

Laryngoscope illuminance in a tertiary care medical center: industry standards and implications for quality laryngoscopy

Approximately one in five reusable laryngoscopes did not meet published illuminance standards in a tertiary-level medical center

Superior mean light output was observed with xenon and LED laryngoscopes compared with incandescent laryngoscopes

Objective

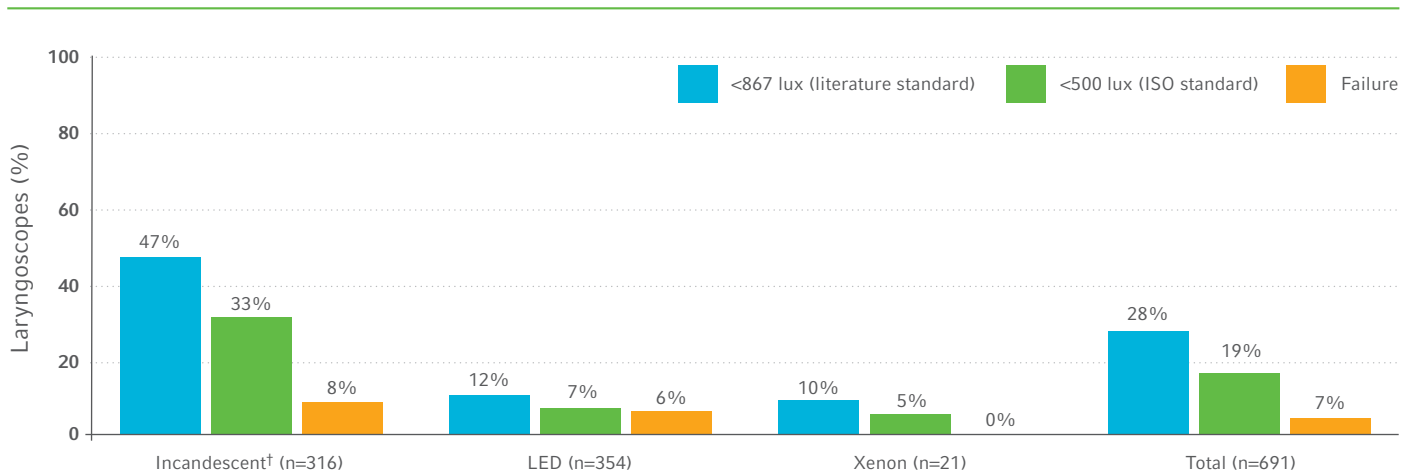
- To evaluate laryngoscope illuminance in a tertiary-level medical center against established standards and to identify factors associated with poor illuminance

Methods

- This was a cross-sectional observational study undertaken in a medical center including a general hospital, level 1 trauma facility, and specialty cardiac hospital
- Reusable laryngoscopes from the operating rooms, emergency department, outpatient surgical and diagnostic unit, and airway code carts were tested
 - Xenon systems consisted of a light box, fiber-optic cable, laryngoscope, and light carrier

- Battery-powered laryngoscopes consisted of a blade and handle
- Laryngoscope illuminance was evaluated using a light-proof wooden box, laryngoscope positioning system and light meter
 - Laryngoscopes were positioned inside the box in a standard fashion using a mechanical arm and the light projected against a light meter
 - Three serial measurements were taken at 10-second intervals for each laryngoscope to provide a mean illuminance value for the device
 - In contrast to the ISO criterion for illuminance, which specifies a test duration of 10 minutes, a much shorter duration (30 seconds) was used in this study; thus, the results are likely to overestimate device performance with respect to ISO standards
 - During testing, components (i.e., handles and blades) for each type of laryngoscope were randomly paired to simulate clinical use
 - Laryngoscopes that failed to illuminate after 5 attempts were assigned an illuminance of 0 and classified as "failing"

Figure 1. Percentage of reusable laryngoscopes that failed to meet published illuminance standards



† Includes bulb-on-blade (n=237) and bulb-in-handle (n=79) laryngoscopes with incandescent bulbs

Results

- Overall, 691 laryngoscopes were evaluated:
 - Type 1, incandescent "bulb-on-blade": code carts, emergency department (n=237)
 - Type 2, incandescent "bulb-in-handle": cardiac operating rooms (n=79)
 - Type 3, light-emitting diode (LED) in handle: main operating room, outpatient surgical and diagnostic unit (n=354)
 - Type 4, xenon light source and fiber optic light carrier: main operating room, outpatient surgical and diagnostic unit (n=21)
- Overall, 19% and 28% of laryngoscopes tested fell below the published illuminance standards of 500 lux (ISO standard) and 867 lux (literature standard), respectively (Figure 1)
 - Of the devices tested, 33% of incandescent laryngoscopes, 7% of LED laryngoscopes and 5% of xenon laryngoscopes did not meet the ISO standard of 500 lux
- Significant differences in mean light output were observed between all groups (Table 1)

Table 1. Mean light output by device type

	ILLUMINANCE, MEAN (SD), LUX	BETWEEN-GROUP DIFFERENCE‡
Incandescent bulb-on-blade (n=237)	810 (700)	P<0.001
Incandescent bulb-in-handle (n=79)	1860 (1220)	P<0.001
LED (n=354)	4730 (3210)	P<0.001
Xenon (n=21)	28,800 (34,500)	P<0.001

‡ one-way analysis of variance (ANOVA)
SD, standard deviation

- The lowest light outputs were recorded with incandescent bulb-on-blade laryngoscopes while LED laryngoscopes demonstrated a mean illuminance that was more than 2.5 times greater than the best incandescent laryngoscopes
- The causes of substandard light output or light failure were not examined within the study; however, possible causes were suggested (Table 2)

Table 2. Possible causes of substandard light output or light failure

Nearly depleted battery
Faulty connection that reduces voltage applied to the bulb or inhibits electron flow
Wearing of the bulb during the cleaning process causing lens clouding
Blown bulb

Conclusion

- Approximately one in five (19% and 28%, respectively) reusable laryngoscopes in a tertiary-level medical center did not meet illuminance standards based on two established metrics (500 lux, ISO standard; 867 lux, literature standard)
- Among battery-powered devices, LED laryngoscopes were superior to incandescent laryngoscopes with a 2.5 times greater mean illuminance reported
- Compared with battery-powered devices, xenon laryngoscopes were an order of magnitude brighter
- The authors noted that, *"Our findings indicate that the quality of laryngoscope light is an area that can be overlooked by hospital quality assurance programs. Proper attention must be paid to laryngoscope maintenance to ensure optimal function, especially for bulb-on-blade style laryngoscopes."*