Development of a Caregiver-Reported Experience Measure for Pediatric Hospital-to-Home Transitions

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Objective. To develop and test a caregiver-reported experience measure for pediatric hospital-to-home transitions.

Data Sources/Study Setting. Primary data were collected between 07/2014 and 05/2015 from caregivers within 2–8 weeks of their child's discharge from a tertiary care children's hospital.

Study Design/Data Collection. We used a step-wise approach to developing the measure that included drafting de novo survey items based on caregiver interviews ($n = 18$), pretesting items using cognitive interviews ($n = 18$), and pilot testing revised items among an independent sample of caregivers ($n = 500$). Item reduction statistics and confirmatory factor analysis (CFA) were performed on a test sample of the pilot data to refine the measure, followed by CFA on the validation sample to test the final measure model fit.

Principal Findings. Of 46 initial survey items, 19 were removed after pretesting and 19 were removed after conducting item statistics and CFA. This resulted in an eight-item measure with two domains: transition preparation (four items) and transition support (four items). Survey items assess the quality of discharge instructions, access to needed support and resources, care coordination, and follow-up care. Practical fit indices demonstrated an acceptable model fit: $\chi^2 = 28.3$ ($df = 19$); root-mean-square error of approximation = 0.04; comparative fit index = 0.99; and Tucker–Lewis index = 0.98.

Conclusions. An eight-item caregiver-reported experience measure to evaluate hospital-to-home transition outcomes in pediatric populations demonstrated acceptable content validity and psychometric properties.

Key Words. Quality of care/patient safety (measurement), patient outcomes/functional status/ADLs/IADLs, hospitals, inpatients, pediatrics

Approximately one in five adult patients experience an adverse event after discharge from the hospital (Forster et al. 2003). Similarly, one in five pediatric patients experience a postdischarge problem and one-third of these require further intervention by a provider (Heath, Dancel, and Stephens 2015). Familial caregivers of both adult and pediatric patients report that problems during hospital-to-home transitions may be the result of suboptimal preparation for home care management, receiving inadequate discharge instructions, lack of support systems, or barriers to accessing postdischarge services (Foust, Vuckovic, and Henriquez 2012; Solan et al. 2015; Desai et al. 2016b). Although there has been a recent emphasis on improving the quality of hospital-to-home transitions (Snow et al. 2009; Berry et al. 2014; Auger et al. 2015), we have a limited understanding of interventions that are effective for improving patient health outcomes and reducing health care utilization for pediatric patients experiencing these transitions (Desai et al. 2015).

A primary barrier to understanding the effectiveness of hospital-to-home transition interventions is the limited number of standardized outcome measures to assess transition quality in pediatric populations. For example, readmissions and emergency department return visits are often used as standardized, quality metrics for hospital-to-home transitions (Hansen et al. 2011; Auger et al. 2013). However, our ability to detect variation in care across hospitals or in response to interventions is limited by low readmission rates for pediatric patients (Bardach et al. 2013). Furthermore, these metrics may not be reflective of the provision or absence of modifiable health services (Benbasat and Taragin 2000; Hain et al. 2013).

In contrast, patient-reported outcomes provide us with information regarding their own perceptions of care as primary stakeholders in the hospital-to-home transition process. Therefore, these outcomes may serve as valuable metrics for monitoring and improving systems of care (Browne et al. 2010; Ahmed et al. 2012). A few patient-reported outcomes have been developed to evaluate hospital-to-home transitions in adult and elderly patients (Coleman, Mahoney, and Parry 2005; Graumlich, Novotny, and Aldag

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2008). Notably, the Care Transitions Measure (CTM) was developed based on findings from qualitative interviews with elderly patients and their caregivers and provides an assessment of constructs relating to information transfer, patient/caregiver preparation, self-management support, and patient empowerment (Coleman et al. 2002). The CTM was pilot tested to refine the measure, underwent robust psychometric testing, and additional testing was conducted to develop a shorter version.

In pediatrics, caregiver-reported outcomes are mainly used to assess experience and quality as a proxy for the patient or family's experience. Existing caregiver-reported outcomes related to pediatric hospital-to-home transition quality primarily assess specific aspects of transition experience such as the discharge process, discharge readiness, and postdischarge coping difficulty, rather than the entire transition experience from discharge to follow-up (Weiss and Piacentine 2006; Weiss et al. 2008, 2017; Auger et al. 2015; Toomey et al. 2015; Desai et al. 2016a). Berry et al. (2013) developed a more global set of items to measure these transitions by adapting items from the CTM through the use of cognitive interviews with parents of hospitalized children. However, psychometric testing was not performed on these survey items to understand which items best capture the transition experience while minimizing redundancy between items. This is important as health systems and health service researchers are increasingly seeking brief patient- or caregiver-reported outcomes to minimize time and logistical constraints related to administration and to minimize response burden (Garcia et al. 2007; Lavalley et al. 2016).

