EMA Emergency Medicine Australasia

Emergency Medicine Australasia (2020) doi: 10.1111/1742-6723.13604

ORIGINAL RESEARCH

To intubate or not to intubate? Predictors of inhalation injury in burn-injured patients before arrival at the burn centre

Kylie DYSON,[1,2] Paul BAKER,[3] Nicole GARCIA,[3] Anna BRAUN,[3] Myat AUNG,[4] David PILCHER,[4] Karen SMITH,[2] Heather CLELAND[3,5] and Belinda GABBE[1,6]

[1]Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Victoria, Australia, [2]Centre for Research and Evaluation, Ambulance Victoria, Melbourne, Victoria, Australia, [3]Victorian Adult Burns Service, Alfred Hospital, Melbourne, Victoria, Australia, [4]Intensive Care Unit, Alfred Hospital, Melbourne, Victoria, Australia, [5]Central Clinical School, Monash University, Melbourne, Victoria, Australia, and [6]Health Data Research UK, Swansea University Medical School, Swansea, UK

Abstract

Objective: Inhalation injury occurs in approximately 10–20% of burn patients and is associated with increased mortality. There is no clear method of identifying patients at risk of inhalation injury or requiring intubation in the pre-hospital setting. Our objective was to identify pre-burn centre factors associated with inhalation injury confirmed on bronchoscopy, and to develop a prognostic model for inhalation injury.

Methods: We analysed acute admissions from the Victorian Adult Burns Service and Ambulance Victoria electronic patient care records for 1 July 2009 to 30 June 2016. We defined inhalation injury as an Abbreviated Injury Scale of >1 on bronchoscopy. A multivariable logistic regression prediction model was developed based on pre-burn centre factors.

Results: Emergency medical services transported 1148 patients who were admitted to the burn centre. The median age of patients was 39 years and most patients had <10% total body surface area (%TBSA) burned. The prevalence of confirmed inhalation injury was 11%. Increasing %TBSA burned, flame, enclosed space, face burns, hoarse voice, soot in mouth and shortness of breath were predictive of inhalation injury. The model provided excellent discrimination (area under curve 0.87, 95% confidence interval 0.84–0.91). A lower proportion of patients intubated at a non-burn centre had an inhalation injury (33%) compared to patients intubated by emergency medical services (54%) and in the burn centre (58%).

Conclusions: A model to predict inhalation injury in burn-injured patients was developed with excellent discrimination. This model requires prospective testing but could form an integral part of clinician decision-making.

Key words: *burn, endotracheal intubation, inhalation injury, pre-hospital.*

Key findings

- Eleven percent of burn-injured patients in our study had confirmed inhalation injury.
- The mortality rate of patients with inhalation injury was 16%.
- Increasing percentage of total body surface area burned, flame, enclosed space, face burns, hoarse voice, soot in mouth and shortness of breath were predictive of inhalation injury.
- A lower proportion of patients intubated at a non-burn centre had an inhalation injury (33%) compared to patients intubated by EMS (54%) and in the burn centre (58%).

Introduction

Inhalation injury occurs in approximately 10–20% of burn patients and is associated with increased mortality.[1,2] Inhalation injury can cause oedema in the airway and subsequent obstruction. Early identification of inhalation injury enables early intubation to occur, preventing airway occlusion or technically difficult intubation because of oedema.[1,2] Although early intubation can be a lifesaving intervention and is advised for all patients with inhalation injury,[2,3] many patients undergo this high-risk procedure[4,5] unnecessarily, often in an uncontrolled environment by inexperienced intubators.[6–8] More evidence is needed to safely guide clinicians about which patients will benefit from intubation.[7]

Correspondence: Dr Kylie Dyson, Department of Epidemiology and Preventive Medicine, Monash University, 553 St Kilda Road, Melbourne, VIC 3004, Australia. Email: kylie.dyson@monash.edu

Kylie Dyson, PhD, Adjunct Research Fellow; Paul Baker, MBChB, Burn Fellow; Nicole Garcia, MD, Physician; Anna Braun, MD, Physician; Myat Aung, MBBS, Anaesthetic Fellow; David Pilcher, MBBS, Intensivist; Karen Smith, PhD, Director of Centre for Research and Evaluation; Heather Cleland, MBBS, Director of Victorian Adult Burns Service; Belinda Gabbe, PhD, Head of Pre-hospital, Emergency and Trauma Research.

