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The Effect of Caregiver Language on Post-operative Length of Stay following Initial Surgery for Congenital Heart Disease

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

The Effect of Caregiver Language on Post-operative Length of Stay following Initial Surgery for Congenital Heart Disease
By Kristina W. Kuo

Background: Several studies have described racial and ethnic disparities in children who have had surgery for congenital heart disease (CHD). However, none have evaluated language barriers as a potential explanation for some of these disparities. The purpose of this study was to evaluate whether caregiver language has an effect on post-operative length of stay.

Methods: A retrospective cohort study was conducted on 3,250 subjects who underwent their initial surgery encounter for CHD at Children's Healthcare of Atlanta between January 1st, 2004 and December 31st, 2010, and who survived hospitalization to be discharged home. Simple linear regression using least-squares means differences of post-operative length of stay for children of non-English vs. English speaking caregivers. Multiple linear regression was used to calculate least-squares means differences for post-operative length of stay.

Results: Average post-operative length of stay was 8.68 days (median 5 days) overall, 8.60 days (median 5 days) for children of English speaking caregivers, and 9.36 days (median 5 days) for children of non-English speaking caregivers. Crude least-squares means (LSM) difference was 0.76 day (95% CI, -0.93-2.45; *P* 0.3771). After adjusting for age at time of surgery, sex, race/ethnicity, presence of genetic syndrome, and surgery risk category, the difference remained insignificant (LSM difference, 0.90; 95% CI, -1.65-3.44; *P* 0.4898).

Conclusion: Previous racial and ethnic differences observed in post-operative length of stay for children who have had surgery for congenital heart disease do not appear to be explained by caregiver language for children who had their initial surgery at Children's Healthcare of Atlanta between 2004 and 2010.

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List of Terms

CHD—congenital heart disease

CHOA—Children's Healthcare of Atlanta

LSM—least-squares means

CI—confidence interval

CICU—cardiac intensive care unit

RACHS—risk adjustment for congenital heart surgery

LOS—length of stay

ASD—atrial septal defect

AVSD—atrioventricular septal defect

DORV—double outlet right ventricle

IAA—interrupted aortic arch

LVOT—left ventricular outflow tract

PA—pulmonary artery

PA/VSD—pulmonary atresia/ventricular septal defect

PAPVR—partial anomalous pulmonary venous return

PDA—patent ductus arteriosus

RVOT—right ventricular outflow tract

TAPVR—total anomalous pulmonary venous return

TGA—transposition of the great arteries

TOF—tetralogy of Fallot

VSD—ventricular septal defect

SES—socioeconomic status

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Background/Literature Review

Racial and ethnic disparities in outcomes for children with congenital heart disease (CHD), particularly post-operative mortality, have been well demonstrated in the literature (1-7), although the disparity appears to vary by region. (4, 8) In a large, national cohort, Oster et al. (5) evaluated post-operative length of stay in addition to post-operative, in-hospital mortality. They found that non-Hispanic blacks and Hispanics have significantly longer post-operative lengths of stay compared to non-Hispanic whites. (5) No additional studies have evaluated racial and ethnic disparities in relation to post-operative length of stay in this population. Although it is clear that racial and ethnic disparities exist, the literature has yet to demonstrate a consistent pattern in or provide a clear explanation for these disparities.

The population of people over 5 years old living in non-English speaking households in the United States (U.S.) has grown from 13.8% in 1990 to over 20% in 2010 according to U.S. Census Bureau data. The percentage of the U.S. population older than five years who speak English less than "very well" has grown from 6.1% in 1990 to 8.7% in 2010. Approximately 1.2 million people over the age of 5 years in the state of Georgia speak a language other than English. (9) Several studies have evaluated language barriers as a potential explanation for disparities in health outcomes and access to healthcare. (10-18) A few of these studies have sought to evaluate the impact of non-English language on hospital length of stay (9, 11, 12), but the results are mixed and none have been conducted in the pediatric population despite the growth of the non-English speaking population in the U.S. over the last two decades. Cohen et al. (18) found, however, that children whose families have a language barrier have a significantly higher risk for serious medical events during hospitalization. In the pediatric congenital heart surgery population, post-operative complications have been associated with significantly higher cost than would be expected otherwise for high resource utilization factors. (19) It could be inferred, accordingly, that language barriers could pose an increased risk for post-operative complications, which could in turn increase the hospital length of stay. Otherwise, due to increased time that may be required to communicate with non-English speaking caregivers of children who have had surgery for CHD, one might expect that this could increase post-operative length of stay in this population.

