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Abstract: Background

Farming is the most dangerous occupation in high-income countries worldwide. However, there is a lack of descriptive literature in this area. Injuries on farms are increasing, at a time when the cohort of trauma patients generally has become older and more medically complex. Farmers continue to work late in life when other industry workers would be retired. This study describes major trauma occurring on farms in the Republic of Ireland, the demographics of patients and treatments they received.

Methods

Data was gathered from the National Office of Clinical Audit Major Trauma Audit (MTA) 2014 to 2016. Patients were included and excluded based on Trauma Audit and Research Network (TARN) inclusion criteria.

Results

There were 430 patients included in this study. The median age was 54.5 years (range 1-93). There were 6.3% (n=27) paediatric patients, and 27% (n=116) over 65-year olds. Patients had predominantly low Charlson Comorbidity Index scores (median 0). Patients >65 years had more comorbidities ($p < 0.001$). The median ISS was 9 (IQR 9-17). The most common mechanism of injury was blow from animal (n=126, 29%) followed by low fall (n=115, 27%). Summer was the most common season of injury (n=128, 30%) and most patients presented to a hospital between 8am-12am (n=412, 96%). There were 11 patients (2.6%) who died after arrival to hospital - most commonly due to head injury (n=5, 45%).

The median length of stay was six days; older patients stayed longer than younger patients (6 vs 12 days, $p < 0.001$). The most common body area injured was limbs (n=139, 32%), followed by chest (n=89, 21%), spine (n=67, 16%) and head injuries (n=64, 15%). There were 84 patients (19.5%) who underwent operative intervention, and 77 (18%) required intensive care unit (ICU) admission. Farm trauma patients were more likely to arrive by helicopter than other MTA patients.

Conclusions

A substantial proportion of trauma on Irish farms involves older men who have co-morbidities and complexity of medical need. Farm trauma occurs in rural and remote locations with longer journey times to trauma centres

and trauma units-this has implications for trauma care education and mode of EMS transport. Older patients who suffer trauma on farms require longer hospital stays and may not return to independent living.

Suggested Reviewers:

Title Page

Trauma on Farms in the Republic of Ireland

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Dr Micheal Sheehan,
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05/02/20

Dear Sir/Madam,

There were no conflicts of interest in the authorship of 'Trauma on Farms in the Republic of Ireland'.

Regards,

Dr Micheal Sheehan

Trauma on Farms in the Republic of Ireland

Highlights

Farming is the most dangerous occupation in high income countries worldwide.

Major trauma on farms affects all age groups, particularly those over 65 years old.

Common injury mechanisms were blow from animal, low fall, fall more than two metres, crush injuries and vehicle injuries.

The median length of stay was six days; older patients stayed longer than younger patients (median 6 vs 12 days).

Farm trauma patients were more likely to arrive by helicopter than other Major Trauma Audit patients.

Dr Micheal Sheehan,
Emergency Department,
St James's Hospital,
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05/02/20

Dear sir/madam,

Major trauma on farms is the most common cause of workplace death in high income countries. There is a paucity of literature in this area. Here, we present the largest case series of this trauma subgroup in the international literature to date.

We have detailed the epidemiology, mechanisms, injuries, treatments and outcomes with a level of granularity not previously attained.

We feel that this is a significant addition to the literature in workplace injuries and that this will help inform public health campaigns and trauma system configuration in the future.

The authors declare that all authors; Micheal Sheehan, Louise Brent and Conor Deasy, each have fulfilled criteria as established by the ICMJE.

There were no conflicts of interest in this article.

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Regards,

Dr Micheal Sheehan

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injury (n=128,30%) and most patients presented to a hospital between 8am-12am(n=412,96%).

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A substantial proportion of trauma on Irish farms involves older men who have co-morbidities and complexity of medical need. Farm trauma occurs in rural and remote locations with longer journey times to trauma centres and trauma units–this has implications for trauma care education and mode of EMS transport. Older patients who suffer trauma on farms require longer hospital stays and may not return to independent living.

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Farming is the most dangerous occupation in high-income countries worldwide.

Major trauma on farms affects all age groups, particularly those over 65 years old.

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The median length of stay was six days; older patients stayed longer than younger patients (median 6 vs 12 days).

Farm trauma patients were more likely to arrive by helicopter than other Major Trauma Audit patients.

