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Burns

DOI:
10.1016/j.burns.2024.05.010

E-pub ahead of print: 09/05/2024

Peer reviewed version

burns xxx (xxxx) xxx–xxx

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/burns

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Exploring misclassification of injury intent: A burn register study

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A R T I C L E I N F O

Article history:
Accepted 2 May 2024

Keywords:
Burns
India
Registries
Suicide
Violence
Accidents

A B S T R A C T

Introduction: Burn registers are an important source of surveillance data on injury intent. These data are considered essential to inform prevention activities. In South Asia, intentional burn injuries are thought to disproportionately affect women. Assessment of injury intent is difficult because it is influenced by personal, family, social, and legal sensitivities. This can introduce misclassification into data, and bias analyses. We conducted a descriptive, hypothesis generating study to explore misclassification of injury intent using data from a newly digitised single centre burn register in south India.

Methods: Data from 1st February 2016 to 28th February 2022 were analysed. All patients in the data set were included in the study (n = 1930). Demographic and clinical characteristics for patients are described for each classification of injury intent. All data cleaning and analyses were completed using RStudio.

Results: Injury intent data were missing for 12.6% of cases. It was the most commonly missing variable in the data set. “Accidental” injuries had a similar distribution over time, age, and total body surface area (TBSA) for males and females. “Homicidal” injuries were more common in females. Injuries reported as “Suicidal” affected men and women equally.

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https://doi.org/10.1016/j.burns.2024.05.010

Please cite this article as: E. Bebbington, M. Kakola, S.M. Majgi et al., Exploring misclassification of injury intent: A burn register study, Burns, https://doi.org/10.1016/j.burns.2024.05.010

A decrease in reporting of "Suicidal" injuries in females corresponded to an increase in high TBSA injuries classified as 'Other' or with missing data. Overwriting of injury intent was present in 1.5% of cases. The overwritten group had a greater proportion of females (62.1% vs. 48.5%) and higher median TBSA (77.5% vs. 27.5%) compared to the group where intent was not overwritten.

Conclusion: Our findings indicate that some subgroups, such as females with high TBSA burns, appear to be more likely to be misclassified and should be the focus of future research. They also highlight that quality of surveillance data could be improved by recording of clinical impression, change in patient reported intent, and use of a common data element for intent to standardise data collection. We also recommend that injury intent is recorded as a unique variable and should not be mixed with other elements of injury causation (e.g. mechanism). Although this is a single centre study, the methods will be of interest to those who utilise routinely collected data and wish to reduce misclassification of this important variable.

1. Introduction

Surveillance of the cause of injuries is essential to inform planning, implementation, and evaluation of prevention activities [1]. The International Classification of Diseases external causes of morbidity or mortality chapter offers users multiple codes that can be used to record diagnostic health information about causation of an injury [2]. Codes include: intent (e.g. unintentional, self-harm, interpersonal violence), mechanism (e.g. exposure to excessive heat), activity when injured (e.g. unpaid work), object or substance producing the injury (e.g. cooking appliance), place of occurrence (e.g. home), and alcohol or psychoactive drug use. Intent is recommended as the first level of classification because it is especially useful for subgroup analyses and identifying intervention opportunities. Assessment of injury intent, however, is recognised to be difficult since it is influenced by personal, social, and legal sensitivities [3]. This can introduce misclassification into data, and bias analyses.

Burn injuries are a major source of morbidity and mortality. The Global Burden of Disease study estimates that 16 million burn injuries were of sufficient severity to require medical care worldwide in 2019 [4,5]. Intentional burns due to self-harm or interpersonal violence are a global concern, and often result in poor patient outcomes due to burn severity [6,7]. Successful prevention activities, particularly in high-income countries, have led burn units to experience a shift in case-mix towards smaller burns, but intentional injury remains a common cause of severe burns [8–11]. Almost 500,000 burn injuries due to self-harm and other forms of violence (e.g. assault, conflict and terrorism, executions and police conflict) are believed to have occurred in South Asia in 2019 [4]. This is the highest incidence of any region, but the reliability of these estimates are reduced by limited national injury surveillance data disaggregated by intent [12–14]. Burn injuries due to self-harm are thought to comprise 2% of all burn injuries, and interpersonal violence to comprise 6% of all burn injuries in South Asia [4]. Local hospital-based studies provide broader estimates for the proportion of burns that are intentional in the region. Available data from such sources suggest that 3–26% of burns reported as self-harm, and that 0.5–20% are reported as due to interpersonal violence [15–19].

It is likely that the proportion of intentional burns reported in routinely collected hospital data are an underestimate, particularly for women. One study from India showed 19% of accidental burn injuries in women were later reported to be self-inflicted and 9% to be homicidal when the patients were interviewed by a researcher [20]. Another showed that 62% of burns recorded as accidental or with missing data in medical records were later recorded as suicidal or homicidal in counsellors' records [21]. Females have the highest age-standardised incidence of burn injuries due to self-harm of any region in the world (5.9 per 100,000 population) [4]. South Asia is the only region where females have a higher incidence of unintentional burn injuries then men [4]. It is conceivable that this may be due to misclassification.