The purpose of this study was to examine whether caregiver language may explain some of the racial and ethnic disparities that have been identified, particularly in relation to post-operative length of stay. We hypothesized that, among children who have undergone surgery for congenital heart disease, post-operative length of stay would be longer for children of non-English speaking caregivers compared to children of English speaking caregivers.

Methods

Study Design

Patients. This study examined data collected retrospectively on a cohort of patients who underwent surgery for congenital heart disease between January 1st, 2004 and December 31st, 2010 at Children's Healthcare of Atlanta (CHOA), Egleston. Only the initial hospitalization in which the initial surgery occurred was considered in order to control for lack of independence for subjects who underwent multiple surgeries during the study period. Patients who were 21 years or older on their surgery date were excluded from the analysis. Approval was obtained from the Internal Review Board prior to examining the data.

Study Variables. The predictor of interest was the caregiver's language documented in the patient registration data obtained from the child's parent, guardian, or other designated caregiver (under special circumstances if the parents or guardian were not available) on admission to the hospital. For descriptive purposes, all non-English languages reported were enumerated. However, for the analysis of post-operative length of stay, caregiver language was dichotomized into English or non-English.

The primary outcome measure was post-operative length of stay. This was determined by subtracting the surgery date from the patient's discharge date. Patients were excluded from the analysis if they were either transferred to another medical facility or if they died while in the hospital.

Covariates of interest were age at time of surgery (<30 days, 31 days to 1 year, and >1 year), sex, race/ethnicity, presence of a genetic syndrome, and surgery risk category. Age at time of surgery was calculated by subtracting the date of birth from the surgery date. Race/ethnicity was obtained from the patient registration data and depicted as American Indian/Alaskan; Asian; black/African-American; multi-racial; native Hawaii/Pacific Islander; non-white, Hispanic; white, Hispanic; non-Hispanic white; or other/declined. For descriptive purposes and analysis, race/ethnicity was further categorized as white, non-Hispanic white; black/African-American; Hispanic; and other. The presence of a genetic syndrome was determined by *International Classification of Diseases, Ninth Revision* codes in the medical record. The surgery risk category was determined using the Risk Adjustment for Congenital Heart Surgery (RACHS-1). (20) The surgery type was obtained from the medical record operative note and by *Current Procedural Terminology* codes used for billing purposes.

Analysis

All analyses were conducted using SAS Version 9.3 (SAS Institute, Cary, North Carolina). Results of all comparisons were considered significant at $\alpha = 0.05$.

Univariate Analysis. Descriptive statistics were performed on the demographic and clinical characteristics of the study population. Median, range, and mean are reported for continuous variables; frequency and percent are reported for categorical variables.

Bivariate Analysis. Because subjects were excluded for in-hospital death and for transfer to another hospital or medical facility, crude relative risks with 95% confidence intervals (CIs) were calculated for these two outcomes to evaluate for differences between children of English speaking caregivers and children of non-English speaking caregivers. Median, range, and mean post-operative length of stay were calculated for each category of clinical and demographic characteristics. Then, simple linear regression analysis was conducted using least-squares means to compare post-operative length of stay between children of English speaking and of non-English speaking caregivers within each category of each characteristic. Bivariate analysis of post-operative length of stay was also conducted for each surgery type for the overall study population, for children of English-speaking caregivers, and for children of non-English speaking caregivers.

