Received: 19 May 2023 | Accepted: 19 October 2023

DOI: 10.1002/jhm.13234

Journal of Hospital Medicine | shm Society of Hospital Medicine

ORIGINAL RESEARCH

Impact of a hospital service for adults with chronic childhood-onset disease: A propensity weighted analysis

Colby Feeney MD[1,2] | Mark Chandler MD[1,2] | Alyssa Platt MA[3] | Shifeng Sun MB[3] | Noppon Setji MD[1] | David Y. Ming MD[1,2,4]

[1]Department of Medicine, Duke University School of Medicine, Durham, North Carolina, USA

[2]Department of Pediatrics, Duke University School of Medicine, Durham, North Carolina, USA

[3]Department of Biostatistics and Bioinformatics, Duke University, Durham, North Carolina, USA

[4]Department of Population Health Sciences, Duke University School of Medicine, Durham, North Carolina, USA

Correspondence

Colby Feeney, MD, Department of Medicine, Duke University School of Medicine, Durham, NC, USA.
Email: colby.feeney@duke.edu;
Twitter: @Colby_Feeney

Funding information

Duke University Hospital,
Grant/Award Number: Clinical Innovations Award

Abstract

Background: Young adults with chronic childhood-onset diseases (CCOD) transitioning care from pediatrics to adult care are at high risk for readmission after hospital discharge. At our institution, we have implemented an inpatient service, the Med-Peds (MP) line, to improve transitions to adult care and reduce hospital utilization by young adults with CCOD.

Objective: This study aimed to assess the effect of the MP line on length of stay (LOS) and 30-day readmission rates compared to other inpatient services.

Methods: This was an observational, retrospective cohort analysis of patients admitted to the MP line compared to other hospital service lines over a 2-year period. To avoid potential confounding by indication for admission to the MP line, propensity score weighting methods were used.

Results: The MP line cared for 302 patients with CCOD from June 2019 to July 2021. Compared to other service lines, there was a 33% reduction in relative risk of 30-day readmission (26.9% compared to 40.3%, risk ratio = 0.67, 95% confidence interval [CI] 0.55–0.81). LOS was 10% longer for the MP line (event time ratio (ETR): 1.10 95% CI 1.0–1.21) with median LOS 4.8 versus 4.5 days. Patients with sickle cell disease had less of a reduction in 30-day readmissions and longer LOS.

Conclusion: Hospitalization for young adults with CCOD on a MP service line was associated with lower 30-day readmission rates and longer LOS than hospitalization on other services. Further research is needed to assess which components of the line most contribute to decreased utilization.

INTRODUCTION

With the passage of the Hospital Readmission Reduction Program in 2012, there is a financial imperative to reduce hospital readmissions.[1] A growing body of research aims to identify those at increased risk of readmission and evaluate multipronged interventions aimed at reducing hospital readmissions.[2,3]

In the United States, patients with the highest adjusted readmission rates are those with multiple chronic conditions, adolescents and young adults with mental health issues, and children transitioning to adulthood.[4] Recently transitioned young adults also reported an overall lower satisfaction with all health care interactions, including hospitalizations.[5] In 2019, we implemented the Med-Peds service line (MP line) to focus on the care of young adults with chronic childhood-onset disease (CCOD).[6] Although multiple interventions have decreased readmissions in other high-risk populations such as congestive heart failure and chronic obstructive pulmonary disease, the effect on readmissions of a dedicated inpatient service for young adults with CCOD has not been described.[7] The primary aim of this study was to assess the impact of the MP service line on the length of stay (LOS) and 30-day hospital readmissions for hospitalized adults with CCODs.

METHODS

Study design

This was an observational, retrospective cohort analysis of patients 18 years or older hospitalized at least once on the MP line between June 29, 2019 and July 01, 2021. We analyzed all inpatient stays for these patients during the study period, including those in which the patients' stays were on other non-MP service lines. Observation encounters were excluded.

Study population

Inpatient encounters for the overall population of patients ever hospitalized on the MP line during the study period were divided into two encounter types. The intervention encounters included inpatient encounters on the MP line, while the control encounters included encounters involving the same patients hospitalized with other services. The details of the team structure and core components of the MP line have been described in detail elsewhere.[6] Briefly, patients were placed on a hospital medicine service staffed by attending physicians with dual board certification in internal medicine and pediatrics. Patients were eligible to be hospitalized on the MP line if they had a CCOD or sequalae of CCOD causing ongoing functional limitations. While patients ages 18 to 30-year-old were targeted, patients older than 30 years with CCOD were included if they had an ongoing disability or high medical complexity given the potential benefits they could receive from the continuity and interventions offered by the service line. As part of the MP line intervention, self-management skills were assessed and taught and social determinants of health (SDOH) screening was conducted.

The control group included inpatient encounters of patients who had been admitted to the MP line and had also been admitted to Other Services at any time during the study period. We defined other services as any inpatient service besides the MP line. The majority of Other Services were other general medicine teams which consisted of one rounding internal medicine attending providing direct care or in a supervisory role to advanced practice providers or to trainees. All services had access to a case manager.