Misclassification in data can occur due to misreporting by either the responder (e.g. patient or attender) or the observer (e.g. healthcare professional recording the data). Patients may not feel able to disclose who, if anyone, inflicted the injury due to fear of criminal investigation, stigma, pressure from family members, or because of concerns about the future of their family [22]. Healthcare professionals may not wish to probe the patients' history due insufficient time or concerns about changes to their account affecting legal proceedings [23]. Distribution of the burns or behaviour of the patient and their relatives may lead healthcare professionals to suspect that the reported intent of the burn is inaccurate [24]. A study from Sri Lanka showed that age, sex, and total body surface area of the burn (TBSA) in cases suspected to be intentional closely matched that of burns reported as self-inflicted [24].

The need for improvement of surveillance data on burn injury intent is well recognised. Over a fifth of clinicians involved in the development of the World Health Organization Global Burn Registry believed that data on injury intent was unlikely to be accurate [25]. The development of a risk assessment tool to distinguish between burns that are unintentional, due to self-harm, or due to interpersonal violence has been identified as an area of research need [20,26]. Current epidemiological studies tend to report injury intent as discrete categorical variables (e.g. unintentional, self-harm, interpersonal violence) with little exploration of the data to understand if there may be misclassification. This limits the utility of the data for development of a prediction tool. Current quantitative and qualitative studies from South Asia strongly suggest that females of childbearing age are at risk of self-harm and gender-based violence, and that intentional burns are more likely to result in larger TBSA burns. These are potentially useful variables to investigate when attempting to detect misclassification. The aim of this study was to explore possible misclassification of injury intent in burn register data.

The study objectives were to:

1. Explore patterns of recording of injury intent in burn register data.
2. Explore patient characteristics associated with different categories of recorded injury intent.

2. Methods

We conducted a descriptive, hypothesis generating study to explore possible misclassification of injury intent using data from a newly digitised single centre burn register from a tertiary government burn unit in south India. We explored systematic variations in the recording of intent data and patient characteristics of different categories of intent. This manuscript has been prepared in accordance with the Reporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement (Appendix Table 1) [27].

2.1. *Ethical review*

Ethical approval for the South Asia Self-Harm Initiative register workstreams has been granted by the University of Manchester University Research Ethics Committee (2019–6534-11297, 2021–10049-17533, 2022–10049-22753), JSS Academy of Higher Education and Research Institutional Ethical Committee (JSSMC/IEC/2903/09NCT/2018–19), and Mysore Medical College and Research Institute Ethical Committee (MMC EC 18/19, MMC EC 86/21). This includes approval to utilise routinely collected hospital data for research purposes without additional patient consent.

2.2. *Setting and participants*

A handwritten register of admissions to the burn unit of Krishna Rajendra (KR) Hospital, Mysuru, India has been kept since 2001 for audit purposes. Data from 1st February 2016 to 28th February 2022 were digitised as part of an international research collaboration to improve surveillance data in the region. A detailed description of the digitisation process, including assessment of data quality, has been published [28]. In summary, KR Hospital is a tertiary government teaching hospital with approximately 1800 beds. It is one of four government funded burn units serving the population of Karnataka, which is estimated to be 70 million people [29]. A process mapping exercise completed during the digitisation project revealed that patients requiring inpatient care are recorded in the handwritten burn register, but patients with minor burns treated on a purely outpatient basis are not included. There are a variety of private and charitable hospitals in the same vicinity as KR hospital. Hospitals do not have a defined catchment area and patients can choose where to seek medical care. It is likely that the data set is skewed more towards severe burns and those who cannot afford private care. All participants in the data set were included in this study.

2.3. *Variables and method of assessment*

All variables in the data set were available to investigators. The main variable of interest in this study was injury intent. Discussions with senior healthcare professionals in the burn unit were completed to understand how injury intent is assessed. This information is recorded in the burn register based upon what the patient or family member reports during medicolegal registration in the casualty department. Options include “Accidental”, “Suicidal”, and “Homicidal” *sic*. These are overarching terms that relate to who, if anyone, was responsible for the injury as opposed to the desire of the patient or their assailant to inflict death. If there is doubt about the intent of the injury, then the entry is left blank in the burn register. If the patient changes their reported intent of the injury, then the medicolegal officer in the hospital is contacted and injury intent is changed in the register book. During the digitisation process, it was noted that occasionally injury intent was crossed out and overwritten (Fig. 1). An additional variable was added during digitisation to allow this observation to be recorded as it may reflect the patient changing their reported injury intent.

Injury intent information was recorded in a column in the handwritten register book headed “Diagnosis”. Free text entries in this column included injury causation information and total body surface area of the burn (TBSA). It was noted that other elements of injury causation were sometimes used instead of or in addition to injury intent (e.g. “Old burn”, “Electrical”, “Thermal”, “Inhalational” injury). Discussion with staff revealed that “Electrical” injuries are usually occupational, so it is important not to attribute culpability because the patient may be eligible for compensation. “Old burn” injuries are those in which a patient is readmitted for further care, usually due to infection, so intent is not recorded again because medicolegal processes were followed during the original admission. Other free text causation information (e.g. “Thermal”, “Inhalational” injury) was written

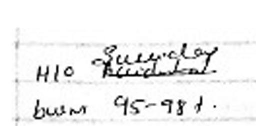

Fig. 1 – Example of overwriting of injury intent in the handwritten burn register. The scan shows that diagnosis of the burn has been changed from “Accidental” to “Suicidal”, and that the burn size is 95–98% total body surface area.

Table 1 – Demographic and injury characteristics according to intent and other categories of causation. Percentages are for columns. Data collection commenced 1st February 2016 and concluded 28th February 2022, so data for 2016 and 2022 does not represent a full year.