Multivariable Analysis. Adjusted comparison of post-operative length of stay between children of English and children non-English speaking caregivers was made using multiple linear regression with least-squares means. Covariates included in the final model were age at time of surgery, sex, race/ethnicity, presence of a genetic syndrome, and RACHS-1 score. These were selected based on two premises: One, that they exhibited a significant association with both the predictor of interest and primary outcome measure; and two, because previous studies of post-operative length of stay in this population and other previous studies evaluating the effect of language barriers on outcomes used similar measures in their multivariable analysis as potential confounders. (5, 12-16) The final model was evaluated for collinearity by testing the variance inflation and for residual outliers that may have influenced the results. The predictor of interest was evaluated for interaction with other covariates.

Results

Univariate Analysis. Of the 3,381 children who had a primary surgery for congenital heart disease between January 1st, 2004 and December 31st, 2010, 51 were transferred to another hospital or medical facility, and 80 subjects (2.37%) died during the encountered hospitalization. This left 3,250 patients to be included in the analyses. **Table 1** summarizes demographic and clinical characteristics of the study population. The overall median post-operative length of stay was 5 days and the mean was 8.68 days. Of the 3,381 eligible patients, 3,037 patients (89.83%) were children of English speaking caregivers; death occurred during the encountered hospitalization for 73 (2.40%) of these children. Children of non-English speaking caregivers accounted for 344 patients (10.17%); death occurred during the encountered hospitalization for 7 (2.03%) of these children.

Bivariate Analysis. Neither the risk of in-hospital death nor the risk of being transferred was significantly different for children of non-English versus English speaking caregivers (relative risk, 0.85; 95% CI, 0.39-1.82; and relative risk, 1.40; 95% CI, 0.64- 3.09, respectively).

Table 2 summarizes post-operative length of stay for patient characteristics. The median post-operative length of stay for children of both English speaking and non-English speaking caregivers was 5 days. The mean post-operative length of stay for children of English speaking and non-English speaking caregivers was 8.60 days and 9.36 days, respectively. The overall unadjusted difference in post-operative length of stay between children of non-English speaking caregivers versus those of English speaking caregivers was 0.76 day (95% CI, -0.93-2.45; *P*=0.3771). Post-operative length of stay was not significantly different for children non-English speaking caregivers compared to children of English speaking caregivers for any category of the demographic and clinical characteristics. However, post-operative length of stay was significantly different depending on patient age and surgery risk category overall, for children of English speaking caregivers, and for children of non-English speaking caregivers. Post-operative length of stay was also significantly different depending on race/ethnicity overall and for children of English speaking caregivers. (Data not shown.) The majority of patients of non-English speaking caregivers were Hispanic race/ethnicity (88.48%). Thus, due to low cell counts of other race/ethnicities for patients of non-English speaking caregivers, a difference could not be reliably tested. Overall, patients of Hispanic ethnicity did not have a significantly longer post-operative length of stay compared to patients of white, non-Hispanic ethnicity (least-squares mean difference, 1.08; 95% CI -0.54-2.70; *P*=0.1930). Neither did Hispanic children of non-English speaking caregivers have a significantly different post-operative length of stay from Hispanic children of English speaking caregivers (least-squares means difference, 0.64; 95% CI, -2.40, 3.68).

Table 3 summarizes post-operative length of stay for surgery types. The longest mean post-operative length of stay was for patients who underwent the Norwood operation. This was consistent for children overall, children of English speaking caregivers, and children of non-English speaking caregivers (25.94 days, 25.27 days, and 30.84 days, respectively). The longest post-operative length of stay was 357 days for a child of an English speaking caregiver and who underwent surgery for atrioventricular septal defect. The shortest post-operative length of stay was 1 day, for children of

English speaking caregivers and who underwent surgeries for patent ductus arteriosus and for vascular ring.

Multivariable Analysis. Adjusting for the covariates mentioned above, there was no significant difference in post-operative length of stay for children of non-English speaking caregivers compared with children of English speaking caregivers (least-squares mean difference, 0.90; 95% CI, -1.65-3.44; *P*=0.4898) (**Table 4**). In the final model, the variance inflation factor was less than 2 for all variables, and no interaction terms were significant. The residual analysis revealed outliers, but they were all plausible values and were kept in the analysis.

