CHEST Online Supplement

Practice, Outcomes, and Complications of Emergent Endotracheal Intubation by Critical Care Practitioners During the COVID-19 Pandemic

Peter C. Nauka, MD; Jen-Ting Chen, MD; Ariel L. Shiloh, MD; Lewis A. Eisen, MD; and Daniel G. Fein, MD

CHEST 2021; 160(6):2112-2122

 DOI: 10.1016/j.chest.2021.06.008

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e-Appendix 1.

Overview

This document outlines our descriptive study of the techniques, success and complications of emergency endotracheal intubation during the examined time period of the COVID-19 pandemic as compared to the time period prior to the COVID-19 pandemic.

Background and Aims

There is limited evidence describing the way in which the COVID-19 pandemic changed the practice of emergency airway management, the outcomes, and the complications that may result from the procedure.

The aims of our study are to compare the following before and after the onset of the COVID-19 pandemic:

1. The techniques of emergency endotracheal intubation.
2. The outcome of emergency endotracheal intubation as measured by the rate of first pass success.
3. The rate of pre-defined complications during and immediately following the procedure.

Study Design

Retrospective observational cohort study of all patients admitted to the three campuses of Montefiore Medical Center between July 19th, 2019 and May 1st, 2020.

Study Hypothesis

During the COVID-19 pandemic emergency endotracheal intubation may be performed differently, have different success rates and have variable procedural complications as compared to the same procedure performed on patients prior to the COVID-19 pandemic.

Data Sources

Almost all data will obtained from Clinical Looking Glass (CLG) (Clinical Analytics, NY, NY). CLG is a tool developed at our instituation,[1] is well-validated and has been utilized in numerous other investigations.[2] Oxygen saturation immediately preceding intubation was extracted by manual chart review. Chart review was performed by a trained study investigator. The oxygen saturation recorded in the electronic medical record most immediately proximal to the examined intubation procedure was recorded.

Cohorts

We include all patients admitted to our tertiary care hospital between July 19, 2019 and May 1, 2020. Patients will be included in the final cohort if they underwent emergency endotracheal intubation outside of the emergency department or operating room. Intubations were excluded if age was less than 18 at time of intubation, if outcome data regarding first pass success was missing or if the intubation was a repeat procedure on the same patient during the study time period.

Outcomes

Rate of first pass success of the intubation procedure preceding as compared to during the pandemic

Practice changes of airway management preceding as compared to during the pandemic as defined by

- Rate of use of video laryngoscopy during first intubation attempt
- Rate of use of paralytics during first intubation attempt

Rate of complications following laryngoscope blade insertion and in the 5 minutes following the intubation procedure including the following:

- Peripheral oxygen saturation less than 80%
- Systolic blood pressure less than 70 mm Hg
- Esophageal intubation
- Witnessed aspiration of gastric contents
- Difficult intubation as defined by greater than two attempts at laryngoscopy
- Patient mortality in the 24 hours following the procedure.

Exposure

The primary exposure of interest is intubation during the COVID-19 pandemic as defined by occurring between March 11th, 2020 up to and including those performed on May 1st, 2020. The comparison pre-pandemic group is defined as all intubations taking place between and including July 19th, 2019 and up to and including March 10th, 2020.

Variables

The following variables will be reported as part of our descriptive work:

- Mean Age (years)
- Male Sex
- Body mass index
- History of obstructive sleep apnea (diagnosis 5 years around cohort inclusion)
- Race (Black, White, Other/Not Specified)
- Socioeconomic score
- Laboratory based acute physiology score
- Charlson Comorbidity Index
- COVID-19 Testing (Positive, Negative, Not Performed)
- Campus (Moses, Wakefield, Einstein, Children's Hospital at Montefiore)
- Location of Intubation (Floor, ICU, Other)
- Last available peripheral saturation (SpO2) prior to Intubation
- Last available SpO2/FiO2 ratio prior to Intubation
- PaO2/FiO2 Ratio After Intubation (< 100, 100 – 200, 200 – 300, > 300)
- Use of Vasopressors
- Indication for intubation (Hypoxemia, Airway Protection, Cardiac Arrest, Hypercarbia, Hemodynamic Instability, Other)
- Cormack-Lehane Grade (Grade 1, Grade 2a, Grade 2b, Grade 3, Grade 4)
- Any Pre-oxygenation (bag-valve mask, non-rebreather mask, non-rebreather mask + bag-valve mask, non-rebreather mask + high-flow nasal cannula, non-rebreather mask + regular nasal cannula, high-flow nasal cannula, regular nasal cannula, noninvasive ventilation, none)
- Any Apneic Oxygenation (high-flow nasal cannula, regular nasal cannula, none)
- Any Sedation (Etomidate, Propofol, Ketamine, Fentanyl, Midazolam)
- Any Paralytics (Succinylcholine, Rocuronium, Vecuronium)
- Use of Video Laryngoscopy
- Use of Bougie

- Non-attending Operator
- Anesthesia Operator

Primary Analysis Plan
We will conduct the following analyses:

Standard summary statistics will be used to describe the above variables in the total cohort and cohorts divided by pandemic versus pre-pandemic.

Standard summary statistics will be used to describe the examined outcomes of first pass success, difficult intubation and complications including procedural hypoxemia, hypotension, aspiration of gastric contents, esophageal intubation and mortality within 24 hours of intubation.

Exploratory logistic regression models will be analyzed with the following covariates:

For first pass success, composite of any complication and mortality after 24-hours using unadjusted logistic regression will be used to impact of the pandemic time period.

For the dependent variables of first pass success and any peri-procedural complication there will be an adjusted model using logistic regression for age, sex, race, campus, body mass index, history of obstructive sleep apnea, use of video laryngoscopy, last available SpO2/FiO2 ratio prior to intubation use of neuromuscular blockade, lack of operator anesthesia training and non-attending operator status.

For the dependent variable of mortality within 24 hours of intubation, there will be an adjusted model using logistic regression for the covariables of age, sex, race, socioeconomic status, hospital campus, Charlson comorbidity index and laboratory based acute physiology score.

Sensitivity Analysis
We will perform one sensitivity analysis. It will involve performing the above analyses designated in the primary analysis with removal of all cases of emergent endotracheal intubation performed for the indication of cardiac arrest as documented by the intubation operator in their procedure note.

Role of Funders
The study is not funded.

Post-Analysis Dissemination
The investigators will synthesize study results for presentation at an international conference and publication in a peer-reviewed journal.

1. Bellin E, Fletcher DD, Geberer N, Islam S, Srivastava N. Democratizing information creation from health care data for quality improvement, research, and education-the Montefiore Medical Center Experience. *Acad Med.* 2010;85(8):1362-1368.
2. Fein DG, Mastroianni F, Murphy CG, et al. Impact of a Critical Care Specialist Intervention on First Pass Success for Emergency Airway Management Outside the ICU. *J Intensive Care Med.* 2019:885066619886816.

e-Appendix 2.

Data Abstraction Plan

Primary cohort:

Inclusion: All patients admitted and with intubation procedure note performed by critical care personnel outside of operating room and emergency department between July 19th, 2019 and May 1st, 2020.

COVID Testing:

Extracted from clinical looking glass with as primary cohort all SARS-COV-2 (COVID-19) lab tests done 30 days around inclusion event.

Death:

Extracted from clinical looking glass with as all deaths within 24 hours of cohort inclusion.

Socioeconomic status:

Calculated by clinical looking glass using census data regarding wealth and income of place of residence. Represented by number of standard deviations from mean SES score for New York State.

Vasopressor administration:

Extracted from clinical looking glass with as all administrations of either epinephrine, norepinephrine, phenylephrine, dopamine drip one hour before or 72 hours following cohort inclusion.

