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# Extubation Readiness Test in a Pediatric Cardiac Intensive Care Unit

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## Abstract

**Problem:** The lack of standard extubation readiness tests (ERTs), that are practiced in pediatric ICUs to monitor extubation readiness, clinicians have the difficult task of weighing the risk versus benefit of extubation. ERTs can aid clinicians in deciphering patients ready to be successfully extubated and have shown to decrease length of mechanical ventilation and decrease extubation failures.

**Methods:** The quality improvement (QI) project utilized a descriptive observational design to assess the effects of the implementation of an ERT in a pediatric cardiac ICU. This project used a convenience sample to include children aged neonate to 18 years of age admitted to the pediatric cardiac ICU who were mechanically ventilated with non-cyanotic single ventricle heart defects. Data collected from Oct 2022-May 2023 and included cardiac defect/admission diagnosis, ERTs used, number of extubation failures, and length of intubation.

**Results:** A (*N*=77) patients met criteria for an ERT to be administered during the data collection period. Pre implementation (Oct 22-Dec 22) of ERT a (*n*=40) and post implementation (Feb 23-May 23) (*n*=37) met criteria for an ERT to be administered. In the post implementation (*n*=37; 100%) had an ERT performed. There was a (*n*=2; 5%) extubation failure rate pre-implementation and (*n*=0; 0%) extubation failures in the post implementation group.

**Implications for Practice**: ERTs should be used in the cardiac ICU to prevent extubation failure, potentially decrease length of mechanical ventilation, and aide clinicians in identifying patients ready for liberation from mechanical ventilation earlier.

**Extubation Readiness Test in a Pediatric Cardiac Intensive Care Unit**

Mechanical ventilation in pediatric patients admitted to ICUs helps to support patients through acute illnesses and acute exacerbations of chronic illnesses. (Kneyber et al., 2016). Extubation is the last step in the liberation of a patient from mechanical ventilation and involves removal of the artificial airway so a patient can resume breathing spontaneously with less respiratory support. Extubation failure is the need of patient to be reintubated within 48 hours of extubation (Al-Matary et al., 2022). Prolonged mechanical ventilation and extubation failure in mechanically ventilated patients is associated with significant implications (Konca et al., 2022). Although mechanical ventilation is lifesaving, there are many risks factors associated with mechanical ventilation, including an increased risk for infections, increased length of stay in the intensive care unit and hospital, increased cost, and increased risk for morbidity and mortality (Poletta et al., 2022). Boettcher et al. (2020) showed an increased risk for depression and anxiety of patients and their caregivers when they experience a prolonged time of mechanical ventilatory support.

In pediatric ICUs, approximately 5-15% of planned extubations result in extubation failure, or the patient needing to be reintubated within 48 hours of endotracheal tube removal (Krasinkiewicz et al., 2021). Extubation failure is also associated with increased morbidity and mortality rates, increased length of ICU stays, and increased costs (Ferguson et al., 2011). Due to lack of standard extubation readiness tests, clinicians working in pediatric ICU’s have the difficult task of weighing the risk of extubation versus the risk of continuing mechanical ventilation. The criteria for

extubation readiness are not standard in pediatrics and much is left up to the discretion of the clinician caring for the patient.

ERTs aid clinicians in deciphering patients that may be successfully extubated using minimal ventilator settings. According to Randolph et al. (2022), a seminal randomized controlled trial (RCT) that is used in pediatric ICUs that have adopted ERTs, ventilator settings include weaning the ventilator to pressure support settings, a minimal positive end expiratory pressure, and an Fi02 around 50% (Randolph et al., 2002). In pediatric cardiac ICUs, the task of balancing extubation failure versus prolonged mechanical ventilation is even more difficult due to the aforementioned, and the complex nature of the effects mechanical ventilation has on the non-respiratory organ systems (Hames et al., 2022).

In a single center pediatric heart center, extubation readiness is subject to the discretion of the clinician and there are no standard clinical criteria used to assess the patient's readiness for extubation. An opportunity for improvement includes creating a standard approach and criteria for assessing extubation readiness by implementing an ERT. The John's Hopkins Nursing Evidence-Based Practice (JHNEBP) model for QI served as the evidence-based framework for this project. The purpose of this project is to implement an ERT in mechanically ventilated patients in a single center pediatric heart center. The aim of the project is to evaluate the rate of extubation failures over 90 days. The primary outcome measure is the number of extubation failures. The secondary outcome measure of interest is the length of days of mechanical ventilation. The study question is: In intubated children from neonate to 18 years of age in a single center

pediatric heart center, what is the effect of implementation of an ERT on extubation failure rates over 90 days?