Therefore, to address some of the limitations of existing measures, the objective of this study was to use a combination of in-depth interviews, cognitive interviews, and psychometric testing to develop a caregiver-reported experience measure for pediatric hospital-to-home transitions that (1) provides a global assessment of the full transition experience from discharge through follow-up while minimizing respondent burden; (2) includes constructs that encompass the transition needs of caregivers (i.e., parents or legal guardians) of pediatric patients; and (3) can be applied to a medically diverse population of hospitalized children.

METHODS

Development of Survey Items

We drafted a set of 46 de novo survey items based on qualitative findings from a prior study (Desai et al. 2016b). The qualitative study identified important

needs and preferences for transitions using data from interviews with 18 English-speaking caregivers of children and youth recently hospitalized at a tertiary care children's hospital. Thematic analysis of the qualitative data led to a multidimensional theoretical framework consisting of three domains, in which caregiver self-efficacy for home care management emerged as the central domain in the framework. Caregivers identified several needs to promote their sense of self-efficacy in two other domains: (1) having comprehensive knowledge of the care plan and (2) having adequate support and resources during the transition. The first author (A.D.) drafted survey items pertaining to specific caregiver needs and preferences within these domains using accepted guidelines for survey development (Sudman and Bradburn 1982) and formatted items according to accepted criteria aimed at reducing nonresponse and measurement error (Dillman 2000).

Cognitive Interviews

We pretested these 46 survey items with 18 different English-speaking caregivers of children and youth who were recently discharged from either the medical or surgical unit at a tertiary care children's hospital from July 2014 to September 2014. The majority were mothers (79 percent), college-educated (61 percent), and under the age of 35 (67 percent). Cognitive interviews were conducted by two research team members (A.D. and E.J.) using a standard interview guide consisting of a combination of "think-aloud" and verbal-probing techniques to assess content validity, item comprehension, information retrieval, decision processes and response processes, and general survey structure (Collins 2003; Willis 2004). Interviews were conducted within 2–8 weeks of the patient's discharge from the hospital. Fourteen of 18 interviews were conducted in person, and the remaining were conducted by telephone to minimize participation bias from caregivers experiencing time and logistical barriers due to their child's level of medical complexity. Multiple rounds of cognitive interviews were conducted with 3–4 participants in each round until we captured the majority of problem items and respondents noted minimal issues with the survey structure. Between each round, research team members (A.D. and E.J.) independently reviewed audio-recordings of each interview and documented problem items. Survey items were subsequently deleted or revised using a negotiated process involving both investigators. General structural changes to the survey were also made prior to testing the revised survey items in the next round of interviews. Participants received a \$100 gift card for completing the interviews.

Expert Provider Review

Coinciding with cognitive testing with caregivers, we also invited four health care providers to review each of the 46 original survey items. Participating providers had extensive experience in research related to pediatric hospital-to-home transitions and included two pediatric hospitalists, one general pediatrician, and one adolescent medicine physician. Providers were encouraged to comment on the face validity, significance, and understandability of survey items. They were also asked to provide an overall score for each item on a scale of 0–5 (0 = poor item; 5 = excellent item) based on these three criteria. Provider comments were used to help refine survey items during the cognitive interviewing process. Using two-sample *t*-tests, we also compared the average provider rating of items that were retained versus removed after the cognitive interviewing process to corroborate findings from caregivers and providers.

Pilot Testing of Survey Items

We pilot tested the revised survey items that remained after cognitive interviews and expert provider review with a sample of English-speaking caregivers of children and youth who were discharged from either the medical or surgical unit at a tertiary care children's hospital from December 2014 to May 2015 ($N = 500$). Pilot testing also included five corresponding screener items. Recruitment and survey data collection were facilitated by the hospital's Outcomes Assessment Program (OAP). Established in January 2010, the OAP is an internally funded program that routinely collects patient and caregiver-reported outcomes data to facilitate quality improvement evaluation work. Surveys containing the revised items were completed within 2–8 weeks after discharge from consenting families. Per OAP protocol, caregivers were eligible to complete the survey unless the patient was younger than 1 month, was in protective isolation (i.e., immunosuppressed), was admitted for a 24-hour video electroencephalogram or a pH probe study, was admitted for suspicion of child abuse, or the caregiver was approached to participate in the OAP program within the past 2 months. Surveys were completed either by telephone interview or online based on caregiver preference. Caregivers who did not respond to the online survey after three attempts were contacted by telephone to complete the survey. Caregivers who did not complete the survey within 8 weeks of the patient's discharge date by either mode were deemed a final incomplete. Data collection was terminated after we obtained 500 completed surveys, as this was determined to be a sufficient sample size to analyze the

factor structure of the survey items (subject-to-variable ratio of 18:1) (Henson and Roberts 2006; Schreiber et al. 2006).

