Validation of predictive factors of dysphagia risk following thermal burn injury: a prospective cohort study

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Abstract

**Purpose:** The objective of this study was to prospectively evaluate the validity and reliability of a risk factor model developed for use in predicting dysphagia risk within the first 24 hours after injury/hospitalisation in patients with thermal burn injury.

**Method(s):** Three hundred and fifty six patients with thermal burns, with or without inhalation injury, who were consecutively admitted to and received management at a quaternary state-wide burn center over a 12 month period, were included. Patients were reviewed for dysphagia risk by nursing staff using an established set of predictive factors. If risk factors for dysphagia were present, referral to speech-language pathology was initiated to investigate swallow function.

**Result(s):** Of the 356 admissions, 83 patients were identified as meeting one or more risk criteria for dysphagia post burn. Of these patients, 24.9% (n =30; 8.42% of the total cohort) presented with dysphagia. Using these criteria, sensitivity and specificity for detection of dysphagia risk were high (100% and 83.74% respectively). The criteria over identify patients who may be at risk of dysphagia and who require dysphagia assessment (positive predictive value = 36.14%). However, as a set of predictors of dysphagia risk when thermal burn is the only complaint, a negative result reassures that a patient does not have dysphagia (negative predictive value = 100%).

**Conclusion:** Overall, the risk factor model provided a valid measure for predicting dysphagia risk. Incorporating these criteria into a dysphagia screening assessment can ensure an evidence-based pathway for early detection and timely referral to speech-language pathology for patients at risk of dysphagia after thermal burn injury.

**Key Words** Dysphagia, risk, burn injury, screening, referral criteria, early intervention
Introduction

Dysphagia (swallowing impairment) is present in 11 to 18% of all people admitted to hospital for the treatment of acute thermal burn injury [1,2]. Difficulties achieving safe and efficient oral intake places the patient at greater risk of malnutrition and dehydration, especially in the presence of the hypermetabolic state which accompanies burn injury. Furthermore, this population has demonstrated a high prevalence of silent aspiration which has the potential to contribute to aspiration pneumonia, increased risk of complications and higher mortality [3-5]. Dysphagia recovery post burn is often protracted over months post injury, with approximately 15% enduring a long-term swallowing disability [6]. During this time, the hospital must bear the burden of the additional financial costs associated with long-term swallowing disability – protracted durations of non-oral feeding (beyond those needed to manage the hypermetabolic state), longer length of stay, additional medical assessment (e.g., x-ray) and management (e.g., antibiotics) alongside increased nursing time and physician consultations [1,3,5-9]. For these reasons, the timely assessment and management of swallowing dysfunction is integral to optimal care. An efficient and effective method of identifying patients at risk of dysphagia is the vital first step.

As economic, personnel and time shortages are becoming more apparent in health care systems globally triage tools that reliably screen, identify and sort individuals upon admission to hospital and determine the need for treatment are needed [10-12]. Dysphagia screening or triage tools that are non-invasive and can be carried out with minimal time and cost have been developed and used successfully by trained nursing staff in a number of acute care populations to allow prompt identification and referral of patients deemed ‘at risk’ [13,19]. However, these tools cannot be readily used in the burns population, as they do not consider the specific nature of the injury, its pathophysiological consequences and medical management. Recently, Rumbach et al [1] used a cohort of 438 consecutive admissions to
establish a core set of statistically significant parameters known within the first 24 hours post injury that showed strong sensitivity (97.96%) and moderate specificity (68.64%) for detection of dysphagia risk when retrospectively applied. These included, in isolation or combination, need for intensive care unit (ICU) admission, need for mechanical ventilation, inhalation injury, total body surface area (TBSA) greater than or equal to 18%, burns to the head and neck and need for escharotomy. Increasing age was also an additional consideration. These criteria are yet to be prospectively validated in a new cohort and therefore applicability and reliability of the original criteria set cannot be generalised to the wider Australian thermal burns population. Therefore, the aim of this project was to prospectively evaluate both the service implementation and the validity of the burns dysphagia risk criteria by incorporating the newly established criteria into a dysphagia screening process conducted by nursing staff.