## Review of Literature

An initial literature search was conducted using the electronic databases Medline, CINAHL, and PubMed using the key search terms and phrases extubation failure, spontaneous breathing trial, mechanical ventilation, pediatrics, endotracheal intubation, extubation readiness test, cardiac and Boolean operators, AND and OR. Initially, the search generated 3,860 results based on the key terms and phrases and the Boolean operators. Inclusion criteria included studies between 2017 and 2022, children 0-18 years old who are intubated and in ICUs, and studies written in the English language. Exclusion criteria included articles not written within the last 5 years (2017-2022), and then expanded to any research on extubation readiness or weaning of pediatric ICU patients because of the lack of research in this subject area. Other criteria included articles on subjects over 18 years of age and written in any language other than English. 70 articles resulted after the inclusion and exclusion criteria were applied and ultimately 21 articles were used for this literature review with levels of evidence from level I to level VI. The 21 articles included in this review were highlighted and examined thoroughly for themes, level of evidence and common data points related to ERT, mechanical ventilation weaning, and liberation from mechanical ventilation in cardiac ICUs.

Herng et. al. (2022) randomized controlled trials studies highlighted adults ICUs using a weaning protocol and ERT improves outcomes when compared with the standard care, including duration of mechanical ventilation. However, the study identified a need in pediatric ICU and unanimous guidelines for the weaning of mechanical ventilation are

lacking. In some pediatric cardiac ICUs, ERT or spontaneous breathing trials are being utilized (Poletto et al., 2022), however the literature was scarce in cardiac specific ICUs. Much of the literature is based on pediatric ICUs and provides contradictory information on the evidence to support ERTs. The literature that was published from cardiac ICUs mainly focuses on early extubation after cardiac procedures and doesn't focus on intubation and their trajectory towards weaning, early extubation, and protocols for weaning (Hames et al., 2022).

In multiple studies, the consensus was ERTs contribute to decreased duration of mechanical ventilatory support, decreased length of ICU stays, decreased the risk of adverse outcomes associated with prolonged mechanical ventilation, and decreased the likelihood of the need for reintubation, therefore decreasing adverse outcomes associated with reintubation (Elisa, 2022; Eissa, 2020; Herng, 2022; Jaber, 2018). The use of a standardized or protocolized ERT or spontaneous breathing trials provides an opportunity for pediatric ICUs and pediatric cardiac ICUs to minimize the risks associated with a longer duration of mechanical ventilation. According to the Pediatric Critical Care Consortium, of 1,734 mechanical ventilation episodes (1,478 patients at eight hospitals) ending in a planned extubation, there were 100 extubation failures (5.8%) (Gaies, 2015). The rate of extubation failure increased as the duration of invasive mechanical ventilation increased from 4% (less than 24 hours of ventilation) to 9% (after 24 hours) to 13% after 7 days (Gaies, 2015).

There is conflicting information about the success versus failure rates after implementation of an ERT. Some of the literature demonstrated significant positive predictive values and high sensitivity of ERTs in predicting successful extubation

(Hames et al., 2022). In patients who completed an ERT, Ferguson et., al. (2011) found there was 97% sensitivity and 89% positive predictive value. Similarly, Mandhari et al. (2019) found a significant decrease in the extubation failure rate from 9.9% to 4.1% and prior to implementation of the ERT, infants were 2.5 times more likely to fail extubation. Eissa et al. (2019), found ERTs had a positive predictive value of 95% with a sensitivity of 90.4%. In contrast to the above-mentioned articles, two of the articles found there was no significant difference in the extubation failure rate between physician judgment, with a 17% extubation failure rate, and an ERT with a 19% extubation failure rate (Herng et al., 2022), and Faustino et al. (2017), found that the positive predictive value for completion of a ERT had a positive predictive value of 92% while the negative predictive value was only 50% with a specificity of 35% (Faustino et al., 2017). Studies showed while the extubation failure rate was relatively low, the reasons that the patients failed extubation were similar. These reasons include duration of mechanical ventilation, respiratory distress, upper airway obstruction, hypoxia, atelectasis, decompensation of hemodynamics, tachypnea, or sedation (Al-Matany et al., 2022; Blackwood et al., 2022; Faustino et al., 2017; Poletta et al., 2022; van Dijik et al., 2019). The article by Jaber et al. (2018), found the overall extubation failure rate was 11% with 12-15% of those patients needing reintubation within 48 hours of extubation.

Hames et al. (2022) study showed the most common reasons for extubation failure were respiratory distress (78%), which included respiratory acidosis, hypoxia, and atelectasis, upper airway obstruction (9%) and hemodynamic instability (7%). Faustino et al. (2016) found while only 8% of extubations, using an ERT, ended in failure, the reasons for the failure were similar. These included upper airway obstruction (65%),

lower respiratory dysfunction with impaired gas exchange (22%) excessive secretions (9%) and tachypnea (4%) (Faustino et al., 2016).

