Supplemental Material

PEDIATRIC VENTILATION LIBERATION: A SURVEY OF INTERNATIONAL PRACTICE AMONG 555 PEDIATRIC INTENSIVISTS

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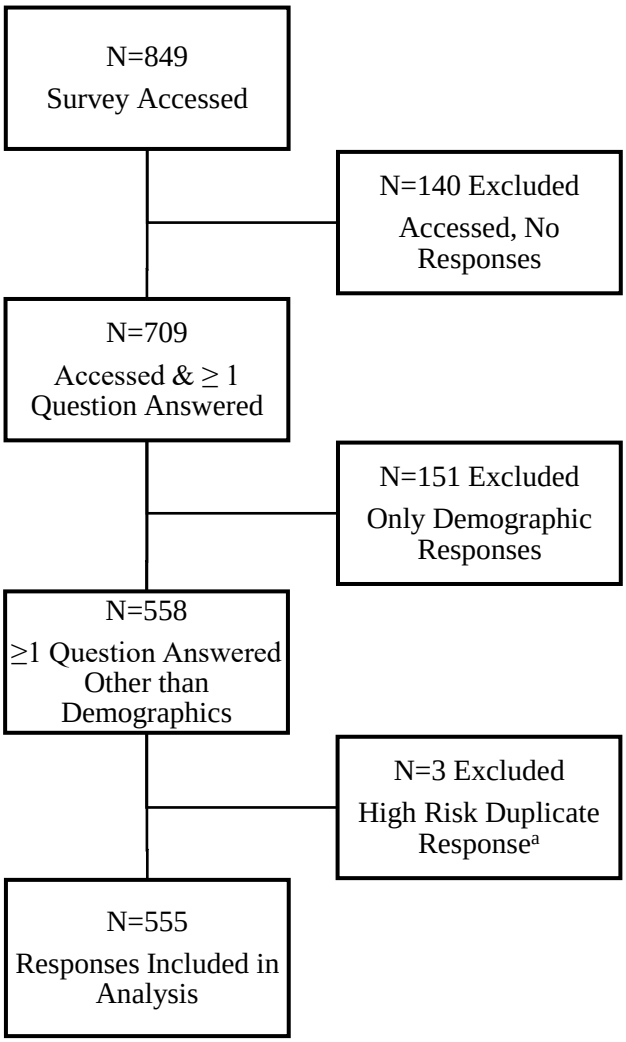
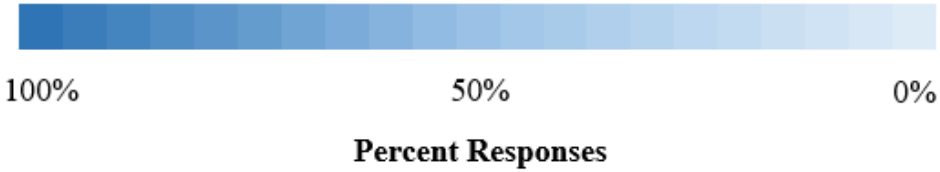


Supplemental Figure 1: Flow diagram describing survey responses and exclusions leading to final analysis cohort of unique practitioner responses; [a]High risk for a duplicate response was determined by analyzing duplicate responses to all of the following: Hospital name, hospital city, hospital country, length of clinical practice, percent clinical time, PICU type, and division chief/medical director status. In cases of high risk for duplicate responses, the response with the fewest questions answered was excluded. In cases where both responses had the same number of questions answered, the second response was excluded.

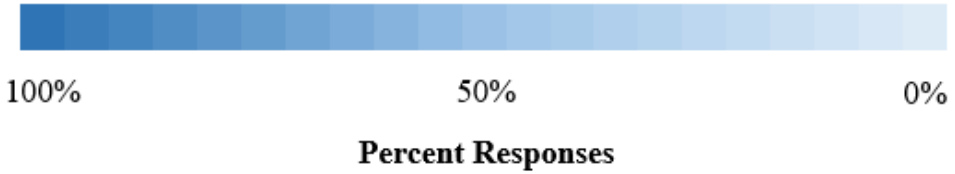
Variables Considered for Spontaneous Breathing Trial Eligibility	South America, Central America, Mexico	United States of America and Canada	Europe	Asia	Australia and New Zealand	Middle East, Africa, Caribbean	*p* value
	n=228	n=134	n=85	n=39	n=8	n=23	
Set Positive End Expiratory Pressure	92.5	98.5	96.5	97.4	87.5	91.3	0.117
Set Respiratory Rate	59.6	51.5	48.2	59	50	82.6	0.046
Set FiO_2	89	96.3	96.5	100	87.5	100	0.010
Measured Peak Inspiratory Pressure	68.4	75.4	80	87.2	50	82.6	0.032
Standardized Sedation Assessment	75	29.1	37.6	42.6	25	47.8	<0.001
Serum pH	50.4	32.8	45.9	48.7	37.5	65.2	0.011
Oxygenation Index	56.6	20.9	20	33.3	0	47.8	<0.001
Oxygen Saturation Index	53.9	17.9	27.1	33.3	0	47.8	<0.001
Number of Vasopressors in Use	55.3	47.8	57.6	66.7	25	60.9	0.138



