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Quantifying the benefits from a care coordination program for tracheostomy placement in neonates

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ABSTRACT

Objective: Value-based care models are becoming instrumental in structuring clinical care delivery in our healthcare climate. Our objective was to determine the value associated with implementation of a Family-Centered Care Coordination (FCCC) program for neonates undergoing tracheostomy.

Methods: A multi-disciplinary FCCC program was implemented at the Massachusetts Eye and Ear Infirmary and MassGeneral Hospital for Children in January 2013. This program is designed to ensure a safe transition out of the hospital for children undergoing tracheostomy, reduce re-admission rates, and increase caregiver quality of life (QOL). Study participants included neonates undergoing tracheostomy in 2012 and 2015. This retrospective cohort study examined length of stay (LOS), utilized time-driven activity-based costing to estimate the cost of care, assessed caregiver QOL with 1-month Pediatric Tracheostomy Health Status Instrument (PTHSI) scores, and assessed complications with 6-month Medical Complications Associated with Pediatric Tracheostomy (MCAT) scores.

Results: Following implementation of the FCCC program, average LOS decreased from 30.5 days (range 17–39) to 16.6 days (range 9–23). The largest process improvement (cost reduction of 61%) occurred in the discharge-planning phase. The overall cost per care cycle was reduced by 36%. A large clinically meaningful benefit was demonstrated for PTHSI (effect size 0.80) as well as MCAT scores (effect size 9.35).

Conclusions: We demonstrated the higher outcomes, including reductions in caregiver burden and complication rates, and the lower costs associated with implementation of the FCCC program for neonates undergoing tracheostomy.

Key Points

Question: What are the differential outcomes and costs associated with creating a Family-Centered Care Coordination (FCCC) program for neonates undergoing tracheostomy for patients and caregivers?

Findings: The FCCC, even with additional personnel, reduced costs through a lower length of stay. It also improved caregiver quality of life and lowered the complications usually associated with tracheostomy for neonates.

Meaning: A multidisciplinary FCCC program for post-operative tracheostomy improved the quality of care, as measured by patient-reported outcome measures, and also lowered the total cost of care

delivery.

1. Introduction

Neonatal tracheostomy is an essential procedure to provide a safe airway for children, especially those with upper airway obstruction or those needing prolonged ventilation [1]. While the typical time to heal from a tracheostomy is five days, the length of hospital stay for children requiring tracheostomy placement can be 40 days or longer as many children have complex medical needs and the preparation needed to live at home with a tracheostomy can be quite challenging [2–4].

MEEI and MGH formed a Family-Centered Care Coordination

Abbreviations: TDABC, time-driven activity-based costing; FCCC, family care coordination program; TCM, Tracheostomy Case Manager

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(FCCC) program, a collaborative initiative that included otolaryngology, case management, respiratory therapy, nursing, neonatology, and the pediatric intensive care unit. FCCC is a collection of programs, policies, and tools to ensure a safe transition home for children undergoing tracheostomies, reduce readmission rates and complications after tracheostomy, and minimize caregiver burden [3]. We implemented the program as a hospital-wide initiative over several months in 2014 and documented that it improved caregiver quality of life and reduced complications associated with tracheostomy [3].

FCCC, however, requires an additional person, the Tracheostomy Care Manager (TCM) to facilitate purposeful engagement with hospital staff caring for children post-tracheostomy placement, coordinate the various programs, and ensure the correct implementation of the FCCC tools. At our institution, our TCM is a registered nurse with a history of clinical interest in tracheostomy patients, a position that has joint funding by both MGH and Department of Otolaryngology at MEEI. In this study, we analyzed whether the added cost of the TCM, who devoted time and attention to the special needs of tracheostomy patients and their families, was repaid through lower total care costs, in addition to the benefits of reducing caregiver burden and readmission rates.

We used time-driven activity-based costing (TDABC) to estimate the total costs of caring for tracheostomy patients. TDABC requires estimation of two parameters: the cost of each clinical and administrative person involved in the patient's care cycle, and the quantity of time required for each person [5]. The TDABC process is: define the cycle of care; outline each step involved throughout the entire care cycle; identify the personnel used at each step; estimate the time spent by the person at the step, calculate the cost per minute for each resource; and, finally, multiply the time used by personal by their cost per minute, and sum across all the personnel involved in the patient's care cycle. TDABC can be used, as illustrated in this study, to accurately compare the costs of all the clinical and administrative processes before and subsequent to the introduction of a quality improvement initiative.

