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Adoption of airway management guidelines during COVID-19 pandemic improved endotracheal intubation success

To the Editor,

Since the emergence of the novel COVID-19 virus in November 2019, there has been significant concern for occupational risk to anesthesiologists involved in airway management in the peri-operative period. As even pre-symptomatic patient may transmit the virus [1], multiple professional societies issued recommendations for safe endotracheal intubation for all peri-operative patients [2–6]. In our health system, the implemented guidelines stated that all patients should undergo rapid-sequence intubation, avoidance of mask ventilation, universal video laryngoscope use, and intubation by the most experienced provider. These changes were instituted for the safety of the airway management teams, and yet the effect on patient outcomes, such as safe and effective intubations, is unknown. We investigated how this rapid and large-scale shift in airway management practice in a real-world setting impacted the rate of first-time successful intubation in our health system.

Institutional Review Board exemption for this project was granted by the Brigham and Women's Hospital IRB Committee. We analyzed surgeries under general endotracheal anesthesia from the time that our health system adopted airway management guidelines on 3/23/2020, until the time when our health system started scheduling more elective cases on 5/21/2020 ($n = 3344$); we compared this to a cohort of surgeries occurring under general endotracheal anesthesia from the year prior ($n = 36{,}789$). Cases were identified through query of our electronic health record in retrospective fashion. Surgical cases were excluded from consideration if the patients were less than 18 years old, if there were multiple successful intubations documented for the case, ASA status of 6 or ASA status was missing, the number of attempts until successful intubation was missing, or if the urgency of the case was not known. Surgeries that took place at hospitals in our health system with less than 100 cases with recorded urgency after the initiation of airway guidelines were excluded.

Multivariable segmented mixed effects logistic regression was used to estimate the association between airway management guideline adoption and the odds of first-time intubation success, video laryngoscopy use, rapid sequence intubation, use of mask ventilation, and attending-only intubation adjusting for hospital, age, sex, emergent/urgent vs. non-urgent/elective surgery, and ASA class. Segmented regression was used to account for pre-guideline levels and trends in outcomes, and mixed effects models with random intercepts and first-order autoregressive correlation structure were used to account for the correlation between multiple surgeries on the same patient. A p-value <0.05 was considered significant.

After airway management guidelines were set, anesthesia providers in our health system adhered to most of these guidelines. Specifically, video laryngoscopy use increased (Odds Ratio 6.01 [95% C.I. 5.09–7.11], $p < 0.001$, Fig. 1A), as did use of rapid sequence intubation (OR 11.21 [9.36–13.42], $p < 0.001$, Fig. 1B). Mask ventilation prior to intubation decreased (OR 0.04 [0.03–0.05], $p < 0.001$, Fig. 1C). However, there was no change in the number of intubations done exclusively by attending anesthesiologists (Fig. 1D).

Coincident to these changes in airway management, there was a significant increase in successful intubation on first attempt (OR 1.66 [1.21–2.28], $p = 0.002$, Fig. 2). Furthermore, there was a greater increase in the odds of successful intubation on first attempt in cases using video laryngoscopy (OR 2.91 [1.99–4.25]) than in cases not using video laryngoscopy (OR 1.31 [0.73–2.35]) (p-value for interaction = 0.025). That is, despite what could be cumbersome requirements for personal protective equipment, improved odd of first-intubation success was seen, especially with the use of video laryngoscopy.

While we think the relationship between increased use of video laryngoscopy was causal to our increased odds of first-attempt intubation success, we were unable to directly test this. Video laryngoscopy is most likely to be beneficial for trainees in helping secure first-attempt intubation success [7,8]. Indeed, our data shows that trainees had increased odds of first-attempt intubation after our airway management guidelines were adopted (OR 1.72 [1.2, 2.47]), but this was not the case for attending only intubations (OR 0.82 [0.41, 1.66]). We speculate that the attending subgroup did not have increased odds of first-attempt intubation success after the pandemic guidelines were issued due to a mixture of more experience with laryngoscopy as well as more expert judgement in when video laryngoscopy was needed prior to the pandemic airway guidelines. Previous study showed that 35.6% of anesthesia providers (both trainees and attending anesthesiologists) would attempt direct laryngoscopy first and use video laryngoscopy (or fiberoptic intubation) as their back-up device for anticipated difficult intubation [9]. If video laryngoscopy use more generally is responsible for the increased odds of first attempt intubation success, further emphasis could be placed on initial video laryngoscopy use in difficult airway management, especially for trainees.

