

## Cattle-related trauma: a 10-year retrospective cohort study of patients admitted to a single tertiary trauma centre in Switzerland

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### Summary

**AIMS OF THE STUDY:** Switzerland is traditionally an agricultural country with more than 50,000 farms and 1.5 million registered cows. However, contemporary literature on cattle-related trauma in Switzerland remain limited. The purpose of this study was to examine injury patterns and outcomes of patients who presented to a tertiary trauma centre in Switzerland following cattle-related trauma.

**METHODS:** Retrospective single-centre study over a 10-year period (2012–2021) including all patients experiencing cattle-related trauma. From retrieved charts demographics, injury data, and outcomes were collected and subsequently analysed.

**RESULTS:** A total of 94 patients with cattle-related injuries were identified. The median age was 52 years (interquartile range [IQR] 37–63) and 75% were male. Cattle-related injuries were most frequent among farmers (73%) and were most often caused by cows (86%), followed by bulls (10%). Blunt trauma (89%) was the leading mechanism of injury including headbutt (36%), kick (35%), physical contact (20%) and trampling injury (12%). Penetrating injury occurred in 11%, all caused by headbutt. Contusions (82%) and lacerations (45%) were the leading injuries, followed by face fractures (28%), closed head trauma (19%) and chest injuries (17%). Overall, 10% of all patients had a head abbreviated injury scale (AIS) score of  $\geq 3$  and 8% had a chest AIS of  $\geq 3$ . The hospital admission rate was 49% for cow-related injury vs 90% for bull-related injuries,  $p = 0.023$ . Overall, in-hospital mortality was 3% and the median length of stay was 4.5 days (IQR 3–8) among patients admitted to the hospital.

**CONCLUSIONS:** Cattle-related injuries in Switzerland mainly affect farmers and are associated with considerable morbidity, especially when caused by bulls. Facial fractures, head injuries and chest injuries are common, and the latter two in particular can be severe. The results of the present study can be used for the implementation of data-driven prevention measures for the safe handling of cattle in Switzerland.

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### Introduction

Cattle are large, strong animals and unpredictable in their behaviour [1, 2]. Handling cattle is a dangerous activity and injuries associated with cattle pose a serious risk to rural communities [3, 4]. It is well described that farmers in particular are at risk for cattle related injuries in their daily farming activities. The farmers may be trapped, trampled, bitten, or impaled with the horns [1, 5, 6]. In the United Kingdom, there are 4–5 cattle-related deaths per year [7]. In the United States, agriculture is among the industries with the highest number of fatal and non-fatal occupational injuries [3]; of these, 7% were reported in connection with cattle [8, 9]. A recently published systematic review claimed cattle related trauma responsible for more fatal work accidents than any other animal [8].

Most cattle-related injuries occur in farmworkers [10], especially in men under 50 years of age [1, 4, 5]. However, contact with cattle is not limited to farmers: other members of the public may also be at risk if they use public footpaths through farms and walk across pastures with cows and calves [7]. Thus, cattle-related injuries are a public risk and their prevention is in the interest of public health.

Switzerland is traditionally an agricultural country with around 8 million inhabitants. In 2020, there were approximately 50,000 farms and more than 1.5 million cattle registered in Switzerland, i.e., there was one cow per six inhabitants [11]. To our knowledge, there are no studies evaluating cattle-related injuries in Switzerland. Consequently, the aim of this 10-year retrospective cohort study was to close the gap in the literature and give an overview on cattle-related injuries of patients admitted to a tertiary emergency department in Switzerland. In addition, the results may be useful in developing data-driven prevention measures for cattle-related injuries.

### Methods

#### Study design

The present study was conducted at the Department of Emergency Medicine for Adults of the Inselspital, Bern University Hospital, Switzerland – a tertiary trauma centre.

This 10-year retrospective analysis included patients with emergency consultations for cattle-related trauma between 1 July 2012 and 30 June 2021. Our emergency department is located in the Swiss capital with a population of 143,043 (as of 30 June 2020) and a catchment area of about 1 million inhabitants for severe trauma; the capital is surrounded by a rural area with meadows and cows.

