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Association Between Facility Type During Pediatric Inpatient Rehabilitation and Functional Outcomes

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Abstract

Objective—To compare functional outcomes between children receiving inpatient rehabilitation at children's hospitals and those at other facilities.

Design—Retrospective cohort study.

Setting—Inpatient rehabilitation facilities.

Participants—Children (N=28,793) aged 6 months to 18 years who received initial inpatient rehabilitation.

Interventions—Not applicable.

Main Outcome Measures—Total, cognitive, and motor developmental functional quotients (DFQs; which is the WeeFIM score divided by age-adjusted norms and multiplied by 100) at discharge from inpatient rehabilitation and WeeFIM efficiency (the change in WeeFIM score from admission to discharge divided by the length of the rehabilitation stay), adjusting for age, sex, race, insurance, region, admission function, impairment type, discharge year, and length of stay.

Results—A total of 12,732 children received rehabilitation at 25 children's hospitals and 16,061 at 36 other facilities (general hospitals or freestanding rehabilitation hospitals). Adjusting for clustering by facility, patients at children's hospitals had a lower cognitive DFQ at admission (difference between children's hospitals and other facility types, −3.8; 95% confidence interval [CI], −7.7 to −0.1), a shorter length of stay (median, 16d vs 22d; $P<.001$), and a higher WeeFIM

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efficiency (difference, 0.63; 95% CI, 0.25–1.00) than did children at other facility types. Rehabilitation in a children's hospital was independently associated with a higher discharge cognitive DFQ (regression coefficient, 2.3; 95% CI, 0.3–4.2) and more efficient rehabilitation admissions (regression coefficient, 0.3; 95% CI, 0.1–0.6).

Conclusions—Children who receive inpatient rehabilitation at children's hospitals have more efficient inpatient rehabilitation admissions, a shorter median length of stay, and a slight improvement in cognitive function than do children at other facility types.

Keywords

Child; Hospitals; Rehabilitation; Treatment outcome

In this era in which the value and quality of health care are closely scrutinized, the facility characteristics needed to care for seriously ill and injured children are critical to understand. To make informed decisions on care practices, differences in outcomes of care at different types of facilities must be available.

Data are inconclusive about the benefits and value of treatment at pediatric-specific facilities. Several studies^{1–3} of pediatric trauma care in the United States using the National Trauma Data Bank or Kids' Inpatient Database have found improved outcomes for injured children treated at pediatric trauma centers or adult trauma centers with added qualifications in pediatrics after adjusting for injury-related factors. Conversely, other studies^{4,5} of single-state hospital discharge records found no difference in injury mortality between trauma centers with pediatric and adult designations. A multivariate analysis of cardiac arrest in children from the National Registry of Cardiopulmonary Resuscitation found improved 24-hour hospital survival in hospitals staffed by pediatric physicians.⁶ However, an analysis of data from the Kids' Inpatient Database found no difference in adjusted mortality from severe sepsis between children's hospitals and nonpediatric facilities, with children's hospitals having longer lengths of stay.⁷

Within pediatric rehabilitation, there is evidence that receiving inpatient rehabilitation at pediatric-specific facilities is associated with improved functional outcomes. A recent analysis of 4839 children with traumatic brain injury (TBI) found that children who received inpatient rehabilitation at children's hospitals had higher cognitive functional scores at discharge than did children admitted to rehabilitation units based at general hospitals.⁸ It is not known whether rehabilitation at children's hospitals has a similar effect on functional outcome for diagnoses other than TBI.

In this study, we compared total, motor, and cognitive functional scores at discharge from inpatient rehabilitation and the efficiency of rehabilitation admissions between children receiving inpatient rehabilitation for all diagnoses at rehabilitation units based at children's hospitals and those at other facilities. We hypothesized that functional scores at discharge, particularly in the cognitive domain, and the efficiency of the rehabilitation admission would be higher at rehabilitation units based at a children's hospital.

Methods

Patient population

This retrospective cohort study included patients aged 6 months to 18 years who received inpatient rehabilitation between January 1, 2004 and December 31, 2014 at inpatient rehabilitation facilities in the United States using the Uniform Data System for Medical Rehabilitation (UDSMR)'s Functional Independence Measure for Children (WeeFIM) instrument and submitting completed data to the UDSMR. The University of Washington Human Subjects Division determined that this study was exempt from institutional review board approval.

