

# Laryngeal Trauma Following an Inhalation Injury: A Review and Case Report

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**Summary:** The primary concern when managing a patient with inhalation injury is security of the airway. Airflow may be impeded by both edema of the upper airway and reduction of oxygen delivery to the lower respiratory tract. Although there has been much discussion regarding management of the latter, the focus of this article is the management of the former. This review aimed to determine the optimum management in burn victims with upper airway inhalation injury as an attempt to prevent laryngeal trauma leading to long-term voice disorders and upper airway dyspnea. We describe the case of a 57-year-old woman with significant inhalation injury and discuss the natural progression of her injuries and the laryngeal controversies surrounding her care. We conclude with advice on the optimal management of this condition based on our experience, combined with current best evidence.

**Key Words:** Inhalation injury–Airway management–Laryngeal trauma–Airway dyspnea–Glottic webs.

## INTRODUCTION

Although hypothermia and fluid redistribution can rapidly lead to significant morbidity, inhalation injury remains the leading cause of mortality in burn patients suffering airway injury, with an incidence of 10%–20%.<sup>1,2</sup> This is often due to a combination of direct thermal damage, chemical denaturation of tissue, and noxious gases impeding oxygen transport.<sup>2,3</sup>

Throughout the airway and particularly within the larynx, the cross-sectional area changes markedly. In the adult, the narrowest point in the upper airway is the glottis.<sup>4</sup> Given that resistance to laminar flow through a tube is inversely proportional to the radius of that tube by the power of four, according to Poiseuille's law it stands to reason that any edema in this area can lead to a rapid onset of respiratory distress. As the inlet to the airway, the larynx is exposed to the most intense thermal damage and highest concentration of chemical exposure within the respiratory system during inhalation injury.<sup>4,5</sup> Animal studies have demonstrated a protective reflex whereby noxious exposure of heated air may result in closure of the glottis to protect the respiratory tree and may be powerful enough to cause asphyxia.<sup>1</sup>

The effect of inhalation injury on the lower respiratory tract has been widely documented in the literature. Detailed description of the effect on the upper airway has been seldom mentioned, and of those the primary focus has been regarding inadvertent thermal damage from beverages in the pediatric population.<sup>6–8</sup> The case presented here describes the initial and long-term management of the larynx in a patient with severe inhalation injury resulting from a domestic fire.

## CASE REPORT

An otherwise healthy, non-smoking 57-year-old with no past medical history suffered inhalation injury when her clothes ignited following contact with open flame from a barbecue. On initial

examination, the patient's facial hair was burned, her oral commissure significantly edematous, she was dysphonic, and she sustained 29% total body surface area burns. This consisted of full thickness burns on her face, neck, torso, and lower limbs. Despite endoscopic examination revealing a moderate-severely edematous larynx, the patient's oxygen saturations remained above 95%, she had no evidence of stridor or wheezing, and she produced a good cough effort. Conservative airway management was instigated. The patient was acutely managed for 3 days with a Hudson face mask with 40% oxygen flow. She was subsequently intubated for 1 day to undergo excision and skin grafting to the cutaneous burn wounds in both the upper limbs and the abdomen, and was managed with a nasal cannula for the subsequent 2 days. The patient remained aphonic for 3 weeks.

At 3 weeks, the patient was dysphonic, and using the GRBAS (grade, roughness, breathiness, asthenia, strain) scale outlined in Table 1 denoted a score of (G2 R1 B2 A1 S2). On video stroboscopy, she had signs of generalized supraglottic edema, slough over both vocal folds onto the interarytenoid, a poor mucosal wave, breath-holding, and muscle tension dysphonia (Figure 1).

By week 12, the patient's dysphonia had worsened (G3 R1 B3 A3 S3). Clinical signs included supraglottic erythema, circumferential glottis constriction, and a significant posterior phonatory gap on comparing abduction (Figure 2) and adduction (Figure 3). At this stage, intensive voice therapy in the multidisciplinary voice clinic was commenced.

