Should closed suctioning be used in the management of pediatric COVID-19 patients?

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Date of Review: [25-June-2020 (version 1)]
Last Updated: [25-June-2020 (version 1)]

KEY FINDINGS

- There is no direct evidence with the beneficial use of closed suctioning compared to open suctioning in treating intubated pediatric patients with COVID-19.

- Although Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2) is mostly transmitted through droplets, aerosol-generating procedures such as open suctioning may lead to airborne transmission.
- There are no completed studies and clinical trials on the clinical utility of closed suctioning in managing COVID-19 pediatric patients.
- Indirect evidence from studies done in non-COVID-19 neonates and infant patients show that closed suctioning 1. reduces the severity and frequency of desaturations compared to open suctioning and 2. minimizes heart rate variability during and after the procedure. There are no significant differences in terms of nosocomial infection, length of hospitalization and mortality.
- Closed suctioning is recommended for COVID-19 by the American Society of Anesthesiologists and the Association of Anesthetists (1,2)

RESULTS

No studies were found using the initial search terms on the use of closed suctioning versus open suctioning on the specified outcomes of interest among children with COVID-19. A second search for indirect evidence using pediatric patients yielded 57 unique results. The studies providing indirect evidence included 8 randomized cross-over trials (5,7,10-14, 16).

Summary of Indirect Evidence

Eight randomized control studies studied infants and neonates (n=521) (5,7,10-14,16) Six studies utilized a cross-over methodology by having a wash-out period between the open and closed suction techniques. In these studies, the patients served as his or her own control (5,7,10-13). The two other studies compared two groups of infants who were randomly assigned to the OS or CS group (14,16).

Seven studies evaluate changes in physiologic characteristics such as heart rate, blood pressure, oxygen saturation before, during and after the procedure (5,7,10-14). Only the study of Cordero et. al. focused on incidence of nosocomial pneumonia and blood stream infections (16). Refer to Appendix 1 for the details of each study.

Indirect evidence showed that closed suctioning reduced the severity or frequency of desaturations compared to open suctioning among non-COVID intubated neonates (5,7,12,13) and infants (10), as well as minimized heart rate variability during or after the procedure (5). Between closed suctioning and open suctioning, there were no significant difference in terms of nosocomial infection, length of hospitalization and mortality (16). Two studies showed no difference in terms of oxygen saturation and heart rate (11,14).

CONCLUSION

At present, there are no studies that evaluated the utility and safety of closed suction compared to open suction in COVID-19 pediatric patients.

Indirect evidence among non-COVID-19 neonates and infants showed closed suctioning can significantly reduce the variability of oxygen saturation (SpO2) and heart rate .

The clinical utility and safety of closed suctioning among intubated critically ill COVID-19 patients should be studied in well-controlled trials specific for this population

Declaration of Conflict of Interest

No conflict of interest

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Appendix 1. Indirect evidence: Characteristics of included studies

No.	Title	Author	Study design	Country	Population	Intervention Group(s)	Comparison Group(s)	Outcomes
1	Closed versus partially ventilated endotracheal suction in extremely preterm neonates: Physiologic consequences/Tan (13)	Tan/2005	Randomized Cross over study	Singapore	15 (Extremely Low Birth Weight (EBLW) Neonates < 1000g on Intermittent Mandatory Ventilation (IMV)	Closed Tracheal Suction System	partially ventilated endotracheal suction method	**SPO2:** **Mean Decrease:** Partial Open 18.6% S.E. 5.99 Closed 4.28 %, S.E. 3.24 (P<0.005) **Desaturation**:<85% 34 incidents, 2 incidents (P<0.01) **Mean HR decrease:** **Partial Open** 24.59 S.E. 24.1 **Closed** 9.5, S.E. 8.79 (p<0.05) Incidence of bradycardia was negligible and not statistically significant
2	Lung volume and cardiorespiratory changes during open and closed endotracheal suction in ventilated newborn infants/ Hoellering(7)	Hoellering/2008	Randomized Blinded Crossover	Australia	20 neonates on SIMV and 10 on HFOV <10 weeks old and receiving ET suctioning at least twice a day	Closed Suctioning for 6 seconds	Open Suctioning for 6 seconds	SPO2: ***Spontaneous Intermittent Mandatory Ventilation (SIMV)***: SpO2min mean difference 6% (95% CI 2.1, 9.8) **Closed suction** Baseline 95.0 (SD 2.7) Minimum 92.0 (SD 4.7) **Open Suction** 9% (mean decrease) Baseline 95 (SD 5.1) Minimum 86 (SD 13.5) ***High Frequency Oscillatory Ventilation (HFOV)*** SpO2min mean difference 2.7 (95% CI -1.6, 7) Closed Suction: 7.4% (mean decrease) Baseline 92.4 (SD 3.9) Minimum 85 (SD 7.8) Open suction 10.5% (mean decrease) Baseline 92.8 (SD 3.7) Minimum 82.3 (SD 8)

