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Original Article

Reducing readmissions following paediatric cardiothoracic surgery: a quality improvement initiative

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Abstract *Background*: We have previously identified risk factors for readmission following congenital heart surgery – Hispanic ethnicity, failure to thrive, and original hospital stay more than 10 days. As part of a quality initiative, changes were made to the discharge process in hopes of reducing the impact. All discharges were carried out with an interpreter, medications were delivered to the hospital before discharge, and phone calls were made to families within 72 hours following discharge. We hypothesised that these changes would decrease readmissions. *Methods*: The current cohort of 635 patients underwent surgery in 2012. Demographic, preoperative, operative, and postoperative variables were evaluated. Univariate and multivariate risk factor analyses were performed. Comparisons were made between the initial (2009) and the current (2012) cohorts. *Results*: There were 86 readmissions of 77 patients during 2012. Multivariate risk factors for readmission were risk adjustment for congenital heart surgery score and initial hospital stay >10 days. In comparing 2009 with 2012, the overall readmission rate was similar (10 versus 12%, $p = 0.27$). Although there were slight decreases in the 2012 readmissions for those patients with Hispanic ethnicity (18 versus 16%, $p = 0.79$), failure to thrive (23 versus 17%, $p = 0.49$), and initial hospital stay >10 days (22 versus 20%, $p = 0.63$), they were not statistically significant. *Conclusions*: Potential risk factors for readmission following paediatric cardiothoracic surgery have been identified. Although targeted modifications in discharge processes can be made, they may not reduce readmissions. Efforts should continue to identify modifiable factors that can reduce the negative impact of hospital readmissions.

Keywords: Congenital cardiac surgery; readmission; quality initiative

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Approximately 10–20% of children are readmitted following congenital heart surgery. Readmissions are now being viewed as preventable complications of the original surgery or hospitalisation, and there have been proposals by insurance agencies to deny coverage of the additional expenses incurred by the readmission.[1]

There are increasing efforts nationwide to identify high-risk patients and to develop interventions targeted at reducing the frequency of hospital readmissions. In 2011, we identified and published risk factors for readmission following congenital heart surgery for 685 children who underwent congenital heart surgery in 2009. Hispanic ethnicity, failure to thrive, and original hospital stay more than 10 days were identified as key risk factors for readmission (Table 1).[2] As part of a quality initiative with the goal of reducing readmissions, the following changes were made in the discharge process for patients falling into these three high-risk groups: all discharges were carried out with an interpreter for non-English speaking families, regardless of their stated understanding of the English language; medications were delivered to

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Table 1. Multivariate regression analysis – 2009 cohort.

Category	Relative risk	Confidence interval		p-value
		Lower	Upper	
Demographic variables				
Ethnicity				
White	Reference			
Black	0.74	0.44	1.24	0.25
Hispanic	1.86	1.10	3.13	0.02
Other	0.63	0.19	2.15	0.46
Preoperative history				
Failure to thrive				
No	Reference			
Yes	2.88	1.54	5.40	0.001
Postoperative variables				
Total length of stay (days)				
1–5	Reference			
6–10	1.13	0.54	2.37	0.75
>10	4.24	2.26	7.97	<0.0001

the hospital before discharge, and a full medicine reconciliation was performed between the family and discharge nurse; and phone calls were made to families within 72 hours following discharge by a midlevel provider, at which time a status update was obtained, and a medicine reconciliation was performed again. Whether this quality initiative has made a difference in readmissions is unknown.

Therefore, the purpose of our study was to determine the risk factors for readmission following our intervention, and compare readmission rates before and after our intervention. We hypothesised that these changes in the discharge process would decrease readmissions following surgery.

Methods

The current cohort of patients was discharged following congenital heart surgery performed at Children's Healthcare of Atlanta in 2012. Institutional Review Board approval was obtained to conducted this retrospective study, and individual patient consent was waived.

