Hospital Consultation From Outpatient Clinicians for Medically Complex Children
A Randomized Clinical Trial

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IMPORTANCE Children with medical complexity (CMC) frequently experience fragmented care. We have demonstrated that outpatient comprehensive care (CC) reduces serious illnesses, hospitalizations, and costs for high-risk CMC. Yet continuity of care for CMC is often disrupted with emergency department (ED) visits and hospitalizations.

OBJECTIVE To evaluate a hospital consultation (HC) service for CMC from their outpatient CC clinicians.

DESIGN, SETTING, AND PARTICIPANTS Randomized quality improvement trial at the University of Texas Health Science Center at Houston with an outpatient CC clinic and tertiary pediatric hospital (Children’s Memorial Hermann Hospital). Participants included high-risk CMC (≥2 hospitalizations or ≥1 pediatric intensive care unit [PICU] admission in the year before enrolling in our clinic) receiving CC. Data were analyzed between January 11, 2018, and December 20, 2019.

INTERVENTIONS The HC included serial discussions between CC clinicians, ED physicians, and hospitalists addressing need for admission, inpatient treatment, and transition back to outpatient care. Usual hospital care (UHC) involved routine pediatric hospitalist care.

MAIN OUTCOMES AND MEASURES Total hospital days (primary outcome), PICU days, hospitalizations, and health system costs in skeptical bayesian analyses (using a prior probability assuming no benefit).

RESULTS From October 3, 2016, through October 2, 2017, 342 CMC were randomized to either HC (n = 167) or UHC (n = 175) before meeting the predefined bayesian stopping guideline (>80% probability of reduced hospital days). In intention-to-treat analyses, the probability that HC reduced total hospital days was 91% (2.72 vs 6.01 per child-year; bayesian rate ratio [RR], 0.61; 95% credible interval [CrI], 0.30-1.26). The probability of a reduction with HC vs UHC was 98% for hospitalizations (0.60 vs 0.93 per child-year; RR, 0.68; 95% CrI, 0.48-0.97), 89% for PICU days (0.77 vs 1.89 per child-year; RR, 0.59; 95% CrI, 0.26-1.38), and 94% for mean total health system costs ($24,928 vs $42,767 per child-year; cost ratio, 0.62; 95% CrI, 0.41-1.10). In secondary analysis using a bayesian prior centered at RR of 0.78, reflecting the opinion of 7 experts knowledgeable about CMC, the probability that HC reduced hospital days was 96%.

CONCLUSIONS AND RELEVANCE Among CMC receiving comprehensive outpatient care, an HC service from outpatient clinicians likely reduced total hospital days, hospitalizations, PICU days, other outcomes, and health system costs. Additional trials of an HC service from outpatient CC clinicians are needed for CMC in other centers.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT02870387

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Published online November 30, 2020.

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Children with medical complexity (CMC) account for only 0.4% of all children\(^1\) but are responsible for approximately 40% of pediatric deaths\(^4\) and 53% of all pediatric hospital charges.\(^5\) These problems reflect the fragmented inpatient and outpatient care that they often receive.

To help address this problem, we have developed an outpatient comprehensive care (CC) program for high-risk CMC at the University of Texas Health Science Center at Houston (UTH) and conducted a randomized clinical trial (RCT) that demonstrated that CC reduced emergency department (ED) visits, hospital, and pediatric intensive care unit (PICU) admissions and days by 47% to 69% and health system costs by $10,200 per child-year.\(^3\) As shown in a stepped-wedge analysis, these benefits were sustained or increased following the trial’s completion.\(^6\) Even so, our CMC still often require hospitalization for acute illnesses or exacerbations, and the pediatric hospitalists who provide their inpatient care are generally unfamiliar with them and their outpatient care.