The primary goal of this study was to quantify whether our FCCC quality-improvement initiative lowered the cost and improved the outcomes from the care we delivered to our patients. We used two primary outcome measures: the FCCC caregiver quality of life, assessed at 1 month status-post tracheostomy placement with a 34-item self-administered survey for caregivers, the Pediatric Tracheostomy Health Status Instrument (PTHSI) [6]; and the complication rate assessed at 6 months status-post tracheostomy placement with the Medical Complications Associated with pediatric tracheostomy (MCAT) questionnaire [3]. Cost changes were calculated, using TDABC, for care cycles modeled both before and after implementation of the FCCC methodology. The cost savings included reductions in the post-FCCC total average hospital length of stay (LOS).

2. Methods

We identified neonates who underwent tracheostomy at the Massachusetts Eye and Ear (MEE) with pre-operative and post-operative care at Mass General Hospital for Children (MGH) and were discharged from our tertiary care children's hospital during a 1-year "preintervention" period (January 2012 to January 2013) and during a "postintervention" period (January 2015 to January 2016). Patients retro-transferred to other hospitals or care centers before home discharge were excluded. Retrospective chart review was performed to estimate average LOS. Institutional Review Board approval was not needed for this study as it was conducted as an initiative for patient care improvement at MEE and MGH.

The creation and implementation of the FCCC program has been previously described [3]. Interventions included peer-to-peer mentor assignments with other families caring for children with tracheostomies, developing education materials (binders, teaching videos, and simulation dolls), a daily schedule of teaching, a "Trach Me Home" Road Map for caregivers modeled from the Children's National Medical

Center's program [7], team-based care coordination, and timely case management to arrange home supplies and nursing as needed.

Caregivers of neonates undergoing tracheostomies either from January 2012 to January 2013 or from January 2015 to January 2016 completed both the PTHSI no earlier than 1 month after discharge home and the MCAT questionnaire no earlier than 6 months following discharge home. These instruments have been previously described [3,6]. Of note, the MCAT specifically addresses Emergency room visits or readmissions for tracheitis, bleeding, plugging, and difficulties with changing the trach. Scores for those caregivers who provided complete medical data for all 6 months were included for comparative analysis.

TDABC was used to estimate the cost of care both prior to and following initiation of the FCCC program. The patient care cycle started on the first day of hospitalization, with admission or transfer from another facility. The end of the care cycle was set at the day of discharge from MGH. Process maps were constructed to outline each step of care that needed to be accounted for in the TDABC analysis (Supplemental Materials), and this was done retrospectively both pre- and post-implementation of the FCCC program. Process maps were made detailing each interaction between the patient and hospital personnel and the minutes of duration for each interaction.

As previously described we used TDABC to estimate personnel costs pre- and post FCCC implementation [8]. We excluded equipment and space costs in the analysis since these were far below (less than 5%) personnel costs. We reported costs of each step relative to the most expensive step (that is the cost of the most expensive step was set at 100, with costs at all other steps reported as a percentage of the expensive step's cost) to avoid disclosing sensitive financial information of MEE and MGH.

Continuous variables are reported using means and ranges. Categorical data are presented as frequency counts and percentages. Two-sided student's t-tests were used to calculate pre-initiative and post-initiative means with normally distributed data. p values < 0.05 were considered statistically significant. Standardized mean difference (Cohen's d ; effect size) was also calculated with definitions of < 0.2 = trivial effect; $0.2-0.5$ = small effect; $0.5-0.8$ = moderate effect; > 0.8 = large effect [9]. Statistical analyses were performed with GraphPad Prism 8.0 (GraphPad, La Jolla, CA).

