The efficacy of using pH levels as a predictor of mortality in burn patients with inhalation injury

Mohammad AlShorman MD*,Mohammad Ismail MD**,NabeelaTawalbeh MD,Ahmad Alsmadi MD*,Haneen Saleh RN+,Dala Omari ++***

ABSTRACT

Introduction: Burns are traumatic injuries, with complex nature. An Inhalation injury is defined as toxic exposure to vapours, gases, liquids, or even solid material through the respiratory tract. Inhalation injury can be a complicating factor in burns, acidosis is predicted with major trauma, yet it's effect on mortality needs further investigation.

Objective: Observing trends and investigating mortality in burns with inhalation injury, evaluate the relation between serum pH and mortality in patients with inhalation injury.

Method: A cross-sectional retrospective data analysis of patients admitted to the burn unit from January 2018 to December 2021. Data collected includes diagnosis of inhalation, age, gender, total body surface area, length of stay, and baseline arterial blood gases. The data was analysed using descriptive and inferential statistics.

Results: A total of 428 records of patient data was retrieved, which showed that 48.8% suffered from direct flame burns and 45.5% from scald burns. The mean age was 18.7±20.2. The average stay was 12.8 days, 24.5% had inhalation injury, and 70.4% of the inhalation injury cases required mechanical ventilation. The first collected and reported serum pH was correlated with the mortality of burn patient with inhalation injury using ROC curve established pH Of 7.32 at a sensitivity of 90%, and specificity 78% to mortality, AUC 0.89 and OR of twice the normal ph.

Conclusion: Acidosis is linked to a higher mortality rate among inhalation injury patients and, thus, can be used as a predictor of mortality.

Keywords: burn inhalation injury, predictor of burn mortality, acidosis

JRMS August 2024; 31 (2): 10.12816/0061995

Introduction

Burns are traumatic injuries that can occur at any setting at any time, whether domestic, industrial, occupational, indoors, or outdoors. According to the World Health Organization, burns affect approximately 30,000 people per day globally. They are responsible for an annual death rate of nearly 270,000 (1,2). In Jordan, the burn mortality rate reached 14.6% (3). The pathophysiology of burn inhalation injury is complex syndrome, it exerted effect from the injury to the localized tissue and overall circulation is catastrophic; and leads to higher morbidity and mortality of the affected patient (1).

From the departments of:
*plastic reconstructive surgery.
** Anesthesia department.
***ENT department.
+Registered Nurse, burn care unit at royal rehabilitation center.
++Radiology department.
Correspondence should be addressed to: Dr. Mohammad AlShorman. Email: dr.alirimawi@gmail.com

Submission date: 30 August. 2022, Acceptance date: 18 May. 2023, Publication date: August,2024
Smoke inhalation and toxic materials can directly affect the pulmonary epithelium or as secondary effect to the pathological process, causing various degrees of damage to the respiratory tract, inhalation injuries account for 70% of the respiratory complications (4). Inhalation injuries associated with burns may complicate burn management. Smoke inhalation injury is considered an independent mortality risk factor in burns, increasing the predicted mortality by 1.5 folds.(5) The pathophysiology of the injury starts with irritation and progressive inflammatory response, leading to pulmonary shunting and may continue to hypoxic respiratory failure, in severe cases (6). The progressive deterioration of respiratory functions over a short period of time is associated with increased oxygen demand, reduction in oxygen-carrying capacity, and systemic inflammatory response; causing escalation in the pre-existing burn related inflammation, and aiding the progression of acidosis (7). More than 10%–20% of hospital-admitted burn patients are diagnosed with inhalation injuries (8). While burn injury is diagnosed and managed under rigorous therapeutic protocols; that are intensively studied, inhalation management is still obscure, with few concrete diagnostic criteria (9).

Acidosis; reduced serum pH, is a condition directly linked to the pathology of burn injury; especially during the acute face of injury (lactate accumulation) (4). The predictive value of acidosis in burn patients was never reported although being reported in general trauma setting (10). Lactic acidosis related to burn injury requires serum lactate results for definitive diagnosis, but the process of serum lactate level sampling can be demanding and susceptible to many vulnerabilities. Also, a high margin of error makes the samples difficult to obtain in emergency burn care setting (11,12).

