European Journal of Pediatrics (2019) 178:1125–1127
https://doi.org/10.1007/s00431-019-03381-0

SHORT COMMUNICATION

Laryngoscope burn risk in neonatal intubation

Emer Ryan[1] · Paul O Neill[2] · Dermot Brabazon[2] · John F. A. Murphy[1]

Received: 14 January 2019 / Revised: 8 April 2019 / Accepted: 9 April 2019 / Published online: 29 April 2019

Abstract

Laryngoscope burns in neonatal intubation Following burns during neonatal intubation, we mounted an in vitro study of laryngoscopes to determine the temperatures reached during clinical use. The temperature of 10 different bulb laryngoscopes heads and two fibre optic heads were measured with a thermocouple, once opened, and upon closing. Within 60 s, all ten laryngoscopes, with light-bulb sources, had gained significant heat to cause thermal injury to neonatal skin. Laryngoscopes with LED light source and fibre optic heads did not.

Conclusion: We recommend that the bulb laryngoscope blade, if used, is not left open prior to intubation and that it is closed between intubation attempts.

What is Known:
• *The preterm epidermis is particularly vulnerable to injury.*

What is New:
• *Bulb laryngoscope light bulbs consistently reach temperatures sufficient to burn neonatal skin in less than 100 s in an* in vitro *study.*
• *Bulb light safety advice should be incorporated into intubation guidelines.*

Keywords Laryngoscope · Intubation · Thermal burn · Neonates · Epidermis

Introduction

Newborn intubation is a critical and time-sensitive procedure. Successful intubation requires proficiently trained personnel and correctly functioning equipment. The laryngoscope is the most important instrument in the process, with an appropriately sized blade and bright light source essential to optimising procedural success. Straight blade laryngoscopes are used in infants due to their small displacement volume, namely the small distance from the chin to the thyroid cartilage. There are two laryngoscope lighting systems currently available for use; a system with the bulb mounted directly on to the blade and another, a fibre optic device where the light source is at the distal end of the handle. To date, there has been a paucity of information about the light and thermal output of laryngoscopy equipment. We became concerned about the potential for laryngoscope blade thermal burns following an episode at our centre. We conducted an in vitro study of laryngoscope blades to determine the temperatures achieved during routine neonatal intubation.

Methods

The temperature of the incandescent light bulb from ten different laryngoscopes was measured using 1 mm diameter K-type stainless steel sheathed thermocouples (RS model number 219-4359). These laryngoscopes were currently in use at our hospital. The thermocouple tips were adjusted so that they

Communicated by Patrick Van Reempts

✉ Emer Ryan
msemerryan@gmail.com

Paul O Neill
paul.oneill37@mail.dcu.ie

Dermot Brabazon
dermot.brabazon@dcu.ie

John F. A. Murphy
johnmurphy104@hotmail.com

[1] Department of Neonatology, National Maternity Hospital, Holles St, Dublin 2, Ireland

[2] School of Mechanical and Manufacturing Engineering, Dublin City University, Dublin, Ireland

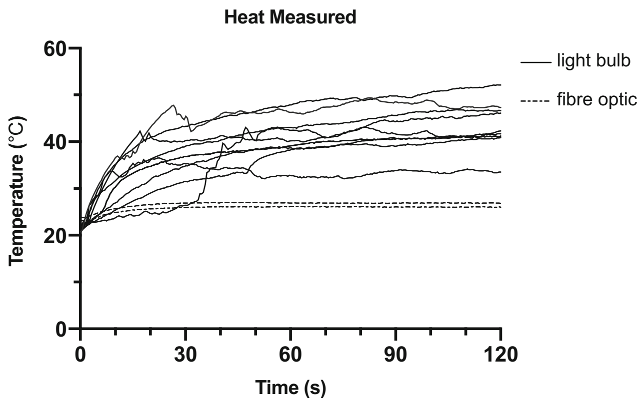

Fig. 1 Raw data showing the temperature versus time plots of ten light-bulb laryngoscopes over a period of 2 min

would make direct contact with the light bulb from commencement of a simulated intubation and for the duration of the procedure. An NI 9219 thermocouple module and an NI cRIO-9074 Real Time controller from National Instruments were used for data logging into a computerised system. This device had cold junction compensation on each input terminal and thermocouples were calibrated at 0 °C and 100 °C to ensure accurate temperature measurement. Tests were repeated three times to obtain 95% confidence intervals and to determine reproducibility of the measurements.