Supplemental Figure #2: Practitioner reported eligibility criteria for spontaneous breathing trials stratified by region. Total responses per region are reported under each column header. Corresponding percentages to the heat map legend are shown in each cell.

LEGEND: Fractional Inspired Oxygen (FiO_2)

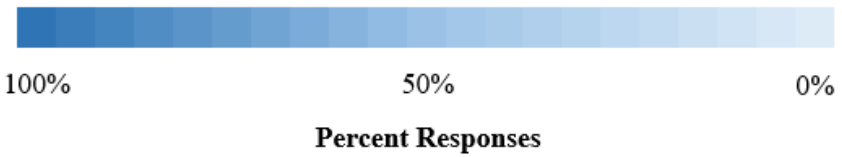
Variables Considered for Spontaneous Breathing Trial Passage	South America, Central America, Mexico	United States of America and Canada	Europe	Asia	Australia and New Zealand	Middle East, Africa, Caribbean	*p* value
	n=204	n=131	n=79	n=39	n=9	n=22	
Exhaled Tidal Volume	55.9	71.8	48.1	53.8	55.6	54.5	0.015
Oxygen Saturation	88.7	91.6	82.3	82.3	97.4	90.9	0.179
End-Tidal Carbon Dioxide	21.1	75.5	55.7	46.2	77.8	68.2	<0.001
P_aO_2	30.4	19.1	25.3	46.2	22.2	54.5	0.001
P_aCO_2	33.3	29.8	48.1	53.8	33.3	77.3	<0.001
FiO_2	35.3	67.9	70.9	56.4	33.3	59.1	<0.001
Measured Respiratory Rate	92.6	98.5	92.4	97.4	66.7	90.9	0.002
Hemodynamic Stability	79.9	75.6	70.9	92.3	55.6	86.4	0.043
Subjective Work of Breathing	73.5	87	87.3	76.9	88.9	68.2	0.013
Objective Work of Breathing Measure	12.3	1.5	1.3	5.1	0	4.5	0.001
Rapid Spontaneous Breathing Index	9.8	6.1	6.3	10.3	0	18.2	0.353
Dead Space Fraction	2	3.8	1.3	0	0	4.5	0.626



Supplemental Figure #3: Practitioner reported pass criteria for spontaneous breathing trials stratified by region. Total responses per region are reported under each column header. Corresponding percentages to the heat map legend are shown in each cell.

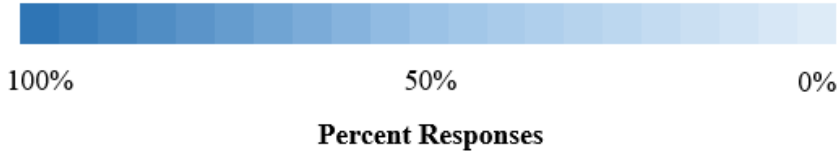
LEGEND: Fractional Inspired Oxygen (FiO_2), Arterial Partial Pressure of Oxygen (PaO_2), Arterial Partial Pressure of Carbon Dioxide ($PaCO_2$)