All trauma patients admitted to our department are treated according to the principles of Advanced Trauma Life Support (ATLS®).

### Search strategy and eligibility criteria

All medical records of adult patients ( $\geq 16$  years) admitted to our emergency department within the given time period were screened using the following keywords “cattle, cow, bull, horn” coupled with the Boolean operator “OR”. The medical emergency department report of every hit in our computerised database (Ecare, Turnhout, Belgium) was then manually screened to ensure that a cattle-related trauma was present. We included all patients who were admitted after a cattle-related injury.

Exclusion criteria were patients  $< 16$  years, as they are not routinely treated in our emergency department for adults. Patients who refused to give general consent for the use of their anonymised data or subsequently withdrew it were excluded from the study.

### Data collection and extraction

For all patients following cattle-related trauma the following data were extracted:

demographic data such as age, gender, occupation of the injured patient (e.g., farmer, veterinary, other), data on the animal that caused the injury (cow, bull, calf), data on mechanism of injury extracted by the clinical notes and classified into the following groups (head-butt, kick, body contact, trample, others), data on anatomic location and severity of the injury by calculating the abbreviated injury scale (AIS) [12] for each body region and the injury severity score (ISS) [13, 14] for each patient. Severe injury was defined as  $\text{AIS} \geq 3$ , and data on treatment procedures were extracted from discharge notes and operation room reports. The procedures were stratified into the following groups: neurosurgical procedure related to brain (craniectomy, craniotomy, intracranial pressure monitoring), fracture reposition including open reduction internal fixation (ORIF), chest procedures including thoracotomy and chest tube insertion, laparotomy, spinal decompression, vascular procedures, wound closure under local or general anaesthesia. Conservative treatment was considered to be present when no procedure was performed. Data on disposition after emergency department consultation for each patient, and data on outcome parameters including the total hospital length of stay and in-hospital mortality were also collected. In addition, the total costs per case calculated by the coding office were extracted for each patient.

Trauma scoring systems provide a method for quantitative and comparative analysis of injury severity [4]. The injury severity score (ISS) was one of the first trauma scoring systems [13] and is by far the most widely used worldwide [6]. The ISS is calculated based on the abbreviated injury scale (AIS) for clinical classification of anatomical loca-

tion and severity of injury, and combines this information into a single score that correlates predictively with outcome (i.e., mortality) [4]. A threshold  $\text{ISS} \geq 16$  is commonly used to define major trauma [15].

### Statistical analysis

The statistical analysis was performed using SPSS for windows version 25.0 (SPSS Inc, Chicago, IL). For descriptive analysis, the distribution of continuous variables were described as median and interquartile range (IQR) as they were not normally distributed. The distribution of categorical data was reported as numbers and percentages. Mann-Whitney U-test was used to compare medians for continuous variables. Categorical variables were compared using chi-Square test or Fisher's exact test. Fisher's exact test was used when more than 20% of cells had expected frequencies  $< 5$  [16]. Univariate analysis was used to identify differences in baseline and outcome variables between patients who were admitted to the hospital vs patients who were treated as outpatients. Variables with  $p$ -value  $< 0.05$  were considered significant.

### Ethical considerations

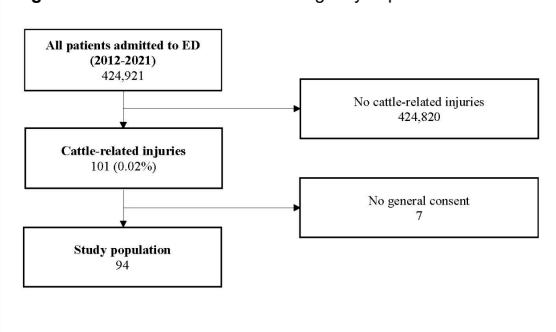
This study has been accepted and approved by the local ethics committee, and informed consent was waived (BE-2021-01949).

### Results

A total of 424,921 trauma patients were admitted to Bern University Hospital between 1 July 2012 and 30 June 2021, of which 101 (0.02%) were cattle-related. After exclusion of 7 patients, who refused general consent, 94 patients with cattle-related trauma remained for final analysis. (fig. 1).

