

## Major Workplace Related Accidents in Singapore: A Major Trauma Centre's Experience

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### Abstract

**Introduction:** Major workplace related accidents pose a significant healthcare resource challenge in Singapore. **Materials and Methods:** Our study looks at the epidemiology of patients who were admitted for workplace related accidents, in a single institution, with an Injury Severity Score of >9. **Results:** There were 196 cases of major workplace related accidents admitted between January 2006 and December 2007. The median age of patients admitted was 37 years with a large percentage being males (95.4%) and non-residents (57.1%). The most common ethnic group was Chinese (53.1%) followed by Indians (23.5%). The most common mechanism of injury was fall from height (66.3%) followed by injuries as a result of falling objects at work (21.9%). The percentage of patients who required surgical intervention was 69.9%. Patients admitted for major workplace related accidents had a median length of stay of 5 days in the hospital, a median length of 24 days of medical leave (ML), certifying them unfit for duty and the average cost of stay for each patient was S\$11,000. **Conclusions:** We have a better understanding of the epidemiology and socio-economic impact of workplace related accidents through this study. Workplace related accidents result in significant number of man-days lost from work and monetary cost to employers, medical insurance and the hospital. With an improved understanding, we propose methods to prevent and reduce such accidents in future. A direct consequence of which will be the possible reduction of hospitalisation costs and better allocation of healthcare resources in the future.

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**Key words:** Occupation, Hazards, Trauma

### Introduction

Workplace related accidents are major problems around the world<sup>1-10</sup> and in Singapore. The Center For Disease Control and Prevention (CDC), United States reported a total of 5702 work related fatal injuries and a rate of 4.0 deaths per 100,000 workers in 2005, with falls and being struck by objects as the second and third most common causes of fatal work related injuries.<sup>3</sup> Major workplace related accidents result in significant morbidity, mortality and socio-economic cost in Singapore. In recent surveys by the Ministry of Manpower (MOM) in 2006, there were a total of 9261 cases of workplace related accidents reported.<sup>11-15</sup> There were also 150 cases workplace fatalities reported to MOM between April 2005 and September 2007.<sup>11-15</sup>

There are currently 2.75 million economically active personnel in Singapore, of which 1.91 million are local residents and the rest are foreigners.<sup>16,17</sup> Of all the local residents, more than one fifth (22.0%) are involved in

occupations at high risk of workplace related accidents such as production related craftsman, machine operators and cleaners and labourers.<sup>17</sup> Thus, it is important to study the epidemiology of workplace related accident, to identify areas that can be improved upon to reduce this problem.

Our Major Trauma Centre, being centrally located and the busiest acute care hospital in Singapore, attends to a significant proportion of these patients admitted for workplace related accidents. A previous study conducted by Carangan et al<sup>18</sup> showed that between 1 December 1998 and 31 May 1999, a total of 3180 patient were seen in Tan Tock Seng Hospital (TTSH) emergency department (ED), of which 1244 (39.1%) were locals and 1936 (60.9%) were foreign workers.<sup>18</sup> Recent statistics from the Trauma Centre emergency department showed that 5998 cases and 6246 cases of workplace related accidents were seen in 2006 and 2007, respectively. This study attempts to describe the epidemiology of the patients admitted to a central

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urban hospital for major workplace related accidents. We also aim to understand the socio-economic impact of such major injuries and hope to propose injury prevention and socio-economic strategies to minimise its impact on our population.

## Materials and Methods

In this study, we studied patients admitted to the Trauma Centre for workplace related accidents from January 2006 to December 2007 recorded in the trauma registry with an Injury Severity Score  $\geq 9$ . Each patient was captured in the trauma registry with a standard form managed by the trauma unit of the department of general surgery (GS). Epidemiologic factors such as patients' age, sex, Injury Severity Score (ISS), cause of injury, nature of injuries, time/location of injury, type of management, length of stay (LOS), number of workman-days lost, morbidity and mortality were studied. The Injury Severity Score<sup>13</sup> (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), and External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. Only patients with an Injury Severity Score (ISS)  $\geq 9$  were recorded in the trauma registry as these patients were likely to have worse injuries and thus, more likely to cause a socioeconomic impact. This common form allowed for accurate and uniform documentation of all the patients admitted to the Trauma Centre for workplace related accidents.