Twenty-four weeks postinjury, the patient's dysphonia had improved (G2 R2 B1 A0 S1). Anterior and posterior glottic webs had developed, limiting the movement of the arytenoids and the anterior thirds of both vocal folds (Figure 4). Endoscopy also revealed arytenoid pachydermia, maintenance of a posterior phonatory gap, and anteroposterior constriction. Given the absence of stridor or diminished exercise tolerance, surgical management of the glottic webs was avoided. Instead, she continued on voice therapy.

The patient continues to be under long-term follow-up and is monitored in the multidisciplinary team voice and airway clinic; she is currently at 16 months posttrauma. Her larynx is regularly assessed using the Voice Handicap Index scoring and fiberoptic endostroboscopy video recording for function and airway patency. Although the patient's voice had not fully

Accepted for publication September 13, 2016.

Conflict of interest: There are no competing financial or personal interests to declare.

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Journal of Voice, Vol. 31, No. 3, pp. 388.e27–388.e31  
0892-1997

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<http://dx.doi.org/10.1016/j.jvoice.2016.09.017>

**TABLE 1.**  
**GRBAS Score**

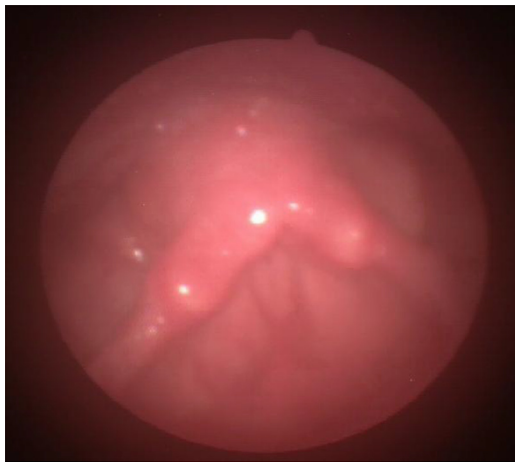
Grade	0 = Absent/Normal	1 = Mild Degree	2 = Medium Degree	3 = High Degree
Roughness	0	1	2	3
Breathiness	0	1	2	3
Asthenia	0	1	2	3
Strain	0	1	2	3

GRBAS score is used to explain the national scoring system used for describing the auditory and perceptual evaluation of hoarseness. Roughness describes the rattling, rasping sound of voice, breathiness is a “whispering” voice, asthenia applies to a small weak voice, and strain is consequential to a constricted throat.<sup>9</sup>

Abbreviation: GRBAS, grade, roughness, breathiness, asthenia, strain.

returned to her normal baseline status, at 16 months she has expressed wishes to be discharged with an open clinic appointment. At this time, her voice is G1 R0 B1 A1 S0, showing a marked improvement owing to voice therapy, which she had found useful.

The cutaneous burns were treated with Flamazine™ cream (Hull, Yorkshire, UK) (silver sulfadiazine 1%) on admission. Grafted wounds were dressed with Betadine (Stamford, CT, USA) soaks as per our normal practice and converted to Flamazine™



**FIGURE 1.** Video stroboscopy image at week 3 postinjury shows evidence of generalized supraglottic edema and minimal airway but full adduction.



**FIGURE 3.** This image represents adduction of the vocal cords at week 12 postinjury. This demonstrates a significant posterior pharyngeal gap, with supraglottic erythema and circumferential glottis constriction.



**FIGURE 2.** Image of vocal cord abduction at week 12 postinjury demonstrates supraglottic erythema with slough over the vocal folds and interarytenoid.



**FIGURE 4.** At 24 weeks postinjury, there is evidence of anterior and posterior glottic webs. Endoscopy also revealed arytenoid pachydermia and maintenance of a posterior pharyngeal gap with anteroposterior constriction.

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