All study procedures were reviewed and approved by the Seattle Children's Hospital Institutional Review Board.

Statistical Analysis

We examined the psychometric properties of the survey items that were pilot tested using a series of steps involving item reduction statistics, confirmatory factor analysis (CFA), reliability testing, and invariance testing. Item reduction statistics and CFA were used to inform decisions regarding which additional items to remove from the measure, whereas reliability and invariance testing were conducted on the final measure. Assessments of conceptual strength of the item or conceptual overlap with other items were also used to inform decisions regarding item removal.

We first used item reduction statistics including examining the percent missing data for each item and any floor or ceiling effects (defined as >70 percent of respondents chose the lowest or highest response option). We also examined item-to-total correlations to identify items that were negatively correlated with the remaining items, suggesting these items may not be relevant to the final measure. We then constructed a correlation matrix to identify items that were highly correlated with each other (item-to-item correlation >0.8), suggesting redundancy among items. Based on these item reduction statistics, we created a list of problematic items that were considered for removal in conjunction with findings from the CFA.

Second, we used split-half methods to randomly divide our pilot test sample into test and validation samples. We first conducted CFA on the test sample to examine the dimensionality of the measure and make item reductions before we tested the fit of the final model using the validation sample. CFA was chosen as the preferred method for factor analysis given the establishment of an a priori theoretical framework from our qualitative work (Henson and Roberts 2006). This theoretical framework suggested that transition quality was comprised of two latent variables: "transition knowledge," meaning the caregiver felt knowledgeable about the child's plan of care; and "transition support," meaning the caregiver felt adequately supported during the transition. Therefore, we mapped each survey item to one of these latent variables (i.e., domains). We then conducted a single-factor CFA for each latent variable using a full information maximum likelihood (FIML) approach to account for missing data from items that were dependent on screener items.

We used modification indices using a threshold of >10 and expected parameter change values using a threshold of >0.2 to identify redundant items that would improve the model fit if the item was removed from the measure. Model fit was examined using the following statistical tests: chi-squared (χ^2), root-mean-square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker–Lewis index (TLI). During the single-factor CFA, we sequentially removed items if they were noted to be problematic based on item reduction statistics and if modification indices and expected parameter change values suggested the item was redundant with other items in the measure. This process was repeated for each domain until we attained acceptable model fits statistics, ensuring that the retained items conceptually fully captured the transition experience for each domain (Iterations 1 and 2 in Table 3).

Third, we conducted a two-factor CFA to test the dimensionality of the measure using the reduced set of items within the “transition knowledge” and “transition support” domains. Items were moved to the other domain or removed altogether based on the same criteria as noted for the single-factor CFA. Similar to the single-factor CFA, the process was terminated once we attained acceptable model fit statistics, and the retained items conceptually captured the full transition experience with minimal overlap between items (Iteration 3 in Table 3). Using the validation sample, we examined fit statistics of the final model (Iteration 4 in Table 3).

Fourth, we examined the internal consistency reliability of each domain subscale and the full measure using McDonald’s coefficient omega statistics with a 95 percent bias-corrected bootstrap confidence interval (McDonald 1999; Raykov and Shrout 2002; Dunn, Baguley, and Brunsden 2014).

Lastly, using a standard approach for invariance testing, we aimed to verify that survey items and the domain structure were similarly interpreted by caregivers of children with varying levels of medical complexity. Medical complexity subgroups were determined using the Pediatric Medical Complexity Algorithm (Simon et al. 2014). The algorithm classifies patients as having either no chronic condition (e.g., a patient with a febrile seizure), noncomplex chronic conditions (e.g., a patient with a single chronic condition such as epilepsy), or complex chronic conditions (e.g., a patient with multiple chronic conditions such as epilepsy, chronic respiratory failure and developmental delay) on the basis of up to 3 years of retrospective International Classification of Disease Ninth Revision Clinical Modification codes beginning with the date of admission. We first tested measurement invariance followed by structural invariance using the following steps: (1) configural invariance or whether the pattern of fixed and freely estimated parameters (factor structure)