Discussion

In our analysis of the effect of caregiver language (non-English compared to English) on post-operative length of stay, we found no significant effect for children who underwent their initial surgery for congenital heart disease at Children's Healthcare of Atlanta, Egleston, between January 1st, 2004 and December 31st, 2010. After adjustment, the average post-operative length of stay for children of non-English speaking caregivers was slightly longer (less than one day) than for children of English speaking caregivers, but this difference was not significant.

Contrary to previous findings on the national level (5), we did not find Hispanics to have a significantly longer post-operative length of stay than non-Hispanic whites at our institution during this study period. Furthermore, the majority of the children of non-English speaking caregivers in our study population were Hispanic. We are not surprised, consequently, that our hypothesis—that, among children who have undergone surgery for congenital heart disease, children of non-English speaking caregivers would have a longer post-operative length of stay than children of English speaking caregivers—was not supported by our findings at this institution. Although no known literature exists for pediatric patients with regard to hospital length of stay and language barriers, these findings are somewhat consistent with studies in medical and surgical literature conducted in the adult population. Karliner et al. (13) found that language barriers did not contribute to longer lengths of stay or increased mortality rates for general medicine patients admitted to the University of California, San Francisco Medical Center. However, readmission rates were higher for non-English speaking patients. In a large multicenter study in California, Grubbs et al. (11) found that with baseline adjustment of potential confounders, length of stay was longer for acute myocardial infarction patients with non-English language preference. However, after adjusting for potential confounders and hospital of service, the difference in length of stay was not significant; nor was it associated with increased mortality. Conversely, John-Baptiste et al. (14) found that, for some medical and surgical conditions, adjusted length of stay was longer for patients with limited English proficiency relative to patients who were English proficient. However, this study was conducted at three major medical centers in Toronto, Canada, where language mix was more diverse than in our study. All of these studies commented on interpreter or language services availability at the centers where the studies were conducted, and it was recognized as a potential source of bias, but none had data available for use in their analyses.

The availability of language services is an important factor to consider in the findings of our study. Qualified medical interpreters in Spanish language are readily available during the daytime at our institution. The departments also have easy access to telephone interpreters of over 180 languages 24 hours a day, 7 days a week. (21) Furthermore, CHOA has a written hospital policy stating, "Any patient and all persons participating in the care and treatment of the patient who has limited English skills will be offered qualified interpreter services, at no cost to him or her, to ensure effective communication." (22) It is regular practice in the cardiac services departments at CHOA to use qualified interpreters in daily communications with non-English speaking families. This potentially contributed to the lack of effect of caregiver language on post-operative length of stay found in our analysis. We did not have reliable data available on the use of interpreter services at this institution, but one could safely assume that the majority of non-English speaking caregivers had at least one encounter with interpreter services and that no English speaking caregiver would have a need for interpreter services. Therefore, including interpreter services in a regression model with language of caregiver would likely lead to collinearity between non-English language and interpreter use. However, some studies indicate that documented interpreter use is relatively low even when interpreter services are available. (13, 23) Still, the lack of association of post-operative length of stay and language of caregiver may reinforce the benefit of using interpreter services in the hospital setting.