The t-test, with a confidence interval of 0.95, was used to compare the means of ISS and LOS of patients with variables such as single versus multiple injuries, fall from a height  $\geq 2$  m versus fall from a height  $< 2$  m and patients requiring surgery versus patients who did not. The purpose was to find out if these variables had any impact on the severity of injuries, outcome, length of stay and hence socio-economic impact to the patients.

Patients who were seen at the emergency department for workplace related accidents but not admitted, those who were admitted but having incomplete data in the trauma registry, and patients with an ISS of  $< 9$  were excluded from the study.

## Results

In our study, there were 196 patients (ISS  $\geq 9$ ) in total admitted to the Trauma Centre for major workplace related accidents in 2006 and 2007 (Table 1), of which there were 86 cases in the former and 110 cases in the latter. Eleven patients were excluded from the study due to ISS  $< 9$  and

incomplete data in the trauma registry. The range of age of the patients was between 20 and 67 years old, with a median age of 37. Majority of the patients (98.5%) were younger than 65 years old, with only a minority (1.5%) of patients being older than or equal to 65. Most the patients admitted for workplace related accidents were males (95.4%) whilst females only formed a minority (4.6%) of the patients. Of the 196 patients admitted for major workplace related accidents, 9 died (4.6%) from accident related injuries, of which 4 were due to fall from height, 3 were due to injuries suffered from falling objects and 1 each from burns and gas explosion. Majority of casualties were admitted during the day (71.4%) and only a small proportion was admitted during night (28.6%) (Table 2).

According to ethnicity, the majority of patients admitted for major workplace related accidents were Chinese, Indians and Bangladeshi, making up 53.1%, 23.5% and 13.8%, respectively (Table 3). The Malays and Thais each made up 3.1% of the patients admitted. The rest of the patients (3.6%) were made up of ethnic minorities like Burmese, Filipinos, Indonesians, and Nigerians. Of all the patients admitted for workplace related accidents, non-residents contributed to a large percentage (57.1%) and a smaller proportion by residents (42.9%) (Table 3). For non-residents, the top 3 groups admitted for major workplace related accidents were Indian nationals (19.9%), Chinese nationals (17.9%) and Bangladeshis (12.8%) in descending order. For residents, the top 3 ethnic groups admitted were Singaporean Chinese (35.2%), Singaporean Indians (3.6%) and Singaporean Malays (2.6%) in descending order.

The most common cause of major workplace related accidents was due to fall from height (66.3%), followed by injuries inflicted by falling objects at work (21.9%), and vehicular accidents during work (3.6%) (Table 4). The remainder of patients admitted for workplace related accidents were due to miscellaneous injuries (i.e. assault, burns, lacerations, machinery related crush injuries, gas explosions and notably being gored by a rhinoceros.)

Given the large numbers of patients admitted for workplace related accidents secondary to falls, further analysis revealed that 76 (58.5%) patients fell from height  $\geq 2$  m and 54 patients (41.5%) fell from height  $< 2$  m. Patients who fell from height  $\geq 2$  m (Mean ISS = 13.7) had a higher mean ISS compared to those who fell  $< 2$  m (Mean ISS = 10.5) and the results were statistically significant ( $P = 0.02$ ) (Table 5). The mean length of inpatient stay (LOS) for patients who fell  $\geq 2$  m (Mean LOS = 9.45 days) was longer as compared to those who fell  $< 2$  m (Mean LOS = 4.94 days) and the results were statistically significant ( $P < 0.01$ ) (Table 6).

The percentage of patients admitted who required surgery was 69.9% (Table 4). The mean ISS (Table 5)

Table 1. Patients Admitted for Workplace Related Accidents from January 2006 to December 2007

	2006	2007	Total
Number of patients	86	110	196
Range of ages	20-64	20-67	20-67
Median age	36	38	37
Mean age	36.7 [10.4]	39.3 [10.5]	38.2 [10.5]
Number of male patients	82 (95.3%)	105 (95.4%)	187 (95.4%)
Age < 65	86 (100%)	107 (97.3%)	193 (98.5%)
Age ≥ 65	0	3 (2.7%)	3 (1.5%)

[ ] denotes standard deviation.