3. Results

3.1. Hospital length of stay and care cycles

10 neonatal patients underwent tracheostomy in 2012 compared to 12 neonatal patients in 2015. Their average lengths of stay were 30.5 days (range 17–39) versus 16.6 days (range 9–23). Care cycles and process maps both prior to implementation of FCCC and following FCCC utilization were created. The care cycle utilizing FCCC is provided as supplemental material. 6 phases of care were detailed in process mapping, including: patient transfer for tracheostomy, tracheostomy planning, day of tracheostomy, tracheostomy maturation, day of tracheostomy change, and preparation for discharge. The final phase of care, "preparation for discharge," accounted for the increased hospital LOS prior to FCCC implementation. The time spent by the TCM in implementation of the FCCC accounted for the difference in personnel cost between the two care cycles.

3.2. Calculating cost by TDABC

Costing data are presented in Fig. 1. Relative costs are presented and are proportional to the most costly phase of care or day in the care cycle. The day of tracheostomy was the most expensive day in each care cycle, and relative cost per day is reported relative to the OR days both pre- and postintervention. Both pre- and post-intervention, the discharge planning was the most costly phase of care, and cost is reported relative to this phase. As shown in Fig. 1, the discharge planning phase

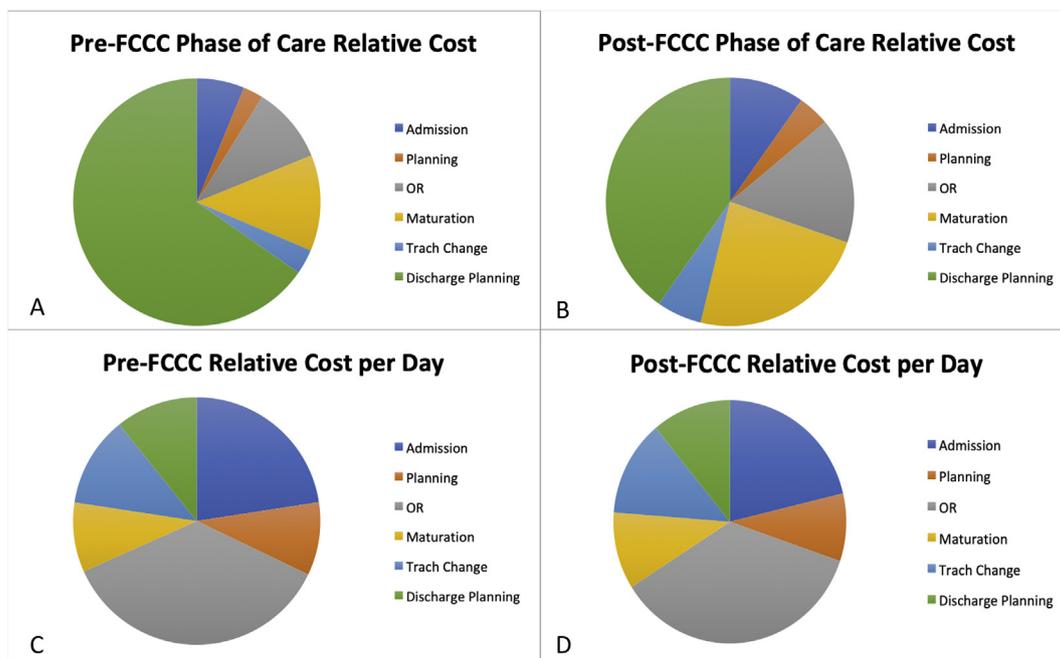


Fig. 1. Relative Costs (A) Preintervention comparison by phase of care (B) Postintervention comparison by phase of care (C) Preintervention comparison per day (D) Postintervention comparison per day. FCCC- Family-Centered Care Coordination; OR- Operating room.

was proportionally reduced following FCCC, with a relative cost savings of 60.6% for this phase. With the exception of patient transfer for tracheostomy and tracheostomy planning (when the TCM is not yet involved and costs are equal), postintervention cost per day was more expensive than preintervention. However, since LOS was significantly reduced postintervention, the overall cost of the care cycle was reduced by 36% following implementation of the FCCC.

3.3. Caregiver burden and complications

PTHSI data was collected on the full cohort of 10 neonates who underwent tracheostomy in 2012 compared to 12 neonates who underwent tracheostomy in 2015. The mean PTHSI decreased from 116.9 (SD = 21.8) to 99.5 (SD = 16.2) following FCCC implementation. Student's t-test was performed to compare the two groups and revealed $p < 0.04$. This difference represented a largely clinically meaningful effect size of 0.8.