The collective body of literature evaluating the benefit of professional interpreter use with patients is inconclusive. Overall it represents decreased disparities, increased patient satisfaction, and improved clinical care. (24) In particular, Lindholm et al. (23) found that patients with limited English proficiency who received professional interpretation on admission and discharge had hospital stays approximately 1.5 days shorter than those who did not have a professional interpreter present at both admission and discharge. Also, patients who did not have an interpreter present for both admission and discharge were 31-41% more likely to be readmitted within 30 days of discharge. In a prospective observational study in a pediatric emergency department, Flores et al. (25) found that ad hoc interpreters (family, friends, or other non-clinical people who had received no formal medical interpretation training) were significantly more likely to commit errors in communication that had potential clinical consequences than trained medical interpreters. To our knowledge, no recent large scale cost analyses exist for interpreter services. Jacobs et al. (26) found that the estimated cost of providing interpreter services was $279 per person per year and that those patients who received interpreter services received more recommended care in the form of preventive services, filling prescribed medications, and physician office visits. In another smaller prospective intervention study, which included length of stay and 90 day readmission rates as outcome measures, the provision of interpreter services was not found to significantly impact costs either way, although physician/patient language concordance was associated with lower costs and fewer emergency department visits. (27) Considering the potential for clinically significant errors, increase in consumption of preventive services, possible reduction in length of stay and readmission rate, it could be inferred that the use of professional interpreters has the potential to reduce costs systemically. More research is needed in this area to provide conclusive evidence in one direction or another. Flores et al. (28), in a systematic review of the literature regarding interpreter services, call for randomized controlled trials in the use of medical interpretation. However, due to the potentially harmful consequences of withholding professional interpreter services for people with limited English proficiency in the healthcare setting, particularly in acute care, a randomized controlled trial would not be a safe or ethical option. Furthermore, several states have comprehensive laws requiring language services to be provided to people with limited English proficiency. (29)

The findings in our study and the other literature related to language barriers suggest that other outcomes may need to be explored. Increases in mortality and length of stay have not been found to be related to language barriers in the adult population (11, 13, 14), but associations between increases in hospital readmission and language barriers have been demonstrated. (13) Furthermore, Taheri et al. (30) reported that the cost on the last day of hospitalization is on average only 3% of the total hospital costs incurred and suggested that the focus on hospital length of stay be diverted to other, more costly processes. The Affordable Care Act of 2009 established the "Hospitals Readmissions Reduction Program" to be regulated and enforced by Centers for Medicare and Medicaid Services (CMS) through payment reductions. (31) A recently published study by Kogon et al. (32) conducted at our institution in response to this program found that, in 2009, a major risk factor for 30 day hospital readmission of patients who have undergone surgery for congenital heart disease was Hispanic ethnicity even though Hispanic ethnicity was not related to longer lengths of stay. This leads us to question whether language barriers play a role in this pattern. This patient population has access to language services while in the hospital, but after discharge, it is possible that they have more difficulty getting questions answered even though professional interpreters are used in cardiology and cardiothoracic surgery follow-up clinic visits.

Strengths and Limitations

Our study has several limitations to consider. First, the retrospective nature of the study design limited the analysis to data available. For example, we used admission data from the registrar to determine caregiver language. The problem with this approach is that the caregiver providing information to the registrar on admission may not have been the child's primary caregiver. Mothers of babies admitted to our institution are often not released from the delivery hospital until a day or two after the infant has been admitted. This leaves the father, grandparent, or other family member to provide information to the registrar and could lead to misclassification of the language of the caregiver if the person providing information is more or less proficient in English than the primary caregiver. Moreover, if non-English speaking families differentially delegated an English speaking caregiver to provide information to the registrar, the language may be differentially documented as English when the primary caregiver was not English speaking. This type of exposure misclassification could have contributed to our not finding an effect when one might truly exist.

Findings from previous studies regarding how language is measured as well as statewide U.S. Census Bureau data provide reassurance that our method of collecting information on caregiver language was sound. Flores et al. (33) evaluated methods of measuring language barriers—parental English proficiency versus language spoken at home and found parental English proficiency to be a superior measurement over language spoken at home. The registrar at our institution determines the language spoken by the language in which the caregiver providing information is able to communicate, which would seem to measure English proficiency rather than language spoken at home. Also, John-Baptiste et al. (14) completed validation of their language data, which they also obtained from admission registration data. They found good inter-rater reliability between the registrar and a research assistant interviewer who evaluated patients for English proficiency (88% agreement; *K* statistic, 0.69; 95% CI, 0.60-0.79). The U.S. Census Bureau estimated that, from 2006 to 2010, 12.7%of people in Georgia over the age of 5 years lived in households where a language other than English was spoken. It was further estimated that about half (46.3%) of these people spoke English less than "very well."(9) The non-English speaking caregivers in our data represented 10.1% of our study population, and Hispanics (the largest non-English speaking population in our study) were slightly higher represented in our study population (12.3%) than in the general population in Georgia (8.8%) according to 2010 Census data. (34) Thus, the population of non-English speaking caregivers in our data is fairly representative of those in the general population.