Vulnerability encountered with lactate sampling, drew attention to pH as a more convenient alternative. In the effort to set a critical pH level to direct treatment.

The objectives of this research are as follows:

1. We aimed to gain perspective of inhalation injury, evaluation criteria, and investigate current management outcomes (Mortality as a key performance indicator) of burn-associated inhalation injury in Jordanian Royal Medical Services.
2. Determine the pH levels of first collected arterial blood gases (ABGs) sample as a predictor of mortality.

Methods

In this retrospective cross-sectional study, we reviewed the medical records of patients admitted to the burns unit of the Royal Jordanian Rehabilitation Centre (RJRC), over a 4 -year-period, from January 2018 up to December 2021. Our burns unit is a referral unit that covers all Jordanian medical Services Hospitals. With an annual admission rate of 99 patients (3). Only patients with the diagnosis of scald burn or direct flame burn (DFB) were included. The Institutional Review Board's consent was obtained (Human Research Ethics Committee, Royal Medical Services, Amman, Jordan, Ref. 5/2022) prior to data collection.

The data obtained through opportunity sampling retrieved all burn patient's electronic and paper records are kept confidential, data access was limited to the research team and for research purposes only.

A total of 428 cases in 427patients admitted to the burn unit were included in the study. The data extracted included the demographic information, cause and type of burns, total body surface area (TBSA) affected, location of burn (face as a main concern), inhalation injury status, mechanical ventilation requirements, and first encounter sampled blood gas analysis result for serum pH, PCO2. And PO2 levels obtained prior to initiation of fluid resuscitation protocol in all patients with suspected inhalation injury (scald and direct flame), results reported as early as the emergency department samples were considered. method of diagnosis, and course of patient management denoted by requirements of advanced air-way in the burn unit was obtained and followed, outcome measure was mortality. The data analysis and description was done using Microsoft Excel 2010. Statistics included central tendency measures, frequency dispersion, and ROC curve, binary logistic regression with adjusted odds ratio, value set < 5% consider statistically significant.

Results

The convenience sampling over the period of January 2018 to December 2021 revealed a total 466 patients admitted to the burn unit. Twelve patients with non-burn cause of admission, Twenty-six had insufficient data to meet research requirements or were readmitted due to the same burn incident during the time range concerned (infection as most common cause of readmission; 57%) and were thus excluded as well. One mortality case of natural causes in a home setting post-discharge was omitted as a mortality incident, 428 cases in 427 patient data collected (one paediatric patient suffered two different incidents of burn)

Patients were distributed as 48.8% suffered from direct flame burns (DFBs) and 45.5% had scald-related injury. The remaining 5.7% of patients suffered from various types of burns with friction-related, chemical, and electrical factors.

The age of the patients ranged from 28 days to 93 years old, with an average age of 18.7±20.24 years, mean of error in age equals 0.97 trimmed with exclusion of extremes to 21±19.9 years and the mode at 2 years of age. The male to female ratio was 1.54:1. The length of stay ranged from 2 hours to 450 days of hospitalization and averaged 12.8 ±27.8, 74 cases admitted 17.3% had 1 day stay, TBSA was 1%–98% with an average of 18.11±19.2%,, standard error of mean 0.91 the mortality rate per admission was reported at 12.1%. Table I contains descriptive data of the burn patients.

Table I patients' burn data

Variable	Category	Frequency	%
Cause of burb	DFB	209	48.8
	Scald	195	45.5
	Friction	3	0.7
	Electric	7	1.6
	chemical	6	1.4
	Contact	8	1.8
Gender	Male	260	60.7
	Female	168	39.2

Variable	Range	Mean	Mood	SD	Mean of errors
TBSA	1%–98%	18.11	10	±19.2	0.91
Age	28 days - 93	18.7	2 years	±20.24	0.97
Length of stay	2 hours to 450	12.8	1 day	±27.8	1.34

Inhalation injury was diagnosed and documented in 105 cases of patients admitted (24.5%). The inhalation injury demographics were as follows: male to female ratio of 1.5:1, age range of 28 days to 60 years, mean age of 32.28 years, and average TBSA of 36.42% at a range of 3%–98%.