Hospitalists and primary care physicians (PCPs) alike have long-standing concerns about difficulty in sustaining continuity of care in the hospital,\(^7,8\) and hospitalists note inadequate involvement of PCPs as an important barrier to effective inpatient care for CMC.\(^9\) Discontinuity of care may increase their total hospital days, PICU admissions, readmissions, and costs. There is a paucity of research, particularly RCTs, assessing strategies to avoid such problems.\(^7,10\)

As described herein, we conducted a Bayesian\(^11-15\) randomized quality improvement (QI) trial\(^16,17\) assessing whether a hospital consultation (HC) service provided by outpatient CC clinicians reduced hospital days compared with usual hospital care for CMC in our center.

### Methods

The institutional review board at UTH approved the trial as a randomized QI project\(^16-19\) of a new service that would increase the continuity and coordination of inpatient care that could not be provided to all patients owing to limited personnel. All patients in both groups continued to receive outpatient CC.\(^3,6\) As allowed under federal regulations for QI studies, judges likely to improve patient outcomes and unlikely to increase their risk,\(^17,18\) our institutional review board waived disclosure and consent for the study. The formal trial protocols can be found in Supplement 1.

### Eligibility Criteria

We included patients younger than 18 years with a chronic illness treated in the UTH High-Risk Children’s Clinic, an enhanced medical home that provides CC to CMC with a history of high hospital use (≥2 hospitalizations or ≥1 PICU admission during the year before enrollment in this clinic). To focus on those likely to have greatest benefit,\(^20\) clinic enrollment also required a high estimated risk of hospitalization without CC (≥50% risk as judged by the clinic’s medical director [R.A.M.] based on the patient’s diagnosis and clinical course\(^3,6\)).

We excluded patients with specific disorders (eg, serious unrepaired congenital heart disease, mitochondrial disorders, or terminal illness) given primary care in other clinics and patients who were on do-not-resuscitate status unlikely to be admitted to the hospital or PICU. Patients exited the study at age 18 years when hospital policy precluded consultation from pediatric clinicians.

### Randomization

Before randomization, patients were stratified by primary CC clinician (n = 5) and estimated baseline hospitalization risk: high risk or very high risk (≥ median risk for CMC in our program) as judged by the clinic’s medical director (R.A.M.). Agreement of his designation of children in risk categories with their observed outcomes has been previously shown.\(^3,6\) Participants were then randomized by a study nurse (M.P.) uninvolved in patient care using a computer-generated algorithm with variable block size. Patients already participating in the clinic were randomized at the outset of the trial. Patients later enrolled were randomized during their first clinic visit.

### Usual Hospital Care

Usual hospital care (UHC) was provided by teams of residents and attending pediatric hospitalists at Children’s Memorial Hermann Hospital (CMHH, a private institution and the primary teaching hospital for UTH). Hospitalizations occurred through the ED. The ED physicians are likely to admit CMCs seen at any hour because of their complexity, their risk for developing serious illnesses or complications,\(^2\) and doubts that any deterioration would be promptly addressed in an outpatient setting. This decision was accepted by the inpatient team without systematically involving the PCPs. Throughout the hospitalization, the inpatient team could request a formal HC from our clinicians but usually had only occasional informal communication with CC clinicians. The inpatient team took responsibility for discharge planning and making follow-up appointments.

### Hospital Consultation

Hospital consultation is contrasted with UHC in the eTable in Supplement 2. To help avoid unnecessary admissions from the ED and optimize care, parents of children in the HC group were told to ask the ED physician to call the CC clinician, particularly if hospitalization was considered. The CC clinician

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**Key Points**

**Question** What is the effect of a hospital consultation service for children with medical complexity (CMC) from their outpatient comprehensive care clinicians?

**Findings** In this randomized quality improvement trial involving 342 high-risk CMC, the Bayesian probability was 91% to 98% that hospital consultation reduced total hospital days relative to usual hospitalist care (primary outcome, 2.72 vs 6.01 days per child-year), hospitalizations, and health system costs.

**Meaning** Among CMC receiving comprehensive outpatient care, a hospital consultation service from outpatient clinicians likely reduced total hospital days, hospitalizations, and health system costs.
and ED physician could then collaborate in treatment decisions, assure the availability of a prompt clinic visit on any weekday, and discuss any admission with the admitting physician. Discussions with the ED team or admitting physician occurred also whenever children were referred from our clinic to the hospital.