No.	Title	Author	Study design	Country	Population	Intervention Group(s)	Comparison Group(s)	Outcomes
								HR: SIMV: Closed suction 12.3 bpm (mean decrease), Open Suction 20 bpm (mean decrease) HFOV: Closed Suction: 20bpm (mean decrease), Open suction 28 bpm (mean decrease) Lung volume: SIMV: Closed suction 15.8 ml/kg (mean decrease), Open Suction 19.3 ml/kg (mean decrease) HFOV: Closed Suction: 0.20 mV (mean decrease), Open suction 0.30 mV (mean decrease) The only significant physiologic difference in measurements was SPO2 decrease in CS versus OS with a mean difference of 6% in SIMV.
3	The effect of open and closed endotracheal tube suctioning system on respiratory parameters of infants undergoing mechanical ventilation. (10)	Taheri/2012	Randomized Cross Over study	Iran	44 infants	Closed Suctioning	Open Suctioning	**SPO2:** **Maximum decrease:** OS: 91.7% (SD 8.6) decreased to 80.7%(SD 12.9) CS: 92.8 (SD 4.8) decreased to 88.4% (SD 6)
4	Randomized crossover trial of endotracheal tube suctioning systems use in newborns (11)	Cardoso/2017	Randomized crossover trial of endotracheal tube suctioning systems use in newborns	UK	13 newborns (GA n = 7, GB n=6)	Closed Suctioning	Open Suctioning	**Mean values** SPO2: OS 94.3% to 90.5% CS 94.8% to 91.6% (P=0.561) HR: OS 143.2 to 149.5 CS 145.2 to 146.8 (P=P=0.479) RR: OS 55.1 to 58.4 CS 56.2 to 56.2

No.	Title	Author	Study design	Country	Population	Intervention Group(s)	Comparison Group(s)	Outcomes
								(p=0.282) No significant difference
5	Randomized, comparative analysis between two tracheal suction systems in neonates (14)	De Paula/2010	Randomized Control study	Brazil	39 newborns gestational age ≥ 34 weeks	Closed Suctioning	Open Suctioning	**Mean Values of maximal decrease:** <u>Group 1</u>: OS 95.6% to 93.7%, CS 94.6 to 93.3% (P=0.745) <u>Group 2:</u> OS 97% to 96 % , CS 96.3% to 95.6% (P=0.432)
6	Closed versus open endotracheal suctioning in extremely low-birth-weight neonates: A randomized, crossover trial (12)	Pirr/2013	Randomized crossover	Germany	15 ELBW neonates GA <32 weeks, BW <1000g, A-line in place	Closed suctioning	Open suctioning	**Mean incidence of hypoxemia <85%** CS = 0.5 OS = 1.1 (P=0.012) **Hypoxemia <80%** CS = 0.5 OS = 0.4 (P=0.774) **Maximum Decrease in SPO2** CS= -5 OS= -8 (P=0.07) **HR:** <u>Bradycardia < 80bpm</u> CS=0 OS=0.07 (P=0.334) <u>Minimum HR</u> CS=131 OS=124 (P=0.117) <u>Maximum Decrease in HR</u> CS= -20 OS= -27 (P=0.155)
7	Comparison of a Closed (Trach Care MAC) With an Open Endotracheal Suction System in Small Premature Infants (16)	Cordero/2000	Radomized Control Trial	United States	175 low birth weight infants (<1250 gm)	Closed Suction (Trach Care Mac)	Open Suctioning	Nosocomial Pneumonia OS: 6 CS:5 Nosocomial Blood Stream Infection OS: 10 CS: 9 no increase in the rate of bacterial airway colonization, frequency, reintubation, duration of mechanical ventilation, length of hospitalization, nosocomial pneumonia, blood stream