For the purposes of this study, we included all children in the UDSMR database whose WeeFIM evaluations were for an initial inpatient rehabilitation admission. We excluded children with missing information on impairment code (the diagnosis necessitating the rehabilitation admission; n=944), sex (n=2034), insurance status (n=3847), or race/ethnicity (n=1131). Children with missing (n=25) or clinically implausible (n=30) functional scores at the time of rehabilitation admission or discharge were excluded. Because WeeFIM is validated only for children 6 months and older, children younger than 6 months were not included.

Functional outcome measures

All patients were assessed by credentialed clinicians using the WeeFIM instrument within 3 days of inpatient rehabilitation admission and at discharge. The WeeFIM measures function over 18 items separated into 3 subscales: mobility (5 items), self-care (8 items), and cognition (5 items), with every item scored from "1" (dependent) to "7" (independent). A description of the Wee-FIM domain items is included in supplemental appendix S1 (available online only at <http://www.archives-pmr.org/>). On psychometric evaluation, the WeeFIM items separate into 2 domains: cognitive and motor (combining the mobility and self-care subscales).⁹

Developmental functional quotients (DFQs)^{10,11} for the motor and cognitive domains and the total WeeFIM instrument were used as the main outcome measures rather than changes in raw scores because of the known effect of age on functional ratings for children younger than 7 years.¹² DFQs allow for comparisons across age groups by providing a quotient score based on age-normative values. A DFQ closer to 100 indicates that a child functions closer to the level expected by age. The normative scores for each age are reported by the UDSMR using a sample of 414 children without known disability or developmental delay. A typically developing 7-year-old is expected to achieve independence on all items, such that the age-normative score for those 7 years and older is the highest possible WeeFIM score.¹³ For children younger than 7 years, it is possible to have a DFQ above 100 if a child functions at a level higher than that anticipated for his or her age. To control for outliers with DFQs that did not make sense clinically, cases with a DFQ at admission or discharge above 150 were excluded as clinically implausible. Secondary outcomes were the percent change in DFQ (the change in DFQ from admission to discharge divided by admission DFQ and then

multiplied by 100) and WeeFIM efficiency (the change in raw WeeFIM score from admission to discharge divided by the length of the rehabilitation stay).

Covariates

The primary covariate of interest was facility type, classified as a rehabilitation unit based at a children's hospital or at other facilities (freestanding rehabilitation hospital or general hospital), and based on the facilities' self-report to the UDSMR. Other covariates included age, sex, race/ethnicity, impairment type, discharge year, length of stay, primary payer for the rehabilitation admission, and region. Impairment type was derived from the 17 WeeFIM Impairment Group Codes used to classify patients according to the diagnosis, leading to inpatient rehabilitation admission. Impairment types included stroke; nontraumatic brain dysfunction; TBI (alone and as part of TBI plus polytrauma); cerebral palsy; other neurological disorders; spinal cord dysfunction; amputation, burns, non-TBI polytrauma; arthritis or pain syndromes; orthopedic conditions; cardiac and pulmonary disorders; congenital disorders (including neuromuscular disorders and spina bifida) and developmental delay; debility or failure to thrive; and other disabling conditions. Primary payer was categorized as private/commercial insurance coverage, Medicaid/Medicare or other governmental insurance, and other (including self-pay and unreimbursed care). Regional variations in functional outcomes were shown in a previous study of children with TBI⁸; thus, region was included as an independent variable. Region was coded in the UDSMR as 1 of the 10 Centers for Medicare & Medicaid Services regions and reclassified as Northeast, South, Midwest, and West. Descriptions of states included in each region are available in supplemental appendix S2 (available online only at <http://www.archives-pmr.org/>).

