Effectiveness of Pre-Anesthetic Induction Checklist in Improving General Anesthesia Induction Set-Up in a Simulated Setting during the Covid-19 Pandemic*

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Abstract

Background: Anesthesiologists being under high pressure and in a stressful environment may predispose to poor pre-induction preparation. The pre-induction period was identified to be a circumstance where medical errors occur. Thus, routine use of checklists is implemented to prevent these.

Methods: A Pre-Anesthesic Induction Checklist was formulated and validated by the members of Department of Anesthesiology and Perioperative Medicine staff. The study was designed as a pragmatic trial, quality improvement, and quasi-experimental conducted in the hospital's main operating room in a simulated setting. The participants included sixteen (16) anesthesiology residents who were divided into two groups, without a checklist and with a checklist, with an equal number of residents per year level who underwent eight simulated general anesthesia induction set-ups each.

Results: The checklist was used in 64 out of 128 simulations. The group with the checklist had an average completeness score of 95.26% and an average duration of 7.06 minutes compared to the group without the checklist, which had an average score of 70.81% and an average time of 8.75 minutes. Thus, there is an average 24.45% decrease in missed steps and an average 1.69-minute decrease in preparation duration among the residents who used the checklist. In the 128 simulations done, the most common actions and items missed of >20% are the following: Succinylcholine (67.97%), laryngeal mask airways (62.50%), confirmation of identifying factors of patients (55.47%), checking of vaporizer (42.97%), checking of sodasorb (36.72%), checking of breathing circuit (30.47%), video laryngoscope (26.56%), and suction (25.00%).

Conclusion: The mean total duration of preparation and mean completeness score between with checklist and without checklist groups are significantly different, both having a p-value of <0.0001. The Pre-Anesthetic Induction Checklist significantly reduced the number of missed steps and the duration of preparation time of a simulated pre-anesthesia induction period.

Keywords: checklist, general anesthesia induction, simulation

INTRODUCTION

In the year 2020, Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome-Coronavirus-2 (SARS-CoV-2) that originated from Wuhan, China rapidly spread globally and contagiously thru human respiratory secretions.[1] Infecting millions of people all over the world, COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020.

The lack of information about the virus predisposed healthcare workers to infection due to close encounters with aerosol droplets.[1] Anesthesiologists, being the front liners in airway management, were constantly exposed to infected respiratory secretions. Thus, the COVID-19 pandemic brought about challenges and modifications in the operating room to heightened precautions.[2] Healthcare institutions were obligated to implement updated protective measures and modify customary practices to minimize perioperative viral transmission and protect both the patient and healthcare workers.[3] This mandate involved changing anesthetic practices to lessen aerosol-generating procedures during general anesthesia induction.[4]

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The practice of anesthesiology has been at the forefront of improving patient safety through the years. However, due to the challenges imposed by the Covid-19 pandemic, the role of anesthesiologists also sheds light on infection prevention.[5] With the changing times and practices, medical errors may be unavoidable. In line with this, the pre-anesthetic induction period was identified as a circumstance where medical errors occur; thus, routine use of checklists are implemented to prevent these. Subsequently, anesthesiologists are under high pressure, and a stressful environment may dispose to poor pre-induction preparation.[6] This study aims to test the effectiveness of the Pre-Induction checklist in improving the set-up of general anesthesia induction in a simulated Covid-19 operating room setting of anesthesiology residents.

METHODOLOGY

Population

The study participants include sixteen (16) residents undergoing training in Anesthesiology. All residents from the first to the third year participated in the study. Pre- residents, pre-fellows, and rotators from other departments and residents who previously consented to the study but later on decided to withdraw, were excluded from the study.

Study Design

The study was designed as a pragmatic trial, quality improvement, quasi-experimental conducted in the hospital's main operating room in a simulated setting.