Context

This study of the MP line was conducted at a tertiary academic hospital in the Southern United States with more than 1000 beds. During the study period at our hospital, there were five general medicine teaching service lines staffed by an attending physician and residents plus 11 general medicine direct care service lines staffed by a hospitalist only without trainees; the MP line was one of the direct care lines. Assignment of admitted patients to a particular service line depended on the primary problem, operational factors (e.g., overall hospital bed capacity and staffing), and decision-making by the lead hospitalist scheduled each day to triage and distribute admissions. Decision-making by the lead hospitalist in charge of each day's admission distribution was informed by additional factors such as cohorting admissions for geographically grouped teams, admission capabilities, overall capacity of each service line, and time of day (e.g., morning admissions between 7:00 a.m. and 12:00 p.m. typically assigned to teaching services that include attending and residents can better accommodate new admissions concurrently with daily rounds than a hospitalist working alone on a direct care line). In addition, our study period overlapped with the COVID-19 pandemic. During that time, one admission distribution strategy used was to assign younger adults to inpatient pediatric services at our hospital to accommodate pandemic-related surges within the adult population.

Measures

The primary outcomes were inpatient LOS and 30-day hospital readmission. Comparison of outcomes between the intervention and control groups were conducted at the encounter level. Encounters used to analyze 30-day readmission had to meet multiple criteria for analysis (Supporting Information S1: Table 1).

Sociodemographic and clinical characteristics of encounters were extracted from electronic health records (EHR; Epic©), including age, gender, race, ethnicity, type of insurance, distance from patient residence to the hospital (<15 miles used as a proxy for residence within the same county as the hospital), type of CCOD, having a primary care physician, previous hospitalizations in the past 2 years, occurrence of an ICU stay during the hospitalization, procedures, admission type, discharge disposition, presence of acute or chronic kidney conditions (Supporting Information S1: Table 2), and readmission risk score at time of admission. The readmission risk score is a validated clinical decision support tool embedded in the EHR and available during the admission. It is calculated using demographic, utilization, and clinical data including diagnosis, laboratory data, medications by quantity and class, all of which are associated with unplanned readmissions. Scores range from 0 to 100, with the highest 25% of scores representing those at high risk for readmission. In a previous study, the high-risk threshold score was 21. For all adult patients involved in the validation study, the area under the curve was 0.716–0.760.[8] Aggregate patient census counts per rounding team were generated to describe hospital volume on the date of inpatient admission.

STATISTICAL ANALYSIS

Sociodemographic and clinical characteristics of patients/hospitalizations are summarized using means (with standard deviations) and medians (with interquartile ranges) for continuous variables and frequencies (with percentages) for categorical variables. In some simple stratified tables, Kruskal–Wallis tests (continuous variables)

and χ^2 tests (categorical variables) are used to describe differences between strata.

Though encounters with the MP line and Other Services were pulled for the same patient cohort, there was concern about potential confounding by service assignment, therefore propensity score overlap weighting methods using logistic regression models were used to help rebalance the sample.[9] Overlap weights down-weight individuals with propensity scores in the tails of the distribution and emphasizes individuals with the most overlap in observed characteristics (i.e., those patients who were equally likely to be admitted to the MP line or Other Services were upweighted while those that were highly likely to be admitted to one or the other were down-weighted). Model selection included any covariates determined by the study team and clinical experience a priori to be plausible confounders with service assignment and the outcomes. Distributions of propensity scores from the final selected models were compared to assess overlap in probability of having an encounter on the MP line (vs. other services). Standardized differences were computed before and after weighting to compare a priori imbalances to balance achieved after weighting, with standardized differences smaller than 0.10 in absolute value considered acceptable balance between arms.

Due to known skew in the distribution of LOS and the possibility of censoring due to inpatient death, LOS was analyzed using accelerated failure time (AFT) models (with loglogistic time distribution) with outcomes of days to discharge alive and treatment arm as the sole covariate. Regression parameters were exponentiated to give the interpretation of event time ratios (ETR).

Because of potential censoring due to death, analysis of 30-day hospital readmission used Cox proportional hazard models with days to readmission as the outcome and death before 30 days postdischarge as a censoring event. Regression parameters were exponentiated to give the interpretation of hazard ratios (HR). To enhance comparability to other studies, risk ratios (RR) for the binary outcome of 30-day readmission were also computed using log binomial risk regressions.

Regression estimates were generated with and without weighting to assess the magnitude of potential confounding bias, with weighted models considered primary. To enhance interpretability of regression models, weighted and unweighted Kaplan–Meier curves were plotted for both outcomes.

Bootstrapping methods were used to calculate valid percentile-based 95% confidence intervals (CIs) (accounting for repeated measures by patient and uncertainty in the propensity score) using 1000 resamples at the level of the individual patient.

Subgroup analyses of patients with sickle cell disease (SCD) and patient's residential zip code using centroid distances from the hospital were (15 miles or less vs. >15 miles) were performed using interaction terms for subgroup and calculating linear combinations to derive estimates by strata. Subgroup analyses were determined a priori and considered exploratory.

Evaluation of LOS and 30-day hospital readmission were both considered as individual hypotheses, thus no adjustment for multiple comparisons was applied. Due to bootstrapping methods, p values are not produced for any outcome and focus should be on precision of estimates as measured by CI width and inclusion or exclusion of a null result in that interval. All analyses were conducted using SAS Software version 9.4 and Stata Software version 17.