was consistent across groups, (2) loading invariance across groups (i.e., whether it was tenable to set the loadings of the measured variables equal to each other, as loadings and their relative sizes should be similar across groups), and (3) intercept (e.g., mean) invariance across groups (i.e., whether it was tenable to set mean values of measured variables equal to each other). We then assessed structural invariance as follows: (4) a test of homogeneity of variances and covariances of the latent variables (i.e., whether they were similar across groups), and, if so, (5) a test of latent mean invariance (i.e., whether the means of the latent variables were similar across groups) (Brown 2014; Kline 2015). We set the scale by setting the latent factor variance equal to 1.0.

RESULTS

Cognitive Interviews and Expert Provider Review

As a result of the cognitive interviews and expert provider review process, we retained and/or revised 21 of the original 46 survey items, and six new items were added to the survey. Examples of survey items that were revised based on the problem areas are presented in Table S1 (available online). The average expert ratings of the original 46 survey items were 4.5 (SD 0.2) for items that were retained ($N = 21$) compared to 3.6 (SD 0.8) for items that were removed ($N = 25$); $p < .001$.

Pilot Testing

Five hundred caregivers completed a survey containing the 27 revised items. Patient, caregiver, and hospital encounter characteristics for the pilot test sample are presented in Table 1. The majority of respondents were college-educated, parents of white children who were hospitalized on the medical unit for <3 days. The sample yielded a relatively even distribution of patients within each medical complexity group.

Item Reduction Statistics

Based on the analysis of item reduction statistics, we identified 13 problematic items that were considered for removal from the instrument based on the percent of missing data (one item), ceiling effects (three items), negative item-to-total correlations (two items), and high item-to-item correlations (eight items),

Table 1: Patient, Caregiver, and Hospital Encounter Characteristics of Pilot Test Sample

	No. (%) [†]
Patient age, year	
0 to <2	116 (23)
2–4	96 (19)
5–12	172 (34)
13–18	116 (23)
Patient female sex	231 (46)
Patient race/ethnicity	
White	328 (66)
Black	14 (3)
Hispanic	53 (11)
Asian	29 (6)
Other/mixed	76 (15)
Patient PMCA category	
No chronic conditions	165 (33)
Noncomplex chronic conditions	149 (30)
Medical complexity	186 (37)
Caregiver education	
≤High school graduate	91 (18)
Some college	72 (14)
College graduate	237 (48)
Caregiver age, year	
18–34	173 (35)
35–44	210 (42)
≥45	113 (23)
Hospital unit	
Medical	314 (63)
Surgical	186 (37)
Length of stay, day	
<3	360 (72)
≥3	140 (28)

[†]Sum may not equal 100% due to rounding.
PMCA, Pediatric Medical Complexity Algorithm (Simon et al. 2014).

which are detailed in Table 2. No items demonstrated floor effects, and one item was noted to be problematic based on multiple item reduction statistics.

Confirmatory Factor Analysis

Modification indices and expected parameter change values for redundant items are presented in Table 2. Model fit statistics of each iteration of the single- and two-factor CFA are described in Table 3. Model fits statistics for the

Table 2: Survey Item Mean Score and Reasons for Exclusion from Final Measure

<i>Survey Items</i>	<i>No. of Respondents[†]</i>	<i>Mean Score (SD)[‡]</i>	<i>Reasons for Exclusion^{§¶}</i>
Transition Knowledge domain			
1. I had a clear understanding of all the discharge instructions I received before we left the hospital	500	9.15 (1.60)	<i>Retained</i>
2. All of my questions about managing my child's care at home were answered before we left the hospital	499	9.16 (1.70)	Overlap with Item 1 (r = 0.80, MI = 86.74, EPC = 0.50)
3. I felt ready to leave the hospital when we did	499	9.16 (1.76)	Overlap with Item 4 (r = 0.83, MI = 25.37, EPC = 0.38)
4. I felt confident about how to care for my child at home	497	9.17 (1.69)	<i>Retained</i>
5. I felt comfortable managing my child's care at home	499	9.20 (1.66)	Overlap with Item 4 (r = 0.95, MI = 212.56, EPC = 0.50)
6. The written discharge instructions I was given were helpful for taking care of my child at home	497	8.87 (2.05)	<i>Retained</i>
7. The written discharge instructions I was given were specific to my child's condition	495	9.01 (1.89)	Overlap with Item 6 (r = 0.83, MI = 108.24, EPC = 1.40)
8. I knew what to do if my child had any problems after we left the hospital	497	9.22 (1.68)	Overlap with Item 4 (r = 0.81, MI = 16.36, EPC = -0.27)
9. I had a good understanding of when and how to give my child's medications after we left the hospital (e.g., timing, preparation, dose)	364	9.51 (1.38)	Ceiling effect; overlap with Item 1 (r = 0.57, MI = 37.77, EPC 0.43)
10. I had clear instructions of how to use my child's medical equipment after we left the hospital	74	9.08 (1.86)	Overlap with Item 11 (r = 0.80, MI = 28.66, EPC 1.75)
11. I had enough practice using my child's medical equipment before we left the hospital	74	9.00 (1.80)	Overlap with Item 9 (r = 0.56, MI = 37.65, EPC = 1.49)
Transition Support domain			
12. I was able to easily contact my child's hospital doctors (e.g., specialists) if I had questions after we left the hospital	474	8.62 (2.28)	<i>Retained</i>

