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UNINTENTIONAL MACHINERY INJURY ON FARMS IN VICTORIA

by

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Abstract:

Aim: We report the distribution of, and characteristics associated with, unintentional machinery injury on farms in Victoria to identify research issues and potential intervention strategies.

Method: Machinery was defined as items classifiable to the external cause of injury code E919 from the International Classification of Diseases Ninth Revision Clinical Modification, which includes agricultural, earth drilling, lifting, woodworking and earth moving machinery. The descriptive epidemiology of farm machinery injury was determined by analysis of four databases covering deaths, hospital admissions and emergency department presentations. Events preceding farm machinery injury, and factors associated with it, were examined in a retrospective case series of 19 adults with injuries meeting the study definition who presented with a machinery injury from 1996-1997 to the emergency department of four Victorian regional hospitals.

Results: There were an average annual of 1 child death, 6 adult work related deaths, 80 hospital admissions and 210 estimated emergency department presentations for machinery injury on farms. The tractor was the most common item of machinery involved, accounting for 100% of the child deaths, 71% of the adult work related deaths, and an estimated 71% of hospital admissions. Males were more frequently killed and injured than females. Passengers accounted for four of the five child tractor deaths. Roll overs and run overs accounted for 57% and 17% respectively of the adult work related tractor deaths, with the relative contribution shifting towards run overs in the last five years of data. The most common non-fatal injuries included bruising and crushing injuries, fractures, lacerations, and sprains, and the most common body parts injured were the hands and fingers. Among those who were hospitalised, 35% and 37% of children and adults respectively remained in hospital for more than 2 days.

Most of the case series participants (14) nominated their primary occupation as farming. Neither the weather nor the age of the machinery appeared to be implicated. Lack of sleep was not commonly reported by the case series participants. However, 8 out of the 19 reported to be working more than 40 hours per week, and 8 had a secondary occupation. Without comparative data, it is difficult to implicate any of the other factors explored in this study.

Implications for prevention and further research: Almost all machinery related deaths among children on farms in this study could have been prevented by not carrying children as passengers on tractors. Given the programs currently addressing tractor roll over events in Victoria, a future challenge in preventing machinery related deaths on farms will be reducing the risk of run-over events. The prevention of machinery injury and deaths on farms would be greatly facilitated by studies that investigate in detail the circumstances leading up to the event, and the machinery involved, among a substantial number of cases. Such studies would determine the relative potential for prevention by either design solutions or work practice modification. The individual and environmental factors should also be investigated and compared with an appropriately selected group of non-injured control farmers, providing quantitative data to the farming community for the purposes of risk identification and management, further identifying high risk groups for prevention programs.

Key Words: farm injury, farm machinery, epidemiology, case-series

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EXECUTIVE SUMMARY

INTRODUCTION

Farmers, farm workers and farm families are a high risk injury group. Overall patterns and leading causes of farm injury mortality and morbidity in Australia have been described, despite limitations with data availability and reliability (Fragar and Coleman, 1996). Machinery is a leading cause of fatal and serious farm injury (Harrison et al., 1989; Clarke and Coleman, 1995). This study was undertaken to quantify and describe the extent of machinery injury on farms in Victoria. A particular aim was to identify the types of non-tractor machinery associated with fatal and non-fatal injuries. Analyses of the available databases were conducted to provide an overview of the nature of farm machinery injury. In addition, a case series study of non-fatal farm machinery trauma incidents was undertaken to explore the circumstances of, and factors associated with these incidents.

METHODS

Machinery injury on farms was defined as unintentional injury, occurring on a farm, caused by exposure to rapid transfer of mechanical, chemical, electrical, or thermal energy from an item(s) of machinery. "Machinery" includes items classifiable to the external cause of injury code (E-code) E919 from the International Classification of Diseases Ninth Revision Clinical Modification (ICD-9-CM). This includes agricultural, earth drilling, lifting, woodworking and earth moving machinery. Powered and un-powered hand tools were not included.

The descriptive epidemiology of farm machinery injury was obtained by the analysis of four databases covering all child injury deaths, all adult work place deaths, all hospital admissions for injury, and a considerable proportion of emergency department presentations in Victoria.

A retrospective case series study was also conducted. Cases were defined as adults (over 18 years of age) with injuries meeting the study definition who presented for treatment from 1996-1997 to the emergency department of four Victorian regional hospitals: Wimmera Base Hospital, Ballarat Base Hospital, Goulburn Valley Base Hospital, and Warrnambool and District Base Hospital. Presentations meeting the study definition for the E-code were selected from the Victorian Emergency Minimum Database. After obtaining ethics approval from Monash University and the 4 hospitals, potential respondents were invited to participate by either letter or telephone. Telephone interviewing by a research nurse was conducted using a questionnaire to gather demographic, individual, machinery and farm characteristics, and information relating to the circumstances leading up to the injury.

RESULTS

Database Analysis

There were an average annual of 1 child death, 6 adult work related deaths, 80 hospital admissions and 210 estimated emergency department presentations for machinery injury on farms. The tractor was the most common item of machinery involved, accounting for 100% of the child deaths, 71% of the adult work related deaths, and an estimated 71% of

hospital admissions. Males were more frequently killed and injured than females. Passengers accounted for four of the five child tractor deaths. Roll overs and run overs accounted for 57% and 17% respectively of the adult work related tractor deaths, with the relative contribution shifting towards run overs in the most recent five years of data (43% and 25% respectively).

The most common non-fatal injuries included bruising and crushing injuries (40%), and fractures (38%) among those admitted to hospital, and lacerations (25%) and sprains (20%) among emergency department presentations. The most common body parts injured included the hands and fingers, accounting for 31% and 34% of hospital admissions and emergency department presentations respectively. Among those who were hospitalised, 35% and 37% of children and adults respectively remained in hospital for more than 2 days.

Case Series

The overall response rate for the case series was 47%. Of the 31 non-respondents, 22 declined to participate and 9 had initially agreed but could not be re-contacted. The non-respondents tended to be younger and have less severe injuries than the respondents. Although selected from the data base according to external cause of injury code for machinery, nine respondents were injured by items which did not meet the ICD-9 definition selected for this study and were excluded. Therefore, 19 cases were available for analysis.