Overall, the median age was 52 years (IQR 37–63) and 75% ( $n = 70$ ) were male. Cattle-related injuries were most common among farmers (73%,  $n = 69$ ) and most often caused by cows (86%,  $n = 81$ ), followed by bulls (10%,  $n = 10$ ) and calves (2%,  $n = 2$ ). Blunt trauma (89%,  $n = 84$ ) was the leading mechanism of injury, including headbutt (36%,  $n = 30$ ), kick (35%,  $n = 29$ ), physical contact (20%,  $n = 17$ ) and trample injury (12%,  $n = 10$ ). Penetrating injury occurred in 11% ( $n = 10$ ), all caused by headbutt. The majority of patients were transported to the hospital by ground ambulance (57%,  $n = 54$ ), followed by self-admission (21%,  $n = 20$ ) and helicopter (21%,  $n = 20$ ). Overall, 43 patients (46%) were transferred in from outside hospi-

**Figure 1:** Patient flowchart. ED: emergency department.



tals (42 patients by ground ambulance and 1 patient by helicopter) (table 1).

Contusions (82%, n = 87) and lacerations (31% superficial, n = 29; 15% deep, n = 14) were the most common injuries after cattle-related accidents, followed by face fractures (28%, n = 26), closed head trauma (19%, n = 18) and chest injuries (17%, n = 16). Following penetrating trauma (n = 10), deep lacerations occurred in 8 cases (80%) and superficial lacerations in 2 cases (20%). The remaining lacerations resulted secondary to blunt trauma (table 2).

All face fractures were associated with a face AIS <3. Eleven patients (12%) had a head AIS of  $\geq 3$ ; eight patients (9%) had a chest AIS of  $\geq 3$ , whereas only three patients (3%) had a severe abdominal injury (abdominal AIS  $\geq 3$ ). All four patients with lower extremity fracture had an AIS of 3. All patients with upper extremity fracture had an AIS <3. All spine injuries were classified as spine AIS <3. One

pelvic fracture was classified as severe (AIS = 3), two pelvic fractures were associated with a pelvic AIS <3.

A combined severe head (head AIS  $\geq 3$ ) and chest trauma (chest AIS  $\geq 3$ ) was present in two patients. One patient had a combined severe chest and extremity trauma (both AIS = 3). All three patients who sustained severe abdominal injuries (abdomen AIS  $\geq 3$ ) did not have associated severe injuries (AIS  $\geq 3$  other than abdomen).

Following the injury distribution, the majority of all patients (63%, n = 59) were minorly injured with an ISS of  $\leq 5$ ; 12% (n = 11) had an ISS of  $\geq 16$ .

In 37% (n = 35), treatment was conservative. Of all procedures, wound closure was initiated most frequently (40%, n = 38), followed by ORIF (28%, n = 26), neurosurgical procedures (6%, n = 6), insertion of a chest tube (3%, n = 3) and laparotomy (2%, n = 2). One patient (1%) required vascular intervention due to a penetrating injury to

**Table 1:**

Baseline characteristics of patients admitted after cattle-related trauma. Values are numbers (percentages) unless indicated otherwise.

		All patients (n = 94)
Demographics	Age, median IQR	52 (37–63)
	– Age >65 years	18 (19%)
	Gender, male	70 (75%)
Occupation of patients	Farmer	69 (73%)
	Veterinary	3 (3%)
	Other	19 (20%)
	Unknown	3 (3%)
Injured by animal	Cow	81 (86%)
	Bull	10 (11%)
	Calf	2 (2%)
	Unknown	1 (1%)
Mechanism of injury	Blunt	84 (89%)
	– Headbutt*	30 (36%)
	– Kick*	29 (35%)
	– Body contact*	17 (20%)
	– Trample*	10 (12%)
	– Others*	3 (4%)
	Penetrating	10 (11%)
	– Headbutt	10 (100%)
Mode of arrival	Ambulance	54 (57%)
	Helicopter	20 (21%)
	Self-admission	20 (21%)
Transferred in from outside hospital		43 (46%)**

\* Percentages exceed 100% due to multiple mechanisms of injury in 5 patients

\*\* † One patient was transferred in by helicopter, the remainder by ambulance

IQR: interquartile range.