Accepted 22 July 2020

Clinicians often rely on clinical signs, such as hoarse voice or singed nasal hairs, to determine which patients are at risk of inhalation injury. However, none of these signs accurately identify inhalation injury before arrival at the burn centre[3,9–13] and an evidence-based tool for clinician decision support is yet to be developed.[8] Numerous studies have attempted to identify criteria for the early diagnosis of inhalation injury but many of these studies had a small sample size,[14–18] focused on whether the patient was intubated,[14,16] or how quickly the patient was extubated,[6–8,19] rather than an objective diagnostic measure of inhalation injury, such as bronchoscopy.[20] Accurate prediction of the likelihood of inhalation injury in the pre-burn centre setting may assist paramedics and non-burn centre physicians with the early diagnosis of inhalation injury and the decision to intubate.

Our objective was to identify pre-burn centre factors associated with inhalation injury confirmed on bronchoscopy, and to develop a prognostic model for inhalation injury.

Methods

We performed a retrospective analysis of acute ambulance transport and secondary transfers admitted to the Victorian Adult Burns Service (VABS). We examined 7 years of data (1 July 2009–30 June 2016) from the VABS registry to identify pre-burn centre predictors of inhalation injury confirmed on bronchoscopy. To determine symptoms of inhalation injury before arrival at the burn centre, we linked the VABS data with the Ambulance Victoria (AV) electronic patient care records (ePCRs). The present study was approved by the Alfred Hospital Ethics Committee (project number: 232/15).

Study design and setting

The Alfred is the only adult burn centre in the Australian state of Victoria. The catchment area for burns patients covers a geographical area of about 227 500 km^2 and population of 6.5 million.[21] Victoria is serviced by a single emergency medical service (EMS), AV who provide road and air (fixed wing and helicopter) transport of patients. It is a two-tiered service, where intensive care paramedics can perform endotracheal intubation. Intensive care paramedics are authorised to perform endotracheal intubation using rapid sequence induction for patients with suspected airway burns and a Glasgow Coma Scale (GCS) score less than 10, or patients with a GCS ≥10 under consultation with the burn centre ED.[22] Patients with suspected inhalation injury can be intubated either at the scene, at the initial assessing hospital (if not directly admitted to the burn centre) or in the ED at the burn centre.

Data sources

The VABS registry collects information on all patients who are admitted to the Alfred Hospital burn unit. The VABS registry includes data on the characteristics of the burn injury, the treatment provided to patients while in hospital and their admission outcomes. We extracted all patients from the VABS registry who were admitted from the scene of injury or referred from another hospital with a new burn injury. For all patients in this cohort who were admitted to the ICU, or had pre-burn centre intubation we examined their hospital records to determine if a bronchoscopy was performed and where available we recorded the Abbreviated Injury Scale (AIS) severity gradation of inhalation injury (Table S1).

To examine the characteristics of patients before they arrived at the burn centre, we extracted data from the AV ePCRs for both primary transports and secondary transfers. Paramedics record all patient assessments and interventions on a laptop using the Victorian Ambulance Clinical Information System software developed by AV.[23] The ePCRs are uploaded wirelessly and are stored in the AV Clinical Data Warehouse where they can be searched and extracted. The ePCR data is prospectively collected as part of routine service and not audited for quality; however, the Victorian Ambulance Clinical Information System does have minimum requirements for data entry by paramedics. We extracted variables from all ePCRs that could be matched to the VABS cohort for their burn injury event. Paramedics use paper PCRs when the computer is faulty or unavailable and these cases were excluded (estimated <10% of all patient encounters).