The diagnosis with inhalation injury was primarily associated with the history of closed area burns in 80.9% of the cases, facial involvement in the burn with inhalation 75.2% of the cases. Clinical presentation physical exam, horsiness of voice, burned nasal and oral mucosa, cough and deteriorated oxygen saturation reported by pulse oximeter and ABGs were used for diagnosis. Among patients diagnosed with inhalation injury ; 49.5% passed away, 70.4% required definitive airway and mechanical ventilation on day zero (immediately after recognition and diagnosis), and 0.952% required artificial ventilation after 24 hours of the diagnosis .

As a result 44.8% of the patients presented with hypoxemic blood changes on the ABGs; (A result of PaO_2 < 80mmHg and /or SaO_2 < 93% was conserered hypoxemia), 36.7% had hypercapnic changes($PaCO_2$ >45), 57% had hypocapnia ($PaCO_2$ >45),49.52% suffered from metabolic, or respiratory acidosis, 20% showed alkalotic change in pH, and 30.4% retained normal primary pH levels Table II.

Table II: descriptive data of inhalational injury.

Variable	Category	Frequency	%
Cause of burb	DFB	103	98
	Scald	2	2
Gender	Male	63	60.

	Female	42	40
Burn location	Facial burns	79	75.2
Conditions	Closed area	85	80.9
Inhalation status	Requires mechanical ventilation day 0	74	70.4
	No mechanical ventilation required	31	29.5
pH.	Acidosis	52	49.5
	Normal	32	30.47
	Alkalosis	21	20

Variable	Range	Mean	Mood	SD	Mean of errors
TBSA	3%–98%	36.4	12	±26.4	2.58
Age	28 days to 60 years	32.28	29	±20.43	1.99
Length of stay	2hrs- 228	17.7	1	±28.2	2.75

Individuals diagnosed with inhalation injury were distributed according to baseline ABGs into three groups, presuming that blood pH levels of 7.35–7.45 were normal. The first group had normal pH levels, the second showed alkalosis; pH of > 7.45, and the third had acidosis; pH< 7.35. Making 3 independent variable categorical set of data available for compression with a binary dependent variable, Each patient was assigned to 0–1 according to mortality (death and survival) to investigate mortality rates among groups.

To investigate the predictors (Age, TBSA, Gender , Facial Burn, pH and Closed area) that have an association with patient's mortality the binary logistic regression revealed that Age and gender were not a significant predictors for a patient's mortality (p>0.05).

Moreover the odds of patient mortality would increase by 1.1 times for one additional percentage of TBSA (p <0.001), additionally the odds of patient's mortality are 4.6 and 5.5 times more likely to increase among those having facial burns and burns in closed area (p=0.006, p= 0.003) respectively, Lastly, the pH Levels have shown significant prediction for mortality; the acidic patients are twice to death than those having normal pH level (OR =2.04, p< 0.001), and the alkalosis patients are 1.16 times more likely to death than those having normal pH (p=0.006). Table III summarizes binary logistic regression analysis for contributing variables.

Table III: Contributing variables for patient mortality

	Coefficients	Standard Error	P-value	Odd Ratio
Age	0.002	0.0120	0.888	1.002
TBSA	0.075	0.0154	**< 0.001**	1.078
Gender/ female	0.372	0.512	0.467	1.451
Facial burn/ yes	1.528	0.551	**0.006**	4.601
Closed area / yes	1.747	0.593	**0.003**	5.537
Acid	0.718	0.176	**< 0.001**	2.049
base	0.150	0.148	**0.006**	1.161
Normal	Reference			1

A receiver operating characteristic curve (ROC curve) used to illustrate diagnostic capacities of pH relationship with mortality AUC was used as a metric evaluation of logistic regression; result was =0.8966 attributing good quality of discrimination and at a cut-off point to maximize diagnostic value to max sensitivity at 0.90, and specificity.78 reflecting a pH of 7.32 acidic interpretation, referee to the diagram Figure (1), appendix A contains the data points and graphical illustrations of data.