The recommendations supported by much of the literature suggests the need for ERTs and protocolized weaning of mechanical ventilation can help identify patients who may be ready for liberation from mechanical ventilation (Eissa et al., 2019; Faustino et al., 2016; Mandhari et al., 2019). While most of the studies agreed ERTs have a high sensitivity and positive predictive value for extubation success, ERTs did not have a good specificity for extubation failure (Hames et al., 2022; Herng et al., 2022). Blackwood et al. (2022), demonstrated a significant decrease in ventilator days and successful extubation by 95%. Hames et al. (2022), suggested further extubation readiness testing research, using RCTs, with a focus on cardiac specific ICU mechanically ventilated subjects needs to be investigated further.

The John's Hopkins Nursing Evidence-Based Practice (JHNEBP) model is an evidence-based framework commonly used for quality improvement in healthcare. In the implementation of an ERT, this three-step process using plan, evidence, and translation (PET) is used to incorporate best practices into patient care. The PET cycle is necessary to support the changes that will continuously be monitored and updated as the guideline/protocol is updated to better support the needs of the patients and the physicians (Johns Hopkins Model). In the pediatric cardiac ICU, the ERT needs to incorporate the respiratory support weaning and the cardiac support that mechanical ventilation provides to help better mitigate the risk of extubation failure and decrease the length of intubation in this fragile population.

In summary, standardization and guidelines were identified as a need in pediatric ICUs. Common themes noted from the literature include the correlation between ERTs and extubation failure rates and common risks factors associated with extubation failure. In one article, by Hames et al. (2022) based in a pediatric cardiac ICUs, the focus of an ERT in a pediatric ICU needs to focus on implementation of ERT and ventilatory weaning protocol with a focus on the non-respiratory organ support (cardiac support) affected by the liberation of mechanical ventilation. There are quite a few gaps in the literature, specifically, much of the research is focused on pediatric ICUs and is lacking for pediatric cardiac ICUs. Similarly, the research that has been done in pediatric ICUs has mainly been focused on early extubation after cardiac surgery and the effects of early extubation. Hames et al. (2022) noted that a better understanding of the reasons for extubation failure in congenital heart disease, factors associated with extubation as well as ERTs tailored to congenital heart patients needs to be identified. Therefore, ERTs and weaning protocols should be implemented in cardiac ICUs to help prevent extubation failure and early liberation from mechanical ventilation. Using the JHNEBP model for change evidence-based practice framework, this study was implemented and evaluated the effectiveness of an extubation readiness test in a single center pediatric ICU.

## Methods

### Design

This QI project utilized an observational descriptive method design. A prospective-retrospective study design was utilized to assess the effects of the implementation of an ERT. Retrospective chart review data was collected from October

2022-December 2022. Implementation of the ERT was in February 2023. Prospective chart review data was collected from February 2023 through May 2023.

**Setting**

The project took place in a single center midwestern pediatric cardiac ICU at a large urban hospital that serves both urban and rural communities. The center treats patients from birth through adolescents. This hospital is ranked in the top 10% of hospitals, has 402 licensed beds, and has served patients from all 50 states and from all around the world, including 80 different countries. The heart center at this hospital is the largest in the region, caring for over 5,000 patients in the last 10 years and is designated as a high-volume center. This center is one of only 25 heart centers to be recognized as an Optum Congenital Heart Disease Center of Excellence since 2011.

**Sample**

This project used a convenience sample of pediatric patients to include children aged neonate to 18 years of age admitted to the pediatric cardiac ICU who were mechanically ventilated for greater than 48 hours during the pre and post implementation time frame. Patients intubated for less than 48 hours, patients requiring mechanically ventilation with a tracheostomy, patients with single ventricle physiology, patients not admitted to the pediatric cardiac intensive care unit and patients older than 18 years or neonates born premature before 36 weeks' gestation were excluded.

**Data Collection/Analysis**

Data was collected through a medical record review prospectively and retrospectively using EPIC data from October 2022 through May 2023. Personal information was deidentified and information was transposed onto an Excel spreadsheet.

Data information includes demographics (age), cardiac defect diagnosis, mechanical ventilation duration, ERTs used, and extubation failures. The primary investigator kept all information stored on a password-protected computer, with deidentified patient information, owned by the investigator. Analysis was performed using independent sample T-tests and multiple regression through the SPSS software.

**Approval Process**

Formal approval for this project was sought from the organization in which the project took place, the student doctoral committee, and the university. Approvals were obtained prior to implementation of this project. There are no known ethical considerations.