	Accidental	Suicidal	Homicidal	Electrical	Old	Other	Missing
Total cases, n	1276	226	33	68	43	41	243
Year of admission, n (%)							
2016	287 (22.5)	78 (34.5)	6 (18.2)	3 (4.4)	10 (23.3)	2 (4.9)	46 (18.9)
2017	203 (15.9)	24 (10.6)	5 (15.2)	12 (17.7)	9 (20.9)	1 (2.4)	53 (21.8)
2018	241 (18.9)	28 (12.4)	6 (18.2)	9 (13.2)	8 (18.6)	0	43 (17.7)
2019	221 (17.3)	45 (19.9)	7 (21.2)	25 (36.8)	10 (23.3)	0	24 (9.9)
2020	122 (9.6)	17 (7.5)	2 (6.1)	13 (19.1)	3 (7.0)	27 (65.9)	36 (14.8)
2021	168 (13.2)	30 (13.3)	7 (21.2)	6 (8.8)	3 (7.0)	10 (24.4)	33 (13.6)
2022	34 (2.7)	4 (1.8)	0	0	0	1 (2.4)	8 (3.3)
Sex, n (%):							
Female	614 (48.1)	121 (53.5)	20 (60.6)	10 (14.7)	29 (67.4)	24 (58.5)	121 (49.8)
Male	630 (49.4)	104 (46.0)	13 (39.4)	56 (82.4)	14 (32.6)	17 (41.5)	117 (48.2)
Missing	32 (2.5)	1 (0.4)	0	2 (2.9)	0	0	5 (2.1)
Age, median (IQR)	28 (8-42)	32 (25-40)	28 (23-33)	29.5 (20.8-35)	34 (26.5-45)	30 (11-45)	26 (10-40)
Missing, n (%)	8 (0.6)	2 (0.9)	0	0	0	0	2 (0.8)
Address district, n (%)							
Chamarajanagar	159 (12.5)	44 (19.5)	5 (15.2)	7 (10.3)	8 (18.6)	4 (9.8)	35 (14.4)
Kodagu	74 (5.8)	6 (2.7)	7 (21.2)	6 (8.8)	3 (7.0)	2 (4.9)	14 (5.8)
Mandya	232 (18.2)	41 (18.1)	8 (24.2)	17 (25.0)	6 (14.0)	11 (26.8)	59 (24.3)
Mysore	760 (59.6)	118 (52.2)	13 (39.4)	36 (52.9)	24 (55.8)	23 (56.1)	122 (50.2)
Missing	10 (0.8)	4 (1.8)	0	0	0	0	0
Income, n (%)							
No income	699 (54.8)	112 (49.6)	15 (45.5)	46 (67.6)	32 (74.4)	12 (29.3)	126 (51.9)
Income	225 (17.6)	65 (28.8)	8 (24.2)	6 (8.8)	3 (7.0)	1 (2.4)	38 (15.6)
Not applicable	218 (17.1)	35 (15.5)	7 (21.2)	7 (10.3)	3 (7.0)	19 (46.3)	55 (22.6)
Missing	134 (10.5)	14 (6.2)	3 (9.1)	9 (13.2)	5 (11.6)	9 (22.0)	24 (9.9)
Multi-casualty, n (%)	123 (9.6)	9 (4.0)	7 (21.2)	2 (2.9)	0	8 (19.5)	33 (13.6)
TBSA, median (IQR)	22.5 (12.5-42.5)	82.5 (57.5-92.5)	55 (26.3-75.0)	12.5 (7.5-19.8)	22.5 (13.8-28.6)	37.5 (22.5-60.0)	27.5 (12.5-57.5)
Missing, n (%)	87 (6.8)	9 (4.0)	1 (3.0)	14 (20.6)	33 (76.7)	2 (4.9)	25 (10.3)
Discharge status, n (%)							
Discharged	845 (66.2)	26 (11.5)	17 (51.5)	50 (73.5)	36 (83.7)	20 (48.8)	137 (56.4)
Death	283 (22.2)	195 (86.3)	14 (42.4)	1 (1.5)	2 (4.7)	18 (43.9)	74 (30.5)
DAMA	107 (8.4)	5 (2.2)	2 (6.1)	9 (13.2)	0	1 (2.4)	26 (10.7)
Transfer	22 (1.7)	0	0	6 (8.8)	4 (9.3)	1 (2.4)	4 (1.7)
Missing	19 (1.5)	0	0	2 (2.9)	1 (2.3)	1 (2.4)	2 (0.8)

particularly from 2020 onwards. We categorised this as 'Other'. A categorical variable for injury causation was created during digitisation. All information was transcribed during the digitisation process.

Other variables of interest include home address district, age, sex *sic*, income, date of admission, TBSA, multiple casualty injury, discharge status, and date of discharge. Additionally, a running total of the number of admissions to the burn unit and to the hospital was available for each patient. Income was recorded in the register as a binary variable (no income or income over 5000 rupees per month). Income was determined using a government issued card shown during inpatient registration. Those with a Ayushman Bharat – Arogya Karnataka Scheme card were considered to be below the poverty line and entitled to free hospital treatment [30]. A multiple casualty event was defined as two or more patients presenting to the hospital from the same address at the same time with a burn injury. More detailed address data (beyond district level detail) will not be reported here because this will be the subject of a separate geographic mapping study.