**Methods**

**Participant Population**

A total of 356 patients consecutively admitted to a quaternary, state-wide burn unit for treatment of acute thermal cutaneous burns, with or without concomitant inhalation injury, over a 12 month period (October 2011 – November 2012) were included in this study. Only those patients who presented with thermal burn injury (i.e., injury attributable to exposure to extremes in temperature) as their primary admitting diagnosis, as confirmed by a medical officer, were included. To ensure that the presence of dysphagia was attributable to the acute burn injury and its management, patients admitted with pre-existing or concomitant injuries (e.g., neurological impairment, spinal injury etc.), for other burn types (i.e., chemical or electrical), revision of old burns and contracture release, those who received palliation and
those with existing history of swallowing impairment were excluded. Table 1 outlines the biographical details of the total population which are consistent with Australian and worldwide reported population data in respect to age and gender distribution, injury etiology, and % TBSA affected [1, 20-27].

/insert Table 1 near here/

**Data Collection**

All patients were reviewed for dysphagia risk upon admission to the burn unit, as part of the admission process, using the criteria established in Rumbach et al\(^1\). These included, with the consideration of increasing age: need for ICU admission, need for mechanical ventilation, inhalation injury, TBSA greater than or equal to 18%, burns to the head and neck and need for escharotomy. In our facility, all patients who require mechanical ventilation must be admitted to the ICU. For this research, a positive indicator on any of the criteria, in isolation or combination, initiated referral to speech-language pathology (SLP) for formal clinical swallow evaluation (CSE) to determine dysphagia status. The CSE was undertaken by a SLP experienced in the assessment and management of the burn-injured patient. The CSE consisted of a patient interview, visual inspection of the oral musculature, cranial nerve examination, perceptual evaluation of voice quality and a series of oral intake trials of food and fluid that also included a water swallow test when appropriate. Dietary consistencies trialled were consistent with the Australian standards for texture-modified food and fluids \[28\] and the range included smooth puree, minced and moist, soft and normal food consistencies as well as extremely thick (level 900), moderately thick (level 400), mildly thick (level 150) and thin (regular) fluids. Patients were classified as non-dysphagic if they were able to safely manage all food and fluid consistencies with no or minimal aspiration risk. Dysphagia was identified when oromotor dysfunction or signs of aspiration or aspiration
risk were observed during the passage of a liquid, semisolid, or solid bolus during the oral preparatory, oral and/or pharyngeal phases of the swallow. Due to patient suitability and feasibility reasons [9], instrumental assessment of swallow function (using either videofluoroscopy or fiberoptic endoscopic evaluation of swallowing) was not used to confirm or refute the presence of dysphagia in this study.

Any patients that either did not meet any risk criteria, or those who were assessed by SLP as being non-dysphagic, were commenced on a normal high energy, high protein diet with thin fluids. To assure clinical reliability of the criteria, all non-dysphagic individuals (admissions who did not present with any of the dysphagia risk criteria and those who met criteria but were identified through CSE as having normal swallow function) were monitored over the course of their admission (through medical chart review and case conference discussions) to ensure nil negative consequences arose from either (a) not receiving a referral to SLP for assessment of swallow function, and/or (b) being commenced on a high energy, high protein diet with thin fluids.

Prior to the commencement of data collection, nursing staff underwent an education session regarding the screening procedure to ensure maximum compliance. To track compliance and nursing staff use of the screening criteria, chart audits occurred at three time-points during the period of data collection (November 2011, March 2012, and at the conclusion of the study in November 2012). Ten charts were randomly audited from each time period.

Data analysis

To ensure the predictive factors for dysphagia after thermal burn injury established retrospectively in Rumbach et al [1] carried the same predictive power in the current
prospective cohort, the statistical relationship between dysphagia outcome and the variables
were re-investigated using chi-square and single, univariate logistic regression modelling
using Stata software (Statacorp, Version 11.0, 2009). Multicollinearity across variables was
investigated, with those variables with variation inflation factors >10 being excluded from
further multivariate regression modelling. Goodness-of-fit of the data to the model was
established using receiver operating characteristic (ROC) curve analysis.

Ethical considerations

Ethical approval for the study was obtained from the relevant hospital and
university ethics committees.