Table 2. Time of Admission into Emergency Department

	Day	Night*
Time of admission into emergency department	140 (71%)	56 (29%)

\*Night is defined as from 1800hrs till 0600hrs.

Table 3. Number of Workplace Related Accidents According to Ethnicity

	Residents	Non-residents	Total
Chinese	69 (35.2%)	35 (17.9%)	104 (53.1%)
Indians	7 (3.6%)	39 (19.9%)	46 (23.5%)
Bangladeshis	2 (1.0%)	24 (12.8%)	26 (13.8%)
Malays	5 (2.6%)	1 (0.5%)	6 (3.1%)
Thais	1 (0.5%)	5 (2.6%)	6 (3.1%)
Others*	0	10 (3.6%)	10 (3.6%)

\* Others include ethnic minorities Filipinos, Indonesians, Burmese and Nigerians.

for patients who required surgery (Mean ISS = 11.4) was lower compared to patients who did not require surgery (Mean ISS = 15.8) and is statistically significant ( $P < 0.01$ ). Patients who required surgery (Mean LOS = 8.86 days) had a longer mean inpatient stay compared to patients who did not require surgery (Mean LOS = 6.92) but is statistically not significant ( $P = 0.19$ ) (Table 6).

The most common site of injury was to the head and neck (34.3%), followed by upper limbs (21.0%), lower limbs (16.2%), spine (11.0%), chest (8.4%), abdomen (4.4%), pelvis (3.4%) and finally perineum (1.2%) in descending order (Table 7). A large percentage of patients were admitted with multiple injuries (59.6%). Patients with multiple injuries (Mean LOS = 9.78) had a longer mean inpatient stay compared to patients with a single injury (Mean LOS = 6.03) and the result is statistically significant ( $P < 0.01$ ) (Table 6).

The percentage of patients who went to the general wards after admission was 74.5%, but a significant proportion

Table 4. Workplace Related Accidents According to Mechanism of Injury

Mechanism of injury	Surgery required	No surgery required
Falls	85 (43.4%)	45 (23.0%)
Falling objects	31 (15.8%)	12 (6.1%)
Vehicular accidents during work	6 (3.1%)	1 (0.5%)
Others*	15 (7.6%)	1 (0.5%)
Total	137 (69.9%)	59 (30.1%)

\* Others include assault, burns, lacerations, machinery related crush injuries, gas explosions and gored by rhinoceros.

Table 5. Mean Injury Severity Score (ISS) for Patients Requiring Surgery, for Patients with Multiple Injuries and for Patients who Fall ≥ 2m

	Mean Injury severity score	P*
Required surgery	11.4	
No surgery required	15.8	<0.01
Multiple injuries	15.4	
Single injury	9.0	<0.01
Fall ≥ 2m	13.7	
Fall < 2m	10.5	0.02

\* Confidence interval of 0.95

Table 6. Mean Length of Inpatient Stay for Patients Requiring Surgery, for Patients with Multiple Injuries and for Patients who Fall ≥ 2 m

	Mean length of inpatient stay (days)	P*
Required surgery	8.86	
No surgery required	6.92	0.19
Multiple injuries	9.78	
Single injury	6.03	<0.01
Fall ≥ 2m	9.45	
Fall < 2m	4.94	<0.01

\* Confidence interval of 0.95

required monitoring and care in the high dependency unit (HD) (13.3%) or intensive care unit (ICU) (8.2%) or immediate surgery (2.0%). A small proportion (2.0%) of patients died on arrival to the hospital (Table 8).

In our study, 9 (4.6%) patients died from workplace related accidents. Patients who died from workplace related accidents (Mean ISS = 31.8) had a higher mean ISS compared to patients who survived (Mean ISS = 11.8) and the result is statistically significant ( $P < 0.01$ ). Four patients died from falls, 3 from injuries inflicted by falling objects at work and 1 each from burns and gas explosion.