**Table 2:**

Injury distribution in patients admitted after cattle-related trauma. Percentages exceed 100% due to multiple injuries per patient. Values are numbers (percentages).

	All patients (n = 94)
Closed head injury	18 (19%)
Face fracture	26 (28%)
Chest injury	16 (17%)
Abdominal injury	4 (4%)
Spine injury	4 (4%)
Pelvic injury	3 (3%)
Upper extremity fracture	7 (7%)
Lower extremity fracture	4 (4%)
Contusion	77 (82%)
Laceration superficial	29 (31%)
Laceration deep*	14 (15%)

\* More than 1 cm deep.

the superficial femoral artery. No thoracotomy was performed. Sixteen patients had ORIF for maxillofacial fractures, six for upper extremity fractures, four for lower extremity fractures. Of the total of six neurosurgical procedures, two patients required a craniotomy to remove intracranial haematoma, one patient underwent reduction of a depressed skull fracture, and three patients required monitoring of the intracranial pressure. The majority of patients (51%) were admitted as inpatients, with a median length of hospital stay of 4.5 days (IQR 3–8). Three patients died, corresponding to an in-hospital mortality of 3%. Two of those were injured by a bull. All three patients were 65 years or older (65 years, 70 years and 75 years) and two of the patients who died had a combined severe head and chest trauma; one patient an isolated severe head trauma. The median cost per case was CHF 3,939 (IQR 860–11,369) (table 3).

Of the patients injured by a bull, inpatient treatment was required in 90% (9 of 10 patients) compared with 49% (38 of 77 patients) injured by a cow,  $p = 0.029$ . Patients who sustained penetrating injuries were more often admitted as inpatients (19% inpatients vs 2% outpatients,  $p = 0.017$ ). Overall, 48 patients were admitted to hospital compared with 42 patients treated as outpatients. Four patients were transferred from our emergency department to outside hospitals and were not included in the outcome analysis. The mean ISS in patients admitted to hospital was 7 (IQR 5–11) compared with 4 (IQR 1–5) in patients treated as outpatients ( $p < 0.001$ ). Conservative treatment was initiated in 26 of 42 outpatients (62%) and in 8 of 48 patients (17%) admitted to the hospital ( $p < 0.001$ ). Cost per case was significantly higher in patients admitted to hospital (CHF 11,241, IQR 5,890–22,974) vs CHF 828, IQR 410–1,384;  $p < 0.001$ ). The in-hospital mortality rate was 6% ( $n = 3$ ) in patients admitted to the hospital (table 4).

## Discussion

In this 10-year retrospective study, 101 of 424,921 trauma patients (0.02%) were admitted for cattle-related injuries. However, the prevalence of cattle-related injuries is likely to be underestimated [4]. In Ireland, for example, it was found that the majority of patients with minor agricultural

injuries (80 %) are treated by the general practitioner [17]. For severe cattle-related injuries, patients are treated in hospital, but often in regional hospitals [4]. Therefore, not all patients with cattle-related trauma are admitted to a tertiary hospital.

In line with the literature, most patients were male farmers in the middle age (median age of 52 years, IQR 37–63, in the present study) [4, 7, 18]. Other studies also described a younger average age: a study from New Zealand found a mean age of 34 years and a Turkish study of 29 years [1, 5]. In the present study, 19% of all patients were over 65 years old. Two other studies found similar data, with 20% and 25% of patients over 65 years of age, respectively [4, 18]. One explanation for this high proportion of injured elderly is that farms are frequently family businesses and farmers often work beyond the average retirement age [19]. An Australian study found that among those over 55 years of age working in agriculture, animal-related deaths were the fourth leading cause of death [20]. Farmers over 75 years of age were even more likely to die on the job and older male farmers with blunt head and chest injuries were identified as the most vulnerable group for livestock-related deaths [19]. In the present study, three fatal accidents related to cattle were recorded. In line with the findings above, all three accidents occurred in patients aged 65 years and older. All of them had a severe traumatic brain injury; two of them also sustained an associated severe chest trauma.