Variable Used in Extubation Readiness Tests	Region	Responses, n	Self-Reported Use: Almost Always (5)	Sometimes (4)	Every Once in a While (3)	Rarely (2)	Never (1)	Median (IQR)	*p* value
Spontaneous Breathing Trial	South America/Central America/Mexico	238	83.6	9.2	1.7	2.5	2.9	5 (5-5)	0.012
	United States of America/Canada	140	83.6	10.7	3.6	1.4	0.7	5 (5-5)	
	Europe	88	69.3	19.3	3.4	4.5	3.4	5 (4-5)	
	Asia	40	72.5	20	0	7.5	0	5 (4-5)	
	Australia/New Zealand	10	40	40	10	10	0	4 (3.8-5)	
	Middle East/Africa/Caribbean	23	91.4	4.3	4.3	0	0	5 (5-5)	
Endotracheal secretion burden	South America/Central America/Mexico	196	53.6	27.6	10.7	5.6	2.6	5 (4-5)	0.184
	United States of America/Canada	125	54.4	28	5.6	9.6	2.4	5 (4-5)	
	Europe	79	53.2	34.2	2.5	8.9	1.3	5 (4-5)	
	Asia	38	44.7	26.3	13.2	15.8	0	4 (3-5)	
	Australia/New Zealand	9	55.6	22.2	0	22.2	0	5 (3-5)	
	Middle East/Africa/Caribbean	16	43.8	25	25	0	6.3	4 (3-5)	
Objective measure of respiratory muscle strength	South America/Central America/Mexico	196	16.3	13.8	13.8	21.4	34.7	2 (1-4)	0.769
	United States of America/Canada	125	16.8	16.8	12	23.2	31.2	2 (1-4)	
	Europe	79	20.3	19	8.9	24.1	27.8	2 (1-4)	
	Asia	38	15.8	13.2	15.8	28.9	26.3	2 (1-4)	
	Australia/New Zealand	9	22.2	44.4	11.1	0	22.2	4 (2-4.5)	
	Middle East/Africa/Caribbean	16	6.3	12.5	12.5	37.5	31.3	2 (1-3)	
Standardized pain or sedation measurement	South America/Central America/Mexico	196	53.1	20.4	6.1	13.8	6.6	5 (3-5)	0.396
	United States of America/Canada	125	55.2	15.2	11.2	12.8	5.6	5 (3-5)	
	Europe	79	57	21.5	5.1	11.4	5.1	5 (4-5)	
	Asia	38	44.7	23.7	15.8	7.9	7.9	4 (3-5)	
	Australia/New Zealand	9	44.4	44.4	0	0	11.1	4 (4-5)	
	Middle East/Africa/Caribbean	16	31.3	25	6.3	18.8	18.8	4 (2-5)	
Fluid balance	South America/Central America/Mexico	196	65.3	20.9	6.1	6.6	1	5 (4-5)	0.143
	United States of America/Canada	125	59.2	20.8	11.2	6.4	2.4	5 (4-5)	
	Europe	79	59.5	26.6	11.4	2.5	0	5 (4-5)	
	Asia	38	44.7	28.9	13.2	13.2	0	4 (3-5)	
	Australia/New Zealand	9	55.6	11.1	0	33.3	0	5 (2-5)	
	Middle East/Africa/Caribbean	16	62.5	18.8	6.3	12.5	0	5 (4-5)	
Endotracheal Leak Test[a]	South America/Central America/Mexico	167	40.7	31.1	7.2	15	6	4 (3-5)	0.851
	United States of America/Canada	111	39.6	32.4	8.1	15.3	4.5	4 (3-5)	
	Europe	66	40.9	28.8	12.1	15.2	3	4 (3-5)	
	Asia	33	45.5	21.2	6.1	18.2	9.1	4 (2-5)	
	Australia/New Zealand	9	33.3	66.7	0	0	0	4 (4-5)	
	Middle East/Africa/Caribbean	15	53.3	26.7	0	13.3	6.7	5 (4-5)	



Supplemental Figure #4: Heat map demonstrating Self-reported variables practitioners consider in extubation readiness tests and practice stratified by region. Total responses per region are reported under each column header. Corresponding percentages to the heat map legend are shown in each cell. [a]Only respondents managing all endotracheal tube types the same were included. LEGEND: Interquartile Range (IQR)

Stem	Responses, n	Strongly Agree (5)	Agree (4)	Neither Agree nor Disagree (3)	Disagree (2)	Strongly Disagree (1)	Median (IQR)
1) Children requiring invasive ventilation for more than 24 hours should have protocolized screening for SBT readiness.	463	31.1	39.7	15.8	4.5	8.9	4 (3-5)
2) Children requiring invasive ventilation for more than 24 hours should have a protocolized extubation readiness bundle performed.	463	33.7	43	12.5	2.6	8.3	4 (4-5)
3) Children requiring invasive ventilation for more than 24 hours should have a SBT included in determining extubation readiness.	463	38	39.3	12.1	2.6	8	4 (4-5)
4) In children extubated to planned non-invasive respiratory support, NIV/CPAP is superior to HFNC in preventing extubation failure.	463	7.8	21.6	44.3	21.6	4.8	3 (2-4)
5) In children extubated without a history of NIV at home, escalation to NIV constitutes extubation failure.	463	1.9	11.2	20.7	53.3	12.7	2 (2-3)



Supplemental Figure 5: Practitioner opinions on selected topics relevant to pediatric ventilation liberation. Total responses reported for each stem. Corresponding percentages to the heat map legend are shown in each cell.