Results

General compliance (i.e., screening criteria completed for all patients) was 100% and
correct action occurred on all occasions audited. Of the total 356 patients screened, 83 people
were identified as being at risk of dysphagia using criteria outlined above and were seen by
SLP for a clinical dysphagia assessment. Three patients that met the criteria for dysphagia
risk were not seen by SLP due to staffing constraints. Dysphagia was confirmed via CSE
conducted by a SLP in 30 cases (36% of those screened). Analysis revealed that presence of
two or more risk criteria indicated higher risk for dysphagia. The three individuals who were
identified to have all six risk criteria, all had dysphagia. Of the 49 patients who presented
with a combination of between two to five of the risk criteria, 26 were diagnosed with
dysphagia. Only one of the 31 individuals who presented with just one of the risk criteria was
identified as having dysphagia. During the period of data collection, only those patients
identified through the screening process to be at risk for dysphagia were diagnosed as having
dysphagia. As determined by medical and nursing staff report and SLP chart review, no
individuals who were commenced on a high energy, high protein diet with thin fluids on
admission, or after SLP assessment, presented with swallowing difficulties during their hospital admission.

**Overall effectiveness of the criteria set**

When the core set of clinical referral criteria were prospectively applied to the current cohort of patients (n = 356), sensitivity was 100% and specificity was 83.74% (see Table 2). Thus using these criteria, all individuals with dysphagia were correctly identified. However, large number of false positives confirms that the criterion over-identifies patients who are at risk of dysphagia and who require full dysphagia screening (see Tables 2 and 3). Despite not all patients receiving a full SLP evaluation, as a set of predictors of dysphagia risk, absence of these criteria in combination in this cohort assured that a patient did not have dysphagia (negative predictive value [NPV] = 100%).

/insert Table 2 near here/

**Re-validation of the set of predictive factors for dysphagia after thermal burn injury**

Results comparing the dysphagic (n = 30) and non-dysphagic (n = 326) groups are outlined in Table 3. A stringent alpha of p < .01 was adopted due to the multiplicity of tests [29]. Results revealed a statistically significant difference (p < .01) between the two groups for all variables examined, except age (p = 0.28). Despite age being non-significant between groups, this variable is known to significantly impact upon morbidity and mortality in the burns population [30-33] and changes in swallow with advancing age are well documented in the literature [34-40]; thus age was not excluded from further analysis.

/insert Table 3 near here/

When criteria were evaluated individually using univariate regression modelling, sensitivity ranged from 0% for age, presence of head and neck burns and need for
escharotomy up to 92.59% for ICU admission and mechanical ventilation. Correct identification of patients without dysphagia post burn using these different criteria in isolation (i.e., specificity) was high for all variables, varying between 94.22% and 100%. The proportion of patients presenting with a specified variable who were correctly diagnosed (i.e., positive predictive value [PPV]) ranged from 58.82 for those who required an ICU admission to 72.22 for those who presented with inhalation injury. PPV for age, presence of head and neck burns and escharotomy were undefined as sensitivity was 0% for these variables. The proportion of patients presenting without a specified variable who were correctly diagnosed (i.e., NPV) were considerably higher, varying from 92.42% for age and presence of head and neck burns to 99.36% for individuals that required ICU admission and mechanical ventilation. These results are consistent with those reported in Rumbach et al [1].

Unable to be included in multiple regression modelling due to exceedingly high odds ratios and considerable multi-collinearity (variation inflation factors >10), data diagnostics again confirmed a relationship between dysphagia presence and the presence of inhalation injury, ICU admission and need for mechanical ventilation (see Table 4). The presence of inhalation injury generally precipitates periods of mechanical ventilation in an ICU setting. When inhalation injury is present, there is a 72.22% risk of dysphagia, whilst those who present without concomitant inhalation injury have a much lower risk of developing dysphagia at 4.14%. If the individual requires ICU admission there is a 56.82% risk of developing dysphagia. However, if the original injury is not severe enough to warrant critical care admission, there is less than a 1% risk of presenting with dysphagia during their hospital stay. Likewise, only 0.64% of the general thermal burn population who are able to maintain their own airway (i.e., no mechanical ventilation) at admission are at risk of dysphagia, as opposed to a 59.52% risk for those who require mechanical ventilation.
Escharotomy was also excluded from further regression analysis as there was no variance within the sample (i.e., all individuals who required escharotomy [n = 4] presented with dysphagia).