Methods and measurements

The degree of inhalation injury was determined using the AIS gradation of inhalation injury ranging from 1 to 5, with 1 corresponding to no evidence of inhalation injury, and 5 corresponding to the most severe form of injury (Table S1). A score of zero means that the bronchoscopy findings were not further specified. The AIS gradation of inhalation injury evaluates the extent of inhalation injury visualised, including mucosal erythema and oedema, blistering, ulceration or bronchorrhea, fibrin casts or evidence of charring. Bronchoscopy is performed within the first 24 h of admission to the burn centre as part of a standardised ICU admission protocol to assess inhalation injury and recorded using a template in the patient's hospital record.

We defined inhalation injury as an AIS severity score of >1 on bronchoscopy. Where the patient was not intubated or bronchoscopy was not performed we considered the patient not to have an inhalation injury. Where a bronchoscopy was performed and the presence or absence of inhalation injury was clearly documented but the score could not be located in the patient notes, we based the presence of inhalation injury on the documentation (n = 5). In addition, for patients who underwent nasal endoscopy, pan-endoscopy or an unknown procedure, and the presence or absence of inhalation injury was clearly documented, we based the presence of inhalation injury on the documentation (n = 10, n = 5 with documented inhalation injury).

The following information was obtained from the VABS registry:

percentage of total body surface area (%TBSA), use of accelerant, enclosed space, flash burn, intentional injury, face/chest/neck burns. The %TBSA burned was used to describe the size of the burn. Use of accelerant was defined as a substance, such as petrol or gas that caused a fire or flash resulting in burn injury. Enclosed space identified incidents that occurred in buildings and vehicles. Flash burn was defined as an incident involving an explosion or flash fire. A burn injury was defined as intentional where it was because of self-harm or assault. The following factors were obtained from the EMS ePCR: mouth burns, mouth/face/neck oedema, hoarse voice, singed nasal hairs, soot in mouth, cough, sore throat, carbonaceous sputum, shortness of breath, stridor, highest respiratory rate greater than 20 and lowest peripheral capillary oxygen saturation less than 92%. We searched the ePCR for documentation of these factors in the secondary survey, vital signs and case description sections.

Analysis

The primary outcome of interest was inhalation injury confirmed on bronchoscopy. Univariate analyses were undertaken to determine the association between each potential predictor variable and inhalation injury. Univariate analysis was performed using χ^2 for categorical variables and the Wilcoxon rank-sum test for continuous variables. Variables demonstrating a P-value <0.25 on univariate analysis were entered into the multivariable model. Cell counts <5 in a predictor category were combined. We performed exploratory analysis of the relationship between continuous predictor variables and the log odds of inhalation injury which led to %TBSA being entered in the model as linear. A P-value <0.05 was considered significant in the model.

The performance of the model was assessed using measures of discrimination and calibration. Calibration was assessed using the Hosmer–Lemeshow statistic and calibration curves to determine how accurately the model predicts over the entire range. Model discrimination was measured using the area under the receiver operating characteristic curve.

The variables considered for inclusion in the model were age, %TBSA burn (continuous), cause of injury (flame/other) and indicator variables (yes/no) for the following: accelerant, enclosed space, flash burn, intentional injury, facial burns, neck burns, chest burns, mouth burns, facial oedema, mouth oedema, hoarse voice, singed nasal hairs, soot in mouth, cough, sore throat, carbonaceous sputum, shortness of breath, respiratory rate >20 and peripheral capillary oxygen saturation <92%. These factors were chosen because they were previously identified in the literature as potential predictors of inhalation injury. Stridor (n = 6) and neck oedema (n = 4) were not considered for inclusion because of small numbers.

Statistical analysis was performed using STATA 14 (StataCorp, College Station, TX, USA).