Continued

Table 2. *Continued*

<i>Survey Items</i>	<i>No. of Respondents[†]</i>	<i>Mean Score (SD)[‡]</i>	<i>Reasons for Exclusion^{§¶}</i>
13. I was able to easily contact my child's regular doctor (e.g., pediatrician) if I had questions after we left the hospital	488	9.04 (1.95)	Conceptually weak; overlap with Item 16 ($r = 0.58$, $MI = 26.37$, $EPC\ 1.25$)
14. My child's regular doctor was aware of what happened to my child in the hospital	266	9.01 (1.92)	Conceptual overlap with Item 24
15. I felt like my child's regular doctor was keeping track of my child's condition after we left the hospital	468	8.13 (2.73)	>5% missing data; negatively correlated with other items; overlap with Item 16 ($r = 0.72$, $MI\ 47.56$, $EPC\ 2.98$)
16. My child's regular doctor knew how to manage my child's medical care after we left the hospital	264	8.77 (2.04)	<i>Retained</i>
17. I felt that taking care of my child at home was stressful after we left the hospital	499	6.64 (3.35)	Weak factor loading on either domain (<0.4)
18. I had enough emotional support to care for my child at home after we left the hospital	496	8.91 (1.97)	Overlap with Item 20 ($r = 0.66$, $MI = 40.95$, $EPC = 1.24$)
19. I had enough social support to care for my child at home after we left the hospital	496	8.91 (1.94)	Overlap with Item 18 ($r = 0.90$, $MI = 192.12$, $EPC = 1.40$)
20. I felt I had everything I needed to take care of my child at home after we left the hospital	498	9.03 (1.86)	<i>Retained</i> (Conceptually more similar to other domain)
21. I felt like our family had everything we needed to easily get back to our normal routine after we left the hospital	499	8.76 (2.05)	Overlap with Item 20 ($r = 0.81$, $MI = 85.5$, $EPC = 1.02$)
22. It was easy to schedule follow-up appointments for my child	343	9.10 (1.84)	Overlap with Item 23 ($r = 0.58$, $MI = 34.10$, $EPC = 1.43$)
23. My preferences (dates/times, location, doctors) were considered when scheduling follow-up appointments for my child	344	8.67 (2.36)	<i>Retained</i>
24. The follow-up doctors knew what happened to my child in the hospital	309	9.25 (1.65)	<i>Retained</i>

Continued

Table 2. Continued

Survey Items	No. of Respondents [†]	Mean Score (SD) [‡]	Reasons for Exclusion ^{§¶}
25. The follow-up appointment at my child's regular doctor's office was useful for caring for my child at home	261	8.36 (2.35)	Conceptually weak; Negatively correlated with other items; overlap with item 16 ($r = 0.59$, $MI = 28.47$, $EPC = 1.76$)
26. It was easy to get all my child's home medications from the pharmacy	367	9.19 (1.84)	Ceiling effect; weak factor loading on either domain (<0.5)
27. I had the right medication(s) to manage my child's pain after we left the hospital	176	9.32 (1.83)	Ceiling effect; conceptual overlap with Item 20

[†]The number of respondents may be lower for some survey items due to ineligibility based on screener items.

[‡]Scores were obtained using a 0–10 Likert scale, where higher scores reflected a higher level of agreement with the statement.

[§]Modification indices (MI) values represent the expected change in chi-squared statistic if the item was removed from the domain.

[¶]Expected parameter change (EPC) values represent how much the parameter changes if freed in the model.

