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Airway laser procedures in children and the American Society of Anesthesiologists' Practice Advisory: A survey among pediatric anesthesiologists

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ABSTRACT

Background and objectives: Recognizing the risk of fire during laser procedures involving the airway, the American Society of Anesthesiologists (ASA) developed recommendations designed to promote safe practice and reduce burn injuries. The aim of this study was to identify how reported anesthetic management of airway laser endoscopies in pediatric patients aligns with the ASA Practice Advisory (ASA-PA).

Methods: An online survey was created in an iterative process, pilot-tested, and distributed using the Society for Pediatric Anesthesia's (SPA) membership email list. Responses were analyzed using descriptive statistics.

Results: Responses from 322 respondents were included, 296 (92%) of whom participated in pediatric laser airway procedures. Fifty-nine respondents (20%) reported the use of an inspired fraction of oxygen (FiO_2) of 90% or greater during laser activation in patients with a native airway, and 101 (34%) reported not waiting after the reduction of the FiO_2 and laser activation in the airway. Sixty-four (36%) of respondents reporting the use of a non-laser-safe tube during laser airway cases did so due to a lack of availability of a laser specific tube or size limitations. Six respondents (2%) reported an airway fire during a laser procedure in a child under their care.

Conclusions: Our results indicate that, in general, pediatric anesthesiologists do not adhere to the ASA-PA in several important aspects. Possible explanations might be knowledge deficiencies about the Practice Advisory or a perceived limited clinical applicability in the pediatric setting. Regardless, airway fires during laser airway surgeries in this population do occur, emphasizing the need for safe practice standards for both anesthesiologists and surgeons.

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1. Introduction

The prevention of operating room fires is an important joint responsibility for the entire operating room team [1]. Airway fires are of particular concern because of the potential for devastating morbidity and mortality [2,3]. In a recent review of the LexisNexis claims database, 26 cases of burn injuries were identified, seven of which were related to airway fires [4]. As a result, the Food and Drug Administration (FDA) has partnered with several organizations including The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), The American College of Surgeons (ACS), and the Joint Commission (JC) to increase awareness of the risks of surgical fires and promote the adoption of risk reduction practices. Recommendations from the Anesthesia Patient Safety Foundation (APSF) include an assessment of fire risk at the start of each case, the minimization of the inspired fraction of oxygen (FiO_2), and consideration for a closed airway device if oxygen requirements exceed 30% [5]. In addition, the American Society of Anesthesiologists (ASA) recently updated its Practice Advisory (henceforth referred to as the ASA-PA) regarding the prevention and management of operating room fires for a wide variety of cases, including airway and laser surgeries [6]. In this document, recommendations include the reduction of supplemental oxygen "to the minimum required to avoid hypoxia", delaying initiation of the laser following

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reduction of inspired oxygen concentration for "a few minutes", and the use of cuffed and laser-resistant airway devices during airway laser cases.

In clinical practice, airway management and oxygen administration during laser surgery are often individualized to accommodate both the patient's clinical requirements and surgeon and anesthesiologist preferences. Infants and children undergoing airway procedures are particularly prone to rapid arterial oxygen desaturation, therefore administration of supplemental oxygen is often necessary [7]. Although a variety of different techniques have been described as safe and effective, most studies or case series are limited to single institutions [8–10]. As such, it is unknown whether the existing published evidence reflects widespread practice. The aim of this project was to describe current practice patterns in the anesthetic management of children undergoing laser airway surgery and their alignment with the current ASA-PA recommendations.

2. Methods

This study was granted exempt status by our institutional IRB. The survey was developed in an iterative process and items generated to elicit responses regarding: preferred anesthetic techniques, use of equipment and devices, safety concerns, and personal experience of airway fire(s). Additional questions explored adherence or deviation from the ASA-PA statements. The survey was first reviewed by content experts to ensure completeness of the themes/topics. Items in the survey were then examined by respondents from various fields of expertise, including non-anesthesiologists and non-medical individuals to test for face and content validity. Questions found to be ambiguous, difficult to understand or answer were reformulated according to the input generated from the respondents. Lastly, a formal pilot test was conducted with a sample of 6 respondents representative of the target study population. The final survey contained 29 items. In general, questions were closed-ended, but with the opportunity to provide additional information (specifics or personal experiences). Response options included discrete mutually exclusive categories or 5-point Likert scales. Several questions called for free numeric entry of a specific variable (such as time in seconds or maximum FiO_2). The survey was distributed to all active members of the Society for Pediatric Anesthesia (SPA) via an email invitation containing a Qualtrics® survey link. After 2 weeks, a single reminder email was sent. Responses were recorded anonymously and untraceable via IP or email address.