Pre-intubation oxygen saturation:

Oxygen saturation immediately preceding intubation was extracted by manual chart review. Chart review was performed by a trained study investigator. The oxygen saturation recorded

in the electronic medical record most immediately proximal to the examined intubation procedure was recorded.

Pre-intubation SpO2/FiO2:

Oxygen saturation prior to intubation was extracted as described above. Oxygen device and fraction of inspired oxygen (FiO2) is routinely recorded by nursing staff within the medical records. In cases where FiO2 was not recorded, it was extrapolated using the following conversions:

Device	**Flow Rate (L/min)**	**Fio2**
Room Air	N/A	0.21
Nasal Cannula	1	0.24
	2	0.28
	3	0.32
	4	0.36
	5	0.40
	6	0.44
	7	0.48
	8	0.52
Nonrebreather Mask	10-15	1.00
Venturi Mask		
	2	0.24
	4	0.28
	6	0.31
	8	0.35
	10	0.40
	15	0.60
High Flow Nasal Cannula		
	40-60	0.40 – 1.00

In several cases, nasal cannula and nonrebreather flow rates were not specified. In those instances, an FiO2 of 28% and 100% were imputed for nasal cannula and nonrebreather.

Post-intubation oxygen saturation:

Extracted from clinical looking glass with as first peripheral saturation within first three hours following intubation.

PaO2:

Extracted from clinical looking glass with as first PaO2 entered within the first three hours after intubation.

FiO2:

Extracted from clinical looking glass with as first FiO2 entered within the first three hours after intubation.

Race:

Extracted from clinical looking glass as Black or African-American, White, Asian, Patient declined, Patient unavailable.

LAPS:

Extracted from clinical looking glass for time point of cohort entry based on albumin, BUN, creatinine, glucose, PCO2, hematocrit, pH, PO2, sodium, total bilirubin, troponin, WBC

Charlson Score:

Calculated by clinical looking glass based on comorbidity diagnoses including myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatic disease, peptic ulcer disease, mild liver disease, diabetes with chronic complications, hemiplegia or quadriplegia, renal disease, any malignancy, moderate or severe liver disease, metastatic solid tumor, AIDS/HIV and age.

Diagnosis of OSA:

Extracted from clinical looking glass with diagnosis of OSA made five years before or after time of cohort inclusion.

Body mass index:

Extracted from clinical looking glass with body mass index calculated one month before or after time of cohort inclusion.

Indication for intubation:

Extracted from intubation note documentation as one or more of the following:

- Hypoxemic respiratory failure
- Hypercapnic respiratory failure
- Airway protection
- Hemodynamic instability
- Cardiac arrest
- Procedure
- Other

Cormack Lehane Grade:

Extracted from intubation note documentation.

Pre-oxygenation:

Extracted from intubation note documentation as one of the following:

- NIV
- Non-rebreather
- Regular nasal cannula
- High flow nasal cannula
- Bag-mask ventilation
- Other

Apneic Oxygenation:

Extracted from intubation note documentation as one of the following:

- None
- Regular nasal cannula
- High flow nasal cannula

Sedation or paralysis administration:

Extracted from intubation note documentation.

Use of video laryngoscopy:

Extracted from intubation note documentation.

Use of bougie:

Extracted from intubation note documentation.

Non-attending operator:

Name of operator extracted by intubation note documentation from clinical looking glass followed by designation in stata as either attending or non-attending (if fellow or PA).

Non-anesthesia operator:

Name of operator extracted by intubation note documentation from clinical looking glass followed by designation in stata as either attending or non-attending (if fellow or PA).