Power was supplied to the laryngoscope through the standard scope base unit which housed two AA alkaline 1.5 V batteries in series. The power from a battery tends to reduce during prolonged testing so new batteries were used for all of the testing. Once the laryngoscope head opens, the light simultaneously turns on via a pressure-based electrical contact switch. In the first set of tests on bulb devices, the temperature was measured directly at the incandescent bulb which protruded from the laryngoscope head. A second series of tests were performed on two newer fibre optic laryngoscopes. The incandescent light source was housed within the main body of the device and the light propagated through a fibre optic to the head of the device, where the temperature was measured. Measurements were taken every half a second for a 10 min duration from the point in time at which the light was turned on in all devices. The temperature fall times from closing and simultaneous turning off of the laryngoscope light were also recorded.

Results

Peak temperature was found to be consistently above 40 °C in four different brands across 10 devices of the first design system of light bulb protruding laryngoscope heads (Fig. 1). Temperature reached was affected by battery charge. Light bulbs reached maximum temperatures between 40 and 53 °C in less than 100 s. Beyond this time, the temperature of the bulbs can be seen to have risen to above 50 °C in the one device (Fig. 1). In comparison, the fibre-optic laryngoscope heads did not reach temperatures higher than 27.5 °C (Fig. 1). The temperature fall times from closing and simultaneous turning off of the laryngoscope light are presented in Fig. 2. The temperatures were all below 30° at a 1-min interval.

Discussion

Bulb laryngoscopes can reach 44 °C within 30 s. The findings from our study indicate that the bulb on blade light source

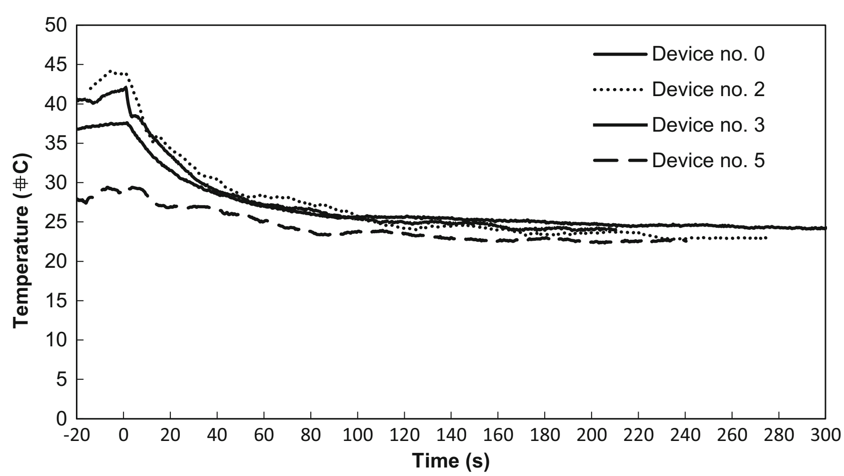

Fig. 2 Graph of the temperature versus time presenting the fall profile of temperature after closing and simultaneous powering off the laryngoscope

laryngoscopes tested reach sufficiently high temperatures to cause thermal injury to thin and fragile skin of a neonate, particularly those of preterm age, where the epithelium is less well developed. In the second trimester, the stratum corneum, the outermost protective epithelial layer, develops. It is a few layers thick before birth, compared with the typical 15 to 18 cell layers found in adults. Preterm skin is particularly vulnerable. Thermal injuries occur in adults with 6 h contact with a surface of 44 °C, in about 45 min at 47 °C, 30 s at 55 °C, and in only 1 s at 70 °C [5]. Following a burn, chemical mediators with vasoactive and tissue-destructive properties are released, including prostaglandins, bradykinin, serotonin, histamine, lipid peroxides and oxygen radicals. In the short term, there are haemodynamic changes associated with pain, including changes in blood flow to the brain [4]. In the longer term, it is purported that there are long-term neurodevelopmental consequences of noxious stimuli in the preterm brain [1]. More severe burns have caused disfigurement.