RESULTS

During the study period, a total of 323 patients suspected of having CCODs had at least one inpatient stay on the MP line with the majority (69.7%) having their first MP line stay in the first year of the study period (Supporting Information S2: Figure 1). Upon retrospective chart review, 21 (6.5%) of the 323 patients were determined not to have CCOD and excluded from analysis, leaving a total patient cohort of 302 with CCOD, of which 156 (51.7%) also had inpatient stays with Other Services during the study time period (Figure 1). Among the 302 unique patients, they had a mean number of 3.6 encounters total with 1.8 encounters on the MP service and 1.8 encounters on Other Services. The 1089 total inpatient encounters for the analyzed study population were divided evenly between admissions to the MP line (544 encounters) and Other Services (545 encounters).

Median age of patients during encounters was 27 (interquartile range [IQR]: 23–33) with 42% of patients ≥30 years (Table 1). Patients were predominantly female (57.9%) and identified as Black race (73.6%) and non-Hispanic ethnicity (95.8%). A majority of patients were on governmental insurance (70.3%) (majority Medicaid) and had a primary care physician (PCP) identified (96.7%) in their medical chart. Most patients (73%) lived greater than 15 miles from the hospital. The most common primary CCODs across all encounters were SCD (47.5%) and type 1 diabetes (12.7%), with rarer diseases included in an "other" category (21.4%). Patient-level sociodemographic and clinical characteristics at the time of their first hospitalization on the MP line can be found in Supporting Information S2: Table 1.

Of the 545 encounters on Other Services, 423 (77.6%) were on other general medicine teams, 9% on surgery, 5.7% on specialty medicine, 3.1% on obstetrics/gynecology, 2.4% on specialty pediatrics, and 2.2% on general pediatrics services. In calculation of the propensity score, age 30 years or older, unreported racial identification, having a PCP identified, having more discharges in the past 24 months, having routine or urgent admissions (vs. emergency admission), and having an ICU stay during the encounter were associated with a lower probability that a patient would be hospitalized on the MP line, while patients of Hispanic ethnicity and those having a CCOD other than SCD were more likely to be hospitalized on the MP line (Supporting Information S2: Table 2). Distributions of propensity scores for encounters on the MP line and those on Other Services can be found in Supporting Information S2: Figure 2. Comparisons of standardized differences before overlap weighting suggested imbalance (defined as having standardized differences >|0.10|) in patient and encounter characteristics between

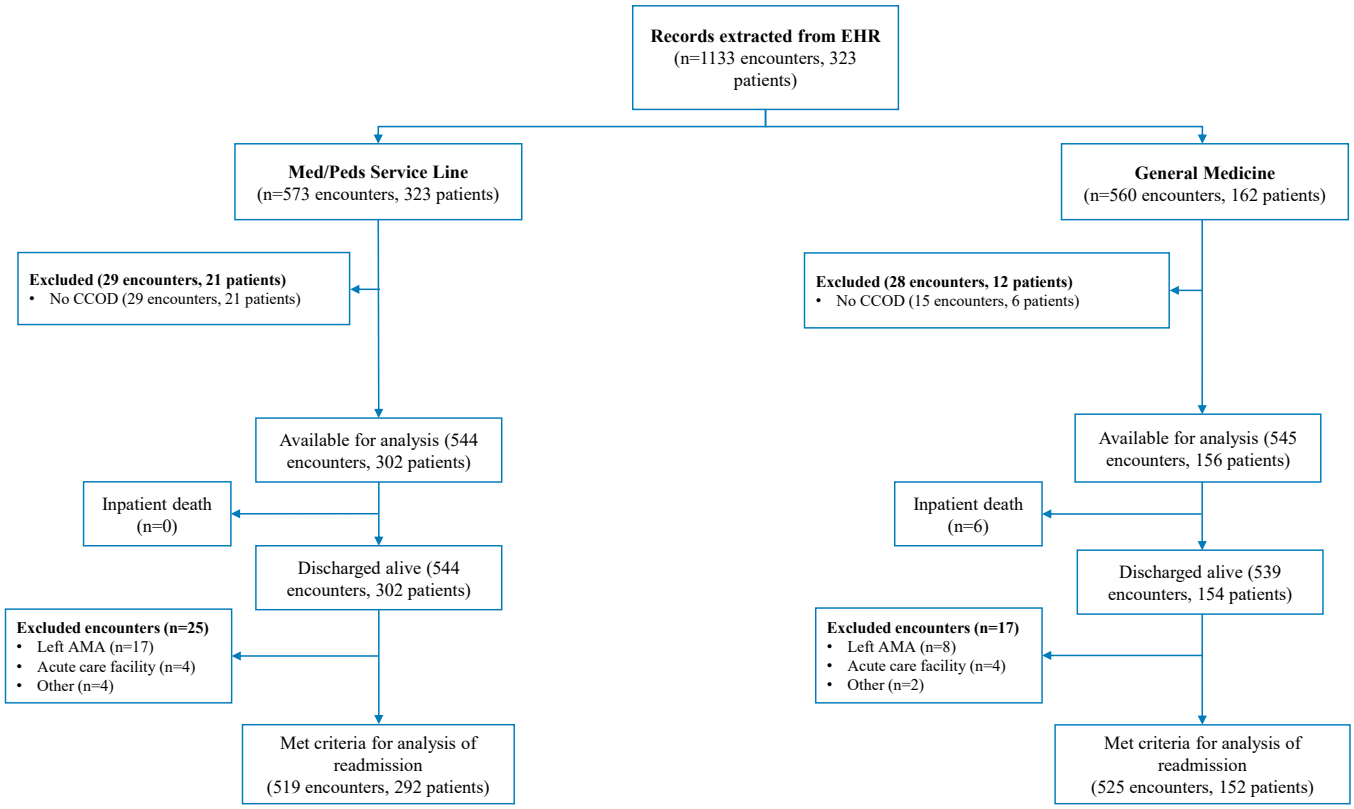

FIGURE 1 Patient flow of encounters and patients on Med-Peds service line and Other Services. CCOD, chronic childhood-onset diseases; EHR, electronic health records.

those seen on MP line versus Other Services; however, after overlap weighting acceptable balance was achieved (standardized difference <0.10; Supporting Information S2: Figure 3).

