Vincent's Hospital Human Research and Ethics Committee for this study.

Table I. *Retention in study at each assessment point*

| | | Assessments | | | |
|---|---|---|---|---|---|
| | Recruitment | Day 10 | Week 6 | Week 12 | Week 18 |
| | *n* | *n* | *n* | *n* | *n* |
| Intervention group | 40 | 40 | 29 | 21 | 13 |
| Control group | 40 | 36 | 31 | 27 | 22 |

Table II. *Demographic characteristics and accident severity of control and intervention groups at baseline*

| | Control ($n$=36) | Intervention ($n$=40) | $p$ |
|---|---|---|---|
| Age, years, mean (SD) | 44.8 (15.1) | 39.1 (16.0) | 0.114 |
| [range] | [21–84] | [21–93] | |
| Injury Severity Score, mean (SD) | 8.8 (5.7) | 8.3 (4.8) | 0.647 |
| [range] | [2–27] | [2–29] | |
| % Male | 78 | 58 | 0.060 |
| Work status, % | | | |
| Fulltime | 61 | 82 | 0.110 |
| Part-time | 19 | 10 | |
| Not working | 19 | 8 | |
| Job type (among those working), % | | | |
| Clerical | 50 | 53 | 0.825 |
| Manual | 50 | 42 | |

Percentages may not sum to 100% due to rounding error with small numbers.
SD: standard deviation.

Table III. *Mode of accident and site of fracture among participants*

| | Control ($n$=36) % | Intervention ($n$=40) % |
|---|---|---|
| Mode of accident | | |
| Motorbike | 39 | 45 |
| Pedestrian | 42 | 35 |
| Motorcar/truck | 14 | 13 |
| Bicycle | 6 | 8 |
| Site of fracture[a] | | |
| Upper Limb | 25 | 30 |
| Lower Limb | 53 | 43 |
| Head (facial, skull) | 8 | 5 |
| Vertebral | 8 | 10 |
| Ribs | 6 | 13 |

Percentages may not sum to 100% due to rounding error with small numbers.
[a]Primary fracture with or without other fractures.

## RESULTS

The demographic characteristics and accident severity of the control and intervention groups at baseline are shown in Table II. Although small differences were observed, none reached statistical significance.

For both groups, motorbike and pedestrian accidents made up around 80% of the sample, followed by car and bicycle accidents (Table III). The intervention and control groups also did not differ regarding the distribution of fracture site as shown in Table III. In those patients with multiple fractures, the most severely injured part (as per AIS scoring) was logged.

For the intervention group, specific rehabilitation recommendations recorded following consultations were as follows. Of the 14 people who scored at least moderate level on the DASS, or had positive scores for PTSD, 6 agreed to psychological interventions. Eight people were recommended for extra physiotherapy, and 4 agreed. Seven people had medical interventions including further Xrays or MRI scans, referral to specialist orthopaedic or trauma surgeons and medication prescription including analgesia and antidepressant medica-

Table IV. *Changes in pain and psychological measures as a function of time and treatment group*