2.4. *Data access and cleaning*

Investigators had access to the whole database for this study. The number of cases in the burn register during the study period determined the sample size. We created a single variable that included injury intent information. There were 107 instances where a patient had two elements of causation recorded (e.g. "Accidental" and 'Other'). Intent information was prioritised over other elements of causation (e.g. "Electrical", "Old burn", and 'Other'). Intent information was only considered to be missing if no causation information was included in the register. Even though "Electrical", "Old", and 'Other' injuries are not a classification of intent, we report these data because they are sometimes used in the register instead of injury intent. This gives a more accurate representation of the data that were recorded in the handwritten register. Validation parameters were used during digitisation so that no variable could be left unfilled. Non-response codes were used as necessary [28]. Variables with the code 'information not in record' or 'unreadable' were regarded as missing data. The code 'not applicable' meant that the variable had stopped being collected. We report the number of missing and not applicable values for each variable of interest. No data linkage was completed during this study.

2.5. Statistical methods

All data cleaning and analyses were completed using RStudio [31]. Packages included tidyverse, dplyr, ggplot2, readr, lubridate, stringr, and broom. This was an exploratory study designed to guide future areas of research. Consequently, no hypotheses were tested and therefore no statistical tests were applied. We used exploratory data analysis techniques to describe the data. For categorical variables, we report number and percentage for each category of injury causation. For continuous variables with skewed date, we report median and interquartile range. Histograms and density graphs were chosen to explore the underlying distribution of continuous and categorical variables that may influence misclassification of injury intent with particular reference to patient sex. Free y-axis scales were used in panel density plots to allow easier comparison of the distribution patterns of causation groups of different sizes.

3. Results

1930 patients were recorded in the burn register during the study period. We found three patterns in the recording of injury intent data: complete, missing, and overwritten. Injury intent data were missing for 12.6% of cases (Table 1). It was the most commonly missing variable in the data set followed by income (10.3%) and TBSA (8.9%). Complete data were available for 87.4% of cases (Table 1). The most common classification was "Accidental" injury accounting for 66.1% of cases. The number of burn admissions reduced over time (Appendix Fig. 1), and as a proportion of all-cause hospital admissions (Appendix Fig. 2).

There were approximately equal proportion of burns classified as "Accidental", "Suicidal", and with missing data for both sexes (Table 1). "Homicidal" injuries were more common in females, and "Electrical" injuries in males. "Accidental" injuries showed a uniform distribution by sex (Fig. 2). There has been a relative increase in free text entries that relate to 'Other' aspects of injury causation (e.g. thermal injury, inhalational injury) since 2020, particularly for females. This coincides with a greater reduction in classification of "Suicidal" burns in females over the same period.

Median age was similar across all classifications of causation (Table 1). "Accidental" injuries have a bimodal distribution affecting childhood and early adulthood, the peak for males was in childhood, whereas it was in early adulthood for females (Fig. 3). or "Suicidal" injuries, the peak is seen at age 20–30 years for females, but age 30–40 years in males. Missing data for males shows a bimodal age distribution similar to "Accidental" injuries. There are more missing sex data for younger patients with "Accidental" injuries. Spikes in the number of cases are seen at five-year age bands from the age of 30 (Appendix Fig. 3). Discussions with staff revealed that the patient or their attender estimates age to a round number if it is not known.

The districts of Mysore, Chamarajanagar, Kodagu, and Mandya accounted for 95.5% of injuries (Table 1). These districts are closest to KR hospital. There was a uniform distribution of injury classifications from these districts except for Kodagu, where a disproportionate number of "Homicidal" burns occurred in the year 2021.

The majority of patients had no income across all classifications of causation (Table 1). These data stopped being collected in October 2020, but there is an increase in recording of 'no income' from 2018 (Appendix Fig. 4). This corresponds to when there was a change in the hospital billing system to allow those with no income to receive free care if the relevant government issued card is shown during inpatient registration. There was little difference in income across injury causation categories and sex.

"Suicidal" and "Homicidal" burns had the greatest median TBSA of all injury classifications (Table 1). They were particularly skewed towards larger burns in females (Fig. 4). A secondary peak in high TBSA (80–100%) burns was also seen for women with burns classified as 'Other' or with missing data. The greatest proportion of deaths were seen in the "Suicidal" injury group, which was the outcome for 86.3% of patients in this group (Table 1). Spikes in the number of cases are seen at five percent TBSA increments (values ending in '0' or '5'), particularly for cases over 20% TBSA (Appendix Fig. 5). This is likely to be due to rounding by the clinician.

Injury intent data was overwritten in 1.5% of cases (Table 2). The original word was legible for 21 cases (Appendix Table 2). These were from "Accidental" (n = 12) and "Suicidal" (n = 9) groups. The most common change was to "Suicidal", which had proportionally three times more cases than in the data that were not overwritten. Overwriting was more common for females, adults, and patients with larger burns (Table 2). A greater median TBSA was seen in the overwritten group for "Accidental", "Suicidal", and 'Other' burns. The "Accidental" group shows the greatest difference, where median TBSA was 82.5% (IQR 60.0–91.3) compared to 22.5% (IQR 12.5–42.5) for injuries that had not been overwritten. The higher TBSA in the overwritten group is likely to account for the greater proportion of deaths.