EPC, expected parameter change; MI, modification indices; r , correlation coefficient between items.

test sample were $\chi^2 = 29.67$ (df 19), RMSEA = 0.05 (90 percent CI: 0.00, 0.08), CFI = 0.99, and TLI 0.98. Similar results were obtained for the validation sample ($\chi^2 = 28.27$ [df 19], RMSEA = 0.04 [90 percent CI: 0.00, 0.08], CFI = 0.99, and TLI 0.98). Based on the content of items that were retained in the final measure, the latent variable “transition knowledge” was changed to “transition preparation” as the items reflected whether caregivers were adequately prepared to manage the child's care at home, as opposed to simply being knowledgeable about the care plan. The final path diagram with standardized factor loadings for each retained item is presented in Figure 1. All factor loadings had a significant p -value of $<.001$.

Internal Consistency Reliability

McDonald's coefficient omega to examine internal consistency reliability was 0.87 (95 percent CI 0.81–0.90) for the “transition preparation” subscale, 0.67 (95 percent CI 0.56–0.74) for the “transition support” subscale, and 0.84 (95 percent CI 0.79–0.88) for the overall measure.

Table 3: Model Fit Statistics for Each Step of the Confirmatory Factor Analysis

<i>Iteration</i>	<i>Model Description</i>	<i>Chi-squared</i> [†]	<i>df</i>	<i>RMSEA</i> [‡]	<i>RMSEA 90% CI</i>	<i>CFI</i> [§]	<i>TLI</i> [§]
1	Single-factor CFA—transition knowledge domain (11 items)	671.66	44	0.24	0.22, 0.26	0.76	0.71
1.1	Removed six items (items 2, 5, 7, 9, 10, 11)	44.07	5	0.18	0.13, 0.23	0.96	0.92
1.2	Removed one item (item 3)	2.91	2	0.04	0.00, 0.14	1.00	1.00
2	Single-factor CFA—transition support domain (15 items)	685.35	90	0.16	0.15, 0.17	0.65	0.59
2.1	Removed five items (items 13, 15, 19, 21, 22)	112.63	35	0.09	0.75, 0.11	0.85	0.80
2.2	Removed two items (items 18, 25)	34.50	20	0.05	0.02, 0.08	0.95	0.93
3	Two-factor CFA—transition knowledge and transition support domains (12 items)	116.45	53	0.07	0.05, 0.09	0.95	0.94
3.1	Removed three items (item 8, 17, 26)	60.32	26	0.07	0.05, 0.10	0.96	0.94
3.2	Removed one item (item 27)	34.73	19	0.06	0.03, 0.09	0.98	0.97
3.3	Moved one item to other domain (item 20)— <i>revised domain label from “Transition Knowledge” to “Transition Preparation” after this iteration</i>	29.67	19	0.05	0.00, 0.08	0.99	0.98
4	Validation sample: two-factor CFA—transition preparation and transition support domains (8 items)	28.27	19	0.04	0.00, 0.08	0.99	0.98

[†]Lower chi-square values indicate a better model fit.
[‡]Lower RMSEA values indicate a better model fit as follows: >0.10 indicates a poor fit, 0.08–0.10 indicates a mediocre fit, 0.05–0.08 indicates an acceptable fit, 0.01–0.05 indicates a close fit, and 0.00 indicates an exact fit.
[§]Higher CFI and TLI values (scale 0–1) indicate a better model fit.
CFA, confirmatory factor analysis; CFI, comparative fit index; CI, confidence interval; *df*, degrees of freedom; RMSEA, root-mean-square error of approximation; TLI, Tucker–Lewis index.

Invariance Testing

To assess whether the latent variables of interest (“transition preparation” and “transition support”) were comparable across medical complexity groups, we assessed invariance of loadings and intercepts of measured indicators across groups (Table 4). Using a CFA with a three-group mean and covariances structures model, we observed evidence of acceptable fit in the initial, freely estimated model ($\chi^2 = 90.32$ [*df*57], RMSEA = 0.06, CFI = 0.952, TLI = 0.93).

Figure 1: Confirmatory Factor Analysis Path Diagram with Standardized Factor Loadings

Notes. Path diagram describes the results of the confirmatory factor analysis showing standardized factor loadings between the two measure domains (Transition Preparation and Transition Support), and each of the retained survey items within that domain. The asterisk symbol represents factor loading values that were significant ($p < .001$). The dagger symbol represents the correlation between the transition preparation and transition support domains.

We then evaluated invariance of the loadings of the measured indicators and found no evidence for differences across groups, as the RMSEA value of the second, nested model falls within the 90 percent confidence interval of the first, comparison model (Little 1997). Invariance testing of the intercepts, by the same criteria, also revealed no evidence of variance across groups.