LOS

Weighted median lengths of stay were comparable between the MP line and Other Services encounters (Median = 4.5 days, IQR: 2.5–7.8 for Other Services; Median = 4.8 days, IQR: 2.9–8 for MP line), with stays on average 10% longer for patients on the MP line (ETR = 1.10, 95% CI: 1.00–1.21) (Table 2). However, comparison of Kaplan–Meier plots indicated little difference between MP line and Other Services (Figure 2). Estimates did not differ when the time to discharge alive was censored at 30 days (>97th percentile), suggesting that outliers were not likely to influence estimation of time comparisons. Comparison of unweighted LOS estimates for encounters on the MP line and Other Services were similar (ETR = 0.99, 95% CI: 0.87–1.12) indicating a substantial amount of bias may have been present before adjustment for confounding (Supporting Information S2: Table 3). Patients with SCD and patients with residences within 15 miles of the hospital had a pattern towards longer LOS on the MP line than their counterparts on Other Services, though these findings were not statistically significant (Supporting Information S2: Figure 4, panel 1).

Thirty-day readmission

A total of 1044 (95.9%) encounters met the criteria to be included in analysis of 30-day readmission, with 519 encounters (292 patients) for MP line and 525 encounters (152 patients) for Other Services (Figure 1). A weighted average of 40.3% of patient encounters with discharges by Other Services had readmissions within 30 days of discharge compared to 26.9% of patient encounters on the MP service line (RR = 0.67, 95% CI: 0.55–0.81). Patient encounters with discharges by the MP line had a 39% lower rate of readmission within 30 days of discharge (HR = 0.61, 95% CI: 0.48–0.77) than encounters with Other Services (Table 2). Unweighted estimates indicate that without adjustment for confounding, effect estimates would have been overestimated (Supporting Information S2: Table 3). There is some evidence that a stay on the MP line may have had less of an effect on the rate and risk of 30-day readmission for patients with SCD and those >15 miles from the hospital, though these findings were not statistically significant (Supporting Information S2: Figure 4, panels 2 and 3).

Comparison of frequencies of encounters between those patients that had only MP line encounters and those patients that had encounters on both the MP line and Other Services raised concern that those with both types of encounters might be patients that were higher utilizers (i.e., more discharges in the prior 24 months), were less likely to be flagged for the MP line service,

TABLE 1 Unweighted sociodemographic and clinical characteristics of patients at the time of inpatient encounters on the Med Peds (MP) service line and Other Services.

	Other Services	MP service line	Total
Encounters	(*n* = 545)	(*n* = 544)	(*N* = 1089)
Patients	(*n* = 156)	(*n* = 302)	
Sociodemographic characteristics			
Age (years) at admission			
Mean (SD)	30.3 (7.7)	27.4 (6.8)	28.8 (7.4)
Median (Q1, Q3)	30 (24, 36)	26 (22, 31)	27 (23, 33)
Female	311 (57.1%)	320 (58.8%)	631 (57.9%)
Race[a]			
White	98 (18.0%)	142 (26.1%)	240 (22%)
Black	433 (79.4%)	368 (67.6%)	801 (73.6%)
Other	6 (1.1%)	22 (4.0%)	28 (2.6%)
Not reported/declined	8 (1.5%)	12 (2.2%)	20 (1.8%)
Ethnicity[b]			
Not Hispanic/Latino	531 (97.4%)	512 (94.1%)	1043 (95.8%)
Hispanic/Latino	9 (1.7%)	23 (4.2%)	32 (2.9%)
Not reported/declined	5 (0.9%)	9 (1.7%)	14 (1.3%)
Insurance type[c]			
Governmental	404 (74.1%)	362 (66.5%)	766 (70.3%)
Nongovernmental	125 (22.9%)	149 (27.4%)	274 (25.2%)
Self-pay	16 (2.9%)	33 (6.1%)	49 (4.5%)
Distance from hospital[d]			
≤15 miles	155 (28.4%)	139 (25.6%)	294 (27.0%)
>15 miles	390 (71.6%)	405 (74.4%)	795 (73.0%)
Clinical and encounter characteristics			
Chronic childhood-onset disease			
Sickle cell disease	322 (59.1%)	195 (35.8%)	517 (47.5%)
Type 1 diabetes	57 (10.5%)	81 (14.9%)	138 (12.7%)
Inflammatory bowel syndrome	10 (1.8%)	36 (6.6%)	46 (4.2%)
Autoimmune	36 (6.6%)	63 (11.6%)	99 (9.1%)
Genetic	25 (4.6%)	31 (5.7%)	56 (5.1%)
Other	95 (17.4%)	138 (25.4%)	233 (21.4%)
Has PCP[e]	538 (98.7%)	515 (94.7%)	1053 (96.7%)
Discharges in the last 24 months			
Mean (SD)	8.9 (7.0)	6.0 (6.3)	7.4 (6.8)
Chronic kidney disease (CKD)[f]	114 (20.9%)	94 (17.3%)	208 (19.1%)
Acute kidney injury (AKI)[f]	94 (17.2%)	131 (24.1%)	225 (20.7%)
End-stage renal disease (ESRD)[f]	60 (11.0%)	42 (7.7%)	102 (9.4%)
Time in ICU (days)			
No ICU	479 (87.9%)	502 (92.3%)	981 (90.1%)