**Procedures**

Using the ERT standardization for testing readiness for extubation versus the current practice of determining readiness for extubation was a QI project led by the Doctor of Nursing Practice (DNP) candidate. The DNP candidate met with key stakeholders including physicians, APRN's, nurses and respiratory therapists to design a standardized document to standardize the approach and criteria to determine which patients may be ready for ERTs. After document finalization by key stakeholders, the DNP candidate performed education and email correspondence with bedside nurses, RT's, physicians and APRN's regarding new standardized ERT document and appropriate use during morning rounds. The hospitals pediatrics ICU had an ERT protocol already in place and that document was used along with additional information related to patients with heart disease diagnoses to create a new cardiac specific ERT approach. An ERT approach for the pediatric ICU at this hospital was implemented into

the electronic health record (EHR) and RTs continued to use this in the heart center to document that ERTs were performed. ERT was discussed during rounds to determine if an ERT was appropriate and if the patient was meeting the guidelines. Data was collected and analyzed using independent t-tests and descriptive statistics via the SPSS statistics software.

**Results**

Medical records reviewed from October 2022 through May 2023 included (*N*=77) patients, (*n*=40) patients pre implementation (Oct 22-Dec 22) and (*n*=37) patients post implementation (Feb 23-May 23). Demographics for the patients included age, gender, race, and cardiac defect. The patients ages ranged from neonate through 18 years old; 64% of the patients were under one year of age, while 36% were over one year of age (see Figure 3). The most common diagnosis for patients in this study were patients with the diagnosis of heart failure (see Figure 1). ERT was utilized on (*n*=37) patients that met the criteria for this QI project. Pre implementation (Oct 22-Dec 22) of ERT a (*n*=40) and post implementation (Feb 23-May 23) (*n*=37) met criteria for an ERT to be administered. In the post implementation (*n*=37; 100%) had an ERT performed. There was a (*n*=2; 5%) extubation failure rate pre-implementation and (*n*=0; 0%) extubation failures in the post implementation group. Therefore, the rate of extubation failure decreased by 100% and resulted in 100% success rate of the ERT.

Statistical analysis of the data was performed using IBM SPSS Statistics Version 27. The distribution of duration of mechanical ventilation is non-normal and right skewed (skewness = 2.65, kurtosis = 7.78) (see Figure 4). A standard parametric *t*-test and standard linear regression are not recommended. Therefore, the Mann-Whitney U-test was used for

the t-test, and negative binomial regression was used in place of the standard linear regression.

The duration of mechanical ventilation was longer after the intervention ($M$=13.51 ,$SD$ = 19.07) than before ($M$ = 11.13,$SD$ = 11.72. Note the very large standard deviations, indicating a great deal of variability within the data. The Mann-Whitney form of the *t*-test indicates there is no significant difference between the pre-intervention group and the post-intervention group ($p$ = .931) (see Table 3).

The data for duration of mechanical ventilation did not fit a normal distribution and is strongly skewed toward "0-2" values for duration of days. Because of this non-normal distribution, the data does not fit one of the important pre-requisites (or assumptions) for linear regression. However, it does lend itself well to regression models that use a negative binomial distribution to accommodate the unusual data distribution. The omnibus test result of this regression model using a negative binomial distribution with two predictors: age and pre- or post-intervention indicates that overall, the model is not significant ($X^2$ =3.46, $p$ = .177) (see Table 6).

For patients over one year, there is a difference between pre-intervention ($M$ = 7.67, $SD$ = 10.44) which was shorter than post-intervention ($M$ = 10.55, $SD$ = 10.44) (see Table 4).

Varying results appear when the pre-and post-data is compared under certain admission diagnoses. Cases in which the mean duration of mechanical ventilation drops after the intervention are shown with "***". For those patients who were admitted with D-transposition of the great arteries, pre-intervention ($M$ = 3.50, $SD$ = .707, $n$ = 2) is <u>much</u>

shorter than post-intervention (*M* = 9.20, *SD* = 11.88, *n*= 5). For those patients who were admitted with Double outlet right ventricle of the great arteries, pre-intervention (*M* = 5.14, *SD* = 3.53, *n*=7) is longer than post-intervention (*M*=3.00, *SD* = 1.41, *n*=2). Patients admitted with Unbalanced Aterioventricular Canal, duration at pre-intervention (*M* = 10.25, *SD* = 6.85, *n* = 4) is slightly longer than post-intervention (*M* =10.00, *SD* = 6.85, *n*=4). ***. Patients admitted with heart failure diagnosis, duration at pre-intervention (*M* = 13.62, *SD* = 12.77, *n* = 13) is shorter than post-intervention (*M* = 14.60, *SD* = 14.56, *n* = 15). Patients admitted with lung transplant diagnosis, duration at pre-intervention (*M* = 4.0, *SD* = 0.0, *n* = 1) is much shorter than post-intervention (*M* = 38.33, *SD* = 56.92, *n* = 3). Patients admitted with tetralogy of Fallot, the duration of pre-intervention (*M* = 2.00, *SD* = 0.0, *n* = 1) is shorter than post-intervention (*M* = 3.67, *SD* = 2.89, *n* = 3).