Study variables

The primary outcome variable was readmission, defined as a repeat admission to Children's Healthcare of Atlanta occurring within 30 days following discharge from a surgical encounter. The predictors of interest evaluated were the same as those in our 2011 study, including various demographic, preoperative, operative, and postoperative characteristics. Demographic data included patients' age at surgery (<30 days, 30 days–1 year, and >1 year), weight at surgery (<5, 5–10, and >10 kg), gender, and race/ethnicity (Caucasian, African-American, Hispanic, and other). Preoperative risk factors included the presence of a genetic syndrome, failure to thrive, developmental delay, gastroesophageal reflux disease, mechanical ventilation, arrhythmia, and asplenia/polysplenia. The most common genetic anomalies were Down's, DiGeorge, Noonan, Jacobsen, and CHARGE syndromes; however, rare miscellaneous mutations were considered as well. Operative factors included surgeon and type of operation. Type of operation was categorised by the risk-adjusted congenital heart surgery method.[3] Surgeries for which a category could not be assigned were considered as a separate category. No operations met the category 5 criteria. Postoperative factors included nasogastric feeds at discharge, the number of functional ventricles, the presence of palliated physiology, duration of intensive care unit stay (none, 1–2, 3–5, and >5 days), and total length of stay (<5, 5–10, and >10 days).

Statistics

We first performed summary statistics for the population as a whole. A Fisher's exact test was used to perform univariate analyses of the candidate predictor variables. For the multivariate analysis, we constructed a generalised estimating equation Poisson regression model that included the variables that were significant $\alpha = 0.10$ in the univariate analyses. Interaction terms were tested, and the model was evaluated for potential collinearity. From the multivariate model, we determined risk ratios and 95% confidence intervals. Significance was considered at $\alpha < 0.05$. Comparisons were then made between the 2009 cohort and the 2012 cohort. All analyses were performed using SAS Version 9.2 (SAS Institute, Cary, North Carolina, United States of America).

Results

There were a total of 635 eligible patients who underwent surgery in 2012 and were discharged home from our institution. The list of demographic, preoperative, operative, and postoperative variables, as well as the summary statistics, are shown in Table 2. In this cohort, there were 86 readmissions of 77 patients. Multivariate risk factors for readmission were risk adjustment for congenital heart surgery score 6 [risk ratio 5.08; 95% confidence interval (1.19–21.75); $p = 0.03$] and initial hospital stay >10 days [risk ratios 4.15; 95% confidence interval (1.87–9.22); $p = 0.0005$]. (Table 3)

In comparing the 2009 cohort with the 2012 cohort, there were no significant differences in the preoperative risk factors or case mix. The overall

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Table 2. Summary of demographic, preoperative, operative, and postoperative factors.

	Total Patients (n = 635)			
	n	%	Median	range
Demographic factors				
Age at surgery (days)			219	(0–8214)
Weight at surgery (kg)			7	(1.9–159)
Gender				
Male	334	53		
Female	301	47		
Ethnicity				
Caucasian	294	46		
African-American	187	29		
Hispanic	67	11		
Other	87	14		
Preoperative factors				
Genetic anomaly	112	18		
Failure to thrive	41	6		
Developmental delay	55	9		
Gastroesophageal reflux disease	70	11		
Mechanical ventilation	52	8		
Arrhythmias	47	7		
Asplenia/polysplenia	30	5		
Operative factors				
Assigned surgeon				
A	226	36		
B	239	38		
C	170	27		
RACHS score				
1	68	11		
2	273	43		
3	156	25		
4	53	8		
6	27	4		
Other	62	10		
Postoperative factors				
Nasogastric feeds at discharge	105	17		
Number of ventricles				
1	115	18		
Palliated physiology	125	20		
Duration of stay				
CICU (hours)			48	(0–2038)
Total (days)			5.0	(0–151)

CICU = cardiovascular intensive care unit; RACHS = risk adjustment for congenital heart surgery

readmission rate was similar (10 versus 12%, p = 0.27). Although there were slight decreases in the readmissions for those patients with Hispanic ethnicity (18 versus 16%, p = 0.79), failure to thrive (23 versus 17%, p = 0.49), or initial hospital stay >10 days (22 versus 20%, p = 0.63), they were not statistically significant. (Table 4)

Discussion

In this study comparing readmission rates following congenital heart surgery in children at two different time points, and following a quality improvement initiative, we found no difference in readmission rates, despite our targeted efforts. Efforts geared towards reducing readmissions in the high-risk group were not found to have a significant impact. These similarities in readmission rates may reflect either (a) that our readmission rate is already at or near its nadir and may not be able to be reduced effectively, or (b) that the risk factors for readmission that were targeted in our campaign are not modifiable, at least by the efforts that we used.