(Continued)

TABLE 1 (Continued)

	Other Services	MP service line	Total
<1 day	11 (2.0%)	9 (1.7%)	20 (1.8%)
1–2 days	16 (2.9%)	12 (2.2%)	28 (2.6%)
>2 days	39 (7.2%)	21 (3.9%)	60 (5.5%)
Inpatient primary procedures[g]			
Procedural	78 (14.3%)	106 (19.5%)	184 (16.9%)
Surgical	43 (7.9%)	33 (6.1%)	76 (7.0%)
Other	91 (16.7%)	85 (15.6%)	176 (16.2%)
No procedure	333 (61.1%)	320 (58.8%)	653 (60.0%)
Type of admission[h]			
Emergency admission	452 (82.9%)	494 (90.8%)	946 (86.9%)
Routine elective admission	18 (3.3%)	10 (1.8%)	28 (2.6%)
Urgent admission	75 (13.8%)	40 (7.4%)	115 (10.6%)
Discharge disposition			
Home or self care	487 (89.4%)	457 (84.0%)	944 (86.7%)
Home health service	36 (6.6%)	59 (10.8%)	95 (8.7%)
Left against medical advice	8 (1.5%)	17 (3.1%)	25 (2.3%)
Other	14 (2.6%)	11 (2.0%)	25 (2.3%)
Readmission risk score (at admission)			
Mean (SD)	28.59 (22.2)	20.92 (17.2)	24.75 (20.2)
Median (Q1, Q3)	21.0 (12.2, 36.6)	15.0 (9.9, 25.0)	17.8 (11.0, 30.6)
Hospital census per rounder			
Mean (SD)	10.6 (1.5)	10.6 (1.5)	10.6 (1.5)
Median (Q1, Q3)	10.5 (9.6, 11.8)	10.5 (9.5, 11.8)	10.5 (9.5, 11.8)

Abbreviations: ICU, intensive care unit; PCP, primary care physician.

[a]In practice, race in electronic health records may either by self-reported race or health care provider perceived race. "Other" includes Asian, American Indian/Alaska Native, or 2+ races.

[b]In practice, ethnicity in electronic health records is predominantly self-reported.

[c]Insurance type defined as governmental (government-sponsored) vs. nongovernmental (private) vs. self-pay (no insurance listed).

[d]Calculated as Euclidean distance between a patient's zip code centroid and the centroid of hospital's zip code.

[e]Includes patients with PCP listed in electronic health record.

[f]See Supporting Information: supplemental methods file for definition.

[g]Procedure were those performed by a nonsurgical service or at the bedside; surgery was performed by surgical service in the operating room.

[h]Type of admission based on electronic health record designation: Emergency are admissions from the emergency department, routine elective are planned admissions, and urgent are unplanned admissions from locations other than the emergency department.

or potentially more serious cases (i.e., more likely for the inpatient encounter to include an ICU stay). Thus, we conducted sensitivity analyses to compare sociodemographic characteristics between patients that had at least one hospitalization on both service groups (MP line and Other Services) and those that had only MP line hospitalizations during the study period. In this analysis, we noted that older patients ($p = .056$ and 0.030), Black patients and those not identifying as Black or White ($p < .001$), patients with governmental insurance ($p = .001$), patients with SCD ($p < .001$), those with higher numbers of discharges in the past 24 months ($p < .001$), and those with higher readmission risk scores ($p < .001$) were more likely to have at least one stay with another service (Supporting Information S2: Table 4). After performing the same propensity score calculation process on this subset of patient encounters, we found similar overall effects of the MP line on LOS. The overall effect on 30-day readmissions was also similar; however, magnitude of effect size attributed to the MP line was slightly reduced (HR = 0.68, 95% CI: 0.53–0.89 compared to HR = 0.61, 95% CI: 0.48–0.77) (Supporting Information S2: Table 5).

TABLE 2 Weighted[a] sample means and regression estimates of the Med Peds (MP) Line and Other Services.

Outcome	Weighted sample summaries by arm		Weighted regression estimates[b]
	Other Services	MP Line	
Length of hospital stay[c]			Event time ratio (95% CI)
Mean (SD)	6.4 (6.9)	7.4 (10.3)	1.10 (1.00,1.21)
Median (IQR)	4.5 (2.5,7.8)	4.8 (2.9,8.0)	
Inpatient death (%)	0.9%	0.0%	
Length of stay (censored at 30 days)			Event time ratio (95% CI)
Mean (SD)	6.3 (5.9)	6.8 (6.3)	1.09 (1.00,1.21)
Median (IQR)	4.6 (2.5,7.9)	4.8 (2.9,8.0)	
Inpatient death (censored at 30 days) (%)	0.5%	0.0%	
Days to readmission (30-day endpoint)[d]			Hazard ratio (95% CI)
Mean (SD)	13.9 (8.3)	14.1 (8.4)	0.61 (0.48,0.77)[c]
Median (IQR)	12.4 (6.8,21.3)	13.1 (7.0,22.4)	
Readmission within 30 days (%)			Risk Ratio (95% CI)
Readmission within 30 days (%)	40.3%	26.9%	0.67 (0.55,0.81)
Death before 30-day readmission (%)	0.7%	0.2%	

Abbreviations: ICU, intensive care unit; IQR, interquartile range.