Results

Characteristics of burn-injured patients

During the study period there were 1599 patients who had an acute admission to the burn centre. Of these, 444 (28%) cases were excluded because the patient was not transported to hospital by EMS or absence of an ePCR. The primary outcome measure of inhalation injury was unknown for three cases and four patients died before a bronchoscopy could be performed, resulting in a final cohort of 1148 (Fig. S1). Bronchoscopy was performed on 252 patients and 10 patients had an equivalent diagnostic procedure. The prevalence of confirmed inhalation injury was 11% (Table 1). A higher proportion of patients with inhalation injury died before discharge from hospital (16% *versus* 2%).

The majority of patients were transported by EMS directly to the burn centre and the remaining patients were transferred from another hospital by EMS (Fig. S2). Air transportation was more frequently used for patients being transferred from non-burn centres than patients who were directly transported to the burn centre (32% *versus* 19%).

Characteristics of intubated patients

Patients were intubated either by EMS (30%), at a non-burn centre (41%) or in the burn centre ED (29%, Table 2). All patients with confirmed inhalation injury were intubated and 54% of intubated patients did not have an inhalation injury. A lower proportion of patients intubated at the non-burn centres had inhalation injury confirmed on bronchoscopy (33%) compared to patients intubated in the burn centre (58%) or by EMS (54%). Less than a third (30%) of intubated patients were extubated within 24 h of admission to ICU, but the proportion of early extubations was higher in the patients intubated at non-burn centres (42%) compared to the EMS (20%) and burn centre (23%) intubations. Most (78%) early extubations did not have an inhalation injury confirmed on bronchoscopy and few patients with inhalation injury confirmed on bronchoscopy were extubated within 24 h in ICU (14%).

Factors associated with inhalation injury

The unadjusted association between pre-burn centre characteristics and inhalation injury are shown in Table 3. Increasing %TBSA burned, flame, enclosed space, face burns, hoarse voice, soot in mouth and shortness of breath were associated with inhalation injury and included in the final model (Table 4). Soot in mouth had the largest effect size resulting in a four-fold increase in the adjusted odds of inhalation injury. Based on the model, the formula for calculating the probability of inhalation injury and an example is shown in Figure 1.

The model provided excellent discrimination (area under the receiver operating characteristic curve 0.87, 95% confidence interval 0.84–0.91) (Table 4). Calibration of the model was acceptable (Hosmer–Lemeshow

TABLE 1. *Characteristics of acute burn injury patients with and without inhalation injury in Victoria, 1 July 2009–30 June 2016*

	Inhalation injury	No inhalation injury	Total†	*P*-value
Number (%)	127 (11)	1021 (89)	1148	
Age (years), median (IQR)	43 (28–59)	39 (26–54)	39 (26–55)	0.034
Male, *n* (%)	97 (76)	768 (75)	865 (75)	0.775
Percent TBSA, *n* (%)				
<10	50 (39)	669 (66)	719 (63)	<0.001
10–20	27 (21)	238 (23)	265 (23)	
>20	50 (39)	114 (11)	164 (14)	
Cause, *n* (%)				
Flame	119 (94)	660 (65)	779 (68)	<0.001
Scald	1 (1)	224 (22)	225 (20)	
Other	7 (6)	137 (13)	144 (13)	
Burn location, *n* (%)				
Facial burns	95 (75)	420 (41)	515 (45)	<0.001
Neck burns	52 (41)	164 (16)	216 (19)	<0.001
Chest burns	44 (35)	157 (15)	201 (18)	<0.001
Endotracheal intubation, *n* (%)	127 (100)	147 (14)	274 (24)	<0.001
Surgery, *n* (%)	85 (67)	692 (68)	777 (68)	0.800
ICU, *n* (%)	125 (98)	224 (22)	349 (30)	<0.001
ICU LOS (h), median (IQR)	137 (55–264)	65 (38–175)	80 (41–216)	<0.001
Vent time (h), median (IQR)	76 (32–201)	30 (15–101)	46 (18–139)	<0.001
Length of stay (days), median (IQR)	14 (7–27)	8 (3–16)	9 (3–17)	<0.001
Discharge disposition, *n* (%)				<0.001
Home	54 (43)	454 (44)	508 (44)	
Hospital in the home	18 (14)	373 (37)	391 (34)	
Rehabilitation	28 (22)	99 (10)	127 (11)	
Died	20 (16)	21 (2)	41 (4)	
Other	7 (6)	73 (7)	80 (7)	