Introduction

Farming is the most dangerous occupation in high-income countries worldwide [1]; just five per cent of Irish workplaces are farms, but almost half of all workplace deaths occur on farms [2]. There are approximately 140,000 farms in the Republic of Ireland; these include 78,000 beef farms, 16,000 dairy farms, 14,000 sheep farms, 17,000 with a mix of grazing livestock, and 15,000 tillage farms [3]. From 2009 and 2015, there were 138 fatal workplace accidents in the Agriculture sector, of a total of 296 fatal workplace accidents in the Republic of Ireland [4]. Agriculture workers suffer more than twice as many non-fatal workplace injuries as workers in other sectors (51 vs 21 per 1,000 workers per year) [4]. Between 2006 and 2010, farm injuries increased by 35%; medical attention was required by 95% of these, and half underwent inpatient hospital management. In 15% of cases, farmers lost 100 or more workdays as a result of the trauma [2]. Most farm accidents reported to the Health and Safety Authority in the Republic of Ireland have significant impacts on farmers' lives and livelihoods. Most farms are family-run, putting all family members at risk of injury; this magnifies the social and economic risk associated with farm injuries [2,5].

Despite its prevalence, little work has been done by the medical community to describe the types of injuries suffered by farmworkers. A 2014 Irish study found that animal-related trauma was the leading cause of both fatal and non-fatal injuries on farms [6]. A 2010 study conducted at a regional Irish hospital exclusively on cow-related trauma established that cow-related trauma is equivalent to high-velocity trauma by comparing injury severity scores [7]. Managing large animal-related trauma as high-velocity trauma akin to road traffic accidents has been established previously in the literature [8,9]. Farm trauma causes a wide variety of injury types to patients of all age groups [10].

Trauma care in the western world is changing. In Ireland, 44% of major trauma patients are over 65 years of age; their most common injury mechanism is a fall of less than two metres [11].

Farmworkers commonly continue to work at ages when workers in other industries would be retired. In Europe, nine per cent of farmers are 65 years of age or older, compared with two per cent

for all workers [12]. Farmers are thus at increased risk of workplace injuries. Older trauma patients have more comorbidities, are more likely to die and less likely to be discharged to their own home following major trauma [11].

Farm trauma patients present unique challenges to prehospital care providers and emergency physicians due to remote locations and complex injury patterns. Farm injuries are a common cause of major trauma worldwide, but descriptive studies are scarce in the existing literature [1]. For this reason, this study aims to describe this major trauma subset in terms of patient demographics, injury mechanisms, injury types, treatments received and outcomes.

Materials and Methods

The Republic of Ireland has a population of 4.8 million people over an area of 70,273 square kilometres [13]. There are currently 26 trauma-receiving hospitals [11]. The National Ambulance Service (NAS) covers the Republic of Ireland exclusively, except for the Dublin area where responsibility is shared between NAS and the Dublin Fire Brigade (DFB). NAS has a National Emergency Operations Centre in Dublin that covers call taking, dispatch functions and coordinates land and air emergency services [14]. Aero Medical services are provided by the Irish Air Corps and the Irish Coast Guard through NAS, and a charitably funded HSE staffed helicopter has recently commenced operations based in Munster [15]. Following a 2018 report from the Trauma Steering Group, a comprehensive trauma system is being established, where a network of facilities and services co-ordinate in the care of injured patients along standardised pathways [16].

Patients who suffered major trauma on Irish farms were identified from the National Office of Clinical Audit (NOCA) Major Trauma Audit (MTA) database from 2014 to 2016. This was achieved by searching the database by 'incident location' 'farm'.

The MTA describes the care and clinical outcomes of patients who experience major trauma in the Republic of Ireland. NOCA has engaged the internationally recognised Trauma Audit and Research Network (TARN) to provide its methodological approach for MTA in Ireland. TARN has been in operation in the UK since the 1990s and has been at the forefront of quality and research initiatives in trauma care [11]. MTA commenced in the Republic of Ireland in 2013; all 26 trauma receiving hospitals are now contributing data with a national data coverage rate of 86% that has grown incrementally, and an excellent national data accreditation rate of 97% [11]. Operationally, data is gathered from the patient's hospital and ambulance records, radiology reports and hospital information systems. This is entered onto the TARN portal by trained audit coordinators at the hospitals; injury severity coding is performed by trained coders on anonymised data at TARN Headquarters in Manchester.