MCAT data was able to be collected on 7 neonates who underwent tracheostomy in 2012 compared to 5 neonates who underwent tracheostomy in 2015. The mean total MCAT score for those who did not receive FCCC was 21.6 (SD = 2.07), while that for those who did receive FCCC was reduced to 2.2 (SD 1.2). Student's t-test was performed to compare the two groups and revealed $p < 0.0001$. This difference represented a largely clinically meaningful effect size of 9.35. The details of the MCAT data are provided as supplemental data.

3.4. Value representation

Fig. 2 represents a radar chart [10] in order to depict both cost and outcomes for neonatal tracheostomy patients at MEEI and MGH pre- and postintervention. Cost is portrayed relative to the preintervention care cycle cost, with a postintervention value of 0.64. Similarly, the length of stay is portrayed in relative terms with a postintervention value of 0.53, PTHSI with a postintervention value of 0.85, and MCAT with a postintervention value of 0.10.

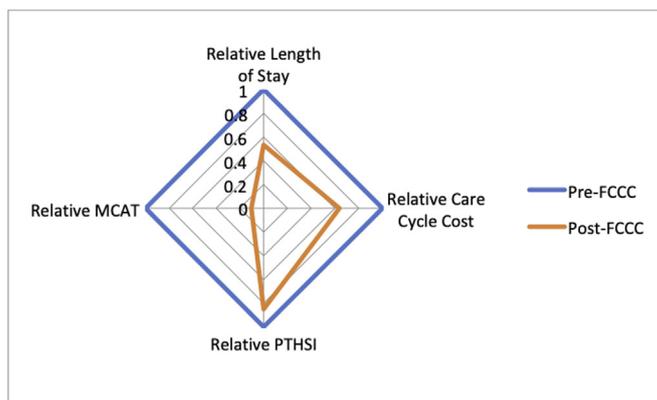


Fig. 2. Radar chart comparing preintervention and postintervention groups based on length of stay, cost, caregiver burden, and complication rate PTHSI- Pediatric Tracheostomy Health Status Instrument; MCAT- Medical Complications Associated with pediatric Tracheostomy.

4. Discussion

We used TDABC to determine the value of a multidisciplinary, family-centered program for post-operative tracheostomy teaching. As quality of care is becoming more defined by patient reported outcome measures and quality of life, such initiatives are imperative to deliver better outcomes for patients. We demonstrate our FCCC program to be effective by four clear measures, including reduction of LOS, reduction in cost per care cycle, improvement in caregiver QOL, and reduction in reported complication rate.

In the implementation of the FCCC, key lessons included the importance of streamlining the teaching process to caregivers by delivering consistent, clear explanations and instructions. For example, we found nurses taught different degrees of sterile technique depending on the phase of care (trach maturation versus discharge planning), which often confused caregivers. However, if we explained to them that methods for trach care change over the course of their stay so as to more closely mimic the home environment (when the number of suction catheters, for example, is limited per month), families were better

prepared for these small changes. In general, we have found families value a balance between both the multidisciplinary team and communication from a team leader, or “Quarterback,” delivering information to families in a concise, straightforward way. In this way, information is synthesized for families by the team leader leading to less miscommunication that decreases outcomes (QOL) and increases cost (LOS).

Traditional hospital charge costing (which is the accounting model on which current hospital budgets are configured) associated with ICU admission is often estimated at about \$6.6k per day [11]. The FCCC program decreased length-of-stay by about 14 days, or an approximate cost savings of about \$92k per tracheostomy care cycle. Therefore, even with traditional cost accounting it can be inferred that children's hospitals performing neonatal or pediatric tracheostomies may well find it cost-effective (not to mention *valuable*) to have a TCM and a coordinated care plan (such as FCCC) in place. Investing in creation of this FCCC model delivers a return on investment through improved outcomes at lower costs. The savings of \$92k per patient stay far exceeds the cost of an additional trach coordinator.