There is one previously reported case of a laryngoscope causing a burn to the flank an older child said to have been produced because of malposition of the blade on the light source causing a short circuit leading to rapid heating of the handle [6]. Another case report described a burn in a full-term neonate from a light-bulb laryngoscope, which recorded a maximum temperature of 78° [2]. Following this case report, the manufacturer issued a warning that due to the nature of the laryngoscope design, as the filament ages, the bulb may get hot during illumination and the ISO now has a standard warning stating that “lamps in an exposed position may generate heat sufficient to burn human tissue”.

During our experiment, we found that the heat generated at the bulb also depended on the power in the batteries. Loose connections at the bulb socket potentially also increased the amount of current required to light the bulb, therefore producing more heat. These bulbs are screwed in and out for autoclaving. It was difficult for us to determine the age of each laryngoscope handle and blade, or indeed how many times the bulb had been removed for autoclaving. There is an inherent design flaw in bulb-operated laryngoscopes, as the device ages. The modern light emitting diodes (LED) laryngoscope with fibre-optic heads may be a safer design, as the temperature does not rise. In addition, the spectral irradiance of the laryngoscopes with LEDs have been said to more closely approximate to the photopic response of the human eye [3].

In conclusion, within 60 s, laryngoscopes with light-bulb sources from four different manufacturers had gained significant heat to potentially damage preterm skin, some within 30 s. This represents a trend towards overheated appliances. This damage may occur after the laryngoscope has been ‘on’ for over 30 s, particularly if equipment is set up in anticipation of intubation. Operators should be aware of the blade’s potential to overheat. We recommend that LED sources with fibre-optic heads are the laryngoscope of choice in neonatal units and that training in this critical procedure incorporates the closing of the laryngoscope blade between intubation attempts. Bulb laryngoscopes remain in use; hence, this safety advice should be incorporated into intubation guidelines.

Authors’ contributions ER drafted the study. All authors were involved in the design of the experiment. PON performed the experiment and recorded the results under DB’s supervision. ER wrote the final manuscript. JFA critically revised and approved the manuscript.

Compliance with ethical statements

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants/and or animals “This article does not contain any studies with human participants or animals performed by any of the authors.”

Consent No individual participants included in the study.”

References

1. Grunau RE, Holsti L, Haley DW, Oberlander T, Weinberg J, Solimano A, Whitfield MF, Fitzgerald C, Yu W (2005) Neonatal procedural pain exposure predicts lower cortisol and behavioral reactivity in preterm infants in the NICU. Pain 113(3):293–300. https://doi.org/10.1016/j.pain.2004.10.020
2. Koh TH, Coleman R (2000) Oropharyngeal burn in a newborn baby: new complication of light-bulb laryngoscopes. Anesthesiology 92(1):277–279
3. Lewis E, Zatman ST, Wilkes AR, Hall JE (2009) Laryngoscope light output. Anaesthesia 64(6):688–689. https://doi.org/10.1111/j.1365-2044.2009.05948.x
4. Mainous RO, Looney S (2007) A pilot study of changes in cerebral blood flow velocity, resistance, and vital signs following a painful stimulus in the premature infant. Adv Neonatal Care 7(2):88–104
5. Moritz AR, Henriques FC (1947) Studies of thermal injury: II. The relative importance of time and surface temperature in the causation of cutaneous burns. Am J Pathol 23(5):695–720
6. Toung TJ, Donham RT, Shipley R (1981) Thermal burn caused by a laryngoscope. Anesthesiology 55(2):184–185