In terms of co-morbidities, patients are classified by the Charlson Comorbidity Index. This is a scoring system which predicts the one-year mortality for a patient who may have a range of comorbid conditions, for a total of 22 conditions. Each condition is assigned a score of 1, 2, 3, or 6, depending on the risk of dying associated with each one. Scores are summed to provide a total score to predict mortality [17].

TARN captures the care of traumatically injured patients whose lengths of stay are 72 hours or more, or who are admitted to a high-dependency area, or who die after arrival to a hospital, or who are transferred to another hospital for specialist care (Appendix 1). Of note, TARN does not capture deaths that occur prehospital. Major trauma is defined as patients with an injury severity score (ISS) of 15 or greater; TARN also collects data on patients with lower ISS who meet TARN inclusion criteria for MTA.

Data were analysed using IBM SPSS Statistics software Version 26. Descriptive statistics, frequencies and graphs were produced. Chi square and Mann Whitney U tests were used to test statistical significance.

Results

In the years 2014 through 2016, 430 patients met TARN MTA inclusion criteria where the incident location was farm; this represents 4% of the overall TARN population. Data coverage for these years was 67%, 55% and 74% respectively and data accreditation, describing the quality of the data collected, was 95% to 96%. The numbers identified increased year on year from 127 patients in 2014 to 157 patients in 2016 explained in part by the increasing data coverage of the MTA.

The demographical makeup of this patient cohort is shown in Table 1. The median age was 54.5 years (interquartile range (IQR) 38 to 67); the patients ranged in age from less than one year old to 93 years of age. There were 6.3% (n=27) in the paediatric (less than 16 years old) age group and 27% (n=116) in the over 65-year-old age group.

Mechanisms of injury are described in Table 1. 'Blow' refers to blunt contact such as a kick from an animal. Paediatric patients' most common mechanisms of injury were 'blow' (n=9, 33%), vehicle incident (n=7, 26%) and a fall less than two metres (n=5, 19%).

Patients were predominantly healthy with low scores on the Charlson Comorbidity Index. There were 75% of farm trauma patients who had a Charlson Comorbidity Index of zero, compared to just 51% among MTA patients generally ($p<0.001$). Predictably, patients over 65 years old had higher Charlson Comorbidity Index scores than those less than 65 (Mann Whitney U, $p<0.001$).

Median injury severity score (ISS) for patients less than 65 years old was nine (IQR 9-17), over 65-year olds had a median ISS of 10 (IQR 9-18). This difference was not statistically significant ($p=0.1$).

Modes of arrival were predominantly by ambulance (266, 80%), followed by car (42, 13%) and helicopter (20, 6%). Farm trauma patients were more likely to arrive by helicopter (6%) than other MTA patients (1.6%, $p<0.001$). A trauma team received only 14% (n=60) of patients. This figure is only 12% (n=14) for patients over 65.

Most patients arrived on Monday (n=70, 16.3%) and least on Sunday (43, 10%). Mean attendances per day of the week were 61. This is shown in figure 5.

Cork University Hospital, University Hospital Galway and University Hospital Limerick received the most patients with 81 (19%), 54 (13%) and 47 (11%) patients respectively.

Table 1. Patient demographics.

Patients' injuries, treatments and outcomes are shown in table 2.

There were 11 patients (2.5%) in this trauma set who died. The median age of patients who died was 68.6 years. This was significantly older than patients who survived, who had a median age of 54.1 years ($p=0.02$). Head injury was the most common cause of death ($n=5$, 45%). The median Injury Severity Score (ISS) for patients who died was 18 (IQR 13-25). ISS was over 15 in eight cases (73%). The median ISS for all patients was 9 (IQR 9-17).

Patients had a median length of hospital stay of six days (IQR 3-11), with a range of one to 370 days. Patients who were over 65 years old had longer hospital stays. The median length of stay for patients over 65 was seven days (IQR 4-17), while the median for patients less than 65 was five days (IQR 3-9.25, $p<0.001$).

Blunt trauma accounted for most of this trauma set ($n=417$, 97%). Only 13 patients (3%) suffered penetrating trauma. The most common body area injured was limbs, followed by chest, spine and head injuries; as shown in table 2. Rates of these injuries were similar to other MTA patients [11].