In addition, we do recognise that some rate of readmission is beneficial. Attempts to eliminate readmissions entirely may have unintended consequences such as out-of-hospital morbidity and mortality.

Identifying risk factors for readmission

Reducing hospital readmissions is a national health-care priority and financial penalties for institutions with high readmission rates have been proposed.[4] This has led to intensified efforts to reduce readmissions. Hospitals across the country, including ours, have tried to identify reasons for readmission and implement successful strategies to reduce them.[4–10] Identification of patients at high risk for readmission is a crucial step towards improving care and developing possible interventions to reduce readmissions. At our institution, we identified patient risk factors for readmission following paediatric cardiac surgery – Hispanic ethnicity, failure to thrive, and original hospital stay more than 10 days.[2] Other studies, looking specifically at patients undergoing arterial switch and Norwood operations, identified other patient risk factors.[11] They showed that patients who began full oral feeds less than 2 days before discharge, patients who had residual hemodynamic lesions following surgery, and patients with an intensive care unit stay more than 7 days were at a significantly higher risk of readmission within 30 days after discharge.[11]

Unfortunately, patient factors vary across institutions and specialties and are not the only cause of readmissions. There have been a number of studies examining factors for readmission in different patient populations. These factors can be grouped into four categories: patient, clinician, social, and system factors.[10] Patient factors associated with readmissions include health status, socio-economic status, and patients' behaviour such as non-compliance with treatment.[10,12] Clinician factors refer to the adequacy and appropriateness of the assessment, management, treatment, and resolution of medical problems.[10,13,14] Social factors include coping, support systems, and community services.[10,15,16] System factors refer to the availability, accessibility, and coordination of care in the health-care delivery system.[10,13,14] Using this classification system, one study showed that avoidable

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Table 3. Multivariate regression analysis – 2012 cohort.

Category	Relative risk	Confidence interval		p-value
		Lower	Upper	
Operative variables				
RACHS				
RACHS 1	Reference			
RACHS 2	2.20	0.55	8.86	0.27
RACHS 3	4.02	1.00	16.07	0.05
RACHS 4	2.34	0.52	10.51	0.27
RACHS 6	**5.08**	**1.19**	**21.75**	**0.03**
RACHS other	0.62	0.09	4.14	0.62
Postoperative variables				
Total length of stay (days)				
1–5	Reference			
6–10	2.25	0.97	5.18	0.06
>10	**4.15**	**1.87**	**9.22**	**0.0005**

RACHS = risk adjustment for congenital heart surgery

Table 4. 2009 and 2012 cohort comparisons.

	No readmission n(%)	Readmission n(%)	p-value
Overall readmissions			
Year 1	615 (89.8)	70 (10.2)	0.2711
Year 2	558 (87.9)	77 (12.1)	
Hispanic ethnicity			
Year 1	68 (81.9)	15 (18.1)	0.7902
Year 2	56 (83.6)	11 (16.4)	
Failure to thrive			
Year 1	37 (77.1)	11 (22.9)	0.4939
Year 2	34 (82.9)	7 (17.1)	
Initial hospital stay >10 days			
Year 1	158 (78.2)	44 (21.8)	0.6272
Year 2	201 (80.1)	50 (19.9)	

readmissions were owing to clinician factors (42.3%), patient factors (41.9%), system factors (14.6), and social factors (1.2%).[10]

Because of the extreme variability in the readmission profile, methods are needed to easily identify those patients at risk for readmission. Some institutions have introduced programmes into the electronic medical record to help identify these high-risk patient groups. One health-care system involving three hospitals introduced an automated readmission risk flag into the electronic health record.[17] They effectively integrated an automated prediction model into an existing electronic health record and identified patients on admission who were at risk for readmission within 30 days of discharge.[17]

Targeting interventions

Even after identifying an institution-specific and specialty-specific group of patients at risk for readmission, targeting interventions to minimise these readmissions may continue to be challenging. Some risk factors are modifiable and some are not. Clinical conditions such as principal diagnosis at index admission, comorbidities, and acuity are not modifiable.[1] Patient characteristics such as gender, age, distance from hospital, insurance status, literacy level, and support systems are not modifiable.[1] On the other hand, numerous hospital operations are modifiable.