A study nurse reviewed the CMHH admission log each weekday to assure all admissions of study children were identified and that HC was initiated for all in the HC group. For that group, the CC clinician talked with the inpatient team before or soon after admission, at intervals throughout the hospitalization as needed, and at discharge. These discussions usually occurred in person on weekdays and by telephone on weekends. The CC clinician spoke with any parents present when consultation occurred in person. Coordination and integration of inpatient and outpatient care was emphasized, and consultation notes with treatment recommendations were recorded in the CMHH electronic medical record. The CC clinicians assisted with discharge planning, routinely called the family within 36 hours of discharge, and scheduled a clinic appointment 10 days or less after discharge.

**Blinding**

While patient care clinicians could not be blinded, our statisticians (C.S.B. and C.P.) and health care economist (E.B.C.A.) were blinded to treatment group.

**Process Measures**

We recorded conversations with ED physicians, total hospital consultations, and phone conversations and clinic visits after hospital discharge from CMHH electronic medical record and clinic records.

**Outcome Measures**

The primary outcome was total hospital days per child-year. Secondary outcomes included hospitalizations, mean hospital length of stay, PICU admissions, PICU days, serious illnesses (death, PICU admission, or hospital stay >7 days), ED visits within 30 days after discharge, 30-day readmissions, parental rating of hospital clinicians, and health system costs. To identify hospital days, ED visits, and hospitalizations, we assessed the ED and hospital logs each weekday for CMHH, the claims data from the 13 Memorial Hermann hospitals, and reports from parents who were asked at each visit about any medical care since prior visit. The percentage of parents who assigned the clinicians a global rating of 9 or 10 (highest scores) on the Consumer Assessment of Healthcare Providers and Systems Hospital Survey was assessed during a postdischarge clinic visit or a telephone call by a study nurse (M.P.) uninvolved in patient care.

A health care economist (E.B.C.A.) conducted detailed evaluations of hospital and clinic costs from the health system perspective. For each ED visit and hospitalization at any Memorial Hermann hospital, itemized and total hospital-specific costs were obtained from their cost-accounting system. The costs at other hospitals (7% of total admissions) were imputed based on the mean costs at CMHH. Costs for physician inpatient services were estimated using claims data and relative value units (RVUs) from the 2019 Medicare Fee Schedule. Clinic costs for CC were estimated using the total expenditures of our clinic (including all personnel costs and overhead). Costs for outpatient services in our center outside our clinic were calculated using RVUs. The incremental costs for the personnel time to provide HC was based on the number of consultations and CC staff salary, fringe, and overhead.

**Figure 1. CONSORT Diagram**

367 Patients assessed for eligibility

25 Excluded
25 Ineligible
11 Had do-not-resuscitate order
2 Had un repaired cardiac disorder
2 Had active cancer
4 Had mitochondrial disorders
1 Was comanaged with an outside primary care physician

342 Randomized

175 Randomized to usual hospital care
175 Received allocated intervention

22 Discontinued intervention
7 Changed insurance to managed care
4 Transitioned out of clinic (healthy)
4 Voluntarily changed clinicians
5 Aged out of pediatric CC unit (>18 y)
1 Moved out of local area
1 Died

175 Included in intention-to-treat analyses

167 Randomized to hospital consultation
167 Received allocated intervention

26 Discontinued intervention
5 Changed insurance to managed care
15 Transitioned out of clinic (healthy)
2 Voluntarily changed clinicians
0 Aged out of pediatric CC unit (>18 y)
3 Moved out of local area
1 Died

167 Included in intention-to-treat analyses

Patient recruitment, randomization, and follow-up.
Table 1. Baseline Characteristics by Treatment Group