| Variable | Day 10–week 6 | Day 10–week 12 | Day 10–week 18 |
|---|---|---|---|
| Pain VAS, mean 1 – mean 2 ($n$) | | | |
| Control | 5.37 – 2.68 (29) | 5.12 – 3.66 (27) | 5.29 – 1.51 (22) |
| Intervention | 6.43 – 2.95 (28) | 6.36 – 2.02 (18) | 6.74 – 1.91 (10) |
| | *t ($p$=0.000) | *t ($p$=0.007); *txg ($p$=0.007) | *t ($p$=0.000) |
| DASS depression, median 1 – median 2 ($n$) | | | |
| Control | 3.5 – 2.0 (30) | 4.0 – 2.0 (27) | 4.0 – 1.0 (22) |
| Intervention | 3.0 – 3.0 (28) | 3.0 – 2.0 (20) | 4.0 – 3.0 (11) |
| | ns | ns | ns |
| DASS anxiety, median 1 – median 2 ($n$) | | | |
| Control | 5.0 – 2.0 (30) | 5.0 – 1.0 (27) | 5.0 – 1.5 (22) |
| Intervention | 4.5 – 2.0 (28) | 4.0 – 1.5 (20) | 3.0 – 1.0 (11) |
| | *t ($p$=0.003) | *t ($p$=0.000); tC ($p$=0.001) | *t ($p$=0.002); tC ($p$=0.004) |
| DASS stress, median 1 – median 2 ($n$) | | | |
| Control | 5.5 – 3.0 (30) | 5.0 – 3.0 (27) | 5.5 – 3.0 (22) |
| Intervention | 8.5 – 7.5 (28) | 8.0 – 6.0 (20) | 7.0 – 9.0 (11) |
| | ns | *t ($p$=0.005); tC ($p$=0.003) | ns |
| PTSD (TSQ), median 1 – median 2 ($n$) | | Week 6–week 12 | Week 6–week 18 |
| Control | na | 1.0 – 2.0 (26) | 1.0 – 1.0 (21) |
| Intervention | na | 4.0 – 3.0 (19) | 4.0 – 2.0 (11) |
| | | tI ($p$=0.008) | ns |

Due to attrition each successive time point was compared to the first time point for that measure, allowing maximum use of existing data. Some variation in means occurs due to changes in underlying numbers of cases.
*t – significant change over time across both groups.
*tI, *tC: significant change over time within intervention group (I) or within control group (C) (non-parametric analysis only).
*txg: significant time by group interaction (ANOVA only). ns – no significant difference.
VAS: visual analogue scale; DASS: Depression Anxiety and Stress Scale; PTSD: post-traumatic stress disorder; TSQ: Trauma Screening Questionnaire.

tion. Amongst those who had further imaging this revealed one lateral malleolus fracture, two knee ligament tears and one thoracic vertebral fracture. A total of 13 individuals received specific interventions. Those people who after assessment did not have outstanding issues requiring intervention were given feedback regarding the expected time course of the healing of their injuries and return to activities.

*Pain outcomes*

Pain levels as measured by VAS were initially high in both control and intervention groups, and declined significantly with time in both groups at each measurement point (Table IV). However, at week 12, the intervention group showed a significantly greater reduction in pain when compared to the control group ($p = 0.007$). While some researchers have argued against the use of VAS (16) as a continuous measure, others have effectively defended VAS as continuous and suitable for parametric analysis (17, 18). In response to this ongoing debate, we confirmed our results using non-parametric methods (as described for the DASS) and found differences to be minimal (e.g. significant change over time for both groups ($p = 0.004$)) with no changes to conclusions.

*Psychological outcomes*

DASS outcomes varied substantially across cases with most scoring within a normal range and a few scoring at moderate to high levels of depression, anxiety and stress. DASS anxiety scores declined significantly over time for both groups combined at each measurement point, as did DASS stress scores at Week 12. Within each group, control cases showed a significant decline in DASS anxiety at Weeks 12 and 18 and in DASS stress at Week 12, while the intervention cases did not. However, no significant group differences were obtained at each follow-up point (*g1, *g2) or across time points combined (*g), which suggests the relative decline for intervention versus control groups over time did not differ.

The TSQ scores for PTSD were first collected at week 6 rather than day 10, so comparisons at week 12 and week 18 were made with reference to week 6. At week 12, the intervention group showed a significant decline in TSQ scores ($p = 0.008$) whereas the control group's scores increased, although not significantly. However, no significant group differences were observed at any time point or across time points combined (i.e. *g1, *g2 or *g), which suggests the relative decline for intervention versus control groups over time did not differ.

*Occupational and driving outcomes*

People in the intervention group were significantly more likely to return to normal work duties over the study period of 18 weeks when compared with the control group ($p = 0.021$) as shown in Table V when controlling for age and severity of injury (AIS). Although the percentage of people returning to any type of work (e.g. light duties) was larger than to normal duties, any differences between groups did not reach significance. Similarly, the intervention and control groups did not differ in percentage returning to driving at each time point following a motor vehicle crash.