Our study showed that cows were responsible for 86% of all accidents, 11% of the patients were injured by a bull and 2% by calves. A prospective study from New Zealand reported that 90% of farmer injuries were caused by dairy cows and only 3% by beef cattle [1]. Reasons for this are that dairy cows are more likely to be in contact with people, for example during milking, and they are also more possessive of their herd [19]. Based on our data, it was not possible to distinguish between dairy cows and beef cattle. It is known that accidents involving bulls occur less frequently, but are associated with more severe injuries, indicated by greater injury severity, and are more likely to result in death [3, 4, 7]. Our data confirm these findings, as patients injured by a bull had a significantly higher ISS than patients injured by cows. Furthermore, 9 out of 10 patients injured by a bull required hospitalisation and two of the three deaths were caused by bull-related trauma.

**Table 3:** Procedures performed, outcomes and case costs of patients admitted after cattle-related trauma.

		All patients (n = 94)
Conservative treatment		35 (37%)
Wound closure		38 (40%)
Neurosurgical procedure		6 (6%)
Reposition of fracture / ORIF		26 (28%)
Chest tube		3 (3%)
Laparotomy		2 (2%)
Vascular procedures		1 (1%)
Disposition after ED	Home	42 (45%)
	Hospital admission	48 (51%)
	Transfer	4 (4%)
Hospital length of stay*, median (IQR)		4.5 (3-8)
In hospital mortality		3 (3%)
Case costs, median (IQR) (Swiss francs)		3939 (860–11,369)

\* Of 48 patients who were admitted to hospital, reported in days

ED: emergency department; ORIF: open reduction, internal fixation.

Cattle-related injuries can be caused by a variety of mechanisms and vary widely in type and severity [8]. Overall, they result in the most severe injuries caused by animals [1, 4, 5, 18] and can lead to injuries of similar severity as high-velocity trauma caused by motor vehicles [8, 21]. Injuries sustained at higher speeds are commonly associated with head and facial fractures, followed by fractures of the lower limbs, particularly the femur [4, 8]. In this study, the majority of patients suffered blunt trauma: head butts (36%) and kicks (35%) were the most common causes. Trampling was noted in 12%. Penetrating trauma from head butts occurred in 11%. It is important to emphasise that in Switzerland an estimated 73% of dairy cows are dehorned for safety reasons. In Europe, dehorning is practised in 61% of cattle herds [22]. We consider the widespread of cattle dehorning to be an important reason why penetrating injuries do not occur more frequently despite the high number of head butts. A review article cites kicking as the most common cause of injury, followed by pushing and head butting [8]. In the present study, two thirds of patients suffered minor trauma (ISS  $\leq 5$ ) and 12% had severe trauma (ISS  $\geq 16$ ). Apart from contusions and lacerations, which frequently occurred as concomitant injuries, fractures (44%) were the most common injuries, followed by closed head injury (19%) and chest injury (17%). Sheehan and Deasy examined 54 patients admitted with farm animal-related major traumas at the largest university teaching hospital in Ireland. Similar to our findings, limb trauma, blunt chest trauma and head injuries were the most common injuries [18]. A study from the UK including 44 emergency department patients after cattle-related trauma also reported that fractures were the most common primary injury, followed by blunt chest trauma and soft-tissue injury [7]. Similar injury patterns are described in other parts of the world, e.g., New Zealand and Sweden [1, 6]. Distal and extremity injuries are associated with high patient morbidity, where-

as torso and head injuries are responsible for high patient mortality [8].

Half of the patients (51%) evaluated in our emergency department after a cattle-related accident were followed up as inpatients with a median length of stay of 4.5 days (ranging from 3 to 8 days). Thirty-seven percent were treated conservatively, 28% required reduction of a fracture, 3% required an insertion of a chest tube and only 2% needed a laparotomy. A previous retrospective study conducted over a 5-year period at an adult major trauma centre in England, which included only patients directly injured by cattle, found slightly higher rates of admission (70%) and surgery (50%), which may be due to the fact that half of these patients were severely injured with an ISS  $>16$  [7].