Statistical Analysis

Descriptive statistics summarized the demographic profile of the participants. Numerical variables were described as mean and standard deviation if the data was normally distributed as assessed by the Shapiro-Wilk test of normality, or median and interquartile range if otherwise. Count and proportion described categorical variables.

Two-way ANOVA was used to compare the mean difference in the total duration of preparation and the mean difference in the completeness score between with checklist and without checklist groups, with the resident as the blocking variable. A subgroup analysis using ANOVA was done to determine if the residency year level affects the duration and completeness score of the participants. The most commonly missed step/item was presented as count and proportion.

Data Collection and Data Analysis

After the approval of the IRB and Ethics Board, several members of the Anesthesiology department conducted an adaptation and content validation of the Pre-Anesthetic Induction Checklist. The panel included residents in training, fellows, junior consultants and medical specialists to ensure the relevance and applicability of the checklist to the local setting.

The checklist was applied in a simulated setting with two test groups, one group using a checklist and one group without a checklist. Residents were asked to prepare stations before general anesthesia induction. The minimum sample size requirement was computed using R version 4.0.3. A sample size of at least eight stations was required to achieve 80% power at a 5% two-tailed significance level in a two-way ANOVA with two groups (without a checklist, and with a checklist) with eight residents participating in each group, to identify a significantly different mean duration and mean completeness score, with medium effect size (Cohen's f=0.25). The study participants were randomly assigned through fishbowl draw into the two test groups with an equal number of residents per year level.

The simulation was conducted in one of the rooms in the hospital's main operating room complex to ensure familiarity with the environment, equipment and items available. A total of eight stations composed of an anesthesia machine, a tray of medications, a box containing anesthesia equipment, a suction machine and an operating table with a dummy patient were prepared. All residents were given eight identical sets of sample cases that were considered the basis for the simulation of the eight general anesthesia induction set-ups they were required to prepare.

Each resident from the no checklist group was asked to prepare eight general anesthesia pre-induction set-ups without using the Pre-Anesthetic Induction Checklist. The principal investigator recorded the time from the entrance of the resident until the time when general anesthesia induction was about to begin when the resident declared "ready for general anesthesia induction." The checklist was used to check the steps done by the resident and take note of the steps missed, each step corresponding to one point. The simulation continued until the resident completed all eight stations. Similar to the no checklist group, the residents from the checklist group were asked to prepare eight general anesthesia induction set-ups based on the same set of sample cases but using the Pre-Anesthetic Induction Checklist. The residents were timed and scored using the checklist. The total simulation scores were recorded, and the investigator also determined the average duration of preparation time and the total number of missed steps.

The two scores and time duration of the no checklist group and the checklist group were statistically analyzed using repeated measures ANOVA. A decrease of at least two minutes in the preparation time and a reduction of 20-30% of missed steps were considered significant.

RESULTS AND DISCUSSION

Anesthesiologists work in a high-risk environment where emergencies and critical conditions require immediate decision-making which makes them susceptible to human medical errors that may lead to patient compromise.[7] It was determined that most of these incidents occur during the pre-induction period.[6] These risks are identified as incidents that are caused by missed steps of even a skilled anesthesiologist.[8] Medical errors may be inevitable, such as missed pre-induction preparation, considering the several roles of the anesthesiologists in the operating room and the heavy workload.[6] Implementation of a checklist may prevent near misses in situations like these. The Pre-Anesthesia Induction Checklist contains a list of equipment that should be prepared and steps that should be done before starting a case. It has been concluded that using a checklist promotes patient safety and decreases morbidity and mortality.[8]

In a study by Boulet et al., the authors discussed that simulation-based assessment in anesthesiology was a developing teaching and grading modality for physicians. It promotes patient safety by identifying deficiencies in skill, medical errors and system problems. Appropriate metrics should be incorporated to ensure the validity of scores, and simulation set-ups should be patterned to real-world settings. Simulation can assess both technical and non-technical skills that may eliminate medical errors in residency training.