The length of inpatient stay ranged from 1 to 65 days with a median length of stay of 5 days. Most patients with workplace related accidents required substantial days of medical leave (ML) certifying them unfit for work, and/

Table 7. Workplace Related Accidents according to Site of Injury and Necessity of Surgery

Site of Injury	Surgery required	No surgery required	Total
Head and Neck	116	55	171 (34.3%)
Upper limbs	60	45	105 (21.0%)
Lower limbs	53	28	81 (16.2%)
Spine (thoracic, lumbar and sacral)	35	20	55 (11.0%)
Chest	36	6	42 (8.4%)
Abdomen	18	4	22 (4.4%)
Pelvis	10	7	17 (3.4%)
Perineum	5	1	6 (1.2%)

Table 8. Disposition of Patients Admitted for Workplace Related Accidents after Review by Emergency Department

Disposition	Number of patients
General ward	146 (74.5%)
High Dependency Unit	26 (13.3%)
Intensive Care Unit	16 (8.2%)
Operating Theater	4 (2.0%)
Mortuary	4 (2.0%)

or for light duty. The median length of ML given was 24 days. The total number of days lost due to inpatient stay was 1624 man-days and ML certifying unfit for work was 6245 man-days (Table 9).

The total inpatient bill for patients admitted for major workplace related accidents amounted to S\$2.1 million. After government subsidy, the total inpatient bill decreased to S\$1.5 million. Of the S\$1.5 million, the hospital managed to recover S\$1.3 million (86.7%). On average, each patient admitted for workplace related accidents spent S\$11,000 for their medical bill (Table 10).

## Discussion

Singapore is a small but rapidly developing nation. With only a limited resident population, a significant part of the work force is contributed by foreigners. Latest data from MOM shows that there are more than 800,000 foreigners who are currently economically active in Singapore, with a significant proportion involved in high accident risk occupations (i.e. production related craftsman, machine operations and cleaners and labourers.)<sup>16,17</sup>

Major workplace related accidents pose a significant healthcare challenge in Singapore. In the most recent survey by the MOM, there were a total of 9261 cases of

Table 9. Median and Total Number of Man-days Lost from Inpatient Stay and Medical Leave Certifying Unfit for Duty

	Inpatient stay	Medical leave
Median	5 (range, 1 to 65)	24 (range, 0 to 157)
Total man-days lost	1624	6245

Table 10. Sum and Mean of Total Inpatient Bill, Amount after Subsidy, Amount Paid and Outstanding Bill

	Total inpatient bill (S\$)	Amount after subsidy (S\$)	Amount paid (S\$)	Outstanding bill (S\$)
Range	750 – 110,000	210 – 97,000	0 – 97,000	0 – 47,000
Sum	2,100,000	1,500,000	1,300,000	190,000
Mean	11,000	7700	6900	1000

Note: Figures are rounded up to 2 significant figures.

workplace injuries reported under the Factories Act (January to February 2006) and the Workplace Safety and Health (Incident Reporting) Regulations (March to December 2006) in year 2006 alone, of which there was a total of 62 (0.7%) fatalities, 168 (1.8%) cases with permanent disabilities and 9031 (97.5%) with temporary disability.<sup>12,14</sup> The top 3 occupations [classified according to the Singapore Standard Industrial Classification (SSIC) 2005]<sup>16,17</sup> with the highest accident frequency rate were metalworking (include manufacture of basic metals, fabricated metal products, machinery and equipment, and electrical machinery and equipment), construction then followed by manufacturing with rates of 4.1, 3.5 and 2.6 per 100,000 persons employed, respectively.<sup>12</sup>

Given the magnitude of this challenge, it is of utmost importance to attempt to minimise workplace related accidents. In order to address this issue, the MOM put in place the Workplace Safety and Health Act (WSHA) to supercede its predecessor the Factories Act in 1 March 2006.<sup>19</sup> The 3 guiding principles that underpin the new WSHA framework are:

- (i) Reducing risks at source by requiring all stakeholders to eliminate or minimise the risks they create;
- (ii) Instilling greater ownership of safety and health outcomes by industry; and
- (iii) Preventing accidents through higher penalties for poor safety management

Our study attempts to address the second principle of the WSHA by studying the epidemiology with the aim at injury prevention and understanding the demands in which it places on our healthcare system. Major workplace accidents (ISS  $\geq$  9) were studied because the victims usually required hospitalisation and incurred more socio-economic cost, thus increasing strain and demand on the healthcare system.