†Seven patients unknown inhalation injury not included in table. IQR, interquartile range; LOS, length of stay; TBSA, total body surface area.

statistic $\chi^2 = 8.24$, $P = 0.41$). The calibration curve shows good calibration in the lower and middle areas of the curve with the upper end of the curve diverging from the line of best fit indicating poorer calibration in this area (Fig. S3).

Discussion

This is the first study to develop a prediction model based on pre-burn centre predictors of inhalation injury confirmed on bronchoscopy. Factors predictive of inhalation injury in the study population included %TBSA burn, flame, enclosed space, face burns, hoarse voice, soot in mouth and shortness of breath. This new knowledge will aid clinicians in decision making but this model still requires external validation and refinement to confirm performance before it can be recommended for widespread use.

The findings of our study show consistency with previous studies which found an association between inhalation injury and %TBSA burned,[16,24–26] flame,[26] enclosed space,[15,27] face burns,[14,16,26] hoarse voice,[16] soot in mouth[14] and shortness of breath.[16] Despite often being cited as a sign to look for, we did not find singed nasal hairs to be associated with inhalation injury. This lack of association is supported by other studies[16,17] and could be considered for removal from guidelines.

TABLE 2. *Characteristics and outcomes of all patients receiving endotracheal intubation in Victoria, 1 July 2009–30 June 2016†*

	EMS	Non-burn centre	Burn centre	Total
Number (%)	82 (30)	113 (41)	79 (29)	274
View of larynx, *n* (%)				
CL 1	47 (57)	70 (62)	48 (61)	165 (60)
CL 2	20 (24)	6 (5)	5 (6)	31 (11)
CL 3	7 (9)	22 (19)	15 (19)	44 (16)
CL 4	6 (7)	1 (1)	1 (1)	8 (3)
AFOI	0 (0)	2 (2)	1 (1)	3 (1)
Unknown	2 (2)	12 (11)	9 (11)	23 (8)
LOS (days), median (IQR)	18 (7–32)	10 (4–17)	19 (8–38)	13 (6–27)
ICU, *n* (%)	80 (98)	110 (97)	79 (100)	269 (98)
ICU LOS (h), median (IQR)	144 (49–277)	65 (38–110)	154 (60–322)	94 (43–247)
Ventilated in ICU, *n* (%)	78 (95)	110 (97)	78 (99)	266 (97)
Vent time (h), median (IQR)	84 (20–183)	27 (13–58)	81 (27–223)	45 (17–138)
Extubation <24 h,‡ *n* (%)	16 (20)	47 (42)	18 (23)	81 (30)
Mortality, *n* (%)	14 (17)	5 (4)	5 (6)	24 (9)
Bronchoscopy score, median (IQR)	2 (1–3)	1 (0–2)	2 (1–3)	1 (1–2)
0, *n* (%)	10 (12)	30 (27)	16 (20)	56 (20)
1, *n* (%)	20 (24)	40 (35)	12 (15)	72 (26)
2, *n* (%)	24 (29)	24 (21)	22 (28)	70 (26)
3, *n* (%)	15 (18)	8 (7)	14 (18)	37 (14)
4, *n* (%)	5 (6)	1 (1)	4 (5)	10 (4)
5, *n* (%)	0 (0)	1 (1)	1 (1)	2 (1)
Unknown score, *n* (%)	0 (0)	3 (3)	2 (3)	5 (2)
Bronchoscopy alternative, *n* (%)	2 (2)	3 (3)	5 (6)	10 (4)
Bronchoscopy not performed, *n* (%)	6 (7)	3 (3)	3 (4)	12 (4)
Inhalation injury, *n* (%)				
Yes	44 (54)	37 (33)	46 (58)	127 (46)
No	38 (46)	76 (67)	33 (42)	147 (54)

†Excludes patients with unknown inhalation injury. For all patients in this table with unknown bronchoscopy score and bronchoscopy alternative it was clearly documented that patient did or did not have an inhalation injury. ‡Less than 24 h of ventilation in ICU. Excludes deaths within 24 h. AFOI, awake fibre-optic intubation; CL, Cormack–Lehane score; IQR, interquartile range; LOS, length of stay.