Finally, a negative binomial regression was performed with duration of mechanical ventilation as the dependent variable, and diagnosis with pre- and post-intervention as independent variables (coded 1-16) (see Table 5).

**Discussion**

An ERT is a tool used by clinicians in ICUs to help decipher if a patient is ready to have their endotracheal tube removed. An ERT was implemented in a pediatric cardiac ICU to decrease the rate of extubation failures and shorten the length of mechanical ventilation. The primary outcome of this study attempted to determine if an ERT significantly decreased the extubation failure rate in the pediatric cardiac ICU. The pre- and post- implementation data showed only (*n*=2) failures prior to ERT implementation out of all (*N*=77) patients. The patients that failed extubation were neonates and were

reintubated within a few hours of extubation. The data showed that of the (*n*=37; 100%) patients that met criteria for the study and received ERTs.

There was no statistical significance shown that an ERT decreases the extubation failure rate. The rate of extubation failure pre implementation was (*n*=2; 5%) and post implementation was (*n*=0; 0%). Due to the small sample size, this does not show statistical significance. However, clinically, the extubation failure rate decreased by 100% in the post implementation data and is clinically significant. The results corroborate the data from the review of literature that indicated implementation of an ERT decreases the percentage of extubation failures and therefore decreased the number of patients that needed to be reintubated.

The secondary outcome measure was to examine if using an ERT decreased the length of time a patient was intubated. The ERT was implemented over a 12-week period and the results showed there was no clinically or statistically significant improvements in the duration of mechanical ventilation. However, there was clinical evidence that when a pediatric patient is older, his duration of mechanical intervention decreases and the ERT was more effective.

**Limitations**

Major limitations for this study included the small sample size and the short timeframe of the project. Due to ebbs and flows in the pediatric cardiac ICU, the acuity of the patients, the number of surgeries being performed, and the time of year, the number of patients with breathing tubes changes frequently as well did the number of patients admitted at any given time. The sample size consisted of (*N*=77) patients and the sample of patients was not consistent from pre and post study, therefore a paired t-test was

unable to be performed, which reduced the power of the study making it more prone to errors.

Additionally, other limitations of this study were the difficult distribution of duration of mechanical ventilation and the large standard deviations. This was likely related to the fact that each patient and diagnosis was unique to that patient and the study did not take into consideration other factors influencing mechanical ventilation. The duration of mechanical ventilation was longer after the intervention than before. The very large standard deviations indicated a great deal of variability within the data.

Lastly, the data showed that children under one year of age had longer durations than those patients over one year of age. The data was unbalanced and showed that there were slightly more patients under 1 year of age pre-implementation than post implementation. This could be a factor in why the mechanical ventilation was longer post intervention than pre-intervention.

**Recommendations**

Morbidity and mortality are significantly increased the longer a patient remains intubated on mechanical ventilation. While the evidence of ERT implementation was not statistically significant, limiting the amount of time patients are intubated is of the utmost importance. The benefits of early extubation not only prevents comorbidities, but they also decrease adverse health effects of prolonged intubation.

Future recommendations include continuing to use the ERT protocol for patients with prolonged mechanical ventilation to decrease the rate of extubation failures. The study should also include a longer timeframe to increase the sample size and to include complex congenital heart defects with single ventricle physiology. Pediatric patients that

have single ventricle physiology are at higher risk for sudden cardiac death. Therefore, revision of the ERT protocol with specific criteria created to mitigate those risks needs to be determined with inclusion of the ICU providers as well as the cardiothoracic surgeons.

The decision to use the ERT can help providers determine earlier in the pediatric patients ICU course that they are ready for liberation from mechanical ventilation sooner, especially for children under one year of age. This determination to use the ERT can prevent failure of extubation and therefore decrease adverse health effects, length of hospital stays, and length of ICU stays. Maintenance of the ERT in this single center pediatric cardiac ICU should include continuing education for providers, RTs, and RNs on ERT guidelines and inclusion criteria. The results should be disseminated to the team to show the decrease of extubation failures with the use of an ERT.