[a]Weights incorporate age at admission, gender, race, ethnicity, insurance type (governmental, nongovernmental, self-pay), distance from hospital, has a PCP identified, discharges in the last 24 months, type of chronic childhood onset disease, chronic kidney disease, acute kidney injury, end stage renal disease, type of admission, readmission risk score at admission, any ICU stay, primary inpatient procedure, and hospital census per rounder.

[b]Number of observations for length of stay analysis (n = 1086), number of observations for analyses of 30-day readmission (n = 1041).

[c]Sample summaries of time-to-event outcomes are conditional on an event having occurred and thus have a lower sample size than regressions.

[d]Test of Schoenfeld residuals p = .751.

DISCUSSION

Overall, this study found that hospitalization on the MP line was associated with a decreased risk of 30-day readmission by an estimated 33% compared to hospitalization of the same patients on Other Services. LOS was 10% longer for the MP line, however median LOS was similar (4.8 vs. 4.5 days). Exploratory analysis suggested that these effects varied depending on whether a patient had SCD and whether the patient's residence was ≤15 miles from the hospital.

Studies focusing on transitional care interventions have demonstrated reduced readmissions, such as in patients with heart failure.[10,11] Outpatient resources have been shown to reduce readmissions and LOS in patients with type 1 diabetes, which made up 14% of our patient population.[12] Interventions in these studies mostly occurred after discharge, unlike our service which focuses on care during the hospitalization and discharge planning. Efforts to improve appointment adherence, which largely occurs during the hospitalization, may be a key factor. Studies show that close follow-up after discharge is associated with reductions in 30-day readmissions with the greatest effect in those at high risk for readmission.[13,14] We considered distance from the hospital as an important variable to account for both within the propensity scoring process and as subgroup for analysis as it may relate to barriers to posthospitalization follow-up, less access to care, or higher clinical complexity (i.e., given our hospital's role as a regional referral center, patients with higher complexity or more serious clinical status may have to travel longer distances for tertiary care).

The MP line consisted of up to seven providers, and with many patients, a longitudinal relationship was formed. When patients have complex medical and social needs, this continuity of care may allow for higher value of care, more trust between patient and provider, less redundancy, and a focus on what the patient's needs are postdischarge.

The most prevalent disease in our patient population was SCD (26%). Patients with SCD have higher readmission rates compared to other populations, and young adults (18–30 years) with SCD may have even higher readmission rates and costlier hospitalizations.[15,16]

Notably, during our study period there was another general medicine service represented within Other Services designed to care for patients with SCD, possibly leading to the disproportionate representation of patients with SCD between Other Services (59%) compared to the MP line (36%) and the attenuated effects of the MP line on readmission rates seen for those patients in subanalysis. Because internal triage workflows prioritized