2.1. Statistical analysis

Statistical analyses were performed using SPSS statistical software (v 21.0, IBM Corp., New York). Responses to the survey were analyzed descriptively using frequency distributions. Continuous data were recorded as mean ± SD or medians and interquartile range. Free-text responses were categorized where appropriate and their frequency expressed as percentage of respondents formulating an answer within a category.

Sample size estimation was calculated using standard survey methodology. Based on an anticipated target population of approximately 2800 SPA members, we needed to survey a minimum of 244 subjects in order to obtain a representative sample; i.e. a sample size of 244 provides 95% confidence that the resulting data lie within ±6% of the target (if all SPA members would respond).

3. Results

A total of 2807 surveys were distributed to active members of the SPA. Of these, 440 (16%) started the survey, and complete responses were obtained from 322 members (11%) after two mailings.

Table 1
Demographics.

	Response ($N = 322$)
Practice setting	
Academic	249 (77.3)
Private practice	63 (19.6)
Other	10 (3.1)
Years in practice	
0–5	72 (22.3)
6–10	55 (17.1)
>10	195 (60.6)
% Pediatric practice	
0–25	10 (3.1)
26–50	37 (11.5)
51–75	34 (10.6)
>76	241 (74.8)
Country of practice	
USA	288 (89.4)
Non-USA	34 (10.6)
Practice involving pediatric laser surgery	
Never	26 (8.1)
0–5/year	91 (28.3)
6–10/year	75 (23.3)
>10/year	130 (40.4)

Data are presented as *n* (%).

The survey sample demographics are summarized in Table 1. As shown, the majority of respondents practiced in predominantly pediatric settings and had greater than 10 years experience. Of the 322 respondents, 296 (92%) indicated that they participated in pediatric airway laser procedures. Fig. 1 describes the preferred management strategies for 2 hypothetical scenarios involving laser endoscopy for a 3-year-old and 3-month-old child. As shown, the majority of respondents preferred spontaneous ventilation (70%) and a non-intubated patient (57%). Most respondents (76%) reported reducing the fraction of inspired oxygen (FiO_2) prior to laser activation.

Table 2 summarizes the most commonly reported techniques and devices for administration of oxygen during laser airway procedures. The preferred route was the port on the surgeon's bronchoscope for 53% of respondents. Both regular and "laser-safe" endotracheal tubes were frequently used to administer oxygen (by 40% and 45% of respondents, respectively), via either insufflation or intubation. Of note, only 23 (8%) of respondents reported not routinely using supplemental oxygen. The maximum concentrations of oxygen used during laser procedures involving either the native airway or when using a regular or laser-safe endotracheal tube (ETT) are described in Fig. 2. Interestingly, while the majority of respondents reported using inspired oxygen concentrations of <50%, 20% of respondents reported using an FiO_2 of ≥90% during laser use in a patient with either a native airway or laser-safe ETT. An additional question asked the minimum oxygen saturation (SpO_2) the subjects accepted for sustained time periods during laser airway surgery. Results revealed a mean minimum SpO_2 value of 85.3% ± 6.9 (median 85.0%, range 35.0–95.0%)

In contrast to the ASA-PA recommendations to wait between discontinuation of supplemental oxygen and laser activation, 101 (34%) subjects reported not waiting at all, and only 11 (3.9%) reported waiting more than 1 min. The average reported waiting time was 17.4 ± 25.6 s (range 0.0–200.0 s). Results also revealed that 175 (59%) of respondents reported the use of a regular (not laser-safe) ETT at least once for airway laser procedures. Fig. 3 describes the reported reasons. As shown, availability and size constraints were significant determinants of regular (not laser-safe) ETT use.

The majority of respondents (91%) reported that they were aware of the ASA-PA recommendations. Of these, 163 (60%) knew of the existence of specific recommendations for laser airway

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