Table V. *Outcomes – percentage return to any work and normal work among patients previously working and return to driving among patients previously driving*

| Variable | *n* | Day 10 % | Week 6 % | Week 12 % | Week 18 % | *p* |
|---|---|---|---|---|---|---|
| Driving | | | | | | |
| Control | 26 | 4 | 27 | 50 | 62 | |
| Intervention | 35 | 17 | 49 | 60 | 71 | ns |
| Return to any work | | | | | | |
| Control | 27 | 19 | 41 | 59 | 70 | |
| Intervention | 37 | 24 | 54 | 68 | 68 | ns |
| Return to normal work | | | | | | |
| Control | 27 | 4 | 11 | 22 | 26 | |
| Intervention | 37 | 11 | 24 | 38 | 49 | 0.018 |

## DISCUSSION

This pilot study indicates that early, proactive rehabilitation interventions can positively affect outcomes in physical and vocational domains of those who sustain a fracture as a result of a motor vehicle crash. Specifically, we have shown reductions in pain levels at 12 weeks post injury and improved return to work rates in our intervention group compared to control group.

We aimed to focus on moderately injured people, rather than those with catastrophic brain or spinal cord injury, because the latter groups have specific challenges regarding recovery and require specialist inpatient rehabilitation units. We also excluded those with only soft tissue injury, as these injuries are expected to heal within a few weeks and are less likely to require rehabilitation. That is, our intention in this pilot study was to identify individuals who would most benefit from brief targeted rehabilitation, often not included in 'usual' care. And the study did identify many individuals in which further treatment was indicated.

Pain levels were initially high in both control and intervention groups. These pain levels may represent sub-optimal pain control in the early post-operative injury period and may be an area where opportunities for improvement are present. Pain levels diminished over time as expected, with the intervention group having significantly less pain at 12 weeks than the control group. The intervention group was given evidence based pain management advice (19) such as regular rather than intermittent dosing and pacing of activities which may have resulted in the improvement in pain levels.

The absence of any significant difference between groups on DASS measures is not surprising given the highly skewed distribution of scores within both groups at baseline (day 10), where most individuals scored within or slightly above normal and only a few scored in high ranges. The fact that the control group showed a significant decline in anxiety and stress over time while the intervention group did not, may, in the absence of significant group differences, reflect the differing sample sizes. Much larger numbers in each group would need to be

recruited to further investigate the impact of rehabilitation services on these psychological measures, especially where individuals have a history of psychological distress prior to their road crash.

Regarding PTSD at week 12, the intervention group did show a significant improvement over time while the control group did not. However, this result is not easy to interpret in the absence of any group differences at baseline or follow up points. The intervention group does decline, but from a significantly higher median score at baseline, while the control group increases but to a median score below that of the intervention group. By Week 12, individuals had been lost to follow up, so it is possible that those who were experiencing more PTSD elected to continue in the intervention group because they were receiving extra attention to their psychological issues. As for the DASS measures, larger numbers need to be recruited to fully understand the role of rehabilitation in assisting people with PTSD following a road crash.

Return to driving is an important marker of both physical and psychological recovery from motor vehicle trauma. The inability to drive can impact on return to work following an injury as other modes of transport to work such as public transport typically require a higher level of physical function than driving. Our finding of similar rates of return to driving is interesting as this indicates ease of transport to work was not a factor in the improved return to work rates in our intervention group.

Return to work rates in the control and intervention groups was comparable with published studies (4). The intervention group had better rates of return to normal work compared with control group, although return to any work did not differ between the groups. Return to work is a complex issue involving individual factors such as site of injury and recovery, psychological distress and attitude to work, type of job and skill level required, workplace flexibility such as the opportunity for graded return to work, and societal factors such as cultural expectations and the compensation environment. Our intervention was focussed on restoration of function through physical and psychological treatments delivered by a co-ordinated rehabilitation team. This area requires further investigation to fully understand the role of rehabilitation in conjunction with other factors that influence return to work.