Like in Rumbach et al [1], presence of head and neck burn, age and % TBSA burned (≥18%) were suitable for analysis via multivariate regression modelling. Analysis using this new prospective participant cohort again revealed that all three factors were statistically significant (p = <.01) predictors of dysphagia presence (see Table 5). Specifically, (a) in the presence of head and neck burn, patients are 13 times more likely to present with swallowing impairment; (b) for every year increase in age there risk increases by 1.04%, and; (c) patient with injuries ≥ 18% TBSA are 16.52 times more likely to have dysphagia than someone who presents with a burn 17.5% TBSA or smaller.

A ROC curve analysis to evaluate goodness-of-fit of the data to the regression model was generated. The area under the ROC curve was 0.929, indicating that the model’s goodness-of-fit was appropriate and accurate [41]. The model’s sensitivity was 44.44%, therefore just under half of those with dysphagia would be correctly identified using these three criteria alone. Specificity, or the ability to correctly identify patients without dysphagia, was 97.57%. Ability to predict the presence (PPV) or absence (NPV) of dysphagia was high, at 60% and 95.54% respectively. Overall post-estimation predictive power of the model was 93.54%.
Discussion

This is the first study to provide prospective validation for a set of clinical criteria that identifies dysphagia risk after thermal burn injury in a large population sample. Although the parameters investigated as part of this criteria set align with those hypothesised to place patients at greater risk for dysphagia [9, 42-50], the current study clinically validates the importance of these criteria. Until now, there has been no objective evidence-base available to aid in accurate speech-language pathology service planning for the burn population.

As burn injury presentation and management is heterogeneous, we sought to validate a set of risk factors easily identifiable within the first 24 hours after injury and/or hospital admission that can be used collectively to account for inter-patient variability. Diagnostics for each individual variable showed high specificity (94.22-100%) yet had a wide range of sensitivity (0-92.59%). However, when used in combination, results indicated that the criteria (i.e., with the consideration of increasing age: need for ICU admission, need for mechanical ventilation, inhalation injury, TBSA greater than or equal to 18%, burns to the head and neck and need for escharotomy), were 100% sensitive for determining dysphagia presence. Therefore, not meeting any of the risk criteria appears to be a good predictor of a patient’s ability to eat and drink safely.

Meeting the risk criteria, however, often does not indicate an inability to swallow safely. Specificity for correct dysphagia classification using the criteria set was moderate (84.74%). Thus, just over 2 out of every 10 people assessed by SLP had normal swallow function. Economically, equal sensitivity and specificity is desired so that the number of admissions requiring full dysphagia screens and SLP referrals are minimised to those who actually need them. A lower specificity ensures that all patients with dysphagia are identified early and thus can be managed appropriately to prevent or minimise any complications that may arise from swallowing issues is clinically appropriate. It is also
important to recognise that screening is not a fail-safe method and will always likely under, or in this case, over-identify patients requiring a full dysphagia assessment. A positive indicator during screening merely recognises an individual as being at risk for dysphagia and does not identify the nature of the problem. Therefore, a distinction between screening and assessment still needs to exist, with SLP referral for further diagnostic assessment being made when these risk criteria are observed.