4. Discussion

We have shown systematic variations in both the recording of injury intent data, and the characteristics associated with categories of injury intent in a newly digitised burn register from a tertiary government burn unit in south India. Findings highlight ways in which the quality of surveillance data on injury intent could be improved, as well as groups that may include misclassified data and should be the focus of future research. Although this is a single centre study, the methods will be of interest to those who utilise routinely collected data and wish to try to identify misclassification of this important variable.

Injury intent was found to be recorded differently to other variables in the register. It was more likely than any other variable in the data set to be missing, overwritten, or to have

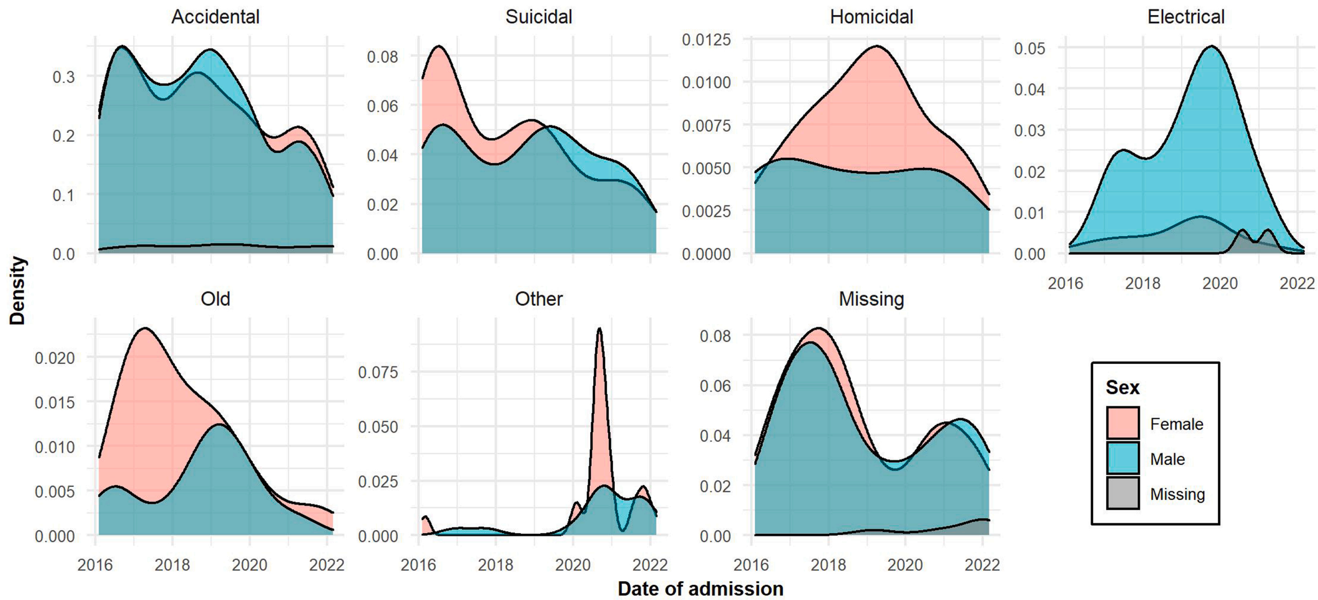

Fig. 2 – Panel of density plots for date of admission subclassified by injury causation and sex. The total area under the smoothed histograms sum to one. Note the y-axis varies between panels and is reflective of the relative size of each group.

other data elements recorded. These findings suggest that it is a problematic variable to complete. Discussion about missing data with staff responsible for completing the register suggested that the field is only left empty if there is doubt about injury intent. Data quality was otherwise good, suggesting that data entrants specifically had difficulty completing the intent variable rather than the entire record. Missing intent data in this register, therefore, could be considered equivalent to a classification of undetermined intent. Previous research has shown that individuals with no recorded injury intent may have burns due to self-harm or interpersonal violence [21]. We found a small secondary peak in high TBSA (80–100%) burns in females, which corresponds to the peak TBSA of "Suicidal" injuries. This may indicate that there is a subset of burns classified as missing that are actually self-inflicted injuries in women. Staff reported that they may suspect an injury is intentional but cannot record it as such unless the patient wishes to change their statement with the medicolegal team. Intent recorded in this register, therefore, is a reflection of what the patient or attender