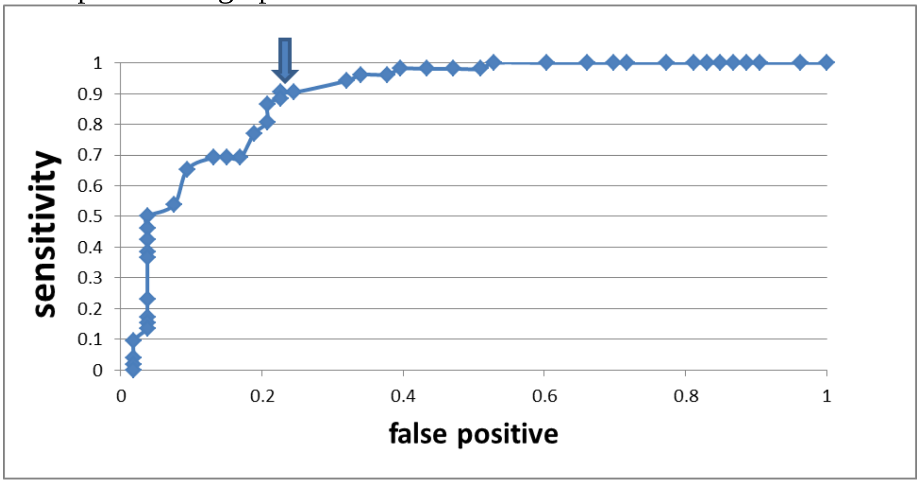

Figure (1) The ROC curve of the association

Discussion

The most common type of burn injury in different settings reported in the United States, Britain, India, and Jordan is DFB, This is followed by scald burn. This study resembled results and reported that DFB was responsible for 48.8% of the injuries (3, 13-15). In the United Kingdom, 60% of the patients were 15–64 years old, 10%≥ 65 years, ages of patients reached 99 compared to mean age in this study was 18.7 and ranged1-93 which lies the same age limits of the British study (13), but the mode age was 2 years, Plotting the distribution direction to a paediatric age group, This is common in less privileged countries, such as India and Iran (16–19).

A mortality rate of 12.1% was reported in this study. This is 6.5 % higher than the 5.6% fatality rate in the United States as presented by the American National Burn Repository report (20), and 5% in Brazil(21), 2.5 % lower than 14.6%, about 15% in a previous study in Jordan, the difference in both sample sizes, the conditions surrounding each study, especially the war time in the area in the previous study might had influence on the results, but still this was considered an indicator of progress, considering therapeutic protocols had no changes in both studies, and the reported inhalation in the previous was 23.9% compared to 24.5% in this study (3).

Inhalation injury is toxic exposure to vapours, gases, liquids, or solid material through the respiratory tract, The irritant material causes damage and symptoms most commonly related to the upper respiratory system.(4) The burn process can be worsened by the inhalation of toxic materials, like carbon monoxide, a toxin that significantly increases systems damage and mortality (22). Inhalation injury is presumed to increase expected mortality rates from burn injuries 20-fold (23). Inhalation incidence at 15.7% was seen in a US-based study (24) The inhalation-related mortality rate was set at 31% compared to 6% in the group with no inhalation injury; that's a five-fold increase (25). The reported mortality rate in the current investigation was 12.1%, at total, was magnified by 4-folds to reach 49.5% in cases of inhalation injury in the patients. In addition 70.4% of the sample required definitive airway and mechanical ventilation (MV) upon admission day 0, which was higher when compared to 33% in the United States(26) Inhalation injuries were seen as a direct link of mortality; Diagnostic criteria of facial burn (p=0.006) and closed area burn (p value 0.003) also showed significance consenting with established literature mortality predictors (10,28), therefore relying on basic diagnostic evaluation of facial and closed area of incidence can be lifesaving; even in the absence of bronchoscopy (4,6).

However, the endotracheal intubation causes were the same, including the Glasgow Coma Scale alteration, airway obstructions, inflammatory changes in the respiratory system, hypoxic and hypercapnic ABG's changes, and pH variations (26).

The primitive diagnosis of inhalation injury determined in this study by location of burn, and clinical presentation; combined with case history, this style is overlooked in modern literature and substituted with the use of bronchoscopy to detect changes on the endotracheal epithelium and carboxylate haemoglobin test (9,12,22,24,26).