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%)</th>
<th>Hospital consultation (n = 167)</th>
<th>Usual hospital care (n = 175)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at enrollment, mean (SD), y</td>
<td>5.8 (4.2)</td>
<td>6.3 (4.7)</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>73 (44)</td>
<td>72 (41)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>94 (56)</td>
<td>103 (59)</td>
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<tr>
<td>Race/ethnicity</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>59 (35)</td>
<td>70 (40)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>76 (46)</td>
<td>78 (45)</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>19 (11)</td>
<td>14 (8)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13 (8)</td>
<td>13 (7)</td>
<td></td>
</tr>
<tr>
<td>No. of unique families</td>
<td>156</td>
<td>163</td>
<td></td>
</tr>
<tr>
<td>Very high baseline risk</td>
<td>76 (46)</td>
<td>86 (49)</td>
<td></td>
</tr>
<tr>
<td>Comprehensive care clinician</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>18 (11)</td>
<td>21 (12)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>38 (23)</td>
<td>42 (24)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>46 (28)</td>
<td>45 (26)</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>44 (26)</td>
<td>46 (26)</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>21 (13)</td>
<td>21 (12)</td>
<td></td>
</tr>
<tr>
<td>Insurance status</td>
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<tr>
<td>Medicaid</td>
<td>143 (86)</td>
<td>164 (94)</td>
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<tr>
<td>Commercial plans</td>
<td>24 (14)</td>
<td>11 (6)</td>
<td></td>
</tr>
<tr>
<td>Premature</td>
<td>88 (53)</td>
<td>78 (45)</td>
<td></td>
</tr>
<tr>
<td>Chronic diseases</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cardiac disorder</td>
<td>9 (5)</td>
<td>13 (7)</td>
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<tr>
<td>Congenital disorder</td>
<td>76 (46)</td>
<td>86 (49)</td>
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<tr>
<td>Ear, nose, and throat disorder</td>
<td>34 (20)</td>
<td>38 (22)</td>
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<tr>
<td>Gastrointestinal disorder</td>
<td>68 (41)</td>
<td>84 (48)</td>
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<td>Immunologic disorder</td>
<td>5 (3)</td>
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<tr>
<td>Musculoskeletal disorder</td>
<td>22 (13)</td>
<td>23 (13)</td>
<td></td>
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<tr>
<td>Neurological disorder</td>
<td>58 (35)</td>
<td>78 (45)</td>
<td></td>
</tr>
<tr>
<td>Respiratory disorder</td>
<td>131 (78)</td>
<td>127 (73)</td>
<td></td>
</tr>
<tr>
<td>No. of disorders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 or More</td>
<td>104 (62)</td>
<td>123 (70)</td>
<td></td>
</tr>
<tr>
<td>3 or More</td>
<td>73 (44)</td>
<td>87 (50)</td>
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</tr>
</tbody>
</table>

All costs were inflated to 2019 based on the Consumer Price Index for medical services.23

Statistical Analyses
We preplanned to use bayesian analyses because the probability of benefit or harm cannot be directly estimated with frequentist analyses and because P values continue to be widely misinterpreted.24,25 Although the intervention was considered likely to be beneficial, our primary analyses (of the primary outcome and all secondary outcomes) involved skeptical prior probability26 centered at a rate ratio (RR) of 1.0 (no effect) and a 95% credible interval (CrI) of 0.3 to 3.3, encompassing the largest likely effect size for major outcomes in RCTs. In addition, total hospital days and health system costs were also assessed in a secondary analyses using a prior probability based on the opinion of experts in treating CMC27,28 This secondary analyses involved an RR centered at 0.78 and 95% CrI of 0.49 to 1.25, reflecting the downweighted pooled values provided for the RR for hospital days by 7 site leaders of the Children and Youth with Special Health Care Needs National Research Network (these values were downweighted as described in the eMethods in Supplement 2 because they were based on opinion rather than objective data from prior trials).26