Fourteen respondents considered their primary occupation to be in the farming industry. An additional three were employed in the trucking industry. Eight respondents had a secondary occupation, seven of which were in the farming industry. All respondents were employed in the farming industry in either the primary or secondary occupation. Eleven respondents were the farm owner. Seventeen respondents had at least 10 years experience in farming, 11 of whom had more than 20 years experience.

All respondents were working at the time of the injury (as opposed to being engaged in recreational activities), and 13 respondents were engaged in paid work. The most common activity at the time of injury was cropping (13 respondents), followed by farm maintenance (4). Among those engaged in cropping activities, 4 were harvesting, and 4 were elevating or augering. Nine of the cropping activities involved grain.

The mechanisms of injury included being run over or into by moving machinery (5), being caught in or between machinery (4), and being struck by falling machinery or a machinery component (4). The tractor was the most common machinery involved (7). It appeared that when adjusted for person hours, the use of a fork-lift carried the highest injury risk.

Among the associated factors investigated, the weather, light conditions, machinery age, experience with the machinery, lack of sleep, or perceived stress did not appear to be implicated. The role of other factors investigated, including eyesight, hearing, impairments, health problems, previous injury, and medication use cannot be determined without adequate comparison data. However, 8 out of the 19 reported to be working more than 40 hours per week, and 8 had a secondary occupation.

DISCUSSION

Results

This study has confirmed that machinery is a major contributor to death and serious injury on farms. The tractor was the most frequent cause of machinery related injury, accounting for 100% of the child deaths, 71% of the adult work related deaths, and an estimated 71% of hospital admissions.

Estimates here indicate that close to one third (29%) of persons admitted to hospital for a machinery related injury on a farm were injured by agricultural machinery other than tractors. The small numbers of cases with sufficient detail limit the extent to which the non-tractor machinery can be characterised. In contrast to the injury frequencies, non-fatal injury rates per 1000 person hours from the case series study indicated that the risk of injury during operation of fork-lifts was greater than that for tractors. However, due to the small numbers in the case series, these results should be treated as preliminary.

A measure of the severity of non-fatal machinery injury on farms is that the admission rate is higher than that for general injury on farms. Further among those who were hospitalised, 35% and 37% of children and adults respectively remained in hospital for more than 2 days. In the case series study, normal working patterns were disrupted for more than 1 week for 12 of the 19 participants.

Males were more commonly killed or injured than females. However, the data presented here do not take exposure into account and exposure may well be different for males and females.

The case series study was intended to compliment the database analysis by providing more details regarding the circumstances leading up to the injurious event. However, the data obtained is limited to some extent by small numbers and response bias. Retrospective recruitment for this kind of study is clearly less than ideal. Nonetheless, the data to provide some indication of factors which may be relevant, including over-representation of those 60 years and over, and having limited time for recreational activities.

Implications For Prevention And Further Research

Almost all machinery related deaths among children on farms in this study could have been prevented by not carrying children as passengers on tractors. The alternative of adequate provision for the safety of child passengers on tractors has not yet been realised in most current tractor designs. Roll over protection frames would greatly reduce the numbers of adult tractor related deaths. This issue is currently being addressed in Victoria with a major roll over protective frame rebate scheme. A future challenge in preventing machinery related deaths on farms will be reducing the risk of run-over events. Guarding of moving parts would appear to be a solution to preventing those injuries associated with being caught in moving parts of farm machinery. However, anecdotal evidence suggests that machinery operations are not always taken into account with respect to the placement of guards. This issue requires further investigation.

The prevention of machinery injury and deaths on farms would be greatly facilitated by studies that investigate the circumstances leading up to the event among a substantial number of cases. Prospective studies which recruit participants close to the time of injury are less likely to suffer the response bias apparent with the retrospective recruitment used

here. Inspection of the machinery should also be included to ascertain design features and operational factors that may be relevant to prevention. Such studies would determine the relative potential for prevention by either design solutions or work practice modification. The individual and environmental factors should also be investigated and compared with an appropriately selected group of non-injured control farmers. This approach would provide quantitative data to the farming community for the purposes of risk identification and management, and would assist in the further identification of high risk groups for prevention programs.

1. INTRODUCTION

The image of farming as a healthy and wholesome life style is gradually being dispelled as information regarding all aspects of farm life is becoming more widely available. Despite increasing productivity, the margin between farm gate product value and farm production costs has reduced markedly from the early 1950's to the early 1990's. Farmers' terms of trade were approximately 30% worse in 1993-94 than in 1980-81 (McLennan, 1996a). The prolonged decline in Australia's net value of agricultural production, coupled with far reaching changes to the provision of education, health and other services to the rural sector, has had a significant impact on the view of farming and rural life as carefree.

In addition, the health and safety performance in agricultural industries is among the worst in Australia. A benchmark study of work related fatalities in 1982-1984 found that the annual rural work related mortality rate ranked third, after mining and construction, both heavy industries well recognised as relatively dangerous (Harrison et al., 1989). In Victoria, the agricultural sector accounts for 27.8% of recorded work related fatalities, though it only employs 4.7% of the workforce (McLennan 1996b).

Overall patterns and leading causes of farm injury mortality and morbidity in Australia have been described, despite limitations with data availability and reliability (Fragar and Coleman, 1996). Machinery is a leading cause of serious farm trauma, often resulting in the loss of digits and limbs. Tractors and powered machinery account for between 55% and 74% of farm work related traumatic deaths (Harrison et al., 1989; Clarke and Coleman, 1995). Roll-over and run over incidents respectively account for 47% and 35% of the tractor related deaths (Clarke and Coleman, 1995). Among children, drowning (48%), farm equipment (16%) and motor vehicle accidents (13%) are the leading causes of farm trauma deaths (Clarke and Coleman, 1995). A number of state and area based studies have identified farm machinery as a leading cause of non-fatal farm trauma (Valuri and Routley, 1994; Griffith, 1994; Ferguson, 1994, 1996; Clarke and Coleman, 1995; Day, 1996; Day et al., 1997). In Victoria, cases of non-fatal agricultural machinery trauma which present to emergency departments have a higher than average rate of admission: 38% compared with 22% for farm injury in general (Day et al., 1997). Similar patterns of fatal and non-fatal trauma have been reported in New Zealand and the United States (Purschwitz and Field, 1990; Marshall et al., 1996).