**Conclusion**

An ERT was implemented to aid providers in the early liberation of mechanical ventilation in the pediatric cardiac ICU. There were no statistically significant changes to the duration of mechanical ventilation or the extubation failure rate. The implementation of the ERT needs to be reevaluated and implemented for a longer period to increase the sample size and therefore increase the power of the study. The sample should also include single ventricle heart lesions as well as the current inclusion criteria for patients. According to the literature review, early liberation from mechanical ventilation has many benefits for patients and their families. Decreasing the length of intubation decreases comorbidities and facilitates earlier family engagement in the patients care.

For this study, ventilated patients in the pediatric cardiac ICU due to cardiac defect diagnosis, specifically patients with complex critical congenital heart lesions with

cyanosis or single ventricle physiology did not meet inclusion criteria. Including these patients would allow for a larger sample size and potentially greater statistical power.

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## Demographics

Figure 1. Frequency chart of admission diagnoses ($N$ = 77) for both pre-and post-intervention

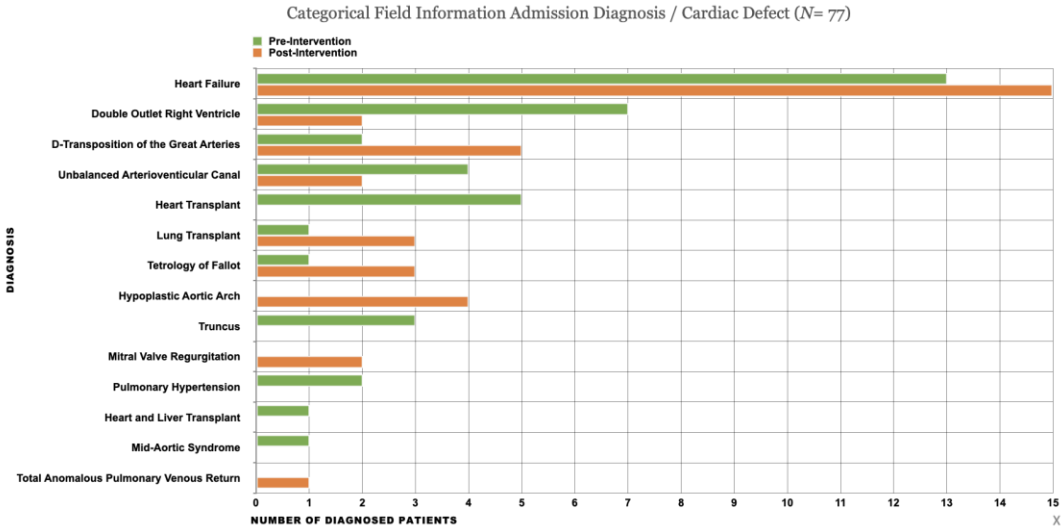

Figure 2: Number of Infants by Admission Diagnosis/Cardiac Defect

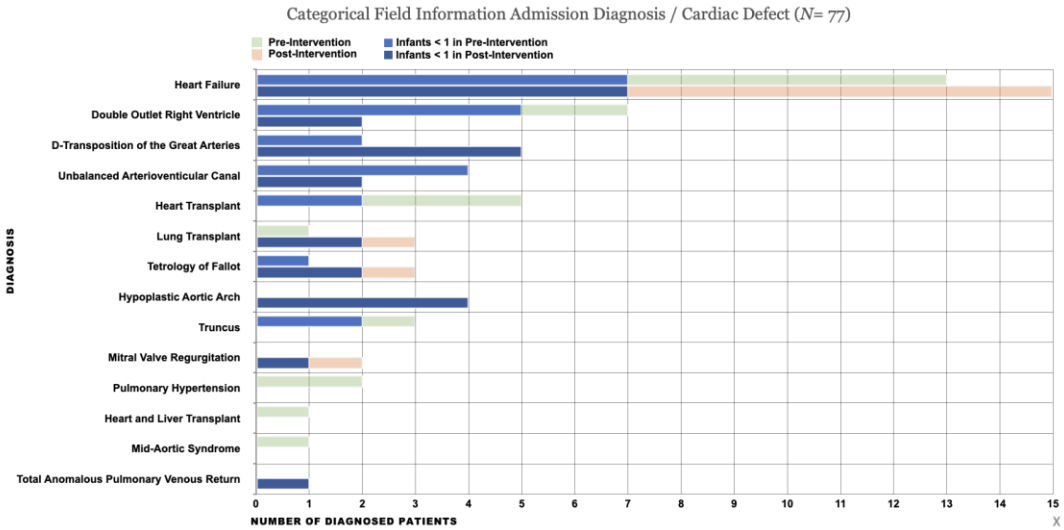

Figure 3. Frequency pie chart of ages of participants (pre- and post-intervention).

