Transition Home Plus Program Reduces Medicaid Spending and Health Care Use for High-Risk Infants Admitted to the Neonatal Intensive Care Unit for 5 or More Days

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Objective To evaluate the effects of a transition home intervention on total Medicaid spending, emergency department visits, and unplanned readmissions for preterm infants born at ≤36[6/7] weeks gestation and high-risk full-term infants.

Study design The Transition Home Plus (THP) program incorporated enhanced support services before and after discharge from the neonatal intensive care unit (NICU) provided by social workers and family resource specialists (trained peers) working with the medical team from October 2012 to October 2014. Rhode Island Medicaid claims data were used to study the 321 infants cared for in the NICU for ≥5 days, who were enrolled in the THP program. THP infants were compared with a historical comparison group of 365 high-risk infants born and admitted to the same NICU in 2011 before the full launch of the THP program. Intervention and comparison group outcomes were compared in the eight 3-month quarters after the infant's birth. Propensity score weights were applied in regression models to balance demographic characteristics between groups.

Results Infants in the intervention group had significantly lower total Medicaid spending, fewer emergency department visits, and fewer readmissions than the comparison group. Medicaid spending savings for the intervention group were $4591 per infant per quarter in our study period.

Conclusions Transition home support services for high-risk infants provided both in the NICU and for 90 days after discharge by social workers and family resource specialists working with the medical team can reduce Medicaid spending and health care use. *(J Pediatr 2018;200:91-7).*

Approximately 15% of newborn infants experience neonatal morbidities and require care in a neonatal intensive care unit (NICU).[1] A significant percent are preterm infants born at ≤36[6/7] weeks' gestational age. In 2015 in the US, almost 10% of infants were born preterm and 8% were low birth weight. The financial burden of preterm births is estimated at $26 billion annually, and Medicaid covers more than one-half of preterm/low birth weight births.[2-6] In addition to medical morbidities, social and environmental adversities of high-risk infants increase resource use and rehospitalization, contributing to a need for enhanced family-centered care provided by a multidisciplinary team including social workers.[7,8] Our prior studies and those of others[9-11] demonstrate the efficacy of a continuum of support from NICU to postdischarge provided by social workers partnering with peer parents to successfully address family barriers to care and psychosocial and environmental needs. This multidisciplinary approach has resulted in fewer emergency department (ED) visits and readmissions.[10,12]

Readmission is estimated to be twice as high among preterm/low birth weight infants and full-term infants admitted to a NICU who are Medicaid beneficiaries, compared with commercial insurance.[2] A spectrum of predischarge and postdischarge interventions involving preparation for discharge, education, counseling, patient-centered services, telephone calls, and assistance to adjustment to home in an effort to reduce early rehospitalization have been implemented with variable success in both the adult Medicare population[13] and for preterm infants cared for in a NICU.[9,10,13-16] Our prior reports of the impact of the Transition Home Plus (THP) program on decreasing the number of ED visits and readmissions demonstrated effects over time but did not include term infants, a comparison group, or cost analyses.

The objective of this study was to use a historical comparison group from the same NICU to determine the THP program effects on total Medicaid spending,

ED	Emergency department
NICU	Neonatal intensive care unit
THP	Transition Home Plus
WIH	Women & Infants Hospital

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ED visits, and unplanned readmissions for preterm and high-risk full-term NICU graduates. It was anticipated that the THP program would decrease unnecessary ED visits, readmissions, and Medicaid spending.

Methods

Women & Infants Hospital (WIH) of Rhode Island received a 3-year Health Care Innovation Award totaling $3.2 million from the Centers for Medicare & Medicaid Services for the period starting July 2012 through June 2015 to set up and maintain the THP program. In October 2012, a THP program was implemented for all inborn and outborn preterm infants (≤36$^{6/7}$ weeks of gestation) with either Medicaid or private insurance who spent ≥5 days in a tertiary care center's 80-bed NICU serving Rhode Island, southeastern Massachusetts, and northern Connecticut.[10] The 5-day cutpoint was chosen because infants admitted to the NICU for <5 days are primarily late preterm or full term with transient respiratory distress,[17,18] and a NICU stay for <5 days would not permit time to provide the predischarge intervention. The program was expanded in August 2013 to include term infants. THP consisted of an interdisciplinary team of physicians, nurse practitioners, social workers, and family resource specialists. Trained family resource specialists were peer parents who had had their own infant previously cared for in the NICU, worked under the supervision of social workers, and were matched with families of similar backgrounds to provide predischarge and postdischarge interventions. The objective was to provide a continuum of individualized family-centered, culturally sensitive support, provide education, and link the family to appropriate community resources (see **Table I** for more detailed descriptions of the program).[19,20] The program expanded on the American Academy of Pediatrics recommendations for discharge planning.[21] As a marker of the intensity of the intervention, the social workers and family resource specialist staff reported 2373 telephone calls with or on behalf of the 321 THP families between NICU enrollment and 90 days after discharge for a mean of 7.39 calls per family. Social workers and family resource specialists completed 65% and 35% of calls, respectively.