The hospital's department of Anesthesiology has a total of sixteen residents who met the inclusion and exclusion criteria set. They were randomly divided into two groups for the simulation testing; with the checklist group and without the checklist group. Each resident completed eight simulations, resulting in 128 simulations. The preparation duration was recorded, and the completeness of the set-up was scored based on the Pre-Anesthesic Induction Checklist.

The total preparation duration and the completeness score were summarized as mean and standard deviation. These were stratified into the intervention groups, i.e., with vs. without a checklist, and into blocks, i.e., by year level. Two-way ANOVA was used to compare the mean total duration of preparation and mean completeness score between with checklist and without checklist groups, and year level as the blocking variable. And the most commonly missed step/item was presented as count and proportion.

Table 1. The comparison of the total preparation duration and the completeness score between the intervention groups and blocks.

	With Checklist n = 8	Without Checklist n = 8	p-value*
Duration, *mins*	7.06 (1.57)	8.75 (2.25)	<0.0001
By year level			0.0001
First years [n=4]	8.09 (1.60)	6.45 (0.61)	
Second years [n=4]	7.22 (1.73)	11.06 (2.03)	
Third years [n=8]	6.47 (1.18)	8.74 (1.63)	
Completeness, *%*	95.26 (2.92)	70.81 (18.63)	<0.0001
By year level			<0.0001
First years [n=4]	94.20 (1.79)	40.18 (3.32)	
Second years [n=4]	94.42 (3.44)	75.67 (4.92)	
Third years [n=8]	96.21 (2.86)	83.70 (4.53)	

***Two-way ANOVA comparing duration or completeness between two intervention groups (with vs without checklist) with year level as blocking variable.**

Results of the comparison of the total duration of preparation and the completeness score between the intervention groups and blocks show that there is sufficient evidence to conclude that the mean total duration of preparation and mean completeness score between those with checklist and without checklist groups are significantly different, both having a p- value of <0.0001.

The results also reveal that there is a longer mean duration of preparation for those without a checklist than those with a checklist and there was a higher completeness score for those with the checklist than those without a checklist with a p-value of <0.0001. The group with the checklist has an average completeness score of 95.26% and an average duration of 7.06 minutes compared to the group without the checklist, which had an average score of 70.81% and an average time of 8.75 minutes. Thus, there is an average 24.45% decrease in missed steps and an average 1.69-minute decrease in preparation duration among the residents who used the checklist, which is considered significant.

In terms of the blocking variable, results show there is sufficient evidence that year level is a significant factor for both duration of preparation and completeness. Post-hoc analysis showed that third years and first years have a significantly shorter preparation duration than second years. There was no evidence of a difference between the third and first years. Third-years who belonged to the checklist group had an average duration of 6.47 minutes, while third-years who belonged to the no checklist group had an average time of 8.74 minutes. Second-years who belonged to the checklist group had an average duration of 7.22 minutes while second-years who belonged to the no checklist group had an average time of 11.06 minutes. First-years who belonged to the checklist group had an average duration of 8.09 minutes while first-years who belonged to the no checklist groups had an average time of 6.45 minutes.

Post-hoc analysis showed that third-years and second-years have significantly higher completeness scores than first-years, and there is no evidence of difference between third and second years. Third-years and second-years from the checklist group have an average completeness score of 96.21% and 94.42%, respectively. On the other hand, third-years and second-years from the no checklist group have an average completeness score of 83.70% and 75.67%, respectively. First-years from the checklist group have an average score of 94.20%, and first-years from the no checklist group have an average score of 40.18%. Results show that there is a 35.49% to 43.52% decrease in the completeness score of first-year residents who did not use a checklist compared to second and third-year residents. First-year residents who did not use a checklist may have performed the pre-anesthetic induction set-up faster than the second years. but their completeness score is significantly decreased.

Table 2. The proportion of instances when the participants miss the preparation step.