Dysphagia post burn is multifactorial, with no two people presenting with the same injury or requiring the same course of management. Therefore, each patient must be considered individually. Although the burn-specific criteria used in this study over-identify patients who are specifically at risk of dysphagia, being non-dysphagic does not preclude the need for SLPs to become involved in the treatment of these individuals. For example, those with burns to the head and neck often require exercises for orofacial movement to prevent skin tightness and contracture formation during the healing process. In some multidisciplinary teams this may be the role of the SLP as it relates to and can impact on both swallowing and communication competence [9]. Perceptual voice evaluation at the time of dysphagia assessment may also identify a need for further SLP investigation and involvement for potential phonatory deficits. Previous research has reported laryngotracheal pathology and laryngeal dysfunction to be highly prevalent in this population [5,7]. Long periods of intubation and mechanical ventilation, in addition to inhalation injury, may contribute to these phonatory deficits [5,7] and hence management many be required. In the current cohort, 39 individuals without dysphagia presented with some degree of thermal injury to the head and neck therefore over-referral for dysphagia assessment is not in and of itself a negative as it allows the SLP to identify those patient who may need to be assessed and managed for issues other than dysphagia management.
Early and informed assessment and management of dysphagia in other critical care populations has proven to improve patient outcomes in terms of reducing respiratory complications and length of stay, thus overall cost to the health system [3, 51-53]. This supports the implementation of formal dysphagia triage tools that incorporate evidence-based aetiologies of dysphagia risk for specific populations. Using criteria that are transparent, are known within the first day after injury or hospitalisation, and are relevant to nursing care, enabled nursing staff to expeditiously identify those at risk of swallowing disability and were able to promptly refer to SLP upon admission for further assessment prior to patients commencing oral intake. Ultimately, the success of implementing the screening/triaging tools in clinical settings is reliant on the education and training of the medical and nursing staff that are available to administer them. Ongoing staff education related to dysphagia and screening criteria needs to be standard practice that occurs on an ongoing basis. Evaluation of staff knowledge is integral. To ensure that the implementation of the triage tool remains successful, regular audits are required to monitor and ensure compliance and accuracy in tool use, including correct action following completion of the tool.

As our goal was to establish an accurate predictive model rather than establish causality, the variables examined were limited to those that were transparent and available to staff within the first 24 hours of injury and/or hospital admission. In order to heighten the specificity for detection of dysphagia risk, future investigation into burn presentation and treatment variables that become known as medical management progresses (e.g., depth of facial burn and necessary surgical and therapeutic management, duration of mechanical ventilation, duration of intubation etc.) is required as the authors acknowledge these may increase dysphagia risk. This study also excluded patients with premorbid conditions which may impact on swallowing. Hence, it is important that the current criteria for dysphagia risk be incorporated into dysphagia screening tools already validated and in clinical use. This
would heighten the accuracy of dysphagia screening for those patients who present with premorbid or concomitant conditions which also heighten their dysphagia risk. Furthermore, this set of criteria for dysphagia risk post thermal burn was both developed and evaluated within a single burn unit, and as such requires validation in other centres.

**Conclusion**

We undertook a prospective validation of a core set of clinical referral criteria that predicted dysphagia risk post burn within the first 24 hours of injury and/or hospital admission. It had a high sensitivity and moderate specificity (84%). This will enable early screening by non-SLP practitioners to identify both those at risk and those who can safely commence normal consistency oral intake. Further, timely, appropriate referral to SLP can be initiated. This serves to minimise aspiration risk and maximise oral intake, thus aiding patients to maximise their recovery potential. Further evaluation of this criteria set needs to be conducted in the long-term to assess any health economic benefits associated with dysphagia screening in the thermal burn population. Identification and investigation of additional factors that independently contribute to heightened dysphagia risk during the course of treatment (>24 hours post injury) may aid in increasing the sensitivity of the overall criteria set. International validation of these criteria is also warranted.
Acknowledgements

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Conflict of interest statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.
References


Table 1

Biographical data for the adult population post thermal burn injury (n = 356)

<table>
<thead>
<tr>
<th>Biographical Variable</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>$M = 38.65$ (SD = 17.8)</td>
</tr>
<tr>
<td></td>
<td>Range = 14-87</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>70.51% (n = 251)</td>
</tr>
<tr>
<td>Female</td>
<td>29.49% (n = 105)</td>
</tr>
<tr>
<td>Aetiology</td>
<td></td>
</tr>
<tr>
<td>Flame</td>
<td>50.84% (n = 181)</td>
</tr>
<tr>
<td>Scald</td>
<td>31.18% (n = 111)</td>
</tr>
<tr>
<td>Contact</td>
<td>17.98% (n = 64)</td>
</tr>
<tr>
<td>Inhalation injury</td>
<td>4.78% (n = 17)</td>
</tr>
<tr>
<td>% TBSA burned</td>
<td>$M = 7.67$ (SD = 10.95)</td>
</tr>
<tr>
<td></td>
<td>Range = 0.2-70</td>
</tr>
<tr>
<td>LOHS</td>
<td>$M = 13.32$ (SD = 16.42)</td>
</tr>
<tr>
<td></td>
<td>Range = 1-133</td>
</tr>
</tbody>
</table>

Note: LOHS = length of hospital stay, $M$ = mean, SD = standard deviation, TBSA = total body surface area
Table 2