Only 84 (20%) of patients required operative intervention; 49 (58%) of operations were performed on limbs, and 15 (18%) were spinal operations. A similar cohort ($n=77$, 18%) were admitted to an intensive care unit (ICU). The median length of ICU stay was 3 days (IQR 1-5). Chest injuries were the most common ($n=23$, 30%), followed by head injuries ($n=16$, 21%).

Table 2. Patient treatments and outcomes.

*Registrar on specialist training program

Table 3. Demographics of patients who died.

Figure 1. Patient ages.

Figure 2. Patient presentations by calendar month.

Figure 3. Time of patient presentations.

Figure 4. Patient discharge destination.

Figure 5. Presentations by day of the week.

Discussion

This is the most extensive case series in the literature on major trauma occurring on farms. We show that a substantial proportion of victims are older men with co-morbidities and complexity of medical need. We show that incidents occur remote from hospitals which has logistical and training implications for emergency medical services (EMS) providers. Patients have extended hospital stays and many do not return home to independent living. Falls of less than two meters (low falls) caused a quarter of major trauma in those under 65 years of age, and low falls make up almost one third of patients over 65 years old. The farm is the most common workplace for patients over 65 years to suffer life-changing or life-threatening injury.

By way of context, in the Republic of Ireland, 44% of patients treated for major trauma are over 65 years old. It is recognised internationally that this cohort is increasing, and that outcomes are poorer for older trauma patients [18]. Older patients are less likely to be received by a trauma team and less likely to be reviewed by a senior clinician. Older patients are more likely to die and less likely to be discharged to their own home following major trauma [11]. These 'silver trauma' trends are evident in our data of injuries occurring to older patients on farms in the Republic of Ireland; this must be considered so that suitable trauma pathways can be developed.

The older profile of farmers sustaining major trauma mirrors the ageing demographic of farmers. In Europe, 9% of farmers are 65 years of age or older, compared with 2% of all workers [12]. Over half (51.4%) of Irish farmers were aged over 55 years [3]. This was an increase from 39.5% in the year 2000 [2,3]. People in the western world are living longer than previously, and farmers are continuing to work well into their senior years. In other industries, these workers would be retired. This may contribute to higher rates of major trauma in the farming sector.

There were 27 paediatric patients who sustained injuries on farms captured in this study. Injuries to patients across all decades of life is a feature peculiar to farm trauma [8,9,10]. Farming is the only occupation where children live and play at the worksite [19]. For this reason, paediatric injuries

occur far more commonly than in other workplaces. Most farms in the Republic of Ireland are family-run [3]. Over 90% of farm work is done by family labour [12]. Unfortunately, this means that the entire family is at risk of workplace injury, which compounds the social and economic risks associated with farm injuries [2,5]. Public health campaigns are beginning to try to combat this [20].

Patients were most likely to present to the Emergency Department (ED) between 5 and 7 p.m. This has implications for trauma system design in Ireland. Staffing levels and access to diagnostics and operating theatres must match this out-of-hours demand. Peaks of attendances occurred at busy times of the year for farmers, in March and July. Farmers were less likely to be injured on Sunday than other days of the week, but a significant portion of injuries occur at weekends. In keeping with other data on workplace injuries, this is a characteristic peculiar to the farming sector [21].

Most patients were discharged to their own homes or the homes of relatives or carers after their inpatient stay. However, 29.3% (n=126) were transferred to another acute hospital to meet their medical needs. Communication and transfer between regional hospitals and referral centres can be challenging without support from a robust network and system. Farm injuries are likely to happen in remote, rural locations. Farm trauma patients were significantly more likely to arrive by helicopter than other MTA patients. Patient location and mode of transport available may necessitate decisions regarding the optimal receiving hospital. As Ireland moves towards formulating an inclusive trauma system, the complex needs of major trauma patients may be met earlier in trauma centres, and it is anticipated trauma networks will improve and streamline the processes involved [16]. It is recommended that all major trauma patients be reviewed by an emergency medicine consultant within 30 minutes of arrival in the ED. Only one-third of this cohort were seen by a consultant in the ED; staffing levels and seniority need to be examined in order to improve this metric.

Current data indicate that dairy farming is the most dangerous type of farming in the Republic of Ireland [2,4,22]. The abolition of the European Union milk quota regime in 2015 has resulted in a dramatic increase in the intensity of Irish dairy farming, and this trend is predicted to continue [23].