A low threshold for intubation of the burn-injured patient is often encouraged because of the chance that the airway could occlude or intubation could become very difficult because of increasing oedema. However, this risk must be balanced with the risk of procedure-related complications and increased resource use, including unnecessary inter-hospital transfers and time in the ICU. Several studies have been initiated because of a belief that many pre-burn centre intubations are 'unnecessary'[6,7,19] and these 'unnecessary' intubations are performed by EMS.[6,19] However, we found that patients intubated by EMS and in the burn centre ED had similar rates of inhalation injury and early extubation. In contrast, the prevalence of inhalation injury was lowest, and rate of early extubation was highest, among patients intubated at non-burn centres. Many of the EMS intubations were performed after consultation with the burn centre

TABLE 3. *Pre-burn centre characteristics of patients with and without inhalation injury in Victoria, 1 July 2009–30 June 2016*

	Inhalation injury	No inhalation injury	Total†	*P*-value
Number (%)	127 (11)	1021 (89)	1148	
Percent TBSA, *n* (%)				
<10	50 (39)	669 (66)	719 (63)	<0.001
10–20	27 (21)	238 (23)	265 (23)	
>20	50 (39)	114 (11)	164 (14)	
Cause, *n* (%)				
Flame	119 (94)	660 (65)	779 (68)	<0.001
Scald	1 (1)	224 (22)	225 (20)	
Other	7 (6)	137 (13)	144 (13)	
Accelerant, *n* (%)	71 (56)	472 (46)	543 (47)	0.005
Enclosed space, *n* (%)	54 (43)	118 (12)	172 (15)	<0.001
Flash burn, *n* (%)	76 (60)	495 (48)	571 (50)	<0.001
Intentional injury, *n* (%)	24 (19)	81 (8)	105 (9)	<0.001
Burn location, *n* (%)				
Facial	65 (51)	346 (34)	411 (36)	<0.001
Neck	28 (22)	143 (14)	171 (15)	0.020
Chest	30 (24)	177 (17)	207 (18)	0.096
Mouth	27 (21)	80 (8)	107 (9)	<0.001
Oedema, *n* (%)				
Face	8 (6)	28 (3)	36 (3)	0.034
Neck	2 (2)	2 (0)	4 (0)	0.014
Mouth	16 (13)	23 (2)	39 (3)	<0.001
Hoarse voice, *n* (%)	26 (20)	36 (4)	62 (5)	<0.001
Singed nasal hair, *n* (%)	27 (21)	75 (7)	102 (9)	<0.001
Soot in mouth, *n* (%)	53 (42)	51 (5)	104 (9)	<0.001
Cough, *n* (%)	13 (10)	21 (2)	34 (3)	<0.001
Sore throat, *n* (%)	12 (9)	25 (2)	37 (3)	<0.001
Carbonaceous sputum, *n* (%)	9 (7)	8 (1)	17 (1)	<0.001
Shortness of breath, *n* (%)	22 (17)	35 (3)	57 (5)	<0.001
Stridor, *n* (%)	3 (2)	3 (0)	6 (1)	0.003
Tachypnoea (RR >20), *n* (%)	54 (43)	239 (23)	293 (26)	<0.001
Hypoxia (SpO_2 <92%), *n* (%)	18 (14)	41 (4)	59 (5)	<0.001

†Seven patients unknown inhalation injury not included in table. RR, respiratory rate; TBSA, total body surface area.

ED, indicating that non-burn centre physicians may benefit from consulting the burn centre ED before intubating patients with suspected inhalation injury to avoid over-triage.