A number of limitations in this study should be noted. First, the sequential cohort design of the study was chosen to avoid contamination of the usual practice of the hospital by the concurrent presence of the intervention group. However, there is potential for usual practice to have changed over time which may have influenced outcomes. Second, study participant numbers were limited to 40 in each arm. Recruitment of more subjects was not possible due to funding constraints. Of the eligible subjects only 80 of 200 agreed to enter the study. Reasons for declining to participate were not asked for in the study protocol, but many potential subjects commented they had no time or lived too far away. Those that did consent were a subset of the motor vehicle trauma with fracture population presenting to St Vincent's Hospital, who may have had fewer time constraints, lived closer or were more altruistic. Whilst this limits generalizability of results to the entire trauma population we believe the results are still valid within the subset of those who agreed to participate, as what was being studied was the impact of early proactive rehabilitation interventions on outcomes compared to usual practice, between two otherwise similar groups. Third, a subset of our subjects may have experienced up to moderate severity traumatic brain injury which we did not specifically categorize, and which may have added to the challenges in returning to work. However, as the overall injury severity was not significantly different between our groups this factor is likely to be present in both control and intervention groups. Fourth, subject retention was imperfect, with 73% and 78% respectively in the intervention and control groups completing week 6 assessments and declining to 33% and 55% at Week 18 assessments. This dropout rate is consistent with other outcome studies. The requirement to attend the hospital in person for a 1-h assessment was a factor in the less than ideal retention rate.

Uptake of rehabilitation recommendations was not universal, with 6 of 14 who were recommended psychological intervention for depression, anxiety, stress or PTSD symptoms taking up the offer. Similarly, 4 of 8 participants in whom physiotherapy was recommended agreed. Reasons for refusal included a perception of not having time and feeling uncomfortable with addressing mental health issues. Such referrals for treatment are still useful even if not taken up, as they indicate to patients that physical and psychological issues are of concern and may need to be addressed, perhaps in their own time.

The rate of missed injury in the intervention group was unexpected, with 13% (5 subjects) having further imaging initiated by the rehabilitation physician. Imaging found one missed thoracic vertebrae fracture, one lateral malleolus fracture, two knees with disrupted ligaments and one metatarsal fracture. We did not collect data on missed injuries in the control group. Other studies (20) have highlighted the importance of the tertiary survey in detecting missed injuries, and commented that missed injuries were higher in those with multiple injuries and in those involved in road crashes. All except one of these subjects had had a tertiary survey performed in the inpatient period. This finding highlights the importance of early post hospital discharge follow-up of fracture patients, irrespective of standard injury survey practice.

Return to work and return to usual activities for those not in paid work are outcomes important for both the individual and society. Factors interacting on return to work and usual activities are complex and include physical injury recovery, psychological recovery and workplace factors such as the ability and willingness to provide modified duties. We did not capture detailed data on the subject's workplace or their expectation regarding work, and despite there being no demographic difference between the groups at the start of the study workplace factors may have influenced the outcomes. People's individual life circumstances may have influenced our results. We note that there was a greater percentage of fulltime workers in our intervention group. It is possible that those who work full time have a financial imperative to return to work which may

have influenced our results. It is our impression that subjects with manual jobs where use of the injured limb is required took more time to return to work than those with clerical jobs. Numbers were not great enough to allow meaningful statistical analysis. The compensation environment has also been a subject of discussion, with a prospective trauma outcome study in Melbourne, Victoria demonstrating worse outcomes in terms of return to work in compensable patients (21).

Rehabilitation is an individualized team based bio-psychosocial approach to minimizing disability. Our proactive approach differed from that provided by primary care physicians in that the patients were followed up at a specific time frame and had an hour of comprehensive assessment. The interaction with primary care physicians is driven by a perceived need by the patient. Patients may consult with their primary care physician only when a problem escalates (e.g. pain, immobility, psychological distress), so early opportunities for intervention, prevention of further disability and further investigation may be missed.