Second, we limited our study population to a single institution, which limited our sample size. This could have increased the probability of committing a Type II error. Increasing our sample size could increase the study power, thereby reducing the probability of committing a Type II error. In order to do this using data from our single institution, we could include all surgeries during the study period instead of only initial surgeries and adjust for lack of independence for patients who underwent multiple surgeries during the study period rather than control for lack of independence, as we did, by restriction. Another way to increase sample size would be to expand the study period. This, however, could introduce potential unmeasurable confounding related to changes in practice with interpreter use or interventions for reducing disparities. It could also increase the probability of committing a Type I error. Increasing our sample size to a broader population database would also increase our study power and reduce the probability of committing a Type II error. The nonsignificant difference observed at our center makes no inference about what might be observed nationally—especially since we observed no significant difference in post-operative length of stay between Hispanics and non-Hispanic whites when these differences have been observed nationally. (5) However, regional differences in these disparities are important to consider, as they have been observed by others (4, 8), and findings could have an effect on clinical practice at individual institutions.

A third limitation is that we did not have data available to control for socioeconomic factors. Some studies have used insurance type as a proxy for socioeconomic status (SES) (4, 13), but Oster et al. (5) demonstrated that insurance type did not have a significant effect on post-operative length of stay in children following congenital heart surgery. Other studies have demonstrated that racial and ethnic disparities in mortality exist that are not explained by socioeconomic factors. (2, 4) Also, a crude association between language of caregiver and post-operative length of stay was not observed, and it is unlikely that controlling for SES would have introduced an association.

Finally, we did not have discharge information about patients transferred to other hospitals. This only accounted for 1.5% of the eligible population, and it was not found to be differentially associated with caregiver language. Thus, we would not expect this to have an effect on the conclusion of this study.

One strength of our study was the absence of missing data. We had no missing data for the eligible study population. Another strength of our study is the accuracy of the data collected. Because procedure type, for example, was collected from two different places in the chart, it is not likely that the patients would have been misclassified to the wrong surgery risk category.

Conclusion/Future Directions

Due to the finding that Hispanic ethnicity is a major risk factor for 30 day readmission (32), further investigation of the impact of language barriers outside the hospital in this population is warranted. Another area where future research may be useful is to evaluate the impact of language barriers on post-operative complications within this population based on the findings from previous studies. (18, 19) The findings in our study indicate that post-operative length of stay does not appear to be affected by caregiver language in our institution for children who have undergone surgery for CHD. This is either a reflection of the presence of a well-established interpreter service or the lack of racial and ethnic disparity for Hispanics in the cardiac surgery patient population at Children's Healthcare of Atlanta.

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Tables

Table 1. Characteristics of in-hospital survivors who underwent initial congenital heart surgery, 2004-2010.

		Total study population (n=3,250)			
Factor	n	%	Median	Range	Mean
Age at time of surgery (days)			161	(0-7,663)	955.33
Age at time of surgery (categories)					
0 to 30 days	860	26.46			
31 days to 1 year	1211	37.26			
> 1 year	1179	36.28			
Sex					
Male	1755	54.00			
Female	1495	46.00			
Race/Ethnicity					
White, Non-Hispanic	1620	49.85			
Black/African-American	928	28.55			
Hispanic	400	12.31			
Other	302	9.29			
Language of Caregiver					
English	2920	89.85			
All Non-English	330	10.15			
Bengali	1	0.03			
Burmese	3	0.09			
Chinese	1	0.03			
French	1	0.03			
Korean	2	0.06			
Mandarin Chinese	1	0.03			
Russian	1	0.03			
Spanish	302	9.29			
Vietnamese	7	0.22			
Other	11	0.34			
Presence of genetic syndrome					
Yes	439	13.51			
No	2811	86.49			
RACHS score					
1	514	15.82			
2	1323	40.71			
3	985	30.31			
4	269	8.28			
5	0				
6	159	4.89			
Duration of stay					
Post-operative (days)			5	(1-357)	8.68
Total CICU (hours) (n=3,037)			52	(0-4147)	113.52
Total (days)			6	(1-398)	11.23