To our knowledge, the literature on initiatives to reduce length of stay on pediatric tracheostomy patients is quite limited. Many studies focus on prevention of post-operative wound complications or variation in surgical technique to prevent complications [12–15]. Importantly, our initiative was formed in parallel and in collaboration with the “Trach Me Home” program at Children's National Medical Center, which standardizes parent and caregiver education before discharging a patient home with a tracheostomy [7]. Although many institutions have created such programs using parent and caregiver education protocols to address readmission and complication rates associated with pediatric tracheostomy [16–18], the literature is limited as to the ultimate success of these programs. Here, we demonstrate one such program that not only reduces LOS and cost, but also improves caregiver QOL and reduces complication rate (as reflected by Emergency room visits or readmissions).

There are multiple factors unique to our care center that may have contributed to the success of the FCCC. First of all, many of our patients are transferred from outside hospitals specifically to undergo tracheostomy. This makes their workup upon arrival and scheduling them for the operating room relatively streamlined. Second, our state Medicaid insurance offers nursing services for the home for children with tracheostomies. Watters et al. [19] found these services to be utilized by only about 38% of Medicaid tracheostomy patients. However, in our experience, the option of home nursing is comforting to caregivers while they are learning to care for a trach. Even if they do not utilize these services at home, many have anecdotally expressed comfort in knowing this is an option. Given the availability of home nursing services through Medicaid in our state, a delay in discharge due to setting up home nursing (which is often the case with medically complex patients [20]) was not often seen for our patients. Therefore, the lack of available home nursing for pediatric patients in other areas of the country may limit the success of implementing a program such as FCCC elsewhere.

We recognize our study does have limitations. There is limited generalizability of our care cycles and process maps, since hospital practice patterns vary as to whether neonates with tracheostomies are cared for exclusively in neonatal intensive care units or are transferred to step-down units and/or inpatient wards once medical stability has been achieved. This can also interfere with streamlined teaching and clear communication between teams, staff, and caregivers. Furthermore, TDABC was applied only to personnel costs, and not space and equipment costs. However, we felt justified in doing so not only since we were comparing effects pre- and postintervention, but also that this would only underestimate the effect of FCCC cost reduction. Additionally, in conducting a TDABC there is often a relatively small sample size. The aim is to measure the processes and system in which the care is delivered, which can be an extremely time-intensive process.

We also recognize that our patient population cannot be generalized to all patients undergoing tracheostomy, as our patients were admitted to the hospital specifically to undergo the tracheostomy procedure. Finally, our study was limited to one care cycle and did not directly examine readmission rates (although these are incorporated in the MCAT caregiver survey). It also did not include clinical resources used post-discharge to advise caregivers at home. Of course, readmissions come at a large cost to health care systems. Further studies are needed in order to incorporate rates of readmissions into costing models in order to better examine how initiatives such as FCCC may reduce cost for pediatric tracheostomy patients.

In summary, the FCCC is an initiative that incorporates peer mentorship, family-centered bedside trach care, and standardized caregiver education that effectively reduces length of hospital stay, cost of hospitalization as measured by TDABC, improves caregiver QOL, and reduces reported complication rate associated with tracheostomy. Further studies are needed in order to follow the progress of this program, measure trends in readmission and complication rate associated with pediatric tracheostomy, and to explore further innovative ways to better care for these complex patients.

Contributors' statement

Dr. Caloway was involved in planning and execution of the study, acquisition of data, analysis and interpretation of data, drafting the article, and final approval of the final manuscript as submitted. Dr. Caloway had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Dr. Shah, Ms. Callans, and Dr. Yamasaki was involved in planning and execution of the study, acquisition of data, analysis and interpretation of data, critical review and revision of the manuscript, and approval of the final manuscript as submitted. Dr. Kaplan was involved in analysis and interpretation of data, critical review and revision of the manuscript, and approval of the final manuscript as submitted.

Dr. Hartnick was involved in planning and execution of the study, acquisition of data, analysis and interpretation of data, critical review and revision of the manuscript, and final approval of the final manuscript as submitted.

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Table of contents summary

Cost reduction analysis using time-driven activity-based costing before and after implementation of Family-centered care coordination program at tertiary care center.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

Acknowledgements

Our Family-Centered Care Coordination program was formulated in parallel and in collaboration with the team at Children's National Medical Center and was influenced by their “Trach Me Home” model for parent and caregiver education.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijporl.2020.110025>.

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