We were unable to investigate other metrics of patient safety in airway management, such as time until intubation, development of hypoxemia, or any morbidity or mortality. Nor were we able to further quantify how our airway guidelines affected occupational exposure, e.g. by quantifying amount of aerosolized particles around the provider [10]. It seems plausible that maximizing the odds of first attempt intubation would minimize the total exposure time of the provider and thus minimize risk. Another limitation in our study is that there might have been other unknown and confounding changes that occurred simultaneously with our adoption of our new airway guidelines, preventing us from establishing a causal link with first-attempt intubation. While other long-term trends, such as the steady maturation in intubating skills of trainees, might also lead to improvement in first-attempt intubation, one

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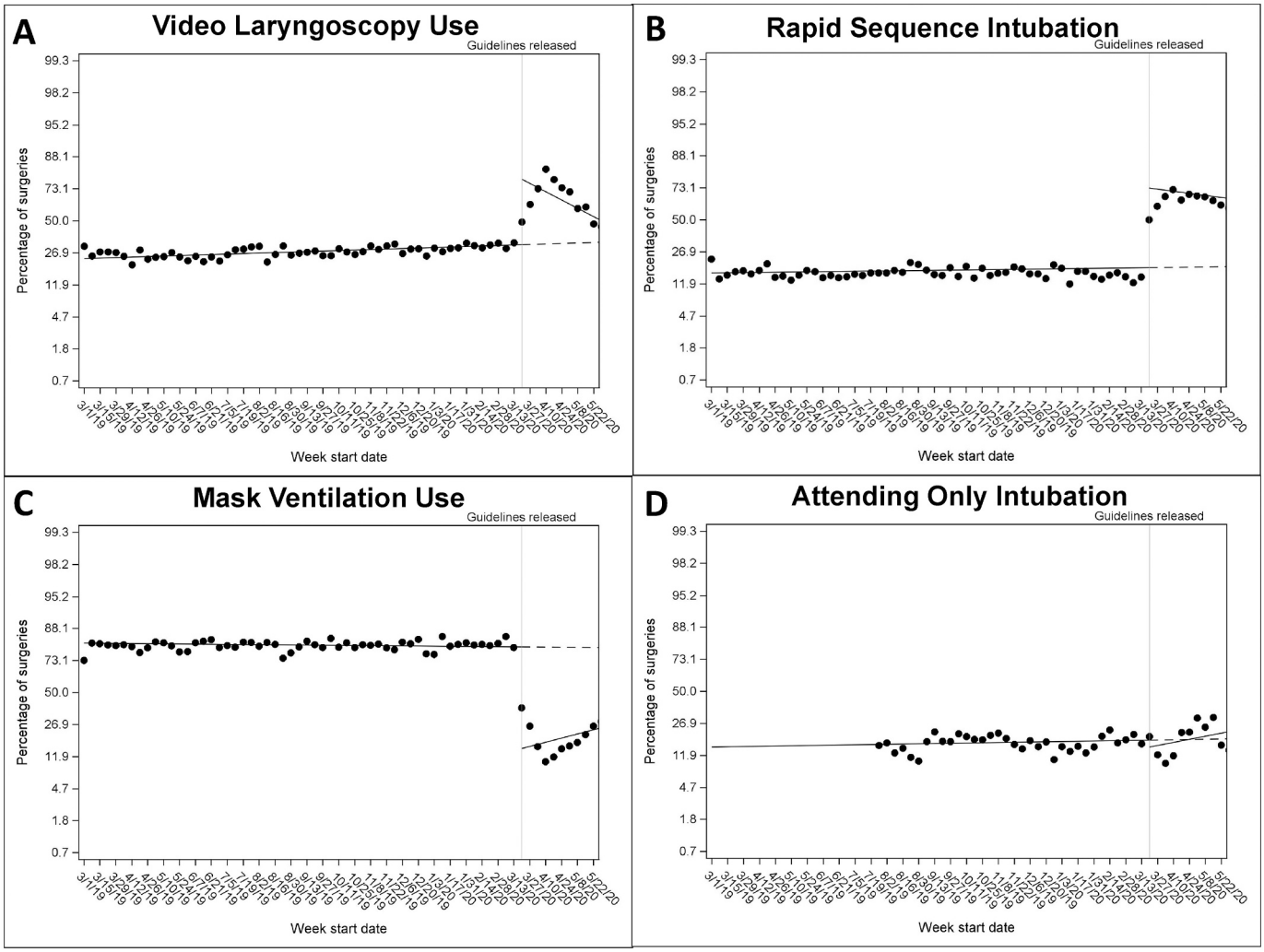