This will increase rates of occupational injury due to a rise in the number of inexperienced recruits, higher work intensity and longer working hours due to increased demands [24,25]. It is difficult to assess this increase in this dataset due to data coverage differences between years. In view of this, the increasing trend in farm injuries looks set to continue. Several safety campaigns and increased media coverage have raised awareness of farm safety concerns over recent years [26,27]. However, mandatory safety training programmes are not on par with those in other industries and should be examined as a method of risk reduction on farms [8,28]. Farming is one of the few industries where no restrictions exist to the number of hours worked [29]. This should be examined as a possible source of risk during busy periods.

In terms of limitations of this study, this represents only major trauma occurring on farms in the Republic of Ireland (appendix 1). Many workplace injuries will not fall into this bracket and so are not represented by this study; farm injuries suffer from poor rates of reporting, and this presents a challenge in documenting these injuries [30]. This study represents those farm injuries that have the greatest impact on patient's lives and implication for healthcare delivery. As described, data coverage was not complete; however, it is national, representative and the largest such case series published in the literature to date, with an excellent data accreditation score.

In conclusion, a substantial proportion of trauma on farms in the Republic of Ireland involves older men who have co-morbidities and complexity of medical need. Farm trauma occurs in rural and remote locations with longer journey times to trauma centres and trauma units; this has implications for trauma care education and mode of EMS transport. Older patients who suffer trauma on farms require a longer hospital stay, and many do not return home to independent living from the acute hospital.

References

1. Härmäläinen P, Takala J, Kiat TB. Global estimates of occupational accidents and work-related illnesses 2017. World. 2017 Sep;2017:3-4.
2. Health and Safety Authority. *Farm Safety Action Plan 2013-2015*. P. 3. Available from: <http://www.medpartnership.com/wp-content/uploads/2013/07/HSA-Farm-Safety-Action-Plan-2013-2015.pdf> [Accessed on 2 March 2020]
3. Central Statistics Office. *Census of Agriculture 2010 - Final Results*. 2012. P. 8, 73. Available from: <http://www.cso.ie/en/media/csoie/releasespublications/documents/agriculture/2010/full2010.pdf> [Accessed on 2 March 2020]
4. Health and Safety Authority. *Summary of Workplace Injury, Illness and Fatality Statistics 2014 - 2015*. P. 34. Available from: http://www.hsa.ie/eng/Publications_and_Forms/Publications/Corporate/HSA_Statistics_Report_2014-2015.pdf [Accessed 2 March 2020]
5. Lee MJ, Cawley DT, Ng JP, Kaar K. Trends in the Fractures and Fatalities of Farmyard Injuries in Ireland: A 10 year analysis. Ir Med J. Available from: <http://imj.ie/trends-in-the-fractures-and-fatalities-of-farmyard-injuries-in-ireland-a-10-year-analysis/> [Accessed on 2 March 2020]
6. Casey MC, Robertson I, Lang B, Bennani F, Khan W, Barry K. Farm-related trauma in the West of Ireland: An occupational hazard. Irish Journal of Medical Science (1971-). 2014 Dec 1;183(4):601-4.
7. Murphy CG, McGuire CM, O'Malley N, Harrington P. Cow-related trauma: a 10-year review of injuries admitted to a single institution. Injury. 2010 May 1;41(5):548-50.
8. Sheehan M, Deasy C. A descriptive study of the burden of animal-related trauma at Cork University Hospital. Ir Med J. 2018 Jan 10;111(1):673.
9. Nogalski A, Jankiewicz L, Cwik G, Karski J, Matuszewski L. Animal related injuries treated at

the Department of Trauma and Emergency Medicine, Medical University of Lublin. *Annals of Agricultural and Environmental Medicine*. 2007;14(1).

10. Jawa RS, Young DH, Stothert JC, Yetter D, Dumond R, Shostrom VK, et al. Farm machinery injuries: the 15-year experience at an urban joint trauma center system in a rural state. *Journal of agromedicine*. 2013 Apr 1;18(2):98-106.