No.	Title	Author	Study design	Country	Population	Intervention Group(s)	Comparison Group(s)	Outcomes
								infections and neonatal mortality
8	Closed suctioning of intubated neonates maintains better physiologic stability: A randomized trial (5)	Kalyn/2003	Crossover trial, block randomization	Canada	200 preterm infants	Closed suctioning	Open suctioning alternate	Infants <1000 g had clinically **<u>Heart rate:</u>** percent decrease -18% OS and -6% CS; (p< 0.016). Recovery time in the OS group was twice that of the CS cohort (4 vs 2 minutes; p<0.001). A significant difference was found in the SaO2 and TcPO2 values, showing more favorable outcomes of CS over the OS method, p¼0.002 and <0.001, respectively (Table 2). The changes in SaO2 and TcPO2 from baseline between the OS and CS groups were also significant, p<0.001 and ¼ 0.001, respectively. Table **HR (N=178)** OS 140 (14) → 127 (26) CS 140(14)→ 136 (21) (P=0.00) **SaO2 (N=173)** OS 96 (2) → 93 (5) CS 96 (3) → 95 (4) (P=0.002) **SBP (N=81)** OS 53(11) → 57 (13) CS 52(11) → 55 (13) (P=0.024)

Appendix 2. Literature search

DATABASE	SEARCH STRATEGY / SEARCH TERMS	DATE AND TIME OF SEARCH	RESULTS	
			Yield	Eligible
Medline	(closed suction* and endotracheal*) and (pediatric* or pedia* or child* or neonate* or infant* or preterm* or adolescent*)	May 20, 2020 12:00 GMT+8	57	13
Medline	(closed suction* and endotracheal*) and (pediatric* or pedia* or child* or neonate* or infant* or preterm* or adolescent*) and ("Coronavirus Infections"[Mesh] OR "Coronavirus"[Mesh] OR coronavirus OR novel coronavirus OR NCOV OR "COVID-19" [Supplementary Concept] OR covid19 OR covid 19 OR covid-19 OR "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR severe acute respiratory syndrome coronavirus 2 OR SARS2 OR SARS 2 OR SARS COV2 OR SARS COV 2 OR SARS-COV-2)	May 20, 2020 11:00 GMT+8	0	0
Cochrane	(closed suction* and endotracheal*) and (pediatric* or pedia* or child* or neonate* or infant* or preterm* or adolescent*)	May 21, 2020 10:00 GMT+8	1	1
Cochrane	closed suction* and endotracheal*) and (pediatric* or pedia* or child* or neonate* or infant* or preterm* or adolescent*) and ("Coronavirus Infections"[Mesh] OR "Coronavirus"[Mesh] OR coronavirus OR novel coronavirus OR NCOV OR "COVID-19" [Supplementary Concept] OR covid19 OR covid 19 OR covid-19 OR "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR severe acute respiratory syndrome coronavirus 2 OR SARS2 OR SARS 2 OR SARS COV2 OR SARS COV 2 OR SARS-COV-2)	May 21, 2020 11:00 GMT+8	0	0
Trial Registries				
Medrxiv.org	(closed suction* and endotracheal*) and (pediatric* or pedia* or child* or neonate* or infant* or preterm* or adolescent*)	May 28, 2020-05-27 10:35 am GMT +8	22	0
ClinicalTrials.gov	Closed Suction and COVID	May 28, 2020-05-27 1:35 pm GMT +8	0	0