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

Table 2. Least-squares means differences with 95% CIs for post-operative LOS (days) of in-hospital survivors of initial congenital heart surgery for English and non-English speaking caregivers by patient characteristic, 2004-2010.

	English (n=2,920)					Non-English (n=330)					LSM difference	95% CI	*P*
			LOS					LOS					
Factor	n	%	Median	Range	Mean	n	%	Median	Range	Mean			
Age at time of surgery (categories)													
0 to 30 days	761	26.06	10	(2-260)	15.25	99	30	11	(3-140)	17.32	2.07	-1.69, 5.83	0.2803
31 days to 1 year	1,075	36.82	5	(1-357)	7.97	136	41.21	5	(2-63)	6.82	-1.15	-4.21, 1.91	0.4609
> 1 year	1,084	37.12	3	(1-76)	4.57	95	28.79	3	(2-49)	4.72	0.15	-0.78, 1.08	0.7501
Sex													
Male	1,588	54.38	5	(1-180)	8.57	167	50.61	5	(2-140)	9.81	1.25	-.78, 3.28	0.2275
Female	1,332	45.62	5	(1-357)	8.65	163	49.39	5	(2-69)	8.90	0.25	-2.51, 3.02	0.8566
Race/Ethnicity													
White, Non-Hispanic	1,615	55.31	5	(1-180)	8.26	5	1.52	6	(4-15)	8.40	0.14	-9.78, 10.05	0.9784
Black/African-American	926	31.71	5	(1-357)	9.71	2	0.61	4	(3-5)	4.00	-5.71	-34.18, 22.76	0.6939
Hispanic	108	3.7	5	(2-101)	8.87	292	88.48	5	(2-140)	9.51	0.64	-2.40, 3.68	0.6776
Other	271	9.28	4	(2-172)	6.74	31	9.39	5	(2-69)	8.45	1.71	-2.66, 6.09	0.4417
Presence of genetic syndrome													
Yes	378	12.95	5	(2-113)	9.06	61	18.48	5	(2-65)	9.52	0.46	-2.84, 3.77	0.7827
No	2,542	87.05	5	(1-357)	8.54	269	81.52	5	(2-140)	9.33	0.79	-1.12, 2.70	0.4164
RACHS score													
1	459	15.72	3	(1-101)	4.28	55	16.67	3	(2-43)	4.11	-0.17	-2.20, 1.87	0.8714
2	1,169	40.03	4	(1-180)	5.94	154	46.67	5	(2-69)	6.47	0.54	-0.96, 2.04	0.4828
3	915	31.34	6	(2-357)	10.17	70	21.21	7	(2-140)	11.94	1.78	-2.76, 6.32	0.4423
4	237	8.12	10	(3-120)	14.40	32	9.7	11.5	(5-49)	13.91	-0.49	-5.27, 4.28	0.8385
5	0					0							
6	140	4.79	16	(5-260)	25.02	19	5.76	18	(9-119)	30.84	5.82	-7.43, 19.07	0.3869
Overall	2,920		5	(1-357)	8.60	330		5	(2-140)	9.36	0.76	-0.93, 2.45	0.3771

LOS = length of stay; LSM = least-squares means; CI = confidence interval; RACHS = risk adjustment for congenital heart surgery

Table 3. Relationship of original operation to post-operative LOS of in-hospital survivors overall and by caregiver language, 2004-2010.