We then assessed whether the variances and covariances of the latent constructs were comparable across the three medical complexity groups, and we observed no significant differences across groups ($\Delta\chi^2 = 3.02$ [df 6], $p > .05$) as shown in Table 4. We also tested invariance of latent means across the same groups, and the results indicated no mean differences between groups ($\Delta\chi^2 = 8.39$ [df 4], $p > .05$).

DISCUSSION

Through a standard, step-wise approach to measure development, we developed a brief, eight-item caregiver-reported experience measure for pediatric

Table 4: Fit Indices for the Nested Sequence in the Multiple Group Confirmatory Factor Analysis

Model	χ^2	df	p-Value	$\Delta\chi^2_{SB}$	Δdf	p-Value	RMSEA	RMSEA 90% CI	CFI	TLI	Constraint Tenable
Measurement invariance											
Configural invariance	90.32	57	<.01	—	—	—	0.06	0.04, 0.08	0.95	0.93	—
Loading invariance [†]	95.66	69	<.05	—	—	—	0.05	0.02, 0.07	0.96	0.95	Yes
Intercept invariance [†]	123.87	81	<.01	—	—	—	0.06	0.04, 0.08	0.94	0.94	Yes
Population heterogeneity											
Homogeneity of var/covar [‡]	120.85	87	<.01	3.02	6	>.05	—	—	—	—	Yes
Latent mean invariance [‡]	132.26	85	<.001	8.39	4	>.05	—	—	—	—	Yes

Notes: Each nested model contains its constraints, plus the constraints of all previous, tenable models.

[†]Evaluated using the RMSEA model test.

[‡]Evaluated using the Satorra–Bentler chi-squared difference test.

hospital-to-home transitions that is grounded in the needs and preferences of families, and assesses the quality of the transition experience from discharge through follow-up. The final domains of the measure reflect findings from key informant interviews published in an earlier study that identify the importance of adequate preparation and adequate support for achieving seamless hospital-to-home transitions (Desai et al. 2016b). Pilot testing survey items with caregivers using cognitive interviews strengthened the content validity of the measure (Patrick et al. 2011), which was also supported by differential ratings by our expert providers in regards to items that were retained versus removed. The final measure demonstrated an excellent model fit with RMSEA values of ≤ 0.05 and CFI/TLI values > 0.95 in both the test and validation samples, suggesting the measure contains acceptable psychometric properties (Schreiber et al. 2006). Furthermore, invariance testing of the final measure demonstrated that items were interpreted similarly among caregivers of children with varying levels of medical complexity; therefore, the measure is broadly applicable across children with no chronic conditions to children with medical complexity.

The final measure we developed assesses the quality of hospital-to-home transitions in several areas noted to be important for achieving successful transitions (Coleman et al. 2002; Berry et al. 2014; Auger et al. 2015; Solan et al. 2015; Desai et al. 2016b; Pollack et al. 2016; National Transitions of Care Coalition 2017). The first domain “transition preparation” measures important constructs such as knowledge, self-efficacy, and resources, whereas the “transition support” domain measures perceptions of access to providers, care coordination, and information exchange between providers. These constructs are similar to those measured by the CTM used in adult and elderly populations and the pediatric-adapted version of the CTM, which include assessments of the quality of caregiver preparation, care management support, information transfer, and caregiver empowerment to assert preferences (Coleman, Mahoney, and Parry 2005; Berry et al. 2013). In fact, many of the survey items in the pediatric-adapted version of the CTM resemble some of the original 46 items we drafted to develop this measure. These original items also include constructs that are similar to those measured by the 18-item Quality of Discharge Teaching Scale (QDTS), the 29-item Readiness for Hospital Discharge Scale (RHDS), and the 11-item Post-discharge Coping Difficulty Scale developed by Weiss et al. (2017). However, after conducting item reductions statistics and confirmatory factor analysis, our findings indicated that several of these items are redundant and these constructs may be captured by a more limited set of items. By using the analytic approach in this study, we were able

to identify the most parsimonious model to capture all of these constructs in a short eight-item outcome measure, which is beneficial given the time, costs, and logistical barriers to administering patient- and/or caregiver-reported outcomes (Garcia et al. 2007; Lavalley et al. 2016).

The invariance testing demonstrated that these constructs and domains are interpreted equivalently across caregivers of medically diverse patients, which also helps to minimize the burden of administering these types of caregiver-reported outcomes. For examples, hospitals could adopt a single measure to assess transition quality rather than administering different measures based on the patient's disease or level of medical complexity. By conducting invariance testing, we are more assured that differences in scores on this measure would be due to true differences in quality rather than differences in the interpretation of survey items.