### *Conclusions*

Recovery from motor vehicle trauma with fracture is complex. This pilot study has demonstrated that early rehabilitation improved outcomes in pain management and return to work rates over the 18 week study period. Further studies with a multicentre randomized design to more precisely identify factors amenable to early rehabilitation intervention which improve outcomes in motor vehicle trauma are needed. For return to work outcomes, more detailed data regarding the workplace and subjects' expectations about work are needed.

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## REFERENCES

1. Australian Bureau of Statistics (ABS). National Health Survey: Injuries, Australia 2001. Canberra: ABS; 2001.
2. Ameratunga SN, Norton RN, Bennett DA, Jackson RT. Risk of disability due to car crashes: a review of the literature and methodological issues. Injury 2004; 35: 1116–1127.
3. Michaels AJ, Madey SM, Krieg JC, Long WB. Traditional injury scoring underestimates the relative consequences of orthopaedic injury. J Trauma 2001; 50: 389–396.
4. Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt DB. Outcome after major trauma: 12 month and 18 month followup results from the trauma recovery project. J Trauma 1999; 46: 765–773.
5. Donaldson LH, Brooke K, Faux SG. Orthopaedic trauma from road crashes: is enough being done. Aust Health Rev 2009; 33: 72–83.
6. Read KM, Kufera JA, Dischinger PC, Kerns TJ, Ho SM, Burgess AR, et al. Life altering outcomes after lower extremity injury sustained in motor vehicle crashes. J Trauma 2004; 57: 815–823.
7. Fitzharris M, Fildes B, Charlton J, Kossmann T. General health status and functional disability following injury in traffic crashes Traffic Inj Prev 2007; 8: 309–320.
8. Shults RA, Jones BH, Kresnow MJ, Langlois JA, Guerrero JL. Disability among adults injured in motor vehicle crashes in the United States. J Safety Res 2004; 35: 447–452.
9. Sluys K, Häggmark T, Iselius L. Outcome and quality of life 5 years after major trauma. J Trauma 2005; 59: 223–232.
10. Richmond TS Kauder D Hinkle J et al. Early predictors of long-term disability after injury. Am J Crit Car 2003; 12: 197–205.
11. The Abbreviated Injury Scale – 1998 update. Association for the Advancement of Automotive Medicine Barrington, USA; 1998.
12. Teasdale G, Jennett B. Assessment of coma and impaired consciousness: a practical scale. Lancet 1974; 2: 81–84.
13. Scott J, Huskisson EC. Graphic representation of pain. Pain 1976; 2: 175–184.
14. Lovibond SH, Lovibond PF. 1995 Manual for the Depression Anxiety Stress Scales. 2nd ed. Sydney: Psychology Foundation.
15. Brewin CR, Rose S, Andrews B, Green J, Tata P, McEvedy C, et al. Brief screening instrument for post-traumatic stress disorder. Br J Psychiatry 2002; 181: 158–162.
16. Kersten P, Kucukdeveci AA, Tennant A. The use of the visual analogue scale (VAS) in rehabilitation outcomes. J Rehabil Med 2012; 44: 609–610.
17. Price DD, Staud R, Robinson ME. How should we use the Visual Analogue Scale (VAS) in rehabilitation outcomes? II: Visual Analogue scales as ratio scales: An alternative to the view of Kersten et al. J Rehabil Med 2012; 44: 800–801.
18. Harms-Ringdahl K. How should we use the Visual Analogue Scale (VAS) in rehabilitation outcomes? III: On the validation requirements for assessments using VAS with ratio properties. J Rehabil Med 2012; 44: 801–802.
19. Australian Acute Musculoskeletal Pain Guidelines Group. Evidence based management of acute musculoskeletal pain. Brisbane: Australian Academic Press; 2003.
20. Janjua KJ Sugrue M Deane SA Prospective evaluation of early missed injuries and the role of the tertiary trauma survey. J Trauma 1998; 44: 1000–1006.
21. Gabbe BJ, Cameron PA, Williamson OD, Edwards ER, Graves SE, Richardson MD. The relationship between compensable status and long term patient outcomes following orthopaedic trauma. Med J Aust 2007; 187: 14–17.