This study was undertaken to quantify and describe the extent of machinery injury on farms in Victoria. A particular aim was to identify the types of non-tractor machinery associated with fatal and non-fatal injuries. Analyses of the available databases produced an overview of the nature of farm machinery injury, but provided little information regarding the circumstances surrounding the injury and other associated factors. Consequently, a case series study of non-fatal farm machinery trauma incidents was undertaken to explore the circumstances of, and factors associated with these incidents.

2. METHODS

2.1 DEFINITION

For the purposes of this study, machinery injury on farms was defined as unintentional injury, occurring on a farm, caused by exposure to rapid transfer of mechanical, chemical, electrical, or thermal energy from an item(s) of machinery. “Machinery” includes items classifiable to the external cause of injury code (E-code) E919 from the International Classification of Diseases Ninth Revision Clinical Modification (ICD-9-CM) (United States Department of Health). This includes agricultural, earth drilling, lifting, woodworking and earth moving machinery. Powered and un-powered hand tools were not included.

For the fatality data, a tractor related incident was defined as an incident involving a tractor, with or without an attached implement, in which the tractor is a major factor in the cause of the injury event, and/or of the injury itself. This definition includes front-end loaders, but excludes deaths that occur due to objects falling from front-end loaders.

2.1.1 Database Analysis

The descriptive epidemiology of farm machinery injury was obtained by the analysis of four databases summarised in Table 1. The databases cover all child injury deaths, all adult work place deaths, all hospital admissions for injury, and a considerable proportion of emergency department presentations in Victoria. These databases have overlapping capture, for which there has been no adjustment.

Table 1: Databases used to describe the epidemiology of unintentional machinery injury on farms in Victoria

Database	Level of Severity	Time Period
Victorian Coroner's Relational Database (for children)	Death	5 years 1989/90-1993/94
Victorian WorkCover Authority Investigated Deaths (for adult work related deaths)	Death	13 years 1985-1997
Victorian Inpatient Minimum Dataset	Admission to all Victorian public hospitals	3 years 1992/93-95/96
Victorian Emergency Minimum Dataset*	Presentation to emergency departments of selected Victorian hospitals	1 year 1996-1997

* Victorian Emergency Minimum Dataset includes injury presentations to 25 hospitals throughout Victoria, 12 of which are in regional areas (Watt and Ozanne-Smith 1996)

Machinery injuries occurring on farms were identified using the location code for farm, and selecting for cases which matched the E-code for machinery (E919). The databases were analysed to determine frequency distributions for a number of variables including age, sex, machinery type where recorded, injuries sustained, and treatment required. Limited information about the events leading to the incident were available in the Victorian Coroner's Relational Database, and the Victorian WorkCover Authority Investigated Deaths.

Agricultural machinery and specific types of agricultural machinery, such as tractors, were identified in the Victorian Coroner's Relational Database and the Victorian WorkCover Authority Investigated Deaths in the text narrative provided for each case. Agricultural machinery was identified in the Victorian Inpatient Minimum Dataset using the relevant sub-category within the E-code for machinery. However, particular items of agricultural machinery eg., tractors, cannot be identified with E-codes and the Victorian Inpatient Minimum Dataset does not include case narratives. Similarly, the coding system used in the Victorian Emergency Minimum Database does not identify types of machinery and 71% of the case narratives for machinery injuries contained insufficient information to specify type of machinery. Therefore, an earlier Victorian emergency department injury surveillance database with a smaller catchment area (the Victorian Injury Surveillance System) was used to estimate the proportion of hospital admissions for agricultural machinery injury on farms which can be attributed to tractors.

2.1.2 Case series of farm machinery injury on farms

While the database analysis allowed description of the epidemiology of machinery injury on farms, detailed information regarding the chain of events surrounding the incident, and factors associated with it, was lacking. Therefore, a retrospective case series study was conducted. Cases were defined as adults (over 18 years of age) with injuries meeting the study definition who presented for treatment from 1996-1997 to the emergency department of four Victorian regional hospitals: Wimmera Base Hospital, Ballarat Base Hospital, Goulburn Valley Base Hospital, and Warrnambool Hospital. Presentations meeting the study definition for the E-code were selected from the Victorian Emergency Minimum Database. After obtaining ethics approval from Monash University and the 4 hospitals, potential respondents were invited to participate by either letter or telephone.

Telephone interviewing by a research nurse was conducted using a questionnaire to gather demographic, individual, machinery and farm characteristics, and information relating to the circumstances leading up to the injury. The time period between the injurious incident and interview was between 7 and 25 months. Data was entered and analysed using SPSS for Windows Version 6.1.

3. RESULTS

3.1 DATABASE ANALYSIS

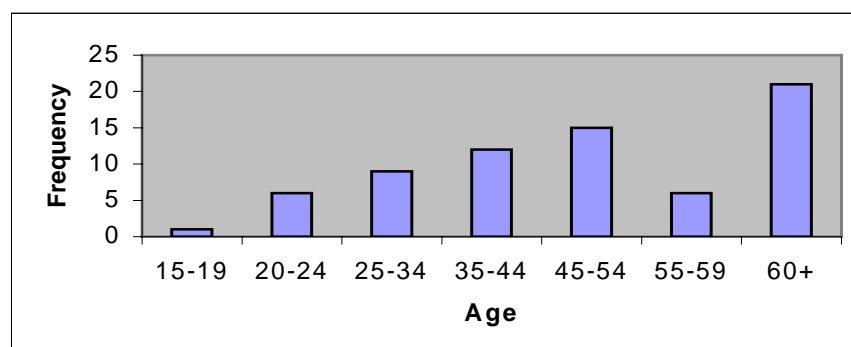
3.1.1 Deaths: children

There were 15 injury deaths to children that were coded as occurring on a farm in the Victorian Coroner's Relational Database 1989/90-1993/94. Six of these were farm machinery incidents, and in all cases involved a tractor. All of the children were under 5 years of age, except one. Four were males and two were females. Four of the deaths resulted when a child fell from a tractor. One resulted from a tractor roll over, and one from a tractor run over of a child by-stander. Five of the tractor related deaths occurred while the child was a passenger.