Various interventions have been proposed to help address these modifiable components of hospital readmissions. Pre-discharge interventions include patient education, medication reconciliation, discharge planning, and scheduling of follow-up appointments before discharge.[7] Post-discharge interventions include follow-up telephone calls, patient-activated hotlines, timely communication with ambulatory providers, timely ambulatory provider follow-up, and post-discharge home visits.[7] Bridging interventions included transition coaches, physician continuity across the inpatient and outpatient setting, and patient-centred discharge instruction.[7] There is a recent shift in

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increased attention to the role the primary care provider, including a more prominent role during the actual hospital admission and more involvement in the post-discharge interventions.[18]

We recognise that we could have chosen interventions to target the most common aetiologies for readmission – pleural/pericardial effusions and gastrointestinal problems. Unfortunately, many of the patients readmitted for these issues had no predictive signs or symptoms at the time of discharge that a specific intervention would address. We were also concerned that the potential interventions would adversely affect the length of hospital stay.

Success?

After performing a risk factor analysis in our 2009 cohort, we made the following targeted changes in the discharge process for patients falling into a high-risk group: all discharges were carried out with an interpreter for non-English speaking families, regardless of their stated understanding of the English language; medications were delivered to the hospital before discharge, and a full medicine reconciliation was performed between the family and discharge nurse; and phone calls were made to families within 72 hours following discharge by a midlevel provider, at which time a status update was obtained, and a medicine reconciliation was performed again. Despite these interventions, the overall readmission rate was similar in 2009 versus. 2012 (10 versus 12%, $p = 0.27$). Although there were slight decreases in the readmissions for those patients with Hispanic ethnicity (18 versus 16%, $p = 0.79$), failure to thrive (23 versus 17%, $p = 0.49$), and initial hospital stay >10 days (22 versus 20%, $p = 0.63$), they were not statistically significant. Although the interventions used in this study did not result in statistically significant decreases in the rates of readmission, we continue to utilise them and feel that they have a beneficial role in the discharge process.

Numerous other programmes have embarked on efforts to reduce hospital readmissions. Many of the aforementioned interventions have been implemented individually or in a bundled manner with varying degrees of success. Some programmes and disciplines have shown statistically significant reductions in readmission rates, whereas others, such as ours, have not achieved such success.

One study gathered data from a web-based survey of hospitals participating in national-quality initiatives to reduce hospital readmissions.[5] Strategies associated with a lower hospital readmission rates included the following: partnering with community physicians or physician groups to reduce readmission (0.33% reduction; $p = 0.017$); partnering with local hospitals to reduce readmissions (0.34 reduction; $p = 0.020$); having nurses responsible for medication reconciliation (0.18 reduction; $p = 0.002$); arranging follow-up appointments before discharge (0.19 reduction; $p = 0.037$); having a process in place to send all discharge paper or electronic summaries directly to the patient's primary physician (0.21 reduction; $p = 0.004$); and assigning staff to follow-up on test results that return after the patient is discharged (0.26 reduction; $p = 0.049$).[5] The authors concluded that the magnitude of change with individual strategies was modest – less than half a percentage point reduction in readmissions; however, hospitals that implemented more strategies had significantly lower readmissions – 0.34 reduction for each additional strategy.[4,5] Kripilani et al[4] also showed that the effect of interventions on readmission rates was related to the number of components implemented and that single-component interventions were unlikely to reduce readmissions significantly.

Limitations

There are some important limitations in our study. We conducted a review of medical records to examine the potential factors contributing to readmissions. We did not gather comprehensive information regarding system-related and social-related contributing factors. Our results only represent patients from a single institution within a surgical subspecialty. Patients from other institutions or within other surgical /medical specialties might have different factors that contribute to readmissions. Our readmission rates may already be well balanced with a short length of stay, and any further reduction in readmission may occur at the expense of a prolonged hospitalization. Finally, our readmission rates may be at a level that is hard to reduce regardless of the intervention.

Conclusions

Our study characterises the risk factors for readmission following paediatric cardiothoracic surgery in a large academic centre. Although targeted modifications in discharge processes can be made, they may not reduce readmissions. Efforts should continue to identify modifiable factors that can reduce the negative impact of hospital readmissions.

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Conflicts of Interest

None.

Ethical Standards

Institutional Review Board approval was obtained to conduct this retrospective study, and individual patient consent was waived.

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