Intention-to-treat analyses were performed. Negative binomial multilevel models were used to assess count outcomes (hospital days, hospitalizations, length of stay, 30-day readmissions, PICU admissions, PICU days, ED visits, parental physician ratings, communications with ED physician, hospital consultations, and postdischarge follow-up), and logistic multilevel models to assess binary outcomes (children with serious illnesses and deaths).29 All models included baseline hospitalization risk (stratifying variable) as a covariate, length of follow-up as an offset variable, and a random intercept for siblings (to account for within-family clustering). Models for process measures, parental survey ratings, and length of stay also included a random effect for patient to account for repeated measures within subjects. Total hospital days and length of hospital stay were measured and analyzed in whole hours but reported in days for ease of interpretation. Bayesian estimates of cost differences were obtained by combining frequentist estimates from generalized estimating equation (GEE) models with γ distribution and log link using robust (sandwich) standard errors to account for within-family clustering. The cost models included baseline hospitalization risk (stratifying variable) as a covariate and length of follow-up as an offset variable. Owing to sparse data by primary CC clinician and minimal variation between clinicians, this stratifying variable was not included in the models.

Research Electronic Data Capture (REDCap) software was used to collect and manage the study data. All the statistical and economic analyses were performed using Stata software, version 15.1 (StataCorp) and R software, version 3.6.1 (R Foundation for Statistical Computing).

Predefined Stopping Guideline
Based on our prior hospitalization data for CMC, we planned to enroll CMC for 3 years unless interim bayesian analyses at the end of the first year identified an at least 80% (posterior) probability that HC reduced total hospital days.30 While much more stringent stopping guidelines are needed for new experimental therapies with major potential hazards, HC involved no new treatments or hazards. Had there been sufficient resources, we could have implemented HC for all CMC to increase their continuity of care as a long-accepted goal of good pediatric practice.31 To avoid unduly prolonging our trial, the stopping guideline was based on the lowest probability of a reduction in hospital days and health system costs that we thought was likely to prompt adequate third-party reimbursements and/or hospital support to sustain and expand HC for all eligible patients.
Results

Enrollment occurred from October 3, 2016, through October 2, 2017, when the first interim analysis identified a 91% probability that HC decreased hospital days. Excluding 25 ineligible children, we randomized 342 CMC, 167 to HC and 175 to UHC (Figure 1). A total of 141 child-years of HC and 150 child-years of UHC were provided. The treatment groups had similar baseline demographic and clinical characteristics (Table 1).

Process Measures

Communication between CC clinicians and ED physicians occurred infrequently but in a larger proportion of ED visits by HC than UHC patients (22% vs 13% of ED visits) (Table 2). The HC group had substantially more hospital consultations than the UHC group (3.98 vs 0.39 per admission). Clinic visits and telephone conversations between CC clinicians and parents were more common within 3, 5, and 10 days after discharge for the HC group than the UHC group.

Clinical and Cost Outcomes

Our primary outcome, total hospital days, for HC vs UHC was 2.72 vs 6.01 per child-year (bayesian RR, 0.61; 95% CI, 0.30-1.26; frequentist RR, 0.47; 95% CI, 0.19-1.15) (Table 3). In our primary analysis using a 50% skeptical prior probability (50% probability of reduced days and 50% probability of decreased days), the posterior probability the HC service reduced the total hospital days was 91%. In our secondary analysis using the more optimistic prior probability centered at RR of 0.78 based on expert opinion, the posterior probability was 96%. These probabilities are indicated by the area under the curves in Figure 2.

Except for deaths (1 in each group), the probability that HC improved other outcomes in our skeptical bayesian analyses was 78% or higher, including 98% for total hospitalizations, 83% for mean hospital stay, 89% for total PICU days, and 90% for 30-day readmissions. The mean total health system costs per child-year in the HC group were $24,928 vs $42,276 in the UHC group (bayesian cost ratio [CR], 0.67; 95% CI, 0.41-1.10; 94% probability of cost reduction in primary bayesian analyses), and 97% in secondary analyses using the prior based on expert opinion. Health system costs with HC were somewhat lower than with UHC in the clinic ($5588 vs $5994; CR, 0.93; 95% CI, 0.86-1.01; 95% probability of a reduction) and considerably lower in the hospital ($18,369 vs $33,208; CR, 0.66; 95% CI, 0.34-1.29; 89% probability of reduction).