First attempt success (similar documentation for following attempts if applicable):

Extracted from intubation note documentation as one of the following:

- Yes
- No

Procedural hypoxemia:

Extracted from intubation note documentation as defined by saturation drop < 80%:

- Yes
- No

Hypotension:

Extracted from intubation note documentation as systolic blood pressure drop < 70 as:

- Yes
- No

Gastric aspiration:

Extracted from intubation note documentation as witnessed vomiting of gastric contents into the airway as:

- Yes
- No

Esophageal intubation:

Extracted from intubation note documentation as

- Yes
- No

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e-Table 1. Intubation outcome measures prior and during pandemic conditions

	Pandemic	Pre-Pandemic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Full Cohort (n = 1280)				
First pass success, n (%)	461 (96.4%)	648 (82.9%)	5.61 (3.34, 9.42)	4.91 (2.65, 9.11)
Any Complication, n (%)	141 (29.5%)	119 (15.2%)	2.33 (1.77, 3.08)	2.21 (1.51, 3.04)
24-Hour Mortality	92 (19.3%)	143 (18.3%)	1.06 (0.80, 1.42)	1.26 (0.86, 1.84)
Cardiac Arrests removed (n = 1125)				
First pass success, n (%)	443 (96.3%)	553 (83.2%)	5.28 (3.12, 8.92)	3.89 (2.15, 7.05)
Any Complication, n (%)	134 (29.1%)	94 (14.1%)	2.50 (1.86, 3.36)	2.48 (1.72, 3.57)
24-Hour Mortality	84 (18.3%)	74 (11.1%)	1.78 (1.27, 2.50)	2.48 (1.59, 3.88)

First pass success and any periprocedural complication were adjusted for age, race, sex, campus, body mass index, OSA history, video laryngoscopy use, neuromuscular blocker use, non-anesthesia training, non-attending status and last available SpO2/FiO2 prior to intubation.

Any complication was defined as a composite of peri-procedural hypoxemia, hypotension, witnessed gastric aspiration or esophageal intubation.

Mortality was adjusted for age, sex, race, SES, hospital campus, Charlson Comorbidity Index, Laboratory-Based Acute Physiology Score.

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e-Figure 1. Institutional COVID intubation protocol

COVID Intubation protocol

Outside of Room:

1. Ensure appropriate PPE is available and used correctly
2. Sedation/induction of anesthesia will be performed with **full sedation and paralysis** - prepare and label all sedatives, paralytics, and pressors prior to entering the room
3. Ensure end tidal capnography, viral filter, and tube holder are available
4. Program the vent with expected settings and place end tidal and viral filter inline
5. Have sedatives available and program sedative PCA
6. All intubations will be performed with Glidescope video laryngoscopy and equipment should be prepared outside the room

Inside the Room:

7. Ensure patient is on vitals machine with pulse oximetry
8. Avoid bag mask ventilation, instead use passive/apneic oxygenation
9. With Glidescope, ensure operator is at arm's length distance from patient's airway
10. Once intubated, place and place directly on vent with end tidal capnography and viral filter in line. Avoid bag ventilation if possible.
11. Use succinylcholine initially, vecuronium/rocuronium when succinylcholine is not indicated

Staffing for Intubation:

No more than 4 people in the room at the time of intubation

One person must be available outside the room to communicate with the staff inside the room

e-Figure 2. Institutional COVID-19 intubation pre-entry checklist

COVID-19 Intubation Pre-entry Checklist

For Providers

To bring inside room:
Inside room
☐ Glidescope
(Only bring in blade(s) you will be using + Glidescope stylet)
☐ Airway Tray
☐ Colorimetric end-tidal CO2 detector

Keep outside room (on standby):

☐ Airway cart (never bring in room)

For Nursing

☐ Etomidate
☐ Succinylcholine or rocuronium
☐ Propofol +/- fentanyl (adequate post-intubation sedation must be assured before providers leave the room).
☐ Norepinephrine infusion
☐ IV normal saline 1 liter fluid

For Respiratory Care

☐ Ventilator with appropriate filters
☐ ET securing device
☐ HEPA filter for Ambu-bag

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e-Figure 3.