11. National Office of Clinical Audit. *Major Trauma Audit National Report 2017*. P. 45, 97.

Available from:

http://s3-eu-west-1.amazonaws.com/noca-uploads/general/MAJOR_TRAUMA_AUDIT_NATIONAL_REPORT_2017_FINAL.pdf [Accessed on 2 March 2020]

12. Eurostat, European Union. *Archive: Small and large farms in the EU - statistics from the farm structure survey*. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Small_and_large_farms_in_the_EU_-_statistics_from_the_farm_structure_survey&oldid=406560 [Accessed on 2 March 2020]

13. Central Statistics Office. *Census 2016 Summary Results - Part 1*. P. 8. Available from:

<https://www.cso.ie/en/media/csoie/newsevents/documents/census2016summaryresultspart1/Census2016SummaryPart1.pdf> [Accessed on 2 March 2020]

14. The National Ambulance Service. *Pre-Hospital Emergency Care in Ireland*. Available from:

<http://www.nationalambulance.ie/aboutnationalambulance/> [Accessed on 2 March 2020]

15. Irish Community Rapid Response. *About the ICRR Air Ambulance*. Available from:

<https://www.icrr.ie/air-ambulance/> [Accessed on 2 March 2020]

16. Trauma Steering Group. *A Trauma System for Ireland*. P. 10-14. Available from:

<https://assets.gov.ie/10116/70fd408b9ddd47f581d8e50f7f10d7c6.pdf> [Accessed on 2 March 2020]

17. Charlson, Mary E.; Pompei, Peter; Ales, Kathy L.; MacKenzie, C. Ronald (1987). "A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation". *Journal of Chronic Diseases*. 40 (5): 373–83.
18. Victorino GP, Chong TJ, Pal JD. Trauma in the Elderly Patient. *Arch Surg*. 2003;138(10):1093–1098.
19. Zepeda, L., Kim, J. (2006). Farm Parents' Views on their Children's Labor on Family Farms: A Focus Group Study of Wisconsin Dairy Farmers. *Agriculture and Human Values*, 23(1), 109–121.
20. Health and Safety Authority. *Annual Report 2013*. P. 11. Available from: http://www.hsa.ie/eng/Publications_and_Forms/Publications/Corporate/Annual_Report_2013.pdf [Accessed on 2 March 2020]
21. Reece SC, Thiruchelvam D, Redelmeier DA. Medical emergencies in farmers. *The Journal of Rural Health*. 2019 Sep;35(4):429-35.
22. Gerberich SG, Gibson RW, French LR, Lee TY, Carr WP, Kochevar L et al. Machinery-related injuries: Regional rural injury study - I (RRIS-I). *Accid Anal Prev* 1998;30:793-804.
23. Dillon E, Donnellan T, Hanrahan K, Houlihan T, Kinsella A, Loughrey J et al. *Outlook 2019 Economic Prospects for Agriculture*. P. 4. Available from: <https://www.teagasc.ie/media/website/publications/2018/Outlook2019.pdf> [Accessed 2 March 2020]
24. Fairris, D. (1998). 'Institutional change in shop floor governance and the trajectory of post-war injury rates in US manufacturing 1946–1970', *Industrial and Labour Relations Review*, Vol. 51, No. 2, pp. 187-203
25. Davies R, Jones P. Trends and context to rates of workplace injury. Health and Safety Executive, UK, Research Report. 2005;386.

26. Health and Safety Authority. *Farm Safety Action Plan 2016-2018*. P. 6. Available from:
[https://www.hsa.ie/eng/Publications and Forms/Publications/Agriculture and Forestry/Farm Safety Action Plan 2016-2018.pdf](https://www.hsa.ie/eng/Publications_and_Forms/Publications/Agriculture_and_Forestry/Farm_Safety_Action_Plan_2016-2018.pdf) [Accessed 2 March 2020]
27. Health and Safety Authority. *Media Campaigns*. Available from:
[https://www.hsa.ie/eng/News Events Media/Archive/Media%20Campaigns/](https://www.hsa.ie/eng/News_Events_Media/Archive/Media%20Campaigns/) [Accessed 2 March 2020]
28. Citizens Information. *Safe Pass Programme*. Available from:
[http://www.citizensinformation.ie/en/employment/employment rights and conditions/health and safety/safe pass.html](http://www.citizensinformation.ie/en/employment/employment_rights_and_conditions/health_and_safety/safe_pass.html) [Accessed 2 March 2020]
29. Citizens Information. *The Working Week*. Available from:
[https://www.citizensinformation.ie/en/employment/employment rights and conditions/ours of work/working week.html](https://www.citizensinformation.ie/en/employment/employment_rights_and_conditions/ours_of_work/working_week.html) [Accessed on 2 March 2020]
30. Pickett, W., Brison, R. J., Niezgoda, H., Chipman, M. L. (1995). Nonfatal farm injuries in Ontario: A population-based survey. *Accident Analysis & Prevention*, 27(4), 425–433.
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Appendix 1. MTA Inclusion Criteria.