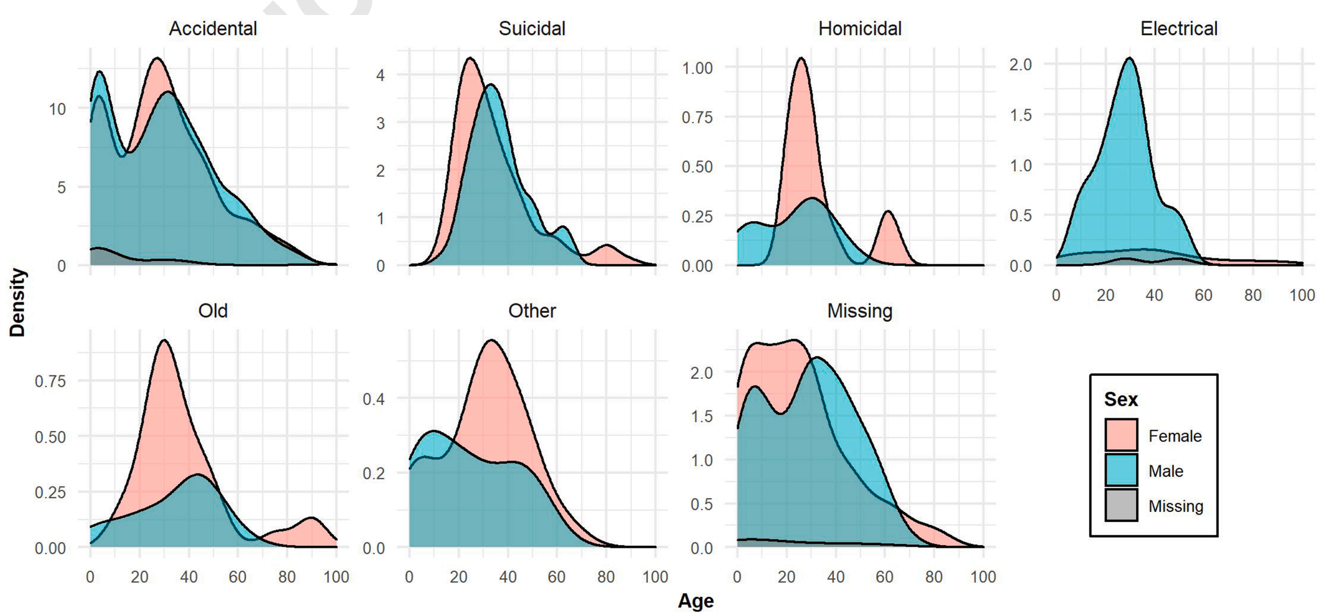

Fig. 3 – Panel of density plots for age subclassified by injury causation and sex.

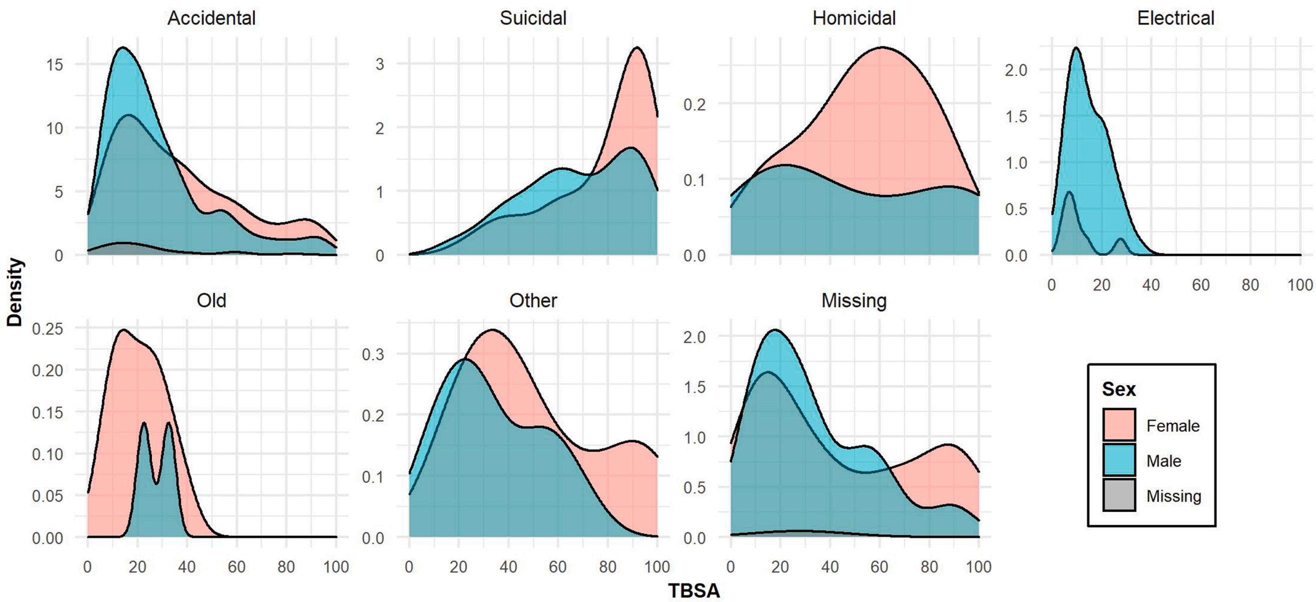

Fig. 4 – Panel of density plots for TBSA subclassified by injury causation and sex.

reports, rather than clinical judgement by a healthcare professional. The Global Burn Registry includes a field to allow the clinician to record their degree of clinical suspicion that an injury of undetermined intent was caused intentionally [25]. Such an approach allows capture of valuable clinical judgement about the intent of an injury in surveillance data, but further qualitative enquiry is required to understand differences in probabilistic judgements of different healthcare professions. If inconsistency was found between the patient reported intent and clinician judgement of intent, then it could indicate misclassification.

A small number of cases were found to have had injury intent overwritten. There was a greater proportion of cases classified as "Suicidal" or "Homicidal" in this group. There was also a larger proportion of females and a higher median TBSA. This is consistent with reports from clinicians and the literature of female patients with large fatal burns sometimes changing their account of the injury prior to death. Such injuries may initially be reported by the woman as accidental due to pressure from their husband or in-laws, but are then changed to suicidal or homicidal once receiving support from their natal family [32]. Although there were a lower proportion of "Accidental" burns in the overwritten group, the TBSA of the "Accidental" burns was similar to "Suicidal" burns. Of the 10 "Accidental" overwritten cases, half were originally reported as "Suicidal" burns. The patient may be motivated to change their reported injury intent from "Suicidal" to "Accidental" in order to avoid police investigation [20]. These findings show that the change in intent data is multi-directional and thus is likely to introduce differential misclassification bias into analyses [33]. Given that a patient must engage with medicolegal processes to change their reported injury intent, and the major differences in characteristics of the overwritten group, it suggests that overwriting is a potentially important predictor variable for misclassification.

