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Risk Analysis to Predict Extubation Failure in the Cardiac Intensive Care Unit

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Risk Analysis to Predict Extubation Failure In the Cardiac Intensive Care Unit

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Background & Intent

The data collected in this project will be used as a part of a multi-center study conducted by Boston Children's Hospital to assess if the software Etiometry® can be used to predict extubation success in patients in the CICU. After compiling the data from EPIC, the goals of our analysis were to find any associations with extubation failure rates. Trends in this data could help identify potential areas of focus to mitigate extubation failures. Some specific hypotheses we explored:

- Delayed sternal closure is associated with an increased risk of extubation failure.
- Extubation failure is associated with an increased length of stay and/or length of post-op stay.
- ECMO is associated with an increased risk of extubation failure.
- Extubation failure is associated with death.
- CHMC's rate of extubation failure is similar to what is reported nationally.

Check out the parent project!

Methods & Materials

- Inclusion criteria
  - Patients <18 years old requiring mechanical ventilation for >48 hours following cardiac surgery between 2017-2020.
- Exclusion criteria
  - Premature infants (<36 weeks' gestation)
  - Admission weight <2kg
  - Unplanned extubation as final extubation in CICU stay
  - Planned reintubation for a procedure withing 48 hours of extubation
  - Patients with a tracheostomy
  - Patients who died prior to first extubation
  - Patients extubated in the OR prior to arrival in CICU.
- Statistical tests
  - For categorical variables
    - Chi squared or Fischer's exact were used as appropriate.
  - For continuous variables
    - Student's T-tests were used.

Results

	Total Cohort (n=84)	Extubation Success (n=72)	Extubation Failure (n=12)	P-value
Age (years)	1.34[α] (0-0.6[β])	1.24[α] (0-0.7[β])	1.93[α] (0-0.1[β])	0.6281
% male	40 (48%)	32 (45%)	8 (67%)	0.2145
Weight	7.98[α] (3.4-7.3[β])	7.56[α] (3.3-7.8[β])	10.46[α] (2.8-4.1[β])	0.5811
Saturation goal				0.6556
70-85%	44 (52.3%)	37 (51.4%)	7 (58.3%)	
>/=90%	40 (47.6%)	35 (48.6%)	5 (41.7%)	
Neonates	41 (48.8%)	32 (44.4%)	9 (75.0%)	0.0646
Preemies	9 (10.7%)	9 (12.5%)	0	0.3458
Prior supplemental respiratory support	48 (57.1%)	40 (55.6%)	7 (58.3%)	0.5420
Length of stay (days)	64.2[α] (16-70.5[β])	62.4[α] (15.8-52.8[β])	74.6[α] (32-86.3[β])	0.5821
Post-op length	54.3[α] (12.8-54.5[β])	51.9[α] (11.8-38.5[β])	68.7[α] (26.5-80[β])	0.4401
Multiple cardiac hospitalizations	34 (40.5%)	30 (41.7%)	4 (33.3%)	0.7540
Delayed sternal closure	25 (29.8%)	20 (27.8%)	5 (41.7%)	0.3299
Open sternotomy Duration (days)	9.46[α] (2-10.5[β])	7.22[α] (2-11.5[β])	18.2[α] (2-5[β])	0.9029
ECMO	13 (15.5%)	8 (11.1%)	3 (25.0%)	0.1884
ECMO Duration (days)	5.45[α] (3-6.5[β])	5.5[α] (2.6-6.3[β])	5.33[α] (3.5-6.5[β])	0.4607
On Vasoactive(s) when extubated	58 (69.0%)	50 (69.4&)	8 (66.7%)	1.0000
Support escalated within 48 hours	24 (28.6%)	24 (33.3%)	8 (66.7%)	0.0504
Intubation duration (days)	7[α] (1.9-9.8[β])	6.9[α] (1.9-9.5[β])	8.99[α] (3.9-12.9[β])	0.3804
Time between reintubation (hr:min)			3:18[α] (1:20-13:21[β])	
Death	7 (8.3%)	4 (5.6%)	3 (25.0%)	0.0569

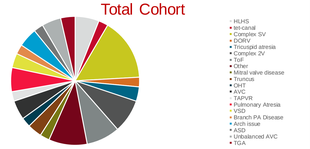
[α] denotes mean
[β] denotes interquartile range

Data Comparison

- **Similarities**
  - **A study published by the Journal of Pediatric Critical Care Medicine in 2019 found a similar trend towards an association between extubation failure and neonate status.**
  - **Our data and a 2005 study published by the Journal of Pediatric Cardiology found associations between extubation failure and death.**
- **Differences**
  - **A 2022 study published by the Journal of the Society of Critical Care Medicine found an association between extubation failure and prior respiratory support while our data showed no association**
  - **A study published by the Journal of Pediatrics in 2007 found a significant association with extubation failure and open sternotomy while our data showed no association.**

Overarching Diagnoses

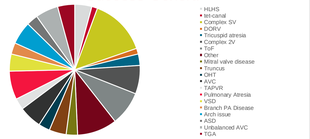
Total Cohort



Top 5 Diagnoses:
1. Complex SV
2. Complex 2V
3. ToF
4. HLHS
5. Pulmonary Atresia

*Other includes: Myocarditis, COVID 19, ECMO, Shone's, Congenital Heart Block, PA/IVS

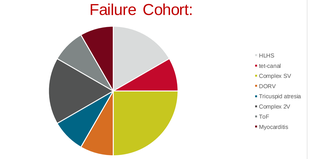
Success Cohort:



Top 5 Diagnoses:
1. Complex SV
2. ToF
3. Complex 2V
4. AVC
5. Unbalanced AVC

*Other includes: Myocarditis, COVID 19, ECMO, Shone's, Congenital Heart Block, PA/IVS

Failure Cohort:



Overarching Diagnosis	Number of Diagnosis
Complex SV	3
Complex 2V	2
HLHS	2
tet-canal	1
DORV	1
ToF	1
Myocarditis	1
Tricuspid atresia	1

Conclusion

- Neonatal status and support escalation within 48 hours trended towards an association with extubation failure.
- Extubation failure trended towards an association with death.
- There was not one overarching diagnosis that was more common in failed extubation encounters than successful encounters
- This data will be used in a multi-center study through Boston Children's Hospital to assess the accuracy of the software Etiometry® in predicating extubation success in the CICU

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