Discussion

Our prior RCT demonstrated that outpatient CC provided in an enhanced medical home substantially reduced serious illnesses, ED visits, hospitalizations, PICU admissions, hospital days, and health system costs for CMC.14 This randomized QI trial provides evidence that the HC service provided in conjunction with CC further reduces such outcomes.

Other studies of interventions to improve the outcomes of CMC have had mixed results. The reasons are uncertain,
partly because the definition of CMC has varied, most studies have involved methodologically weak before-after designs, and very few RCTs have been performed. The CC that both groups in our trial received includes features that also appear to have contributed to improved outcomes in other studies: constant in-person or telephone access to the PCPs, same-day or next-day clinic appointments for acute illnesses, and provision of specialty care within the same clinic. Other CC features that we believe are also important to reducing costs as well as adverse patient outcomes include a low staff-to-patient ratio (<1 to 90), prospective outcome tracking, and weekly intensive scrutiny of the care given before any ED visit or hospitalization of our CMC. Our HC service was designed to further address factors that compromise care of CMC by avoiding unnecessary hospitalizations, assuring hospitalists were well informed about the problems, needs, and prior treatment of individual CMC, avoiding duplicate or other unnecessary tests, promoting evidence-based therapies, and facilitating earlier discharge and prompt follow-up assessments.

We used bayesian analyses as in an increasing number of clinical trials partly to avoid the pervasive misinterpretation of frequentist analyses. As emphasized by the American Statistical Association, a P value greater than .05 does not imply evidence in favor of the null hypothesis; many other hypotheses may be equally or more consistent with the data, and scientific conclusions should not be based on whether a P value passes a specific threshold. Similarly, arbitrary prob-

<table>
<thead>
<tr>
<th>Table 3. Clinical and Cost Outcome Measures by Treatment Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td><strong>Primary outcome</strong></td>
</tr>
<tr>
<td>Total hospital days</td>
</tr>
<tr>
<td><strong>Secondary outcomes</strong></td>
</tr>
<tr>
<td>Total hospitalizations</td>
</tr>
<tr>
<td>Initial admissions</td>
</tr>
<tr>
<td>CMHH-only admissions</td>
</tr>
<tr>
<td>Admissions with length of stay &gt;7 d</td>
</tr>
<tr>
<td>30-d Readmissions</td>
</tr>
<tr>
<td>PICU admissions</td>
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<tr>
<td>PICU days</td>
</tr>
<tr>
<td>Total ED visits</td>
</tr>
<tr>
<td>ED visits within 30 d of hospital discharge</td>
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<tr>
<td>CMHH-only ED visits</td>
</tr>
<tr>
<td>Deaths</td>
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<tr>
<td>Children with serious illnesses (death, length of stay &gt;7 d, or PICU admission)</td>
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<tr>
<td>Length of hospital stay, mean (SD)</td>
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<tr>
<td>Overall parental rating of 9 or 10 (highest values) for all inpatient clinicians (CAHPS Hospital Survey), No. of children/admissions (%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Health system costs</strong></th>
<th><strong>Mean costs/child-year (95% CI)</strong></th>
<th><strong>Bayesian cost ratio (95% CrI)</strong></th>
<th><strong>Probability of cost reduction, %</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinic</td>
<td>5588 (5300-5875)</td>
<td>5994 (5591-6396)</td>
<td>0.93 (0.86-1.01)</td>
</tr>
<tr>
<td>Hospital</td>
<td>18 369 (9416-27 323)</td>
<td>33 208 (15 410-51 005)</td>
<td>0.66 (0.34-1.29)</td>
</tr>
<tr>
<td>Total</td>
<td>24 928 (18 428-31 428)</td>
<td>42 276 (27 436-57 117)</td>
<td>0.67 (0.41-1.10)</td>
</tr>
</tbody>
</table>

Abbreviations: CAHPS, Consumer Assessment of Healthcare Providers and Systems; CMHH, Children’s Memorial Hermann Hospital; CrI, credible interval; ED, emergency department; PICU, pediatric intensive care unit.