LEGEND: Continuous Positive Airway Pressure (CPAP), High Flow Nasal Cannula (HFNC), Interquartile Range (IQR), Non-invasive ventilation (NIV), Spontaneous breathing trial (SBT)

Supplemental Table 1: Core questions, hypotheses, and variables for extubation practice survey development

Core Question	Hypothesis	Variables
How is de-escalation of ventilation support and liberation most commonly performed?	The most common approach to ventilator weaning and liberation will be progressive weaning of ventilator settings to a lower degree of support followed by an SBT then extubation without a standardized protocol/pathway.	Screening protocols, ICU type, RT/RN-guided protocols
Is routine protocolized screening for ERT/SBTs readiness performed?	Among all respondents, routine protocolized screening will be performed rarely. Among those that do perform routine protocolized screening, large academic PICUs will predominate.	Screening protocols, ICU type, RT/RN-guided protocols, ICU resources, ICU geographic location
Is a protocolized SBT process used?	Among all respondents, a protocolized SBT process will be performed rarely. Among those that do perform a protocolized SBT, large academic PICUs will predominate.	ERT bundle protocols, ICU type, RT/RN-guided protocols
For patients who undergo an SBT, how is the timing of initiation determined?	Among respondents who report using an SBT, the most commonly utilized factors for timing of SBT initiation will be the following: Set PEEP, Set respiratory rate, set FiO_2, and measured peak inspiratory pressure.	PEEP, respiratory rate, FiO_2, peak inspiratory pressure, standardized sedation score, serum pH, oxygenation index, oxygen saturation index, vasopressor support, length of invasive ventilation
In those who are undergoing an SBT as part of extubation readiness assessments, should pressure support be used?	Among those that utilize an SBT, the majority will report using some amount of pressure support. Most respondents will report using a standardized pressure of 10 cmH_2O or variable levels of pressure support dictated by and inversely related to ETT diameter.	Amount of pressure support, ERT bundle protocols, RT/RN-guided protocols, Patient dependent factors (e.g. age, ventilation duration, indication for intubation, co-morbid conditions)
In patients who are undergoing an SBT to assess for extubation readiness, is the SBT conducted for > 30 minutes?	Among those that utilize an SBT, the majority will report conducting them for > 30 minutes duration, with most reporting an SBT duration of 2 hours.	Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions), ERT bundle protocols, ICU type, RT/RN-guided protocols
In patients who are undergoing an SBT to assess for extubation readiness, what pass/fail criteria should be considered?	Among those that utilize an SBT, the most commonly reported variables used in determining SBT success/failure will be expired tidal volume, oxygen saturation, respiratory rate, heart rate, and subjective assessment of work of breathing.	Expired tidal volume, oxygen saturation, end-tidal carbon dioxide, PaO_2, $PaCO_2$, respiratory rate, heart rate, hemodynamic stability, work of breathing (subjective), work of breathing (objective), rapid shallow breathing index, dead space fraction
Is endotracheal secretion burden a part of the extubation readiness assessment?	Endotracheal secretion burden will be considered by the majority of respondents. Furthermore, this will be a common consideration for patients intubated for a respiratory pathology, neuromuscular pathology, and for patients with a neurologic co-morbidity.	Patient-dependent factors (e.g. indication for intubation, co-morbid conditions, cough strength)

Supplemental Table 1 Cont.