Undoubtedly, age, TBSA, comorbidities, and systemic inflammatory response syndrome (SIRS) play a major role in burn mortality. Inhalation itself is considered an independent mortality predictor of burn that is associated with longer hospitalization, increased care costs, and poor outcomes (9,12,13,15,20,21,24,26). The result of the study confirmed TBSA, facial and closed area burns to be a significant link of mortality ($p < 0.001$. $=0.006$, $=0.003$ respectively).

Acidosis as a post-traumatic injury is considered one of trauma's lethal triad, Burns fall under trauma critical cases management; The lethal triad that leads to increased mortality includes; acidosis (mainly lactic acidosis from systemic inflammatory response syndrome(SIRS)), hypothermia, and coagulopathy(27).odds of mortality increased 25 times in people with acidosis than patients with no acidosis in general trauma sitting, wither reported in pH, Lactate or Base deficit, acidosis is still discussed as a marker of prognosis in trauma management (28). The pathophysiological changes occurring in burns include hypothermia, coagulopathy and acidosis (27).Yet, there are no known predictors of mortality calculated for acidosis as a sensitive indicator to predict mortality, the main focus of established mortality prediction formulas specific to burn was on TBSA and age (10), the most well-known baux score had some limitations(29), and didn't look changes of pH to its formula (30), similar to other studies burn patients reported higher mortality than general admissions(31) acidosis was a prevalent feature with early post burn periods, attributable to sympathico-adrenergic effect and accumulation of fixed acids in the blood(27).

Our data suggest that treatment of acidosis should be directed toward those patients with a pH < 7.32, the observed result showed a sensitivity of 90% specificity 78% at a AUC 89% to a pH of 7.32 to predict mortality, an adjusted odds ratio of 2.1 fold higher risk than normal pH group, even when compared to established TBSA and presence of inhalation. Furthermore the data support a pH goal higher than 7.2 in resuscitation (27, 28). managing acidosis with administration of Bicarbonates was deemed to increase complication. While lowering CO_2 and early initiation of mechanical ventilation improved survival (29). The high positive correlation coefficient and the P value of <0.001 suggests that a pH of <7.32 may be an appropriate treatment goal for acidosis in cases of burn related inhalation injury.

Coagulopathy and hypothermia are also associated with increased mortality (27,28,30)further work is needed to identify and target potintialy modifiable factors in patients with acidosis such as coagulopathy. This study successfully correlated all three factors—inhalation injury, burn, and acidosis—as predictors of mortality at a confidence level of 95% and a p-value <0.001, Acidosis showed 90% predictability of mortality at a cut-off point of pH+ 7.32 , and specificity .79 in cases of burn.

Conclusion

Burns are a complex trauma associated with notable mortality, which can be predicted by formulas and criteria checklists. The reported mortality in Jordan is higher than economically-advanced countries and magnified 4 times in inhalation, Our diagnostic methods are basic, and data demonstrated significant difference in mortality among patients of acidosis based on preliminary ABG analysis of patients with inhalation injury(p<0.001), with a 90% sensitivity at 7.32 pH. Thus this provides a predictive value for mortality. This study is a first step of developing a new model of mortality prediction in burn.

Limitation

Instead of basic diagnostic criteria for inhalational injury, we advocate the use of advanced diagnostic procedures. The use of bronchoscopy as a diagnostic measure of inhalation injury will help account for more accurate results in the future, drawbacks on using bronchoscopy such as cost, availability, service provision in certain areas might be an issue.

Recommendation

We suggest an additional study to be conducted with better inclusion criteria and protocol, with a larger sample, and implementation of bronchoscopy to enhance diagnostic efficiency of inhalation instead of recognizing facial burns and close area as key determinants.

Acknowledgment

We recognize the medical statistical consultant, Mr. Anees Hijazeen, for his statistical analysis. Without his help, it would have been impossible to accomplish. We are grateful for his enormous help and guidance through the analysis, and would like to thank him for the insight he provided.