Statistical analyses

Descriptive statistics were used for the demographic and impairment characteristics of patients at rehabilitation units based at children's hospitals and at other facility types. To account for clustering by facility, differences by facility type were examined with multinomial logistic regression for categorical variables and univariate linear regression for continuous variables. The difference in median length of stay was examined with nonparametric quartile regression. Univariate linear regression models with admission and discharge DFQs for total, motor, and cognitive domains as well as WeeFIM efficiency as dependent variables and facility type as the independent variable were used to compare functional outcomes between rehabilitation units based at children's hospitals and those at other facility types. Nonparametric quartile regression was also used to determine the differences in median percent change in total, motor, and cognitive DFQ scores. In the regression models, the regression coefficient represents the difference between facility types. All regression models used a between-cluster variance estimator to account for observations of children clustered within rehabilitation facilities.¹⁴

Multiple linear regression models with robust between-cluster variance estimates to account for within-facility correlation¹⁴ determined the independent association of facility type with discharge DFQ and percent change in total, motor, and cognitive scores and WeeFIM efficiency. Additional independent variables to be used for adjustment were established on a

priori hypotheses and for all regression models included admission DFQ, age, sex, race/ethnicity, impairment type, discharge year, primary payer for the rehabilitation admission, and region. The regression models with DFQ or percent change as the dependent variable included length of stay as an independent variable. Because length of stay is included in the calculation of WeeFIM efficiency, it was not included as a dependent variable for that regression model. Year of discharge from rehabilitation was included to account for potential changes in care over the 11-year study period. The reported regression coefficients are interpreted as the mean difference in outcomes for a child receiving inpatient rehabilitation at a children's hospital versus at other facility types when all other covariates are equal.

Statistical significance was set at a *P* value of .05 for all analyses. Stata 13^a was used for statistical analyses.

Results

Patient characteristics

A total of 28,793 patients were included in this study: 12,732 received inpatient rehabilitation at 25 children's hospital-based rehabilitation units and 16,061 at 36 rehabilitation units at other types of facilities. As shown in table 1, compared with patients at other facilities, those at children's hospitals had a different distribution of race/ethnicity (*P* = .0002) and impairment groups. There were significant differences in the geographic distribution between children's hospital-based rehabilitation units and other facility types. Children treated at rehabilitation units based at children's hospitals were more likely to be in the Midwest or West and less likely to be in the Northeast than were those treated at other facility types. The median length of stay was significantly shorter at children's hospitals than at other facility types (16d vs 22d, respectively; *P* < .001). There was no significant difference in age or sex distribution between facility types. A total of 46% of children receiving rehabilitation at children's hospitals had private insurance as compared with 40% of those at other facility types. However, when adjusting for within-facility correlation, there were no statistically significant differences between facility types.

Univariate analysis

When comparing combined total, motor, and cognitive DFQs at rehabilitation admission and adjusting for within-facility correlation but no other covariates, children receiving rehabilitation at children's hospitals had a significantly lower cognitive DFQ than did those at other facility types (table 2). The mean cognitive admission DFQ for those at children's hospitals was 56.7 (95% confidence interval [CI], 56.2–57.3) as compared with 60.7 (95% CI, 60.2–61.1) for those at other facility types (between-group difference, –3.9; 95% CI, –7.7 to –0.1; *P* = .043). Motor domain DFQ and total DFQ at admission and total, motor, and cognitive DFQs at discharge from rehabilitation were similar between facility types (see table 2).

Children receiving rehabilitation at both children's hospitals and other facilities had notable improvements in function as evidenced by the percent change in DFQ. The percent change in cognitive functional score was greater for children receiving rehabilitation at children's

hospitals, with a median percent change in cognitive DFQ of 16.7% (interquartile range [IQR], 0–65.8) as compared with 6.5% (IQR, 0–40.0) at other facility types ($P=.012$). Although the median percent change in total DFQ score and motor DFQ score was higher for children at children's hospitals (43.1 [IQR, 20.1–89.7] and 57.1 [IQR, 24.4–125], respectively) than for those at other facilities (33.9 [IQR, 9.9–70.6] and 45.5 [IQR, 10.0–103.0], respectively), there was no statistically significant difference between the groups (see table 2).

Children receiving rehabilitation at children's hospitals had more efficient rehabilitation admissions than those at other facility types, with a mean WeeFIM efficiency of 1.92 (95% CI, 1.88–1.95) as compared with 1.29 (95% CI, 1.26–1.32) for those at other facility types (between-group difference, 0.63; 95% CI, 0.25–1.00; $P=.002$) (see table 2).