Is an objective measure of respiratory muscle strength during airway occlusion (i.e. NIF or PiMax) included in determining extubation readiness?	Objective measures of respiratory muscle strength will be used rarely. Such measures will be utilized more commonly in patients intubated for a primary neuromuscular pathology or with a neuromuscular co-morbidity.	Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions, use of neuromuscular blockade/steroids), Cuff leak pressure management/interpretation, ICU resource availability/capability
Is an endotracheal tube air leak test to predict post-extubation obstruction measured prior to extubation?	The endotracheal tube air leak test will be used frequently. The use of the test will be independent of ETT type (cuffed vs. uncuffed).	ETT type (cuffed vs uncuffed), Cuff pressure management protocols, Patient dependent factors (e.g. age, ventilation duration, indication for intubation, co-morbid conditions, difficult airway history, surgical airway interventions)
Are systemic steroids administered prior to extubation to prevent post-extubation upper airway obstruction?	Systemic steroids will be administered frequently. Furthermore, respondents who use an endotracheal air leak test will be more likely to use systemic steroids to prevent post-extubation upper airway obstruction.	ETT type (cuffed vs uncuffed), Cuff pressure management protocols, Patient dependent factors (high vs low risk)
Is planned non-invasive respiratory support (BiPAP/CPAP, HFNC) used after extubation?	Planned non-invasive respiratory support will be used frequently. HFNC will be used more commonly.	Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions), ICU resource availability/capability
Is a standardized measure of pain and sedation included in determining extubation readiness?	Standardized measures of pain and sedation will be used occasionally as a part of determining extubation readiness.	Screening protocols, ICU type, RT-guided protocols, Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions)
Is a measure of fluid balance be included in determining extubation readiness?	Among all respondents, a measure of fluid balance will be used frequently in determining extubation readiness.	Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions), ICU resource availability/capability, ICU type (specifically cardiac ICUs)
Does time of day (day shift vs. night shift) influence the decision to extubate?	Among all respondents, most will prefer to extubate during day shift. A larger majority will prefer to extubate perceived high risk patients during day shift.	Patient-dependent factors (e.g. ventilation duration, indication for intubation, co-morbid conditions), ICU resource availability/capability, ICU type, Nocturnal attending staffing model

Bi-Level Positive Airway Pressure (BiPAP), Continuous Positive Airway Pressure (CPAP), Endotracheal Tube (ETT), Extubation Readiness Test (ERT), High Flow Nasal Cannula (HFNC), Intensive Care Unit (ICU), Negative Inspiratory Pressure (NIF), Maximum Inspiratory Pressure (PiMax), Partial Pressure of Arterial Oxygen (PaO_2), Partial Pressure of Arterial Carbon Dioxide ($PaCO_2$), Positive End Expiratory Pressure (PEEP), Registered Nurse (RN), Respiratory Therapist (RT), Spontaneous Breathing Trial (SBT)

Supplemental Table 2: Self-reported weaning, extubation, and post-extubation support practices for all respondents and stratified by region

Variable	All Respondents	South America, Central America, Mexico	United States of America and Canada	Europe	Asia	Australia and New Zealand	Middle East, Africa, Caribbean	*p* value
IMV Weaning and Extubation Practice, %	539	238	140	88	40	10	23	
Weaning followed by SBT then extubation (no protocol)	44.7	35.7	47.1	61.4	55	50	39.1	<0.001
Weaning followed by SBT then extubation (protocolized)	41.7	56.7	38.6	14.8	22.5	10	56.5	
Weaning and extubation using clinical impression	13.5	7.6	14.3	23.9	22.5	40	4.3	
Spontaneous Breathing Trial Support Method, %	483	203	132	78	39	9	22	
Any Pressure Support	82.4	77.8	89.4	84.6	66.7	100	95.5	0.002
No Pressure Support or T-piece	17.6	22.2	10.6	15.4	33.3	0	4.5	
Spontaneous Breathing Trial Duration, %	466	202	127	70	39	8	20	
≤ 30 Minutes	34.8	40.1	21.3	45.7	41	12.5	25	0.003
31 Minutes – 1 Hour	39.3	39.1	44.9	37.1	28.2	50	30	
> 1 Hour	26	20.8	33.9	17.1	30.8	37.5	45	
Frequency of Planned HFNC Use Post-Extubation, %[a]	410	153	125	77	32	9	14	
≤ 25%	49.5	43.8	50.4	50.6	50	66.7	85.7	0.442
26-50%	33.7	39.9	29.6	35.1	31.3	22.2	7.1	
51-75%	12.7	12.4	15.2	11.7	12.5	11.1	0	
> 75%	4.1	3.9	4.8	2.6	6.3	0	7.1	
Frequency of Planned NIV Use Post-Extubation, %[a]	448	188	125	78	35	9	13	
≤ 10%	47.8	46.3	49.6	51.3	48.6	33.3	38.5	0.528
11-20%	32.1	35.1	26.4	33.3	37.1	44.4	15.4	
21-30%	12.5	12.2	12.8	11.5	8.6	11.1	30.8	
> 31%	7.6	6.4	11.2	3.8	5.7	11.1	15.4	

Total responses (n) are shown in each shaded row. Percentages are reported in non-shaded cells using the reported total responses as the denominator. [a]Responses from units without HFNC or NIV capability were excluded; High Flow Nasal Cannula (HFNC), Invasive Mechanical Ventilation (IMV), Non-invasive Ventilation (NIV), Spontaneous Breathing Trial (SBT)

END OF SUPPLEMENTAL MATERIAL