References

1. World Health Organization. Health statistics and information systems: cause-specific mortality estimates for 2000–2012. [Internet]. World Health Organization [cited 2022]. Available from: http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html.
2. Peck M, Molnar J, Swart D. A global plan for burn prevention and care. Bulletin of the World Health Organization. 2009;87:802–3.
3. El-Maaytah K, Albdour M, Aldabbas M, El Sayegh O, Alshdowh H. Patterns and sequelae of burn injury at the Jordanian Royal Medical Services Rehabilitation Center in 2005–2017: a cross-sectional study. Electronic Physician. 2019;11(2):7552–7.
4. Gorguner M, Akgun M. Acute inhalation injury. The Eurasian Journal of Medicine. 2010;42(1):28.
5. Shahram F, Reza K, Neda K, Samira P, Roya S, Bahare S. Predictive factors of mortality in burn patients. Journal of Trauma Care Surgery. 2014;19(1):e14480. doi:10.5812/traumamon.14480.
6. Traber DL, Hawkins HK, Enkhbaatar P, Cox RA, Schmalstieg FC, Zwischenberger JB, et al. The role of the bronchial circulation in the acute lung injury resulting from burn and smoke inhalation. Pulmonary Pharmacology & Therapeutics. 2007;20(2):163–6.
7. Cancio LC. Airway management and smoke inhalation injury in the burn patient. Clinics in Plastic Surgery. 2009;36(4):555–67.
8. Palmieri TL, Warner P, Mlcak RP, Sheridan R, Kagan RJ, Herndon DN, et al. Inhalation injury in children: a 10-year experience at Shriners Hospitals for Children. Journal of Burn Care & Research. 2009;30(1):206–8.
9. Tanizaki S. Assessing inhalation injury in the emergency room. Open Access Emergency Medicine. 2015;7:31.
10. Sharma S, Tandon R. Predicting burn mortality using a simple novel prediction model. Indian journal of plastic surgery. 2021 Jan;54(01):046-52.
11. Muthukumar V, Arumugam PK, Narasimhan A, Kumar S, Sharma U, Sharma S, et al. Blood lactate and lactate clearance: refined biomarker and prognostic marker in burn resuscitation. Annals of Burns and Fire Disasters. 2020;33(4):293.
12. Jeschke MG, Kamolz LP, Sjöberg F, Wolf SE. Handbook of burns volume 1: acute burn care. Vol. 1. Springer Science & Business Media; 2020.