3.1.2 Work related deaths: adults

There were 77 work related machinery fatalities on farms among adults 15 years and over during the 13 year period 1985-1997, which accounted for 70.6% of all farm fatalities. The average annual was 5.9, however over the last three years the average annual was 4.6. All cases were males (1 case where gender was missing). The age distribution is shown in Figure 1 (7 cases where age was missing).

Figure 1: Unintentional machinery fatalities among adults on farms by age, Victorian WorkCover Authority, 1985-1997



n=70

With the exception of two cases, all adult machinery fatalities were tractor related (75) and 44 of these were roll over events (including anterior/posterior flip overs). The frequency of roll over events appears to be decreasing over recent years (Table 2). The category of tractor run overs included cases where the person fell off a tractor and was run over by either the tractor and/or an attached implement (n=2). It also included cases where the person was run over while in the vicinity of a tractor (n=8). Mounting or dismounting a tractor, and working on a tractor were two common scenarios among these cases.

Tractor incidents classified as “caught in or between” included being caught between a tractor and another object (3), between a tractor and an attached implement (4), on a moving shaft (4), and in linkages (1).

Table 2: Unintentional work related machinery fatalities on farms, 15 years and over, Victoria, 1985-1997 (Data source: Victorian WorkCover Authority)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
Tractor														
Roll over	2	5	7	5	2	4	2	5	3	5	2	1	1	44
Run over		1		1	2	1	1			1	4	1	1	13
Caught in or between		3		1		1		1	2	2		1	2	13
Other	1	1				1			1	1				5
Total tractor	3	10	7	7	4	7	3	6	6	9	6	3	4	75
Other machinery														
Post hole digger												1		1
Excavator													1	1
Total other												1	1	2
Total	3	10	7	7	4	7	3	6	6	9	6	4	5	77

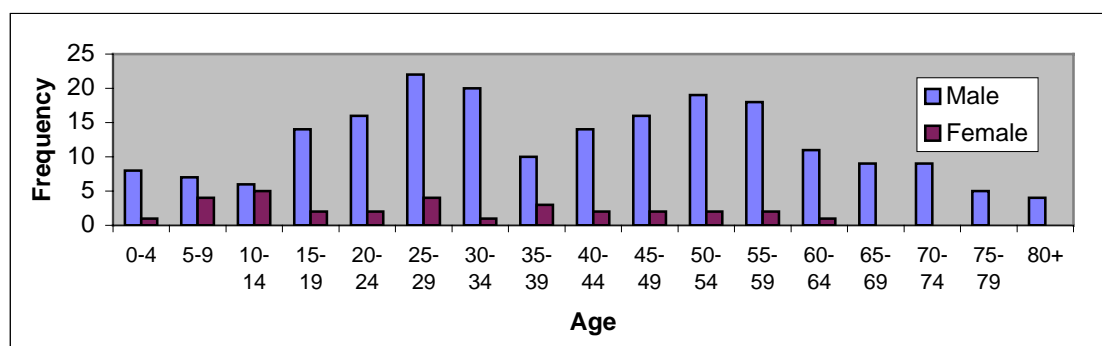
3.1.3 Hospital admissions

Machinery was the fourth leading major cause of unintentional farm injury hospitalisation during the period July 1993 to June 1996 (n=239), accounting for 12% of the total. On average, 80 people were hospitalised each year as a result of unintentional machinery injury events on farms.

Eighty seven percent were male. The male: female ratio was 6.7:1, ranging from 20:1 in the 30-39 year group to 1.2:1 in the 10-14 year age group. The age and sex distribution is shown in Figure 2. Eighty-eight percent of cases had a rural postcode of residence.

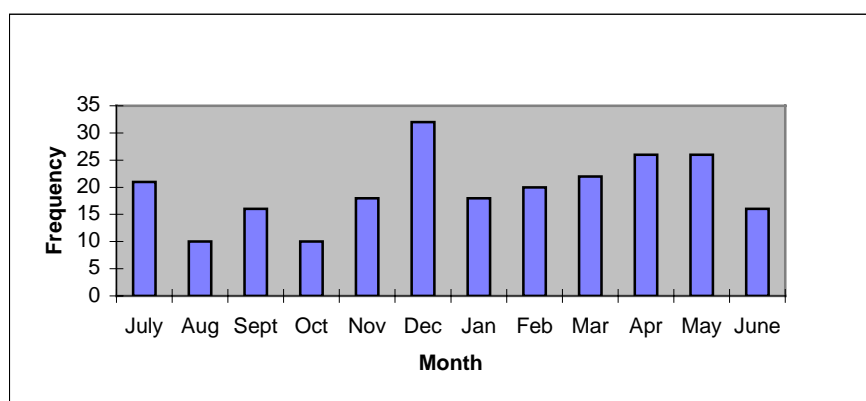
Seasonal variation in the month of admission was observed (Figure 3). No clear temporal trend was observed (89 cases in 93/94, 73 in 94/95, and 77 in 95/96).

Figure 2: Unintentional machinery injuries on farms by age and sex, Victorian Impatient Minimum Dataset 92/93 – 95/96



n=239

Figure 3: Month of admission, unintentional machinery injury on farms, Victorian Inpatient Minimum Dataset 1992/93 — 1995/96