1. Trauma patients: Irrespective of age

2. Who fulfil one of the following lengths of stay (LOS) criteria:

In hospital for >3 days

Admitted to a critical care area (regardless of LOS)

Transferred out for specialist care or repatriation* (total LOS >3days)

Transferred in for specialist care or repatriation* (total LOS >3days)

Deaths (including deaths in ED, even if COD is medical)

*Patients admitted under care of Rehabilitation team only: Not included in TARN

3. AND whose isolated injuries meet one of the following criteria:

	Included	Excluded
Head Injuries	Skull fracture	Scalp injury
	Traumatic haemorrhage	Spontaneous haemorrhage
	Brain contusion	Loss of consciousness
	Brain laceration/penetration	
	Traumatic brain swelling	

	Vascular Injury	
	Nerve injury	
	Diffuse axonal injury (DAI)	
Facial Injuries	Unstable fracture	Skin injuries
	Orbital blow out fracture	Closed/stable fracture/s
	Le fort fracture (I, II or III)	All other eye injuries
	Pan-facial injury	All injuries to ear
	Vascular injury	
	Nerve injury	
	Eye avulsion	
	Traumatic retinal detachment	
	Globe rupture	
Neck injuries	Vascular injuries	Skin injuries
	Organ injury	Nerve injury
	Hyoid fracture	
Thoracic injuries	Vascular injuries	Skin injuries
	Organ injuries	
	Rib fracture/s	
	Flail chest	

	Haemothorax	
	Pneumothorax	
	Haemomediastinum	
	Pneumomediastinum	
	Sternum fracture	
Abdominal injuries	Vascular injuries	Skin injuries
	Organ injuries (contusion, laceration, transection, avulsion, perforation, rupture)	
	Retroperitoneal haemorrhage	
Spinal injuries	Vertebral fracture	Spinal strain
	Vertebral dislocation	Ligament
	Disc injury	
	Nerve root injury	
	Cord injury	
Femoral injuries	Hip fractures: Neck of Femur, Intertrochanteric, Pertrochanteric or Greater trochanteric:	Hip fractures: Neck of Femur, Intertrochanteric, Pertrochanteric or Greater trochanteric:

	Aged <65yrs old	Aged >65yrs old
	Distal or Shaft or Subtrochanteric #: Any age	
	Femoral vessel injury	
	Femoral nerve injury	
Pelvis/acetabulum fractures	Acetabulum fracture	Single pubic rami fracture
	Ischium, sacrum, coccyx or ileum	
	Multiple pubic rami fractures	
	Symphysis pubis joint injury	
	Sacro-iliac joint injury	
	Lateral compression fracture (LC1-LC3)	
	Anterior posterior compression fracture (AP1- AP3)	
	Open book fracture	
	Vertical shear fracture	
	Malgaigne fracture	

UPPER LIMB or LOWER LEG Injuries Excluding hands & feet	Open fracture	Closed fractures &/or dislocation of one limb (even if multiple)
	Total crush injury	All other nerve injuries
	Traumatic amputation	Muscle injury
	Multiple limb fractures &/or dislocations	Tendon injury
	Transected vessels	Ligament injury
	Sciatic nerve injury	Sprain
Hands and feet injuries	Crush of entire Hand (including carpals, metacarpals and phalanges)	Hand or Foot fracture/s
Crush = Total destruction of bones, vessels/nerves & soft tissue	Crush of entire Foot (including tarsals, metatarsals and phalanges)	Crush: Digits alone
	Amputation: entire Hand or entire Foot	Amputation: Digits alone
		All other digit injuries
Burn or inhalation injuries	Full thickness burn (Not treated at Burns unit)	Any burn (Treated at Burns unit)

	>10% TBS burn (Not treated at Burns unit)	Inhalation injury (Treated at Burns unit)
	Inhalation injury (Not treated at Burns unit)	≤10% burn
Other injuries	Electrocution injuries	Bruises
	Full thickness frostbite	Abrasions
	Asphyxia (hanging or strangulation)	Minor skin lacerations
	Drowning	Minor penetrating injuries to skin
	Skin lacerations: Blood loss >20%	Hypothermia
	Penetrating injuries to skin: Blood loss >20%	