Step	Done		Missed	
	n	%	*n*	%
Machine Check Out	111	86.72%	17	13.28%
Vaporizer	73	57.03%	55	42.97%
Leak Test	112	87.50%	16	12.50%
Sodasorb	81	63.28%	47	36.72%
Breathing Circuit	89	69.53%	39	30.47%
ECG	112	87.50%	16	12.50%
NIBP	112	87.50%	16	12.50%
Pulse Oximeter	112	87.50%	16	12.50%
Capnograph	112	87.50%	16	12.50%

Thermometer	112	87.50%	16	12.50%
Laryngoscope with blades	128	100.00%	-	-
Video laryngoscope	94	73.44%	34	26.56%
Suction	96	75.00%	32	25.00%
Face Masks	127	99.22%	1	0.78%
Guedal oral airways or nasal airways	128	100.00%	-	-
ETT tube	125	97.66%	3	2.34%
LMAs	48	37.50%	80	62.50%
Bougie or stylet	117	91.41%	11	8.59%
Emergency medications	128	100.00%	-	-
Anxiolytic drug	128	100.00%	-	-
Opioid drug	128	100.00%	-	-
Sedative drug	128	100.00%	-	-
Non-depolarizing neuromuscular blocker	127	99.22%	1	0.78%
Succinylcholine	41	32.03%	87	67.97%
Identifying factors of patients	57	44.54%	71	55.47%
Monitors attached to the patient	128	100.00%	-	-
Baseline vital signs	118	92.19%	10	7.81%
IVF	104	81.25%	24	18.75%

In the 128 simulations done by the sixteen residents, the most common steps and items missed of >20% are the following: Succinylcholine (67.97%), laryngeal mask airways (62.50%), confirmation of identifying factors of patients (55.47%), checking of vaporizer (42.97%), checking of sodasorb (36.72%), checking of breathing circuit (30.47%), video laryngoscope (26.56%), and suction (25.00%). It was observed that the residents whether they were using the checklist or not, commonly prepared a non-depolarizing neuromuscular blocker and not prepare Succinylcholine on purpose. Laryngeal mask airways are also not routinely prepared by the residents even with the use of the checklist. Checking of the parts of the anesthesia machine was also commonly missed. Video laryngoscope was not usually prepared because the residents preferred to use direct laryngoscopes. Suction was commonly missed by residents who did not use the checklist.

CONCLUSION

Based on the study done by Wetmore et al., it is during the pre-induction period that human medical errors commonly occur. Due to the ongoing pandemic and the increasing work demands, incomplete pre-induction set-up becomes a common mistake. A checklist containing all the essential aspects of anesthesia induction that is presented in a logical order and written using terms commonly used in the operating room setting can significantly reduce medical errors.[10]

In line with the study's result, the Pre-Anesthetic Induction Checklist significantly reduces the number of missed steps and the duration of preparation time of the pre-anesthesia induction period with a p-value of <0.0001. Thus, the Pre-Anesthetic Induction Checklist may be considered as a tool to decrease human medical errors among resident anesthesiologists.

Nonetheless, there are identified limitations of the study. A sample size of at least eight set-ups and a limited number of research participants of only sixteen residents garnered only 80% power of the study. The pre-anesthetic induction checklist was based on the institution's available medications, equipment and materials. Neuromuscular blocker reversal agents were not included in the checklist because it is not available in the institution's drug formulary. Lastly, the checklist only contained medications, equipment and materials commonly used during general anesthesia induction. However, apparatus for possible difficult airways is also limited. The fiberoptic intubating scope is not included due to its current unavailability. Items used during regional anesthesia are also not included.

Due to the mentioned limitations of the study, it is recommended to conduct the study with a similar design to a larger population to achieve a higher statistical power. A more comprehensive checklist that can be applied in both general and regional anesthesia induction set-ups are also recommended. Apparatus for possible difficult airways must also be secured, such as Fiberoptic intubating scope. The study also motivates the inclusion of neuromuscular blocker reversal agents in the drug formulary as it is an essential element in general anesthesia induction.

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