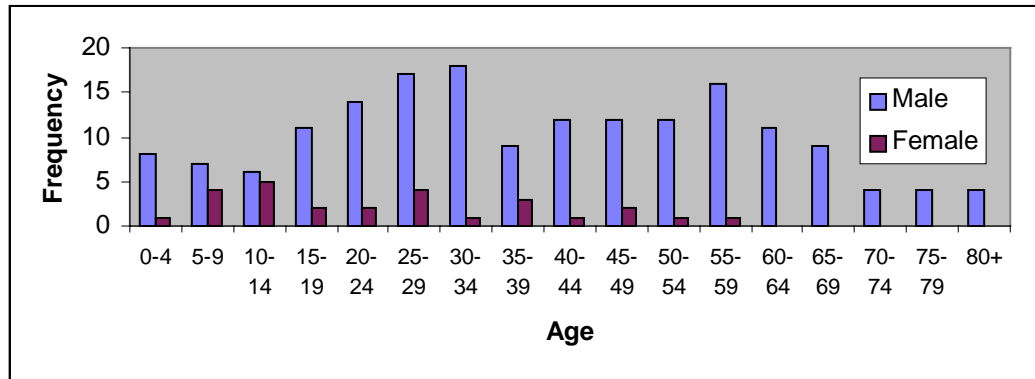
n=235

Agricultural machinery was the major category of unintentional machinery injury on farms among both adults and children (Table 3). This category includes tractors, harvesters, combines, augers and other powered agricultural machinery. E-codes do not allow identification of the type of agricultural machinery involved in each case. However, a crude estimate of the proportions can be made using admitted cases in the Victorian Injury Surveillance System emergency department data surveillance, which does include sufficient detail in the narratives to identify the specific machine. Of the 24 cases in this system admitted for agricultural machinery injury, 17 (71%) were associated with tractors or tractor attachments. Six of these 17 cases resulted from being caught in or between the tractor parts and/or its attachments, 4 resulted from being run over by a tractor, and a further 2 resulted from falling off a tractor and being run over. The non-tractor machinery items were horticultural grading conveyor belts (5), grain auger (1), and an unspecified roller (1).

Table 3: Major causes of unintentional machinery injury on farms, Victorian Inpatient Minimum Dataset 1992/93 — 1995/96

Machinery sub group	<15 yrs	>15 yrs	Total
Agricultural machinery	31	170	201
Woodworking machinery	0	14	14
Lifting machines & appliances	0	2	2
Other specified machinery	0	19	19
Other unspecified machinery	0	3	3
Total	31	208	239

Figure 4: Unintentional agricultural machinery injuries on farms by age and sex, Victorian Impatient Minimum Dataset 1992/93 — 1995/96



n=201

The age and sex distribution showed a steady increase in injuries for males between 15 and 34 years, and second peak among 55-59 year old males (Figure 4).

Bruising/crushing and fractures were the most common agricultural machinery injuries requiring hospital admission (Table 4).

Table 4: Nature of unintentional agricultural machinery injury on farms, Victorian Impatient Minimum Dataset 1992/93 — 1995/96

Nature of injury	<15 years	>15 years	Total	%
	n	N		
Bruising/crushing	7	71	78	38.8
Fracture	15	62	77	38.3
Burn	2	9	11	5.5
Intracranial (ex skull fracture)	1	6	7	3.5
Open wound	1	6	7	3.5
Internal (chest/abdom/pelvis)	0	5	5	2.5
Dislocation	0	3	3	1.5
Sprain/strain	1	2	3	1.5
Superficial injury	1	1	2	1.0
Other asphyxia	1	0	1	0.5
Other injuries	2	5	7	3.5
Total	31	170	201	100

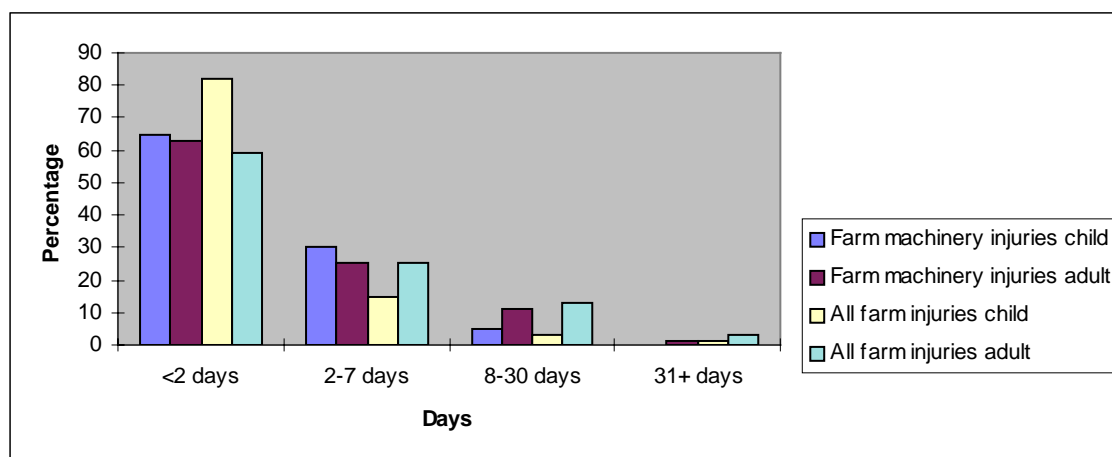
The hands and fingers were the most commonly injured body region for both adults and children (Table 5). Children, however, sustained more injuries to the upper arm and shoulder, while adults sustained a higher percentage to the lower extremities.

Table 5: Body region injured, unintentional agricultural machinery injury on farms, Victorian Inpatient Minimum Dataset 1992/93 — 1995/96

Body region injured	<15 years	>15 years	Total	
	n	n	n	%
Hand and fingers	7	55	62	30.8
Lower extremity	3	41	44	21.9
Upper extremity (nec)	2	15	17	8.5
Abdomen and pelvis	3	12	15	7.5
Head	2	11	13	6.5
Chest	1	12	13	6.5
Forearm, elbow, wrist	2	11	13	6.5
Upper arm, shoulder	5	5	10	5.0
Face, excl. eye	2	3	5	2.5
Neck	3	0	3	1.5
Other and unspecified	1	5	6	3.0
Total	31	170	201	100

The length of hospital stay for machinery injuries on farms was less than two days for 63% of adults and 65% of children. When compared with all injuries on farms, machinery injury among children tended to require longer periods of hospitalisation (Figure 5).