Our data shows that a total of 196 cases of major workplace

related accidents were admitted to the Trauma, 86 in 2006 and 110 in 2007. The slight increase in patients admitted in 2007 may be due to higher incidence reporting due to the implementation of the WHSA or the vibrant economic environment in Singapore. However with our limited data, it is difficult to analyse the trend of workplace related accidents and the effectiveness of the WHSA in reducing workplace related accidents, and it will require the combined efforts of both hospitals and MOM for collection of more data for future analysis to see if the new act is effective.

Majority of casualties admitted for major workplace related injuries were in the morning (71.4%). The reason for this could be due to the strict guidelines and safety measures set by the government to ensure strict proper conduct of work at night, thus resulting in lower injury rates at night (28.6%).

The median age of patients admitted for workplace related accidents was 37 years and most admitted for major workplace related accidents were males. A significant percentage of patients admitted were non-residents (57.1%). The likely reasons for them to be young-aged and male is that most of the patients admitted were in labour intensive and high risk occupations such metal working, construction or manufacturing which tend to employ young males.

A large proportion of non-residents (Chinese nationals, Indian nationals and Bangladeshis) come to Singapore in search of work and are unable to afford formal education. Many of them have no formal training in occupations such as construction or metalworking. As such, they have minimal safety awareness, thus contributing to a larger proportion of workplace related accidents. Language barriers also pose significant problems for the non-residents as English is the main working language used in Singapore, they may not be able to fully understand specific instructions, danger signages or occupational safety talks, thus leading to higher accident rates.

Our data show that a large percentage of patients admitted were due to injuries from falls (66.3%) and injuries secondary to falling objects at work (21.9%). This corresponds closely to the data from the survey by MOM for Workplace injuries 2006 which show falls (23.3%) and injuries secondary to falling objects at work (12.2%) being the second and fourth most common cause of workplace related injuries respectively.<sup>12</sup> Given that falls and injuries as a result of falling objects at work are the main causes of workplace related accidents, measures should be devised specifically to address this issue such as enforcing that all workers working at height to wear safety harnesses and helmets at all times at the work place. Another possible way to prevent such injuries is to educate the foreign migrant workers in their own native language, the risks when working in high rise construction sites and the mandatory

safety measures that are to be observed. The Ministry of Manpower (MOM) has enforced that all foreign workers working in the construction sector must go for a full day Construction Safety Orientation Course (CSOC) to ensure that they are familiar with the common safety requirements and health hazards within the industry.<sup>20</sup> Foreign workers must pass this course before they are granted their work permits and validity of the course and work permit must be renewed on a regular basis. MOM also has in place legislation to lawfully enforce work safety practices and this has possibly resulted in the relatively “low” number of such accidents despite the rapid growth of our construction industry. However, we have to recognise that although legislation helps, the onus should still be not only on the employer but also the workers themselves to ensure good safety practices.

Our study also show that patients who require surgery (Mean LOS = 8.86 days), have multiple injuries (Mean LOS = 9.78 days) or fell from a height  $\geq 2$  m (Mean LOS = 9.45 days), had a longer mean length of inpatient stay (LOS). A longer length of in-patient stay translates to higher hospital bills and more number of man-days off from work. Further improvements to workplace safety (especially at high rise work sites) and a possible review of medical insurance coverage for workers exposed to increased risks may partially address the issues of healthcare costs to both the employer and hospital.

Our data also show that patients with multiple injuries (Mean ISS = 15.4) and patients who fell from a height  $\geq 2$  m (Mean ISS = 13.7) have a higher mean ISS compared to patients with single injuries (Mean ISS = 9.04) and those who fell  $< 2$  m (Mean ISS = 10.5). Previous studies<sup>21,22</sup> have shown that the ISS score correlates linearly with mortality, morbidity, hospital stay and other measures of severity. The patients in our study, with multiple injuries and those who fall from greater heights tend to be more severely injured, validates this conclusion.