* There were 141 child-years in hospital consultation group.
+ There were 150 child-years in the usual hospital care group.
† Included baseline hospitalization risk (stratifying variable) as a covariate, length of follow-up as an offset variable, and a random intercept for siblings (to account for within-family clustering).
‡ Posterior probability of rate ratio less than 1 rounded to nearest percentage and obtained from bayesian model with a skeptical prior centered at rate ratio of 1 with 95% prior interval of 0.3 to 3.3.
§ Dependent variable was measured and analyzed in in whole hours but reported in days for ease of interpretation.

Data for surveys available for 63 patients with 114 admissions in usual hospital care group and 46 patients with 77 admissions in the hospital consultation group.

All the estimated costs were inflated to 2019 US dollars.

Bayesian estimates of differences in costs were obtained by combining frequentist estimates from a generalized estimating equation models with y distribution and log link using robust (sandwich) standard errors to account for within-family clustering. The cost models included baseline hospitalization risk (stratifying variable) as a covariate and length of follow up as an offset variable.
ability thresholds must also be avoided when conducting bayesian analyses. Regardless of how the analyses are performed, the treatment recommendations should ultimately depend on the consequences of falsely concluding benefit for truly ineffective or harmful interventions and the consequences of falsely concluding no benefit for truly beneficial interventions.24,25

Bayesian analyses provide a formal method to estimate the (posterior) probability of a treatment benefit or harm after a trial is completed considering the (prior) probability estimated before the trial was performed. A range of prior plots may be used that reflect the preexisting uncertainty about the treatment effect. Our primary analyses involved a skeptical prior probability assuming that HC would likely have no effect (RR, 1.0; 95% CrI, 0.3-3.3), despite the increased continuity of care from PCPs highly experienced in the care of CMC. As a result, the effect of HC on our primary outcome, total hospital days, was estimated more conservatively in our primary bayesian analyses (RR, 0.61; 95% CrI, 0.30-1.26) than in conventional frequentist analyses (RR, 0.47; 95% CI, 0.19-1.15). These bayesian analyses also identified a 91% probability that HC reduced total hospital days (primary outcome). A 96% probability was identified in our secondary analyses using a more optimistic prior probability, reflecting the opinion of 7 experts in the care of CMC. The substantial reduction in total hospitalizations with HC was not expected or fully explained by our process measures. However, the time and attention of CC clinicians devoted to HC may well have prompted greater parental focus on avoiding unnecessary admissions for the HC group and awareness of the benefits of seeking pediatric care from the PCPs in our clinic rather than ED physicians unfamiliar with their child and inclined to admit any acutely ill CMC. Beyond the effects of HC on hospitalizations, our analyses using a skeptical bayesian prior identified an 81% to 94% probability that HC reduced length of stay, total PICU days, readmissions, serious illnesses, and health system costs.

Limitations

The most important limitation of this trial is the uncertain generalizability of our findings. Our trial involved a single center, a limited number of clinicians, and methods of patient care and a patient population that may differ substantially from those in other locales. The absolute risk and cost reductions with HC can be expected to be less for populations at lower risk than the CMC we assessed.20

Conclusions

Compared with UHC, an HC service from the outpatient CC clinicians was likely to reduce admissions, readmissions, total hospital days, PICU days, and health system costs for CMC. Our findings should encourage trials of hospital consultation from PCPs providing CC to CMC in other centers.
compensation was received by any of these individuals. We also thank Deborah Garcia, Manager of the Master of Science Program in Clinical Research. Center for Clinical Research and Evidence-Based Medicine. University of Texas Health Science Center at Houston, for her assistance with the online tool used for eliciting the expert opinion. We appreciate the contribution of the hospitalists and other faculty and staff of McGovern Medical School and the support of our partner in this project, Children’s Memorial Hermann Hospital. We thank the parents and children who participated in the study.

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