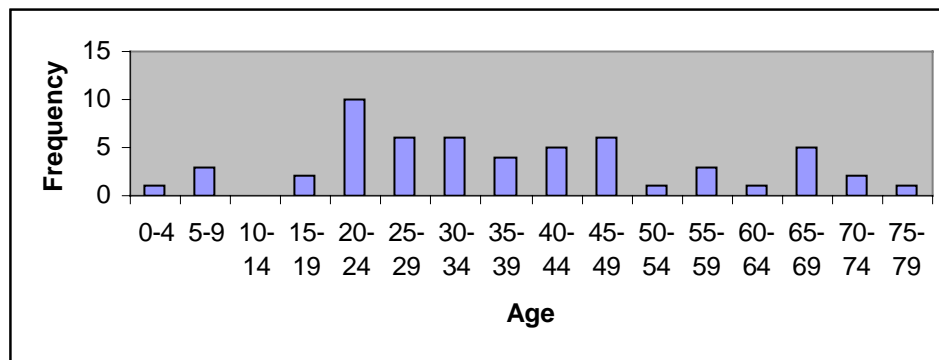
Figure 5: Length of stay, unintentional injuries on farms, Victorian Inpatient Minimum Dataset 1992/93 — 1995/96



3.1.4 Emergency department presentations

There were 56 cases of machinery injury on farms presenting to Victorian Emergency Minimum Database hospitals in the 12 month study period (excluding admissions). Eighty-two percent of cases were male, giving a male:female ratio of 4.6:1 male:female. Figure 6 shows the age distribution. The nature of the machinery was unspecified in 71% of cases.

Figure 6: Unintentional agricultural machinery injuries on farms by age and sex (excluding admissions), Victorian Emergency Minimum Dataset 1995/96-1996/97



n=56

The most frequent injuries were open wounds (14), and sprain or strain (11) (Table 6). The most frequent body region injured was the hand (19) (Table 7). Twenty-two cases (39%) were referred to their local doctor or a specialist, and 8 (14%) were scheduled for review in the emergency department. Fifteen required no referral and data was missing for 8 cases.

It is problematic to deduce the total number of emergency department presentations from the VEMD data, since it is drawn from a non-random sample of Victorian hospitals. However, an estimate of 210 total emergency department presentations per year for machinery injury on farms can be derived by applying the VEMD admission rate for machinery injury on farms (38%) to the total number of admissions obtained from the VIMD.

Table 6: Nature of unintentional machinery injury on farms (excluding admissions), Victorian Emergency Minimum Dataset, 1995/96 - 1996/97

Nature of injury	Frequency
Open wound (ex. eye)	14
Sprain/strain	11
Crushing injury	7
Superficial (excl. eye)	6
Fracture (ex. teeth)	4
Injury to muscle/tendon	4
Traumatic amputation	2
Eye injury (ex. fb.)	2
Other	4
Missing	2
Total	56

Table 7: Body region, unintentional machinery injury on farms (excluding admissions), Victorian Emergency Minimum Dataset, 1995/96-96/97

Body region	Frequency
Hand (inc finger)	19
Foot	6
Lower leg	4
Ankle	3
Multiple	3
Forearm	3
Head (ex.face)	2
Other	8
Missing or not required	8
Total	56

Table 8: Summary of leading causes and nature of unintentional machinery injury on farms in Victoria

	Deaths	Hospital admissions¹	Emergency department presentations (ex admissions)	Case series
Most Common	n=83	n=239	n=56	n=19
Type of machinery	Tractor	Agricultural ²	Insufficient detail	Tractor
Nature of injury most common	not applicable	Fracture Bruise/crush	Open wound Sprain or strain	Laceration
Body part injured	not applicable	Hands and fingers Lower extremity	Hands & fingers Feet	Fingers

¹ To the most specific level of detail available

² Approximately 71% tractor

3.2 CASE SERIES

3.2.1 Response rates

The overall response rate was 47%, ranging between 44-100% (Table 9). Of the 31 non-respondents, 22 declined to participate and 9 had initially agreed but could not be re-contacted. The non-respondents tended to be younger and have less severe injuries than the respondents (Table 10). Although selected from the data base according to external cause of injury code for machinery, nine respondents were injured by items which did not meet the ICD-9 definition selected for this study. These items included powered hand tools, welders, workshop tools and a utility truck.

Table 9: Response rates, unintentional machinery injury on farms case series, Victoria 1997

Recruitment mechanism	Potential respondents (n)	Agreeing to participate (n)	Interviews completed (n)	Response rate (%)
Letter directly from Monash	18	10	8	44
Letter from Monash dispatched by hospital	2	2	2	100
Letter from treating hospital	18	12	8	44
Telephone call from treating hospital	21	13	10	48
Total	59	37	28	47

Table 10: Comparison of respondents and non-respondents, unintentional machinery injury on farms case series, Victoria 1997

Characteristic	Non-respondents N=31	Respondents N=28
Average age	40 years	47 years
Males	97%	93%
Admitted to hospital	35%	43%

3.2.2 Demographics

The age distribution is shown in Table 11. A total of 17 respondents were males, with the 2 females being 55 and 58 years of age.

Table 11: Age distribution, unintentional machinery injury on farms case series, Victoria 1997

Age	Frequency
20-29	4
30-39	2
40-49	2
50-59	3
60-69	4
70-79	4
Total	19

Fourteen respondents considered their primary occupation to be in the farming industry. An additional three were employed in the trucking industry. The remaining primary occupation was in the wool buying industry. One respondent was retired. Eight respondents had a secondary occupation, seven of which were in the farming industry. All respondents were employed in the farming industry in either the primary or secondary occupation. Eleven respondents were the farm owner, 3 were employees, and 3 were relatives of the farm owner. Twelve respondents reported living on the property, and of the 7 who did not, 4 lived in a rural area and 3 lived in an urban area.

Seventeen respondents had at least 10 years experience in farming, 11 of whom had more than 20 years experience. Four respondents had completed high school, with a further 14 having completed some high school education. Nine respondents had completed agricultural education or training courses.

3.2.3 General description of the injurious event

All respondents were working at the time of the injury (as opposed to being engaged in recreational activities), and 13 respondents were engaged in paid work (nature of work not specified in 7 cases). Nine injuries occurred in paddocks and 2 occurred in a farm building (excluding the farm house). The most common activity at the time of injury was cropping (13 respondents), followed by farm maintenance (4). Among those engaged in cropping activities, 4 were harvesting, and 4 were elevating or augering. Nine of the cropping activities involved grain. There was no clear pattern of activity among those engaged in farm maintenance activities.