Major workplace related accidents pose a healthcare economics challenge. Our data also showed a large proportion of patients admitted for occupational related trauma were non-residents (57.1%), with a majority made up of Chinese nationals, Indian nationals and Bangladeshis. Being non-residents, they will not be entitled to government subsidies with regards to healthcare costs.

Our data show that between 2006 and 2007, there were a total of 1624 man-days lost from inpatient stay alone. Most patients also required medical leave certifying them unfit for duty after hospitalisation and resulted in a total of 6245 man-days lost. Each patient admitted for workplace related accidents had a median length of inpatient stay of 5 days and required a median length of 24 days of medical leave after being discharged from the hospital. Of the patients

admitted, 23.5% of them required intensive care in the High Dependency Unit, Intensive Care Unit or emergency surgery in the operating theatre (OT), thus placing significant strain on healthcare resources. About 70% of patients admitted required surgery, and the mortality rate from workplace related accidents was 4.6%. The total inpatient bill for major workplace related accidents amounted to S\$2.1 million and was reduced to S\$1.5 million after government subsidy. Of the S\$1.5 million, the hospital only managed to recover S\$1.3 million (86.7%). The remaining S\$200,000 was written off by the hospital. On average, each patient admitted for workplace related accident spent S\$11,000 in the hospital. This cost does not include further outpatient follow-up or investigations costs. If we include minor workplace related accidents that only required outpatient follow-up or treatment, then the amount of healthcare cost (borne by the parent company, insurance or individual) will definitely be significantly higher.

Currently in Singapore, it is mandatory for employers to purchase workplace injury insurance for manual worker and non-manual workers earning less than \$1600 per month.<sup>23,24</sup> On top of that, employers are also required to buy medical insurance for the foreign workers employed. The workplace injury insurance ensures that in the event of a workplace related injury, the worker is entitled to medical leave wages, payment of his medical bills as well as compensation in the event of death or permanent incapacity. The current rules governing the payment for medical expenses is that employers are liable for the payment of medical expenses incurred within one year from the date of the injury, or up to a cap of S\$25,000, whichever is reached earlier.<sup>23</sup> On top of that, for foreign workers, employers are required purchase medical insurance of coverage of S\$5000 or more in event of medical illnesses or accidents not covered by the workplace injury insurance.<sup>24</sup> Given that each patient would spend an average of S\$11,000 from his inpatient (Range, S\$750 to S\$110,000) stay alone, we propose that employers or MOM increase the insurance coverage for workers in order to avoid having to pay huge medical bills at the end of the day as a result of major workplace related accidents.

Thus, it is evident that more resources should be invested in promoting safety awareness at work, ensuring safety in workplace environment and improving the healthcare insurance coverage in an attempt to reduce workplace related accidents and its socio-economic impact. We propose such measures be taken, especially in injury prevention, as this will benefit both the employer as well as the workers not just economically but also from a medical point of view.

## Conclusion

Major workplace related accidents pose a healthcare challenge in Singapore. Through this study, we have a

better understanding of the epidemiology and the extent of the socio-economic impact of workplace related accidents. Patients admitted for workplace related accidents are likely to be young males who are non-residents. The most common injury is fall from height and the most common site of injury is the head and neck. Patients who require surgery, have multiple injuries or fell from a height  $\geq 2$  m have a longer inpatient stay in hospital. Workplace related accidents also result in significant number of man-days lost from work and monetary cost to employers, insurances and the hospital. With an improved understanding, we can better propose methods to prevent and reduce such accidents in future. Although legislation and legal enforcement are in place, worker and employer education, and awareness of safety measures, together with responsible safe worksite practices are the cornerstone to injury prevention and reduction of the socio-economic impact of workplace related accidents. We further propose that medical insurance coverage be increased in order to minimise the financial impact on the employers, healthcare system, and more importantly the victim.

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