This cohort is a subset of the main study and includes early, moderate, and late preterm, and full-term infants with Rhode Island Medicaid (fee-for-service or managed care) admitted to the NICU from October 1, 2012, and September 30, 2014. The comparison group, which was not part of the original study, was a convenience sample of infants on Rhode Island Medicaid cared for in the same NICU for ≥5 days in the year before the study. At discharge, 94% of THP vs 86% of the comparison group were discharged home, and 6% vs 14% were retrotransferred to a level II nursery. Institutional review board approval and informed consent were obtained for the prospectively enrolled infants.

All analyses were completed by RTI International. The study used Rhode Island Medicaid claims data for the 321 newborn beneficiaries enrolled after the THP launch in October 2012, and a comparison group of 365 infants on Medicaid admitted to the WIH NICU during 2011. Outcome measures were Medicaid spending, ED visits (excluding visits that led to a hospitalization), and unplanned readmissions. The measures were calculated through analysis of the Rhode Island Medicaid claims from January 2011 to December 2014. Owing to the limited availability of the claims data and the program rolling entry design, statistical analyses were restricted to up to the first 8 quarters (24 months) after birth when infants in both groups were enrolled in Medicaid. Programming specifications on sample selection, rolling treatment, and outcome measures are provided in **Appendix 1** (available at www.jpeds.com).

Because differences were identified between study groups, inverse probability of treatment weighting (propensity score weighting) was done to balance the demographic and health

Table I. THP program interventions

Predischarges	Provider	Postdischarge	Provider
Identify eligible infants, inform family of program, and obtain consent for THP and CurrentCare*	Social worker or family resource specialist	Call within 48 hours	Social worker or family resource specialist
Communicate enrollment to PCP	Social worker or family resource specialist	Findings of all visits communicated with PCP	MD, NNP, social worker, family resource specialist
Weekly rounds with families	THP team	24/7 on call	MD or NNP
Regular meetings with family, identify challenges, partner to address needs, review education binder	Social worker or family resource specialist	Home visit for infant/family assessment	NNP
Identify family challenges (ie, food insecurity, housing); home visit to assess needs if concerned	Social worker or family resource specialist	Calls to and from family and PCP as needed	MD, NNP, social worker, family resource specialist
Family discharge readiness assessment and facilitate referrals as needed	Social worker or family resource specialist	Edinburgh at 30 days; facilitate referrals as needed	Social worker or family resource specialist
Review all meds, formula mixing, safe sleep, positioning, etc, before discharge	Social worker or family resource specialist	1- and 3-month clinic assessment	MD, NNP, social worker, family resource specialist
Inform PCP of all infants eligible for Synagis	Letter from MD/THP team	Respond to all CurrentCare* real time alerts of ED visit or hospitalization	Social worker or family resource specialist with MD and NNP

MD, Medical doctor; *NNP*, neonatal nurse practitioner; *PCP*, primary care physician.
Terms and Definitions
*CurrentCare is RI's Health Information Exchange, a secure electronic network that integrates laboratory results, medication histories, care coordination data, and so on.