13. Hettiaratchy S, Dziewulski P. ABC of burns: introduction. BMJ: British Medical Journal. 2004;328(7452):1366.
14. Lee KC, Joory K, Moiemen NS. History of burns: the past, present and the future. Burns & Trauma. 2014;2(4):2321–3868.
15. Buchade D, Kukde H, Dere R, Savardekar R. Pattern of burns cases brought to morgue, Sion hospital, Mumbai: a two-year study. Journal of Indian Academy of Forensic Medicine. 2011;33(4):309–10.
16. Othman N, Kendrick D. Epidemiology of burn injuries in the East Mediterranean Region: a systematic review. BMC public health. 2010 Dec;10(1):1-0.
17. Hashemi SS, Sharhani A, Lotfi B, Ahmadi-Juibari T, Shaahmadi Z, Aghaei A. A systematic review on the epidemiology of pediatric burn in Iran. Journal of Burn Care & Research. 2017;38(6):e944–51.
18. Dissanaike S, Rahimi M. Epidemiology of burn injuries: highlighting cultural and socio-demographic aspects. International Review of Psychiatry. 2009;21(6):505–11.
19. Dhopte A, Tiwari VK, Patel P, Bamal R. Epidemiology of pediatric burns and future prevention strategies—a study of 475 patients from a high-volume burn center in North India. Burns & Trauma. 2017;5.
20. Bloemsma GC, Dokter J, Boxma H, Oen IMMH. Mortality and causes of death in a burn centre. Burns. 2008;34(8):1103–7.
21. Macedo JLSD, Santos JB. Predictive factors of mortality in burn patients. Revista do Instituto de Medicina Tropical de São Paulo. 2007;49(6):365–70.
22. Kealey GP. Carbon monoxide toxicity. Journal of Burn Care & Research. 2009;30(1):146–7.
23. Mercel A, Tsihlis ND, Maile R, Kibbe MR. Emerging therapies for smoke inhalation injury: a review. Journal of Translational Medicine. 2020;18(1):1–16.
24. Galeiras R, Seoane-Quiroga L, Pértega-Díaz S. Prevalence and prognostic impact of inhalation injury among burn patients: a systematic review and meta-analysis. Journal of Trauma and Acute Care Surgery. 2020;88(2):330–44.
25. Witt CE, Stewart BT, Rivara FP, Mandell SP, Gibran NS, Pham TN, et al. Inpatient and post-discharge outcomes following inhalation injury among critically injured burn patients. Journal of Burn Care & Research. 2021;42(6):1168–75.
26. Folwell JS, Basel AP, Britton GW, Mitchell TA, Rowland MR, Cindass R, et al. Mechanical ventilation strategies in the critically ill burn patient: a practical review for clinicians. European Burn Journal. 2021;2(3):140–51.
27. Henry S. ATLS 10th edition offers new insights into managing trauma patients. Bulletin of the American College of Surgeons. 2018.
28. Corwin GS, Sexton KW, Beck WC, Taylor JR, Bhavaraju A, Davis B, Kimbrough MK, Jensen JC, Privratsky A, Robertson RD. Characterization of acidosis in trauma patient. Journal of Emergencies, Trauma, and Shock. 2020 Jul;13(3):213.
29. Karimi H, Motevalian SA, Rabbani A, Motabar AR, Vasigh M, Sabzeparvar M, Mobayen M. Prediction of mortality in pediatric burn injuries: R-baux score to be applied in children (pediatrics-baux score). Iranian journal of pediatrics. 2013 Apr;23(2):165.
30. Mitra B, Tullio F, Cameron PA, Fitzgerald M. Trauma patients with the 'triad of death'. Emergency Medicine Journal. 2012 Aug 1;29(8):622-5.
31. Burton KR, Sharma VK, Harrop R, Lindsay R. A population-based study of the epidemiology of acute adult burn injuries in the Calgary Health Region and factors associated with mortality and hospital length of stay from 1995 to 2004. Burns. 2009;35(4):572–9.

Appendix A

ph.	Alive	death	Grand Total	sensitivity	False positive
6.7		2	2	1	1
6.8		3	3	1	0.962264
6.9		1	1	1	0.90566
6.99		1	1	1	0.886792
7.01		1	1	1	0.867925
7.05		1	1	1	0.849057
7.06		1	1	1	0.830189
7.09		2	2	1	0.811321
7.1		3	3	1	0.773585
7.13		1	1	1	0.716981
7.14		2	2	1	0.698113
7.16		3	3	1	0.660377
7.2		4	4	1	0.603774
7.21	1	1	2	1	0.528302
7.23		2	2	0.980769	0.509434
7.24		2	2	0.980769	0.471698
7.25		2	2	0.980769	0.433962
7.26	1	1	2	0.980769	0.396226
7.28		2	2	0.961538	0.377358
7.29	1	1	2	0.961538	0.339623
7.3	2	4	6	0.942308	0.320755
7.31		1	1	0.903846	0.245283
7.32	1		1	0.903846	0.226415
7.33	1	1	2	0.884615	0.226415
7.34	3		3	0.865385	0.207547
7.35	2	1	3	0.807692	0.207547
7.36	4	1	5	0.769231	0.188679
7.37		1	1	0.692308	0.169811
7.38		1	1	0.692308	0.150943
7.39	2	2	4	0.692308	0.132075
7.4	6	1	7	0.653846	0.09434
7.41	2	2	4	0.538462	0.075472
7.42	2		2	0.5	0.037736
7.43	2		2	0.461538	0.037736
7.44	2		2	0.423077	0.037736
7.45	1		1	0.384615	0.037736
7.46	7		7	0.365385	0.037736
7.47	3		3	0.230769	0.037736
7.48	1		1	0.173077	0.037736
7.49	1		1	0.153846	0.037736
7.5	2	1	3	0.134615	0.037736
7.51	3		3	0.096154	0.018868
7.53	1		1	0.038462	0.018868
7.54	1		1	0.019231	0.018868
7.56		1	1	0	0.018868
Grand Total	**52**	**53**	**105**		