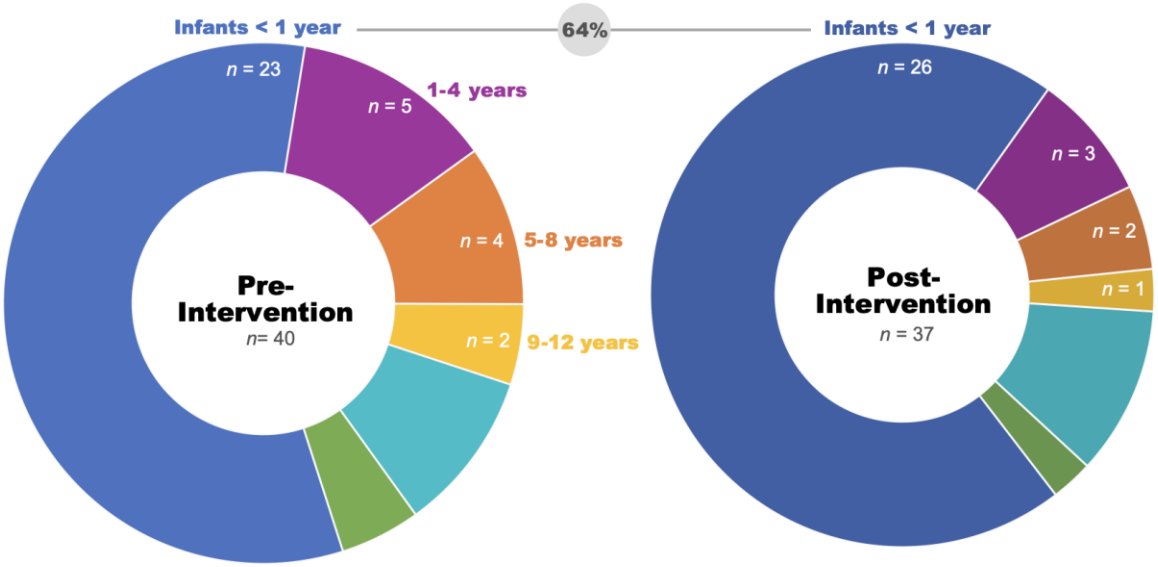

Figure 4 Histogram of duration of mechanical ventilation

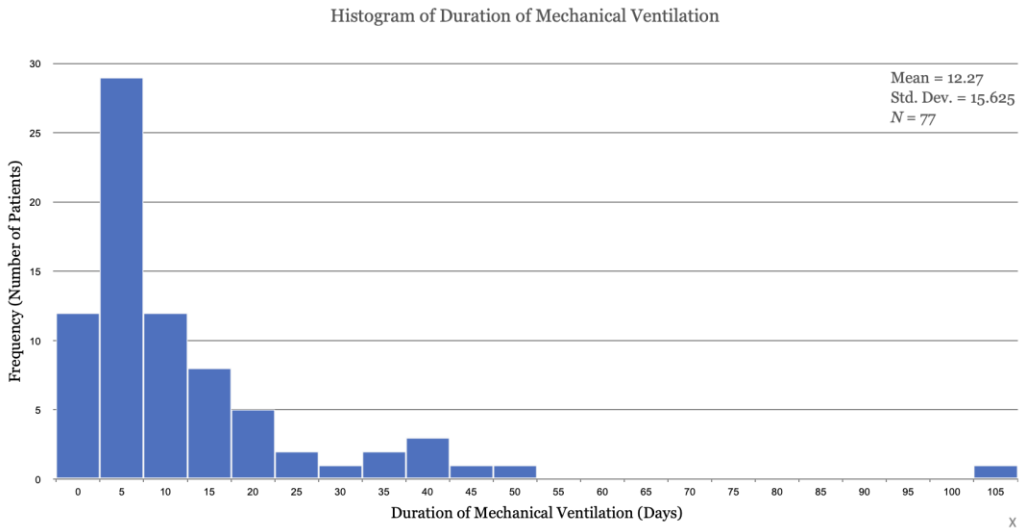

Table 1: Extubation Failures Pre and Post-Intervention

| | Extubation Failure | |
|---|---|---|
| | **N** | **Percentage** |
| Pre-Intervention | 2 | 5.0% |
| Post-Intervention | 0 | 0.0% |

Table 2: Duration of mechanical ventilation by pre- and post- intervention

Descriptive data for duration of mechanical ventilation by pre- and post-intervention

Duration of Mechanical Ventilation

| Pre / Post | Mean | N | Std. Deviation |
|---|---|---|---|
| Pre-Intervention | 11.13 | 40 | 11.722 |
| Post-Intervention | 13.51 | 37 | 19.067 |
| Total | 12.27 | 77 | 15.625 |

Table 3. Independent sample Mann-Whitney Test

*Hypothesis Test Summary*

| | Null Hypothesis | Test | Sig.[a,b] | Decision |
|---|---|---|---|---|
| 1 | The distribution of Duration of Mechanical Ventilation is the same across categories of Pre1_Post2. | Independent-Samples Mann-Whitney U Test | .931 | Retain the null hypothesis. |

Note. The significance level is .050.
Asymptotic significance is displayed.