In contrast to pediatric quality measures that assess process metrics related to discharge (Toomey et al. 2015; Desai et al. 2016a; Parast et al. 2017), or perceptions of readiness for discharge (Weiss et al. 2008), this measure is intended to be a global measure of the entire transition process including an assessment of the quality of outpatient support and resources following hospitalization. By assessing these constructs after hospital discharge, we may obtain a more accurate measure of actual quality during the transition versus perceived quality prior to discharge. Our measure also builds upon the aforementioned existing measures. For instance, our "transition support" domain includes items that expound on the construct of family social and emotional support after hospitalization assessed by the Post-discharge Coping Scale developed by Weiss et al. (2017) by including constructs related to receiving adequate support from providers after hospitalization. These constructs have not been integrated into other transition-related patient- or caregiver-reported outcomes. These items include being able to easily contact hospital providers with questions (item 12), ensuring follow-up providers are knowledgeable about the hospital course (item 24), and ensuring follow-up providers are capable of managing the child's follow-up care (item 16). Therefore, administration of the measure should ideally occur after postdischarge follow-up appointments have occurred.

While practical fit indices such as RMSEA, CFI, and TLI for the final model were within optimal range (Schreiber et al. 2006), the internal consistency reliability of the "transition support" domain was less optimal. This may have been due to lower item-level reliability of items 16, 23, and 24, which may be a result of vagueness of specific words within the survey item (e.g., "follow-up doctors" or "follow-up appointments" without specifying a

particular provider or appointment) or ambiguous phrasing (e.g., “what happened” instead of specifying that the provider was aware of the child’s hospital course). Improving the clarity of these items through further cognitive testing may improve item-level reliability. Additionally, based on their factor loadings, 14–34 percent of the variance in these items were accounted for by the “transition support” domain, which suggests these items measure other latent variables that were not included in the model. The multidimensionality of these items may have also contributed to lower scale reliability; however, exclusion of any of these items would conceptually weaken the measure by excluding important constructs that were not adequately captured by other items in the measure.

We note several limitations of this study. First, data for the qualitative study, cognitive interviews, and pilot test were collected from a study population at a single tertiary care center, which is a limitation of this study. Second, survey items were also developed and refined based on testing in an English-speaking population; therefore, item constructs, survey item responses, and psychometric findings may differ if this approach was replicated among caregivers with limited English proficiency. Third, pilot testing of survey items was conducted within a cohort of caregivers who chose to participate in the hospital’s OAP, which is generally less racially and ethnically diverse relative to the patient population at the hospital (44 percent vs. 49 percent identify as non-white) (Desai et al. 2014). Fourth, the majority of cognitive interviews occurred in person, which may have biased perspectives regarding content validity toward those who have better access to tertiary-level care. Fifth, patients were not invited to complete survey items even if they were cognitively able to do so; therefore, it is unclear whether self-reported responses and interpretability of survey items would be similar to caregiver-report. For these reasons, further testing is needed to assess whether these psychometric findings are consistent across hospitals and among more diverse populations of respondents.

CONCLUSIONS

This study resulted in the development of a brief, eight-item caregiver-reported experience measure for pediatric hospital-to-home transitions. We established face validity of the measure, and pilot testing indicated the measure consists of acceptable psychometric properties among caregiver respondents at a single tertiary children’s hospital. Further testing is required to

understand the generalizability of the measure in diverse populations, examine differences in survey responses by demographics, establish convergent validity, and measure responsiveness to quality improvement efforts prior to widespread use. By incorporating these types of patient/caregiver-reported outcome measures in our evaluation of the pediatric hospital-to-home transition experience, we can tailor interventions and quality improvement strategies to better meet the needs of patients and their families.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure statement: This study was conducted under funding from the Academic Pediatric Association Young Investigator Award and the Seattle Children's Research Institute Pediatric Early Research Career Award. The sponsors had no role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

We would like to thank Lindsay Durkin for her help with recruitment, as well as the following individuals for serving as our expert providers: Maria Britto, MD, MPH; Mark Shen, MD; Tamara Simon, MD, MSPH; and Christopher Stille, MD, MPH/MSPH. None of these individuals have any conflict of interests or disclosures to report.

Disclosure: None.

Disclaimer: None.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the supporting information tab for this article:

Appendix SA1: Author Matrix.

Table S1: Examples of Survey Item Revisions Based on Cognitive Interview Analysis.