Injury intent was the main variable of interest, but it was found that other elements of causation were sometimes recorded instead of, or in combination with, intent. This has been identified in other studies from South Asia and in international burn registers [34,35]. It reflects one of the challenges of accurate and consistent reporting of injury intent in surveillance data, and reduces the comparability of data between studies. A suggested solution to this is the use of common data elements (CDE), which are increasingly being used in multicentre studies to improve data consistency and sharing [36]. CDEs include a variable name, prompt, and set of permissible values. Prior work has shown that there is variation in the collection of burn registry data internationally and that CDEs for burn injuries would benefit from also including a variable definition, response option definitions, and recommended method of measurement [34,35]. A CDE for injury intent was not found when searching the National Institutes of Health CDE repository [37]. Development of a set of CDEs for burn injuries is likely to be of value to the burns community beyond standardisation of intent. It would facilitate a move towards FAIR principles (findability, accessibility, interoperability, and reusability) for all burns data [36]. The European Joint Programme on Rare Diseases recently developed a set of common data elements to be implemented across all rare disease registries in Europe [38,39]. Development of a set of CDEs for a disease registry is typically done using an expert consensus process (e.g. Delphi) [38,40,41]. The process is time-consuming and CDE sets are usually relatively small to enable implementation across all registries [39]. This can be considered akin to a minimum data set. Implementation of a set of CDEs could be done in paper and electronic medical record systems. Paper

Table 2 – Demographic and injury characteristics according to overwriting of intent information.

	Overwritten	Not overwritten
Total cases, n	29	1901
Injury intent/cause, n (%):		
Accidental	10 (34.5)	1266 (66.6)
Suicidal	11 (37.9)	215 (11.3)
Homicidal	4 (13.8)	29 (1.5)
Electrical	3 (10.3)	65 (3.4)
Old	0	43 (2.3)
Other	1 (3.4)	40 (2.1)
Missing	0	243 (12.8)
Year of admission, n (%):		
2016	6 (20.7)	426 (22.4)
2017	2 (6.9)	305 (16.0)
2018	6 (20.7)	329 (17.3)
2019	11 (37.9)	321 (16.9)
2020	2 (6.9)	218 (11.5)
2021	2 (6.9)	255 (13.4)
2022	0	47 (2.5)
Sex, n (%):		
Female	18 (62.1)	921 (48.5)
Male	11 (37.9)	940 (49.5)
Missing	0	40 (2.1)
Age, median (IQR)	35.0 (28.0-45.0)	28.0 (13.0-40.0)
Missing, n (%)	1 (3.5)	11 (0.6)
Address district, n (%):		
Chamarajanagar	5 (17.2)	257 (13.5)
Kodagu	4 (13.8)	108 (5.7)
Mandya	6 (20.7)	368 (19.4)
Mysore	12 (41.4)	1084 (57.0)
Missing	0	14 (0.7)
Income, n (%):		
No income	19 (65.5)	1023 (53.8)
Income	7 (24.1)	339 (17.8)
Not applicable	2 (6.9)	342 (18.0)
Missing	1 (3.5)	197 (10.4)
TBSA, median (IQR)	77.5 (56.3 - 92.5)	27.5 (15.4 - 57.5)
Missing, n (%)	2 (6.9)	169 (8.9)
Discharge status, n (%)		
Discharged	6 (20.7)	1125 (59.2)
Death	19 (65.5)	568 (29.9)
Discharged against medical advice	4 (13.8)	146 (7.7)
Transfer	0	37 (1.9)
Missing	0	25 (1.3)

based registers can then be digitised to a high standard [28], but it is likely to be easier to directly apply validation parameters (i.e. restricted response options for a CDE) in a fully electronic data collection system.

We found that the number of burn admissions for all classifications of intent reduced over time. They also reduced as a proportion of all-cause admissions, which suggests that the number of burn admissions is reducing rather than there being a reduction in the number of patients being treated by the hospital. A downward trend in burn incidence is also seen in international burn data [11,42]. For India this may specifically relate to the removal of subsidies for household kerosene, and government targets for major cities to no longer use kerosene [43]. Kerosene is a commonly used substance for burns due to self-harm and interpersonal violence. This is because it is readily available in the home and remains liquid at room temperature meaning it can be poured or thrown [44,45]. Households increasingly use bottled liquid petroleum gas or piped natural gas, which is likely to further reduce burn injuries [46].

The number of injuries categorised as “Suicidal” was similar for men and women. A greater number of self-inflicted burns might have been expected in women based on the literature and following discussion with clinicians in the burn unit [20,47]. A relative reduction in “Suicidal” injuries in women is seen since 2020, but there is a corresponding increase in documentation of ‘Other’ aspects of injury causation (e.g. thermal injury, inhalational injury). The secondary peak in very high TBSA burns for women in the ‘Other’ classification group is suggestive of self-inflicted injury patterns. This may indicate that there is a subset of burns classified as ‘Other’ in women that are actually self-inflicted. Further gendered patterns were also seen in the data. Injuries for women peaked at childbearing age for all classification groups. This is seen in national data and is thought to be due to cooking responsibilities and risk of gender-based violence when moving into the marital home [23,26,45,48].