Contingency table for the dysphagia risk post thermal burn criteria: prospective analysis of a clinical cohort (n = 356)

<table>
<thead>
<tr>
<th>Test Outcome</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>30 (a = true positive)</td>
<td>53 (b = false positive)</td>
</tr>
<tr>
<td>Negative</td>
<td>0 (c = false negative)</td>
<td>273 (d = true negative)</td>
</tr>
</tbody>
</table>

Sensitivity = $\frac{a}{a+c} = \frac{30}{30+0} = 100.00\%$

Specificity = $\frac{d}{b+d} = \frac{273}{53+273} = 83.74\%$

PPV = $\frac{a}{a+b} = \frac{30}{30+53} = 36.14\%$

NPV = $\frac{d}{c+d} = \frac{273}{0+273} = 100.00\%$
Table 3
Between-groups comparison – dysphagic and non-dysphagic population subgroups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of participants identified to meet criteria from total cohort (N = 356)</th>
<th>Dysphagic (N = 30)</th>
<th>Non-dysphagic (N =326)</th>
<th>P*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of head and neck</td>
<td>62</td>
<td>23</td>
<td>39</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Inhalation injury</td>
<td>18</td>
<td>13</td>
<td>5</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>ICU admission</td>
<td>44</td>
<td>28</td>
<td>16</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>42</td>
<td>28</td>
<td>14</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Escharotomy</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>% TBSA ≥18</td>
<td>41</td>
<td>18</td>
<td>23</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

*P values are based on $X^2$ and t-test.
Table 4

Diagnostic variables for dysphagia risk and need for SLP referral post burn

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>SENS (%)</th>
<th>SPEC (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>+LR (%)</th>
<th>-LR (%)</th>
<th>CC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escharotomy</td>
<td>0</td>
<td>100</td>
<td>UD</td>
<td>93.47</td>
<td>0</td>
<td>0.01</td>
<td>93.47</td>
</tr>
<tr>
<td>ICU admission</td>
<td>92.59</td>
<td>94.22</td>
<td>56.82</td>
<td>99.36</td>
<td>16.02</td>
<td>0.08</td>
<td>94.10</td>
</tr>
<tr>
<td>Mechanical ventilation</td>
<td>92.59</td>
<td>94.83</td>
<td>59.52</td>
<td>99.36</td>
<td>17.91</td>
<td>0.08</td>
<td>94.66</td>
</tr>
<tr>
<td>Inhalation injury</td>
<td>48.15</td>
<td>98.48</td>
<td>72.22</td>
<td>95.86</td>
<td>31.68</td>
<td>0.53</td>
<td>94.66</td>
</tr>
<tr>
<td>%TBSA≥18</td>
<td>0</td>
<td>100</td>
<td>UD</td>
<td>92.42</td>
<td>0</td>
<td>0.01</td>
<td>92.42</td>
</tr>
<tr>
<td>Presence of head and neck burns</td>
<td>0</td>
<td>100</td>
<td>UD</td>
<td>92.42</td>
<td>0</td>
<td>0.01</td>
<td>92.42</td>
</tr>
<tr>
<td>Age</td>
<td>0</td>
<td>100</td>
<td>UD</td>
<td>92.42</td>
<td>0</td>
<td>0.01</td>
<td>92.42</td>
</tr>
</tbody>
</table>

Note: SENS = Sensitivity; SPEC = Specificity; PPV = Positive Predictive Value; NPV = Negative Predictive Value; +LR = Positive Likelihood Ratio, -LR = Negative Likelihood Ratio; UD = undefined; CC = Correctly Classified

Note: PPV = number of true positives/(number of true positives + number of true negatives). Therefore, when sensitivity is 0, PPV is unable to be defined.
Table 5

Results of logistic regression model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (adjusted)</th>
<th>P value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of head and neck burn</td>
<td>13.00</td>
<td>0.000</td>
<td>4.26</td>
</tr>
<tr>
<td>Age</td>
<td>1.04</td>
<td>0.005</td>
<td>1.01</td>
</tr>
<tr>
<td>% TBSA≥18</td>
<td>16.52</td>
<td>0.000</td>
<td>4.89</td>
</tr>
</tbody>
</table>