The mechanism of injury is shown in Table 12. Two of the events involved the respondent putting a hand into operating machinery, 2 involved a fall, and 2 involved the jamming of machinery components.

Table 12: Mechanism of injury, unintentional machinery injury on farms case series, Victoria 1997

Mechanism	Frequency
Run over or into by moving machinery	5
Caught in or between machinery	4
Struck by falling machinery or machinery component	4
Striking against or struck accidentally by machinery	2
Cut or pierced by machinery component	2
Other	2
Total	19

3.2.4 Associated factors

The temperature at the time of injury was 10-20 degrees C in 7 cases, and 20-30 degrees C in 8 cases. The weather was clear in 18 cases. The wind was either calm or a light breeze in all cases. The surface was dry in 16 cases and wet in 2 cases. The injury occurred in daylight in 17 cases, in good artificial light in 1 case and in the dark in 1 case. There were no cases where the injury occurred at dawn, dusk, or in light conditions reduced due to dust, smoke or fog. Two respondents believed that the weather conditions influenced the injury occurring. These were thought to be due to heat in one instance, and rain and cold in the other.

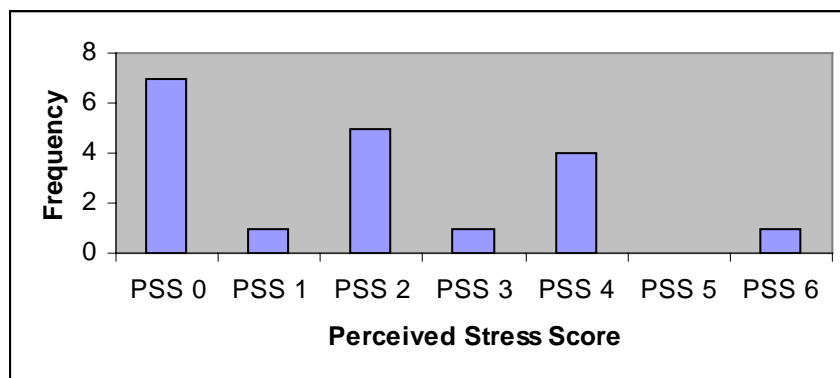
Twelve respondents reported the use of some type of personal protective equipment. Twelve were wearing safety or work boots, two were wearing ear muffs or plugs, and one was wearing heavy duty gloves.

Lack of sleep did not appear to be a factor. Most of the respondents (15) had 8 hours or more sleep the night prior to the injury, and 8 hours or more sleep on average each night during the week prior to the injury. The remaining respondents had between 5 and 7 hours sleep on the night prior to the injury, and the same amount on average each night during the week prior to the injury. Similarly, most respondents worked 8 hours or less on the day prior to the injury (17). However, 8 respondents reported working more than 40 hours the week prior to the injury. Four reported working between 40 and 49 hours, 1 reported working between 50 and 59 hours, and 3 reported working 60 hours or more. The maximum number of hours was 96.

The mean Epworth Sleepiness Scale score was 7.2. The normal range is from 2 to 12. The mean score in a group of 155 uninjured farmers in New South Wales was 7.03 (Griffith, 1994).

The distribution of the Perceived Stress Scores was skewed towards the lower end of the scale, indicating that high levels of perceived (and reported) stress were infrequent (Figure 7).

Figure 7: Perceived stress, unintentional machinery injury on farms case series, Victoria 1997



n=19

Seven respondents had suffered prior farm injuries which required time off work or medical attention. Two had suffered more than one such prior injury.

Eight respondents wore eyeglasses or contact lenses, and six of these rated their sight with their glasses as very good or excellent. Three respondents reported having trouble in hearing what is said in normal conversation, but none wore a hearing aid. Five respondents reported having impairments or health problems which limit the kind or amount of work they could do. Five respondents had reported using medication in the 24 hours prior to the injury. No respondents reported being unwell in the 24 hours prior to the injury.

Eleven respondents reported that they were very experienced with the piece of machinery, 5 reported being experienced or somewhat experienced, and 1 reported being inexperienced. The length of time the machinery had been in use immediately prior to the injury was 1-3 hours in 9 cases, 3-6 hours in 7 cases, less than 1 hour in 1 case and more than 6 hours in 1 case.

3.2.5 Machinery characteristics

Table 13: Type of machine, unintentional machinery injury on farms case series, Victoria 1997

Machine	Frequency
Tractor	7
Harvesting machine	3
Grain auger	3
Other specified mobile plant*	6
Total	19

* includes seeder, fertiliser, excavator, fork-lift, ride on mower, hay baler

Tractors were the most common item of machinery involved (Table 13). Three pieces of equipment were manufactured in the 1990's, 7 were manufactured in the 1980's and 4 were manufactured in the 1970's. Six respondents could not recall or did not know the year of manufacture. The items of machinery had been in use on the property for less than 5 years

in 7 cases, 5-10 years in 4 cases, 10-20 years in 4 cases and more than 20 years in 1 case. Ten respondents either did not know or could not recall when the machinery had been last serviced. Three respondents reported that the machinery had last been serviced in the week prior to the injury, and a further two respondents reported servicing in the previous 3, 6 and 12 months each. All of the respondents, except 1, rated the state of the repair of the machinery as average or better (3 average, 11 good, 4 excellent). Two respondents reported that there had been modifications to the machinery. It appeared that when adjusted for person hours, the use of a fork-lift carried the highest injury risk (Table 15).

Table 14: Exposure adjusted rates, unintentional machinery injury on farms case series, Victoria 1997

Machine	Person hours use week prior to injury	Injury frequency	Injuries per 100 person hours
fork lift	24	1	4.2
hay baler	35	1	2.9
grain auger	116	3	2.6
tiller/seeder	40	1	2.5
tractor	305	7	2.3
harvesting machine	163	3	1.8

Responses to an invitation to comment on the machinery included:

- 3 respondents reported that the fault was not with machine
- 3 respondents commented on the age of the machinery
- 2 respondents commented on machine features (catch hard to release, gears wrongly marked)
- 2 respondents comment on unfamiliarity with the machinery

Other comments related to the known dangerousness of the machine, and the need to have the machinery open to view operation.