Fig. 1. Interrupted time series plots of intubation approaches before and after COVID-19 airway management guideline implementation, unadjusted for patient or surgery characteristics. In each panel, the vertical axis is on the logit scale to correspond to the logistic regression analysis. The black dots represent the weekly percentage of surgeries with the corresponding intubation characteristic. The solid black lines represent the outcome slopes in the pre-implementation and post-implementation periods, estimated using mixed effects logistic regression. The dashed black line represents the projected post-implementation trend in percentage of surgeries with the corresponding intubation characteristic, estimated with a mixed effects logistic regression model using only pre-implementation observations. The gray vertical line represents the date of guidelines implementation (3/23/2020). A) Video laryngoscopy use increased after the initiation of COVID-19 airway management guidelines (OR 6.01 [95% C.I. 5.09–7.11], $p < 0.001$). B) Rapid sequence intubation also increased (OR 11.21 [9.36–13.42], $p < 0.001$). C) Mask ventilation prior to intubation decreased (OR 0.04 [0.03–0.05], $p < 0.001$). D) There was no significant change in the number intubations done exclusively by attending anesthesiologists. Airway staff was only available in the electronic medical record from starting from 7/21/2019. All post vs. pre-implementation comparisons were performed using segmented logistic regression.

of the strengths of segmented logistical regression is to compare, and thus account for, changes in trends over time.

It is unclear if the experience at other health systems was similar to the experience of our health system and if any differences were due to different simulation and training practices. More research is needed to further understand how sudden and significant changes in airway management practice can safely be implemented in the real-world. Nevertheless, at our institution we saw that the changes to airway management implemented during the COVID-19 pandemic, such as avoidance of mask ventilation, increased use of rapid sequence intubation, and universal use of video laryngoscopy led to improvement in first-attempt intubation success. These changes were not only necessary for the safety of perioperative airway staff but led to safe and improved airway management for patients.

Disclosures

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Declaration of Competing Interest

The authors declare no competing interests.

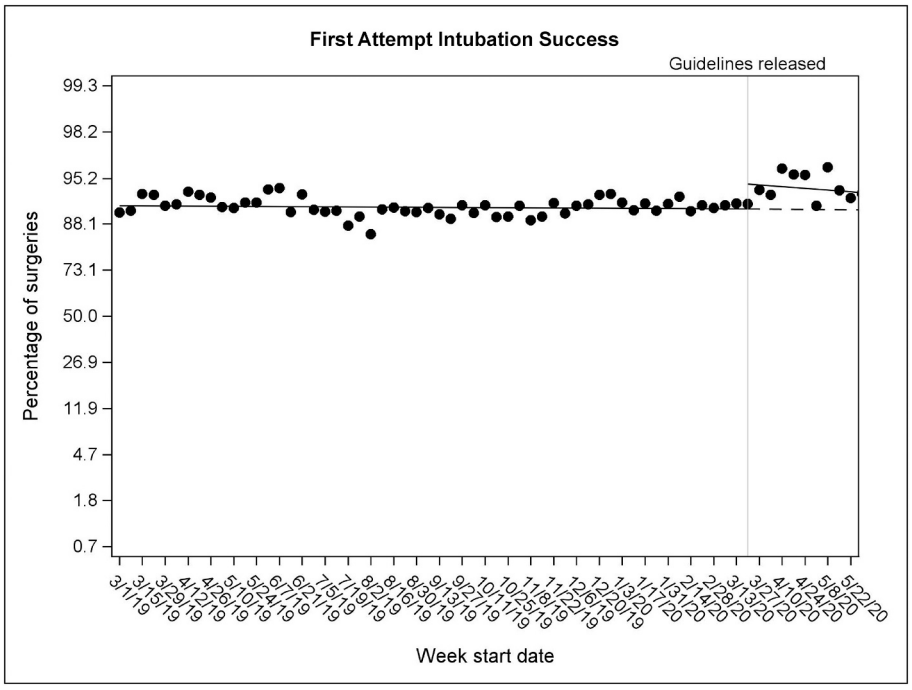

Fig. 2. Interrupted time series plot of first attempt intubation success before and after COVID-19 airway management guideline implementation, unadjusted for patient or surgery characteristics. The vertical axis is on the logit scale to correspond to the logistic regression analysis. The black dots represent the weekly percentage of surgeries with the corresponding intubation characteristic. The solid black lines represent the outcome slopes in the pre-implementation and post-implementation periods, estimated using mixed effects logistic regression. The dashed black line represents the projected post-implementation trend in percentage of surgeries with the corresponding intubation characteristic, estimated with a mixed effects logistic regression model using only pre-implementation observations. The gray vertical line represents the date of guidelines implementation (3/23/2020). First attempt intubation success rate increased after the initiation of COVID-19 airway management guidelines (odds ratio 1.66 [95% CI: 1.21–2.28], $p = 0.002$, segmented logistic regression).

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