Table 4. Mechanical ventilation by Over/Under one year of age by pre- and post-intervention.

Duration of Mechanical Ventilation

| Age | Pre1_Post2 | Mean | N | Std. Deviation |
|---|---|---|---|---|
| One Year or under | Pre-Intervention | 16.71 | 23 | 20.216 |
| | Post-Intervention | 16.19 | 26 | 23.019 |
| | Total | 16.45 | 49 | 21.486 |
| Over One Year | Pre-Intervention | 7.67 | 17 | 10.438 |
| | Post-intervention | 10.55 | 11 | 10.718 |
| | Total | 8.88 | 28 | 10.443 |

Table 5. Mechanical Ventilation by Diagnosis

**Descriptive Statistics**

Dependent Variable: Duration of Mechanical Ventilation

| Admission Diagnosis/Cardiac Defect | PrePost | Mean | Std. Deviation | N |
|---|---|---|---|---|
| D-transposition of the great arteries | Pre | 3.50 | .707 | 2 |
| | Post | 9.20 | 11.862 | 5 |
| | Total | 7.57 | 10.081 | 7 |
| Double Outlet Right Ventricle | Pre | 5.14 | 3.532 | 7 |
| | Post | 3.00 | 1.414 | 2 |
| | Total | 4.67 | 3.240 | 9 |
| Heart and Liver Transplant | Pre | 2.00 | . | 1 |
| | Total | 2.00 | . | 1 |
| Heart Failure | Pre | 13.62 | 12.771 | 13 |
| | Post | 14.60 | 14.564 | 15 |
| | Total | 14.14 | 13.517 | 28 |
| Heart Transplant | Pre | 16.00 | 16.985 | 5 |
| | Total | 16.00 | 16.985 | 5 |
| Hypoplastic aortic arch | Post | 15.50 | 9.678 | 4 |
| | Total | 15.50 | 9.678 | 4 |
| Lung transplant | Pre | 4.00 | . | 1 |
| | Post | 38.33 | 56.924 | 3 |
| | Total | 29.75 | 49.547 | 4 |
| Mid-Aortic Syndrome | Pre | 44.00 | . | 1 |
| | Total | 44.00 | . | 1 |
| Mitral Valve Regurgitation | Post | 9.50 | .707 | 2 |
| | Total | 9.50 | .707 | 2 |
| Pulmonary Hypertension | Pre | 6.50 | 3.536 | 2 |
| | Total | 6.50 | 3.536 | 2 |
| Tetralogy of Fallot | Pre | 2.00 | . | 1 |
| | Post | 3.67 | 2.887 | 3 |
| | Total | 3.25 | 2.500 | 4 |
| Total Anomolous Pulmonary Venous Return | Post | 2.00 | . | 1 |
| | Total | 2.00 | . | 1 |
| Truncus | Pre | 13.00 | 7.000 | 3 |
| | Total | 13.00 | 7.000 | 3 |

| | | | | |
|---|---|---|---|---|
| Unbalanced Aterioventricular Canal | Pre | 10.25 | 6.850 | 4 |
| | Post | 10.00 | 6.850 | 4 |
| Total | Pre | 11.13 | 11.722 | 40 |
| | Post | 13.51 | 19.067 | 37 |
| | Total | 12.27 | 15.625 | 77 |

Table 6. Parameter estimates of negative binomial test of model effects

*Parameter Estimates*

| | | | 95% Wald Confidence Interval | | Hypothesis Test | | |
|---|---|---|---|---|---|---|---|
| Parameter | B | Std. Error | Lower | Upper | Wald Chi-Square | df | Sig. |
| (Intercept) | 2.277 | .2496 | 1.788 | 2.766 | 83.189 | 1 | .000 |
| [Over1Year=0] | .437 | .2557 | -.064 | .938 | 2.919 | 1 | .088 |
| [Over1Year=1] | 0[a] | . | . | . | . | . | . |
| [PrePost=1] | -.171 | .2380 | -.638 | .295 | .517 | 1 | .472 |
| [PrePost=2] | 0[a] | . | . | . | . | . | . |
| (Scale) | 1[b] | | | | | | |
| (Negative binomial) | 1[b] | | | | | | |

Dependent Variable: Duration of Mechanical Ventilation

Model: (Intercept), Over1Year, PrePost

a. Set to zero because this parameter is redundant.

b. Fixed at the displayed value.