Multivariate analysis

The mean cognitive score at discharge was 2.3 DFQ points higher (95% CI, 0.3–4.2) for children treated at children's hospitals than for those treated at other facility types when controlling for all covariates in multiple linear regression models. This means when all other covariates are equal, including admission score, children receiving rehabilitation at children's hospitals gained an additional 2.3 cognitive DFQ points over the course of admission as compared with those at other facilities. The mean WeeFIM efficiency was 0.3 points higher per day of rehabilitation (95% CI, 0.1–0.6) in children treated at children's hospitals as compared with those treated at other facility types after adjusting for all covariates. Rehabilitation at a children's hospital was independently associated with 6% more improvement in the total DFQ score (95% CI, 0.2–12.5) and 10% more improvement in the cognitive DFQ score (95% CI, 3.7–16.4) as compared with other types of facilities when controlling for all covariates (table 3).

Discussion

This study documented an independent association between facility type and cognitive function at discharge from rehabilitation and the efficiency of the rehabilitation admission for children receiving inpatient rehabilitation. After adjusting for demographic and impairment-related factors and functional status at admission, children treated at children's hospital-based rehabilitation units had on average 2.3 points higher discharge cognitive functional scores and had greater percent change in total and cognitive DFQs than did children treated at other types of facilities. The clinical significance of the differences in DFQ and percent change is challenging to interpret given the lack of established minimal clinically important difference standards for the WeeFIM and the associated DFQ, but it is unlikely that a difference of 2.3 DFQ points is clinically meaningful. However, in this study, those treated at children's hospitals had a significantly shorter length of stay and more efficient rehabilitation admissions, with these children gaining on average an additional 0.3 points on the WeeFIM per day of the rehabilitation admission as compared with children at other facility types after adjustment for multiple covariates including functional status at admission. A shorter length of stay—without sacrificing functional outcome—diminishes

the potential for exposure to nosocomial infections, decreases the time the child and family spend away from their home environment, and reduces the cost of care.

These findings corroborate the study of children with TBI, where those receiving rehabilitation at children's hospitals had improved cognitive function as compared with those at other facility types.⁸ The development of evidence-based and expert-endorsed quality-of-care indicators focusing on the structure, organization, and processes of care of pediatric inpatient rehabilitation was undertaken with the ultimate goal of improving patients' outcomes. The quality-of-care indicators focused on those that may affect functional outcomes for children with TBI¹⁵ but will likely operate similarly for children with all diagnoses relevant to inpatient pediatric rehabilitation. Differences in the structure of the rehabilitation team and processes of care between rehabilitation units based at children's hospitals and those at other facility types may explain this study's findings of improved cognitive outcomes and WeeFIM efficiency at rehabilitation units based at children's hospitals. In an earlier study,¹⁶ pediatric-specific rehabilitation units met a higher number of quality-of-care indicators, even after adjusting for patient volume. Pediatric-specific rehabilitation units were more likely to deliver cognitive, neuropsychological, and school reentry care that met the quality indicators that may help explain the results of this study.¹⁷

Rehabilitation at a children's hospital may not be accessible to all children needing inpatient rehabilitation services. As with the previous study of children with TBI,⁸ this study found racial/ethnic and insurance-based differences in receipt of rehabilitation at children's hospital-based rehabilitation units. This study's findings of improved efficiency of rehabilitation admissions with shorter lengths of stay at children's hospital-based rehabilitation units suggest that children, particularly those with impairments affecting cognitive function, would be best served at rehabilitation units within a children's hospital setting. The decision to admit a pediatric patient to a specific inpatient rehabilitation unit may be based on several factors, including relation between the referring facility and the rehabilitation unit, coverage by the insurer, and family choice that may reflect the distance from the family's home and support system. Although family choice is imperative, one must also take the value of rehabilitation care provided into consideration.