	Overall				English				Non-English			
		LOS				LOS				LOS		
Original Operation	n	Median	Range	Mean	n	Median	Range	Mean	n	Median	Range	Mean
ASD	251	3	(2-84)	3.34	224	3	(2-84)	3.38	27	3	(2-5)	3.04
AVSD	281	5	(2-357)	7.42	264	4	(2-357)	7.45	17	5	(3-24)	6.94
Aortic Arch Repair	131	4	(2-55)	7.11	121	4	(2-55)	6.75	10	9	(2-31)	11.40
Coarctation	268	5	(2-113)	7.54	236	5	(2-113)	7.60	32	5	(2-29)	7.09
DORV	33	5	(3-45)	7.64	29	5	(3-45)	7.52	4	7.5	(4-15)	8.50
Fontan	94	8	(4-33)	8.78	88	7.5	(4-33)	8.70	6	8	(6-21)	9.83
Glenn	62	5	(2-51)	6.63	47	5	(2-33)	6.09	15	6	(3-51)	8.33
IAA	35	15	(5-54)	17.60	32	15.5	(5-54)	17.88	3	14	(14-16)	14.67
LVOT procedure	27	4	(3-15)	5.26	26	4	(3-15)	5.31	1	4		
Norwood	157	17	(7-260)	25.94	138	16.5	(7-260)	25.27	19	18	(9-119)	30.84
PA plasty	82	6	(2-88)	11.80	73	6	(2-88)	11.67	9	7	(3-63)	12.89
PA/VSD	29	9	(5-183)	19.62	29	9	(5-183)	19.62	0			
PAPVR	46	3	(2-8)	3.35	42	3	(2-8)	3.29	4	3	(3-7)	4.00
PDA	83	2	(1-53)	4.80	69	2	(1-53)	4.43	14	3.5	(2-43)	6.57
RVOT procedure	44	4	(2-76)	6.75	40	4	(2-76)	6.95	4	3.5	(3-9)	4.75
Shunt	198	9	(3-172)	15.26	176	9	(3-172)	14.72	22	10.5	(5-140)	19.59
TAPVR	81	8	(3-84)	10.62	62	8	(3-84)	10.74	19	8	(4-31)	10.21
TGA	155	9	(5-38)	10.82	143	9	(5-38)	10.80	12	9	(5-31)	11.00
TOF	241	5	(3-69)	6.63	222	5	(3-34)	6.42	19	5	(3-69)	9.11
Truncus	41	11	(6-120)	19.59	39	11	(6-120)	20.00	2	11.5	(7-16)	11.50
VSD	497	4	(2-180)	5.62	427	4	(2-180)	5.67	70	4	(2-25)	5.29
Valve replacement/repair	227	4	(2-210)	6.93	220	4	(2-210)	7.00	7	5	(3-7)	4.71
Vascular ring	94	2	(1-118)	5.44	87	2	(1-118)	5.64	7	2	(2-5)	3.00
Miscellaneous/other	93	5	(2-63)	8.54	86	5	(2-63)	8.34	7	5	(2-49)	11.00
Total	3,250	5	(1-357)	8.68	2,920	5	(1-357)	8.60	330	5	(2-140)	9.36

LOS = length of stay; ASD = atrial septal defect; AVSD = atrioventricular septal defect; DORV = double outlet right ventricle; IAA = interrupted aortic arch; LVOT = left ventricular outflow tract; PA = pulmonary artery; PA/VSD = pulmonary atresia/ventricular septal defect; PAPVR = partial anomalous pulmonary venous return; PDA = patent ductus arteriosus; RVOT = right ventricular outflow tract; TAPVR = total anomalous pulmonary venous return; TGA = transposition of the great arteries; TOF = tetralogy of Fallot; VSD = ventricular septal defect

Table 4. Adjusted least-squares means difference in post-operative length of stay (days) and 95% confidence intervals by language after initial congenital heart surgery, 2004-2010.

	LOS		
Caregiver language	**LSM difference**	**95% CI**	***P***
English	Referent		
Non-English	0.90	-1.65, 3.44	0.4898

LOS = length of stay; LSM = least-squares means; CI = confidence interval