Ten suggestions were made on possible safety improvements to the machinery involved, three of which related to cut off mechanisms (Table 15).

Table 15: Suggested safety improvements, unintentional machinery injury on farms case series, Victoria 1997

Machine	Suggested safety improvement
Tractor	platform to stand on neutral start switch automatic cut off when bucket is down
Harvesting machine	two seats in cabin, for passengers to prevent falls automatic cut off switch
Grain auger	make bin higher
Tiller/seeder	make catch easier to release
Fertilise spreader	wind up stand attached so that when it is transferred it can't drop onto anything
Mower	dead man seat cut off

3.2.6 Farm characteristics

Cereal grains were the predominant commodity of properties on which the injured person was working (Table 16). The most common property size was 100-499 hectares (Table 17)

Table 16: Commodity group, unintentional machinery injury on farms case series, Victoria 1997.

Commodity	Primary	Secondary
Cereal grains	9	4
Meat cattle	4	0
Milk cattle	3	1
Sheep (wool)	0	5
Other	3	1

3.2.7 First aid and treatment

Ten respondents reported being alone at the time of injury. Twelve respondents were transported to hospital by another person: 9 driven by were relatives, and 3 were transported in an ambulance. Five respondents drove themselves to the hospital. A total of 37 injuries were sustained by the 19 respondents (up to three injuries could be nominated). The most common body part injured was the fingers (11), mainly lacerations (5) and other wounds including amputations (5). Other commonly injured body parts included the toes (5), mainly fractures, the feet (4) and the upper leg (4). Ten cases were admitted to hospital (53%). The length of time that normal working patterns were disrupted is shown in Table 17.

Table 17: Descriptive of normal working patterns, unintentional machinery injury on farms case series, Victoria 1997.

Few hours to 1 day	1 day to 1 week	2 weeks	1 month	1 to 3 months	Still disrupted
2	4	3	1	3	5

4. DISCUSSION

4.1 RESULTS

This study has confirmed that machinery is a major contributor to death and serious injury on farms. The tractor was the most frequent cause of machinery related injury, accounting for 100% of the child deaths, 71% of the adult work related deaths, and an estimated 71% of hospital admissions.

Estimates here indicated that close to one third (29%) of persons admitted to hospital for a machinery related injury on a farm were injured by agricultural machinery other than tractors. The small numbers of cases with sufficient detail limit the extent to which this non-tractor machinery can be characterised. Further, due to the regional nature of the data used for this estimation, the types of non-tractor machinery implicated in this study could not be generalised. In contrast to the injury frequencies, non-fatal injury rates per 1000 person hours from the case series study indicated that the risk of injury during operation of fork-lifts was greater than that for tractors. However, due to the small numbers in the case series, these results should be treated as preliminary.

Non-fatal machinery injury on farms most frequently resulted in fractures, lacerations, sprains, and bruising/crushing injuries. The extremities of the body were the most vulnerable, indicated by the hands and fingers, and feet being most frequently injured. A measure of the severity of these injuries is that the admission rate for machinery injury on farms is higher than for general injury on farms (Day et al ,1997). Further among those who were hospitalised, 35% and 37% of children and adults respectively remained in hospital for more than 2 days. In the case series study, normal working patterns were disrupted for more than 1 week for 12 of the 19 participants.

Males were more commonly killed or injured than females. This may be a reflection of the gender distribution among users of farm machinery, since the data presented here do not take exposure into account.

The above findings on the prominence of machinery among causes of farm injury, the predominance of males, seasonal variation and types of injuries are similar to those of overseas studies (Pickett et al., 1995, Young 1995, Hopkins 1989, Simpson 1984).

The case series study was intended to compliment the database analysis by providing more details regarding the circumstances leading up to the injurious event. However, the data obtained is limited by small numbers and response bias. Retrospective recruitment for this kind of study is clearly less than ideal. Nonetheless, the data do provide some indication of factors which may be relevant.

Most of the case series participants nominated their primary occupation as farming. Notwithstanding the response bias towards older age, those over 60 years did appear to be particularly over-represented. Forty-two percent of the case series participants were over 60 years of age compared with 24% over this age in the agricultural work force (Australian Bureau of Statistics, 1995). Neither the weather nor the age of the machinery appeared to be implicated in these events. Lack of sleep was not commonly reported among the case series participants, as indicated by both the hours sleep and the Epworth Sleepiness Scale. However, since 8 out of the 19 reported to be working more than 40 hours per week, and 8 had a secondary occupation, the injured participants were busy people, probably with reduced time for recreation. Without comparative data, it is difficult to implicate any of the

other factors explored in this study. A case-control study in which similar data is collected from a suitable sample of non-injured farmers would be of great benefit in identifying specific factors that place farmers at increased risk of machinery injury.

4.2 IMPLICATIONS FOR PREVENTION AND FURTHER RESEARCH

Almost all machinery related deaths among children on farms in this study could have been prevented by not carrying children as passengers on tractors. The alternative of adequate provision for the safety of child passengers on tractors has not yet been realised in most current tractor designs. Roll over protection frames would greatly reduce the numbers of adult tractor related deaths. This issue is currently being addressed in Victoria with a major roll over protective frame rebate scheme. A future challenge in preventing machinery related deaths on farms will be reducing the risk of run-over events. Guarding of moving parts would appear to be a solution to preventing those injuries associated with being caught in moving parts of farm machinery. However, anecdotal evidence suggests that machinery operations are not always taken into account with respect to the placement of guards. This issue requires further investigation.

The prevention of machinery injury and deaths on farms would be greatly facilitated by studies that investigate the circumstances leading up to the event among a substantial number of cases. Prospective studies which recruit participants close to the time of injury are less likely to suffer the response bias apparent with the retrospective recruitment used here. Inspection of the machinery should also be included to ascertain design features and operational factors that may be relevant to prevention. Such studies would determine the relative potential for prevention by either design solutions or work practice modification. The individual and environmental factors should also be investigated and compared with an appropriately selected group of non-injured control farmers. This approach would provide quantitative data to the farming community for the purposes of risk identification and management, and would assist in the further identification of high risk groups for prevention programs.

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