With the cost of health care in the United States expected to be \$5.4 trillion by 2024,¹⁸ the focus on reducing costs are well underway. In adults, discharges to post-acute care facilities (including inpatient rehabilitation facilities) increased almost 50% from 1996 to 2010,¹⁹ with post-acute care spending representing the fastest growing health spending category among adults.²⁰ Investigating cost-saving methods in inpatient pediatric rehabilitation has not been a focus of hospitals, insurers, or governmental agencies. However, this study's findings of improved cognitive outcomes, higher WeeFIM efficiency, and a 6-day shorter median length of stay for those admitted to a rehabilitation unit based at a children's hospital versus other facility types suggest that facility type may prove to be an important factor when selecting an inpatient rehabilitation program for a child. Future research linking functional outcomes with pediatric-specific rehabilitation teams, processes, and other quality indicators could identify how to improve outcomes for all children, but particularly those who may not have access to pediatric-specific rehabilitation units.

Study limitations

This retrospective study has several limitations. The inpatient rehabilitation facilities self-identified their facility type as a children's hospital, freestanding rehabilitation hospital, or general hospital when reporting data to the UDSMR. Some freestanding rehabilitation hospitals have pediatric-specific rehabilitation units and pediatric-trained staff that would be included in the "other facility type" in this analysis. However, the inclusion of these pediatric units would be expected to increase the mean functional scores for the "other facility type" cohort, meaning that the effect of pediatric-specific rehabilitation facilities may actually be larger. This study is limited to children who received inpatient rehabilitation at facilities using the WeeFIM instrument and subscribing to the UDSMR database. There may be regional differences in propensity to subscribe to the UDSMR; this database does not contain many children's hospital-based rehabilitation units in the Northeast. This database does not contain information on functional level before the event that necessitated an inpatient rehabilitation admission. There may be unmeasured confounding, which we attempted to mitigate by controlling for available sociodemographic (age, sex, race, insurance, region) and clinical (impairment type, admission functional score, year of discharge from rehabilitation, length of stay) factors.

Conclusions

Children who receive inpatient rehabilitation at children's hospitals have more efficient inpatient rehabilitation admissions with shorter lengths of stay and slightly better cognitive function at discharge than do children at other types of facilities. This information should be considered by clinicians referring children, especially children with impairments affecting cognitive function, to inpatient rehabilitation programs as well as by insurers and policymakers.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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List of abbreviations

CI	confidence interval
DFQ	developmental functional quotient
IQR	interquartile range
TBI	traumatic brain injury
UDSMR	Uniform Data System for Medical Rehabilitation
WeeFIM	Functional Independence Measure for Children

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Table 1

Patient characteristics by type of inpatient rehabilitation facility, UDSMR 2004–2014 (N=28,793)

Characteristic	Children's Hospital (n=12,732)	Other Facility Type (n=16,061)	P
Age (y)	10.3 (10.2–10.4)	10.7 (10.6–10.8)	.197
Sex			.845
Male	7151 (56.2)	8988 (56.0)	
Female	5581 (43.8)	7073 (44.0)	
Race/ethnicity			.0002
White	7437 (58.4)	7962 (49.6)	
Black	3113 (24.4)	3282 (20.4)	
Hispanic	1136 (8.9)	1896 (11.8)	
Asian	254 (2.0)	354 (2.2)	
Native American	136 (1.1)	90 (0.6)	
Multiracial	162 (1.3)	165 (1.0)	
Other	494 (3.9)	2312 (14.4)	
Insurance			.351
Private/commercial	5895 (46.3)	6356 (39.6)	
Medicaid/government	5773 (45.3)	8276 (51.5)	
Other	1064 (8.4)	1429 (8.9)	
Region			.002
Northeast	72 (0.6)	4780 (29.8)	
South	6047 (47.5)	7783 (48.4)	
Midwest	3750 (29.4)	2263 (14.1)	
West	2863 (22.5)	1235 (7.7)	
Type of impairment			<.0001
TBI	3833 (30.1)	4065 (25.3)	
Nontraumatic brain dysfunction	3044 (23.9)	2938 (18.3)	
Stroke	996 (7.8)	941 (5.9)	
Cerebral palsy	368 (2.9)	819 (5.1)	
Spinal cord dysfunction	1047 (8.2)	1194 (7.4)	
Congenital disorders, DD	132 (1.0)	523 (3.3)	
Other neurological disorders	938 (7.4)	856 (5.3)	
Amputations, burns, non-TBI polytrauma	454 (3.6)	701 (4.4)	
Arthritis, pain syndromes	311 (2.4)	803 (5.0)	
Orthopedic conditions	681 (5.3)	1588 (9.9)	
Cardiac, pulmonary	290 (2.3)	519 (3.2)	
Debility, failure to thrive	377 (3.0)	647 (4.0)	
Other disabling conditions	261 (2.1)	467 (2.9)	
LOS (d)	16 (9–28)	22 (12–41)	<.001

NOTE. Values are mean (95% CI), n (%), or median (IQR). *P* values have been adjusted for clustering by facility using multinomial logistic regression for categorical variables, linear regression for age, and quartile regression for LOS, with all regression models accounting for within-facility correlation.