In summary, over 70% of all cattle-related injuries treated in our emergency department involved farmers. As a consequence, preventive measures to reduce cattle-related morbidity and mortality should be implemented primarily among farmers. It is important to take preventive measures that target the working environment, on-the-job training and personal protective equipment for farmers [3, 8]. In addition, training and understanding of animal behaviour are critical.

### Strengths and limitations

To our knowledge, this is the first study evaluating cattle-related injuries not only in Switzerland but in all German speaking countries. One strength is the inclusion of all consecutive admissions after cattle-related injuries in a large tertiary trauma centre over a 10-year period. However, this was a retrospective study and was associated with all the inherent limitations of this study design. Consultations with primary care physicians and at smaller rural emergency departments after minor trauma were not included in the analyses. This underestimates the prevalence of cattle-related injuries. As Bern University hospital is a tertiary

**Table 4:**

Comparison of patients treated as outpatient and patients admitted to hospital. Four patients were transferred from our emergency department to outside hospitals and were not considered for this analysis. Pearson chi-square test unless indicated otherwise;.

		Outpatients (n = 42)	Admitted to hospital (n = 48)	p-value
Age, median, IQR		52 (35-57)	52 (39-68)	0.087 <sup>†</sup>
Gender, male		31 (74%)	37 (77%)	0.718
Occupation of patients	Farmer	29 (71%)	38 (79%)	0.574*
	Veterinary	1 (2%)	2 (4%)	
	Other	10 (24%)	7 (15%)	
	Unknown	2 (5%)	1 (2%)	
Injured by animal	Cow	39 (93%)	38 (79%)	0.029*
	Bull	1 (2%)	9 (19%)	
	Calf	2 (5%)	0 (0%)	
	Unkown	0 (0%)	1 (2%)	
Mechanism of injury	Headbutt	13 (31%)	25 (52%)	0.043
	Kick	13 (31%)	15 (31%)	0.976
	Body contact	11 (26%)	5 (10%)	0.051
	Trample	4 (10%)	2 (4%)	0.412*
	Others	1 (2%)	2 (4%)	1.000*
Penetrating***		1 (2%)	9 (19%)	0.017*
ISS, median IQR		4 (1-5)	7 (5-11)	<0.001**
Conservative treatment		26 (62%)	8 (17%)	<0.001
In hospital mortality		–	3 (6%)	
Case costs, median IQR (Swiss francs)		828 (410-1384)	11,241 (5,890-22,974)	<0.001**

\* Fisher's exact test \*\* Mann-Whitney test; \*\*\* all penetrating injury due to headbutt. Values are numbers (percentages) unless indicated otherwise.

IQR: interquartile range; ISS: injury severity score.

trauma centre almost 50% of the patients were transferred in from outside hospitals, which may lead to an additional selection bias. Furthermore, in more than 50% of the cases, no precise description of the circumstances of the accident could be determined from the data. An analysis in this respect could therefore not be performed. Finally, patients who died before hospital admission due to cattle-related trauma could not be considered for this analysis.

### Conclusions

In Switzerland, cattle-related injuries mainly affect male farmers and are associated with considerable morbidity and mortality. Kicking and head butts are the two most common mechanisms leading to trauma. Facial fractures, head injuries and chest injuries are common after cattle-related trauma, and the latter two in particular can be severe. Patients presenting to the emergency department following injuries from cattle, particularly those injured by bulls, should be treated as high velocity trauma. Unlike other professions, there are no standards for safety training in cattle-handling for farmers. The results of the present study can help to formulate data-driven preventive measures for the safe handling of cattle in Switzerland.

### Acknowledgements

Author Contributions: SE, JK, DAJ designed the study. SE, FB, DAJ did the literature search, FB, JK, DAJ carried out data acquisition, FB, DAJ analysed data, SE, DAJ wrote the first draft of the manuscript. All authors contributed to the interpretation of the data and writing of the manuscript and approved the final version of the manuscript.

### Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest was disclosed.

### Financial disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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