Eleven percent of burn-injured patients in our study had confirmed inhalation injury compared to other studies which vary between 7% and 20%.[24,25,28,29] These differences may be due to differences in the inclusion criteria or how burn care is coordinated. In line with other studies, a greater proportion of patients with an inhalation injury died compared to patients without an inhalation injury.[24,25,29] However, the mortality rate of patients with inhalation injury (16%) was lower than other studies, which ranged from 18% to 35%.[1,24,25,29]

Limitations

For our analysis of pre-burn centre predictors of inhalation injury, we included factors documented on the

TABLE 4. *Final multivariable model†*

	Adjusted odds of inhalation injury (95% confidence interval)	*P*-value
Per cent TBSA	1.05 (1.03–1.06)	<0.001
Flame	2.66 (1.14–6.20)	0.024
Enclosed space	2.98 (1.71–5.20)	<0.001
Face burns	2.24 (1.35–3.74)	0.002
Hoarse voice	3.40 (1.61–7.19)	0.001
Soot in mouth	4.34 (2.32–8.14)	0.020
Shortness of breath	2.27 (1.13–6.54)	0.025
Constant	0.01 (0.00–0.01)	<0.001

†C-statistic 0.87 (95% confidence interval 0.84–0.91), Hosmer–Lemeshow statistic $\chi^2 = 8.24$, $P = 0.410$. TBSA, total body surface area.

Predicted risk of inhalation injury = exp(z)/1 + exp(z)

Where z = -4.760944 + 0.0462661 (per cent TBSA) + 0.9768775 (flame) + 1.092459 (enclosed space) + 0.8078726 (face burns) + 1.224117 (hoarse) + 1.468162 (soot) + 1.001516 (shortness of breath)

Example of use of predictor tool

1) A patient presents with 15% TBSA burned including facial burns that was caused by flame. Based on the formula above, the prediction of likelihood of inhalation injury equals 9%.

2) If this same patient was in an enclosed space when the burn occurred the likelihood of inhalation injury increases to 23%.

3) If the same patient is also presenting with a hoarse voice and soot in their mouth the likelihood of inhalation injury increases to 82%.

Figure 1. *An example of the use of predictive factors to develop a formula for calculating the probability of inhalation injury.*

EMS ePCR; however, there may be other unknown or unmeasured factors, such as those documented at the non-burn centre. Also, this was a single-centre retrospective study so the findings of the present study need to be validated prospectively and externally. The model is not sufficiently validated for a predictive algorithm. Our findings may not apply to settings without highly centralised burn care in a large geographic area.

Patients may have been intubated for reasons other than inhalation injury but we did not have the data to identify reasons for intubation. Other reasons could include pain control or safety in long aeromedical transfers as the VABS covers a geographical catchment area of about 227 500 km^2. We were not able to discern non-resuscitative intubations that required long transfers. In addition, we were not able to collect data on any complications arising from intubation. We were not able to accurately determine which patients were not transported by EMS and which patients had a missing EMS ePCR. Based on previous work we estimate this to be less than 10%.

Conclusions

A model to predict inhalation injury in burn-injured patients was developed with excellent discrimination. This model requires prospective testing but could form an integral part of clinician decision-making in regards to pre-burn centre intubation and referral decisions based on suspected inhalation injury alone.

Acknowledgement

BG was supported by an Australian Research Council Future Fellowship (FT170100048) during the preparation of this manuscript.

Competing interests

None declared.

Data availability statement

The data that support the findings of this study are available from the Victorian Adult Burns Service and Ambulance Victoria. Restrictions apply to the availability of these data.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Figure S1. Flowchart of inhalation injury diagnosis for patients admitted to the Victorian Adult Burn Service 1 July 2009 to 20 June 2016.
Figure S2. Transport route of patients admitted to the Victorian Adult Burn Service 1 July 2009 to 20 June 2016.
Figure S3. Calibration curve for the model.
Table S1. Abbreviated Injury Scale grading scale for inhalation injury on bronchoscopy.