There are a number of strengths to this study. It was written in accordance with RECORD guidance for observational studies using routinely collected health data [27]. Although this guidance is aimed at studies using large multicentre databases, high quality single centre registers can still provide useful insights that can influence patient care and policy. It is important, therefore, for single centre burn register studies to consider and report the same criteria to allow readers to fully appraise the strengths and weaknesses of the data set. This study is the first burns study that we are aware of that utilise exploratory techniques to identify possible misclassified groups. These techniques are likely to be of interest to other users of routinely collected burns data. It provides a useful basis for future study and exploratory work to understand which variables cluster together as indicators of misclassification.

There are some limitations to this study. Firstly, we found that age and TBSA were often rounded to five-unit intervals. This is known as digit preference, where continuous data includes visible peaks usually at values that end in zero or five. It is a well-recognised phenomenon for self-reported age (also known as age heaping), and has been found in Indian census data [49,50]. We have not found any previous reports of digit preference in TBSA measurement, but it has been observed in other clinician-reported measurements that have a critical relationship with patient outcomes such as breast cancer diameter [51]. It is unlikely that digit preference affects individual patient outcomes. At a population level it distorts continuous data, which can lead to erroneous conclusions being made about the distribution of variables in a population [50]. It is likely to have introduced misclassification bias into our analyses that utilise age and TBSA data. It will also limit the utility of these data as predictor variables in future studies. Digit preference can be identified relatively easily, but it also givens an indication of the pervasiveness of measurement bias in routinely collected data. The starting point of this study was recognising that misclassification bias is likely to exist in intent data, but that its identification is challenging. The methods demonstrated here are a starting point for improving identification of this, and we hope that this study will encourage others to explore methods to identify misclassification in problematic variables.

Secondly, we had intended to calculate length of stay using date of admission and date of discharge data. It was found that date of discharge could refer to the date of discharge from the hospital or from the burn unit. This meant length of stay could not be interpreted and so was not included in our analyses.

Thirdly, the determination of intent is inherently difficult. There is no gold standard for the determination of injury intent in a hospital setting. The term 'intent' can have different meanings to different groups. In this setting, the terms "Accidental", "Suicidal", and "Homicidal" related to who, if anyone, was responsible for the injury as opposed to the desire of the patient or assailant to cause death. Assessment of who was responsible for an injury is more straightforward than the assessment of thought processes at the time of an injury. We have suggested techniques to potentially improve the reliability of data (e.g. implementation of a CDE) and methods that might indicate misclassification (e.g. overwriting, inconsistent distribution of variables, recording of clinician impression). In combination, this is likely to lead to a probabilistic categorisation, but it is unlikely that the 'true' intent of an injury can ever be known.

We recommend that users of routinely collected burns data consider critically exploring data recording practices for injury intent and explore groups that may be at risk of misclassification. Future research could use more advanced statistical techniques (e.g. latent class analysis) to explore grouping of responses to look for discrete classes that might indicate misclassification. We believe that quality of injury intent data could be improved by recording changes in patient reported injury intent, and the clinicians' impression about the intent of the injury. We recommend that injury intent is coded as a unique variable and should not be mixed with other elements of injury causation (e.g. mechanism). This can be achieved locally by development of a data dictionary that includes definitions for variables, response options, and how variables should be measured or assessed. These can be a used as a guide for staff and those utilising the data. However, to improve reliability and move towards FAIR principles (findability, accessibility, interoperability, and reusability) for all burns data internationally, we believe that is it necessary for the global burns community to unite to develop a set of CDEs that can be used as a minimum data set across all burn registers. We recommend that the data set includes a CDE for intent.

5. Conclusions

Burn registers are an important source of surveillance data on injury intent that informs prevention activities. Understanding likely sources of misclassification bias is essential to understand the limitations of these data, improve data collection techniques, and inform future areas of research. We found that intent data were more likely to be missing and overwritten than other variables. Some subgroups, such as females with high TBSA burns, appear to be more likely to be misclassified. This affects the reliability of a data item that is deemed essential for prevention activities. Although this is a single centre study, it is the first study that we are aware of to explore misclassification bias of burn injury intent. The next step in this work is to use more advanced statistical techniques to explore grouping of responses to look for discrete classes that might indicate misclassification. Data driven techniques to improve assessment of injury intent should not, however, overshadow the global need to improve data collection of injury intent information such as through recording clinician impression, change in patient reported intent, and implementation of a common data element.

Funding

This work was supported by the South Asia Self-Harm Initiative. The South Asia Self-Harm initiative is funded by the Global Challenges Research Fund, UK Research and Innovation. Project number: MR/P028144/2. Principal Investigator: Catherine Robinson.

CRediT authorship contribution statement

MKa had the original idea. MKa, EB, RP, and CR refined the study idea. EB cleaned and analysed the data. All authors reviewed raw and analysed data providing contextual interpretations. EB drafted the manuscript. All authors have been involved in the revision of the manuscript and its final approval.

Declaration of Competing Interest

None.

Acknowledgments

We are grateful to the clinical team at the Burns Unit of Krishna Rajendra Hospital, Mysore, and the rest of the South Asia Self-Harm Initiative project team for their contributions and support with this work. Thank you to the two anonymous reviewers for their helpful comments.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.burns.2024.05.010.

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