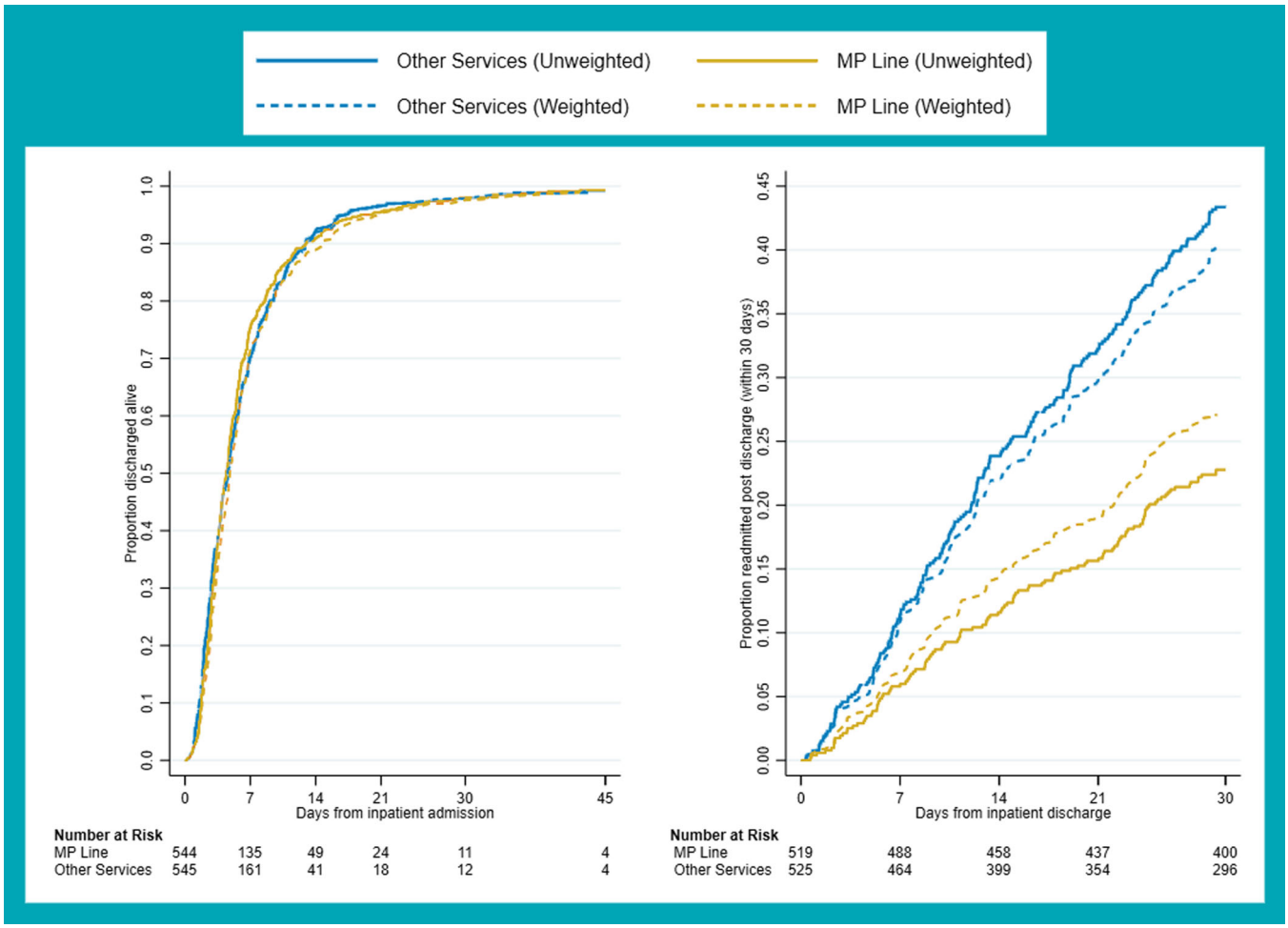

FIGURE 2 Weighted and unweighted Kaplan–Meier curves for length of stay and 30-day hospital readmission for Med-Peds line and Other Services.

assignment of patients with SCD to the MP line or the other general medicine SCD service line, there was likely significant overlap between the two services.

Given the higher risk of readmission among the SCD population, over-representation of patients with SCD on Other Services may have contributed to their overall higher observed readmission rate, though we expect this discrepancy to have been minimized by the propensity score weighting process. However, the literature also supports that factors such as financial insecurity, mental health needs and clinic appointment adherence are associated with readmissions.[17] The MP line aimed to systematically assess and address these patient needs, whereas there was likely variation in the degree to which Other Services may have approached these health-related social needs. Furthermore, many of the frequently hospitalized patients with SCD have inpatient care plans which has been shown to reduce LOS and readmissions at 7 days but not at 30 or 90 days.[18]

Finally, in a previous study of Medicaid beneficiaries, patients with longer lengths of stay were more likely to have a readmission within 30 days.[19] While we did not directly perform this analysis, in aggregate, we found minimal difference in LOS and a large reduction in 30-day readmission rate for encounters discharged by the MP line.

This study was limited by being observational at a single center. Though there were a similar number of encounters in each group, the Other Services had roughly half the number of patients represented in their sample compared to the MP line. Patients discharged by Other Services were more likely to have an ICU stay and higher readmission risk scores on admission, but the weighted models adjusted for these differences. Propensity score models were used to help remove possible confounding caused by differences between patients hospitalized on the MP line versus those cared for by Other Services, however residual confounding from unmeasured variables remains a limitation. A factor not accounted for is assignment of the patient to a team, which may include inherent clinician bias and subjectivity, and is particularly relevant to patients with SCD who could have been assigned to the MP line or the other SCD-focused general medicine service. In addition, during the COVID-19 pandemic, some younger patients with SCD were assigned to pediatric hematology services to help offset the general medicine census.

Factors that may be particularly pertinent to young adult patients include the presence of emotional support in the hospital, mental health conditions, and bias by caregivers towards young adults. Based on intention-to-treat principles, patients were assigned to analytical groups based on their assignment at discharge; therefore, it is possible that patients could have switched between MP line and Other Services earlier within the same hospital stay. Furthermore, our patient population grouped heterogeneous diseases. There may be differences in outcomes based on disease, which this study did not assess besides SCD.

Our study raises questions about which factors are associated with lower readmission rates among hospitalized young adults with a variety of childhood-onset diseases. It also suggests that there may be benefit to grouping these patients on a single team to improve patient-provider continuity and best match patients with providers with patient care skillsets that cross the lifespan. Future prospective studies should be performed to help analyze which aspects of the intervention may most strongly contribute to reduced readmission rates, as well as understand why there were differences between disease-specific populations and distance from the hospital. Finally, patients with certain sociodemographic characteristics, notably being older, identifying as Black race, and having governmental insurance, were all more likely to have an encounter on another service which may represent bias in team assignment and resource allocation. If hospital care for young adults with CCOD on a MP line is truly beneficial for health outcomes, further investigation is warranted to ensure equitable access for all patients to benefit from this specialized form of hospital care.

CONCLUSION

Hospitalization of young adults with CCOD on a dedicated MP line was associated with lower 30-day readmission rates and modest increases in LOS. More research is needed to understand what features of this young adult-focused inpatient care model are most effective for reducing readmissions and how to facilitate equitable access for diverse subpopulations.

ACKNOWLEDGMENTS

We would like to thank the contributions of the Duke Hospital Medicine leadership and the entire Medicine-Pediatrics Service Line team during the study period, including Yasmin Marcantonio, Sonya Patel-Nguyen, Jesse Rhodes, Mary-Nel Saarloos, and Kevin White. Dr. Feeney's contributions were supported in part by the Clinical Innovations Award from Duke Hospital Medicine from 2019 to 2021. Dr. Ming's contributions were supported in part by the National Institutes of Health, National Heart, Lung, and Blood Institute (K12HL13830).