Abbreviations: DD, developmental disability; LOS, length of stay.

Table 2

Unstandardized functional outcomes: DFQs and rehabilitation efficiency

Variable	Children's Hospital (n=12,732)	Other Facility Type (n=16,061)	Difference Between Facility Types	P
Total admission DFQ	43.5 (43.2 to 43.9)	47.3 (47.0 to 47.7)	-3.8 (-8.4 to 0.8)	.102
Total discharge DFQ	65.5 (65.1 to 65.9)	65.5 (65.2 to 65.9)	-0.02 (-3.6 to 3.5)	.990
Total DFQ percent change, median (IQR)	43.1 (20.1 to 89.7)	33.9 (9.9 to 70.6)	9.2	.057
Motor admission DFQ	38.5 (38.1 to 38.8)	42.2 (41.8 to 42.6)	-3.7 (-8.8 to 1.3)	.145
Motor discharge DFQ	63.2 (62.9 to 63.6)	63.5 (63.1 to 63.9)	-0.2 (-4.1 to 3.7)	.912
Motor DFQ percent change, median (IQR)	57.1 (24.4 to 125)	45.5 (10.0 to 103.0)	11.6	.096
Cognitive admission DFQ	56.7 (56.2 to 57.3)	60.7 (60.2 to 61.1)	-3.9 (-7.7 to -0.1)	.043
Cognitive discharge DFQ	71.5 (71.0 to 71.9)	70.9 (70.5 to 71.3)	0.6 (-2.6 to 3.8)	.728
Cognitive DFQ percent change, median (IQR)	16.7 (0 to 65.8)	6.5 (0 to 40.0)	10.2	.012
WeeFIM efficiency	1.92 (1.88 to 1.95)	1.29 (1.26 to 1.32)	0.63 (0.25 to 1.00)	.002

NOTE. The differences between facility types were determined using univariate linear regression models for analysis involving DFQ and rehabilitation efficiency and using nonparametric quartile regression for analysis involving the percent change in score. All analyses were adjusted for within-facility correlation. Values are mean (95% CI) or as otherwise indicated. DFQ=(WeeFIM score/age norms)× 100, unless specified otherwise. Percent change= [(discharge DFQ–admission DFQ)/admission DFQ] ×100. WeeFIM efficiency=change in WeeFIM score/length of stay.

Table 3

Effect of facility type on functional outcomes when controlling for other covariates in multiple linear regression models

Variable	Children's Hospital Regression Coefficient (95% CI)
Total discharge DFQ	1.4 (−0.5 to 3.3)
Total DFQ percent change	6.3 (0.2 to 12.5)
Motor discharge DFQ	0.9 (−1.1 to 2.9)
Motor DFQ percent change	4.0 (−3.6 to 11.7)
Cognitive discharge DFQ	2.3 (0.3 to 4.2)
Cognitive DFQ percent change	10.0 (3.7 to 16.4)
WeeFIM efficiency	0.3 (0.1 to 0.6)

NOTE. The regression coefficients are interpreted as the mean difference in outcome for a child receiving inpatient rehabilitation at a children's hospital vs at other facility types when all other covariates are equal. All models use a robust variance estimate that adjusts for within-cluster correlation and adjusts for admission DFQ, race, sex, age, impairment type, primary payer for admission, region, and year of discharge. All models except the rehabilitation efficiency model adjust for length of stay. Because length of stay is part of the calculation of efficiency, it was not adjusted for in the efficiency model. The reference category for facility type in all models was "Other facility type." Percent change in DFQ is calculated by subtracting admission DFQ from discharge DFQ and then dividing by admission DFQ and multiplying by 100.