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

ORCID

Colby Feeney http://orcid.org/0000-0002-3741-5205
David Y. Ming http://orcid.org/0000-0003-2836-6656

TWITTER

Colby Feeney @Colby_Feeney

REFERENCES

1. Wadhera RK, Yeh RW, Joynt Maddox KE. The hospital readmissions reduction program—time for a reboot. *N Engl J Med*. 2019;380(24):2289-2291. doi:10.1056/NEJMp1901225
2. Dimensions AI: the most advanced scientific research database. Dimensions. Response to "Published interventions to reduce hospital readmissions". 2023. Accessed January 5, 2023. https://www.dimensions.ai/
3. Kripalani S, Theobald CN, Anctil B, Vasilevskis EE. Reducing hospital readmission rates: current strategies and future directions. *Annu Rev Med*. 2014;65:471-485. doi:10.1146/annurev-med-022613-090415
4. Berry JG, Gay JC, Joynt Maddox K, et al. Age trends in 30 day hospital readmissions: US national retrospective analysis. *BMJ*. 2018;360:k497. doi:10.1136/bmj.k497
5. Hargreaves DS, Viner RM. Children's and young people's experience of the National Health Service in England: a review of national surveys 2001-2011. *Arch Dis Child*. 2012;97(7):661-666. doi:10.1136/archdischild-2011-300603
6. Feeney CD, Platt A, Rhodes J, et al. Redesigning care of hospitalized young adults with chronic childhood-Oonset disease. *Cureus*. 2022;14(8):e27898. doi:10.7759/cureus.27898
7. Saxena FE, Bierman AS, Glazier RH, et al. Association of early physician follow-up with readmission among patients hospitalized for acute myocardial infarction, congestive heart failure, or chronic obstructive pulmonary disease. *JAMA Netw Open*. 2022;5(7):e2222056. doi:10.1001/jamanetworkopen.2022.22056
8. Gallagher D, Zhao C, Brucker A, et al. Implementation and continuous monitoring of an electronic health record embedded readmissions clinical decision support tool. *J Pers Med*. 2020;10(3):103. doi:10.3390/jpm10030103
9. Li F, Thomas LE. Addressing extreme propensity scores via the overlap weights. *Am J Epidemiol*. 2018;188(1):250-257. doi:10.1093/aje/kwy201
10. Dhalla IA, O'Brien T, Morra D, et al. Effect of a postdischarge virtual ward on readmission or death for high-risk patients: a randomized clinical trial. *JAMA*. 2014;312(13):1305-1312. doi:10.1001/jama.2014.11492
11. Chauhan U, McAlister FA. Comparison of mortality and hospital readmissions among patients receiving virtual ward transitional care vs usual postdischarge care: a systematic review and meta-analysis. *JAMA Network Open*. 2022;5(6):e2219113. doi:10.1001/jamanetworkopen.2022.19113
12. Burns K, Farrell K, Myszka R, Park K, Holmes-Walker DJ. Access to a youth-specific service for young adults with type 1 diabetes mellitus is associated with decreased hospital length of stay for diabetic ketoacidosis. *Intern Med J*. 2018;48(4):396-402. doi:10.1111/imj.13649
13. Wiest D, Yang Q, Wilson C, Dravid N. Outcomes of a citywide campaign to reduce medicaid hospital readmissions with connection to primary care within 7 days of hospital discharge. *JAMA Netw Open*. 2019;2(1):e187369. doi:10.1001/jamanetworkopen.2018.7369
14. Tong L, Arnold T, Yang J, Tian X, Erdmann C, Esposito T. The association between outpatient follow-up visits and all-cause non-elective 30-day readmissions: a retrospective observational cohort study. *PLoS One*. 2018;13(7):e0200691. doi:10.1371/journal.pone.0200691

15. Fingar KR, Owens PL, Reid LD, Mistry KB, Barrett ML. Characteristics of inpatient hospital stays involving sickle cell disease, 2000-2016. *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs [Internet]* (Statistical Brief no. 251). Agency for Healthcare Research and Quality (US); 2006.
16. Kumar V, Chaudhary N, Achebe MM. Epidemiology and predictors of all-cause 30-day readmission in patients with sickle cell crisis. *Sci Rep*. 2020;10(1):2082. doi:10.1038/s41598-020-58934-3
17. Cronin RM, Hankins JS, Byrd J, et al. Risk factors for hospitalizations and readmissions among individuals with sickle cell disease: results of a U.S. survey study. *Hematology*. 2019;24(1):189-198. doi:10.1080/16078454.2018.1549801
18. Welch-Coltrane JL, Wachnik AA, Adams MCB, et al. Implementation of individualized pain care plans decreases length of stay and hospital admission rates for high utilizing adults with sickle cell disease. *Pain Med*. 2021;22(8):1743-1752. doi:10.1093/pm/pnab092
19. Chopra I, Wilkins TL, Sambamoorthi U. Hospital length of stay and all-cause 30-day readmissions among high-risk Medicaid beneficiaries. *J Hosp Med*. 2016;11(4):283-288. doi:10.1002/jhm.2526

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Feeney C, Chandler M, Platt A, Sun S, Setji N, Ming DY. Impact of a hospital service for adults with chronic childhood-onset disease: A propensity weighted analysis. *J Hosp Med*. 2023;1-10. doi:10.1002/jhm.13234