Table II. Maternal and infant characteristics before and after inverse probability of treatment weighting using the propensity score

Variables, mean (% or actual value)	Before weighting			After weighting		
	Intervention group mean (n = 321)	Comparison group mean (n = 365)	Standardized difference	Intervention group mean (n = 321)	Comparison group mean (n = 365)	Standardized difference
Mother's age (y)						
<20	11.2	15.6	0.13	11.2	11.2	0.00
20-25	34.9	37.3	0.05	34.9	35.6	0.02
26-35	42.7	36.2	0.13	42.7	41.5	0.02
>35	11.2	11.0	0.01	11.2	11.7	0.02
Cesarean delivery	45.2	46.3	0.02	45.2	45.1	0.00
White	40.2	44.9	0.1	40.2	40.7	0.01
Black	19.6	18.6	0.03	19.6	19.0	0.02
Female infant	44.6	45.8	0.02	44.6	44.9	0.01
Early preterm (<32 wk)	26.8	21.9	0.11	26.8	26.7	0.00
Moderate preterm (32-33 wk)	15.3	18.1	0.08	15.3	15.7	0.01
Late preterm (34-$36^{6/7}$ wk)	37.4	29.0	0.18	37.4	36.9	0.01
Full term (>$36^{6/7}$ wk)	20.6	31.0	0.24	20.6	20.7	0.00
Birth weight (kg)	2.1 ± 0.9	2.3 ± 0.9	0.22	2.1 ± 0.9	2.1 ± 0.9	0.01
Multiple birth	17.8	11.8	0.17	17.8	16.2	0.04
Morbidity count (integer count)	0.2 ± 0.6	0.1 ± 0.4	0.18	0.2 ± 0.6	0.2 ± 0.5	0.04
Bronchopulmonary dysplasia	10.6	4.7	0.23	10.6	8.9	0.06
Intraventricular hemorrhage grade 3 or 4	3.1	1.1	0.14	3.1	1.5	0.11
Necrotizing enterocolitis (Bell stage II or higher)	2.2	2.5	0.02	2.2	3.5	0.08
Sepsis	4.4	3.3	0.06	4.4	4.4	0.00
Discharged on oxygen	6.2	2.5	0.19	6.2	5.8	0.02
Days in NICU	35.1 ± 41	27.2 ± 29	0.22	35.1 ± 41	33.7 ± 35	0.04
Postmenstrual age (wk)	38.7 ± 3.6	38.4 ± 2.8	0.10	38.7 ± 3.6	38.5 ± 3.0	0.07

Continuous variables are presented as mean ± SD.

characteristics between groups. The covariates in the propensity score model including a major morbidity count are shown in **Table II**. The morbidity count is similar to that used by Schell et al, and refers to the following 4 conditions: bronchopulmonary dysplasia, intraventricular hemorrhage grade 3 or 4, necrotizing enterocolitis (Bell stage II or higher), and sepsis.[15] We included the 4 major neonatal morbidities and postmenstrual age at the time of discharge in the table for informational purposes. They were captured in the propensity score model by other covariates such as the morbidity count, gestational age, and days in the NICU. The procedure used to generate the propensity score weights is described in **Appendix 2** (available at www.jpeds.com). After performing inverse probability of treatment weighting using the propensity score, the absolute standardized differences between the THP and comparison groups were calculated. An absolute standardized difference of ≤0.10 indicated acceptable balance.[22]

Regression analyses with quarterly fixed effects were run to determine the impact of the THP program on spending and number of ED visits. One set of regressions allowed for heterogeneous quarterly intervention effects by interacting the intervention indicator with the 8 quarterly indicators. Another set of regressions used an overall intervention indicator to estimate an average quarterly intervention effect. In addition to quarter and THP (intervention) indicators, all regressions controlled for key covariates as shown in **Table II**. A linear ordinary least squares model was used to estimate Medicaid spending, and a negative binomial model to estimate ED visits.

For unplanned hospital readmissions, the unit of observation was an index hospital discharge within a quarter. The dependent variable was set to 1 if the child had an unplanned hospital readmission within 30 days after the initial index hospital discharge. Thus, the sample size of index hospital discharges within a quarter can be much smaller than the sample of beneficiaries in the study because not all individuals will have an index hospital discharge within a quarter. Therefore, the regression for readmissions used an overall intervention indicator to estimate the average quarterly intervention effect instead of allowing for heterogeneous quarterly intervention effects. A logistic regression model was used to estimate the rate of readmissions.

Results

Table II shows the maternal and infant characteristics for the study groups. The intervention newborns on average had lower birth weight, more days in the NICU, and a higher percentage of births at <32 weeks of gestation than the comparison group (27% vs 22%). The propensity score weighting reduced the absolute standardized differences and achieved adequate balance for all group demographic characteristics.

Table III reports Medicaid spending per patient in the 8 quarters after enrolling in the THP program, as well as per patient in the 8 quarters after birth for the weighted comparison group in a previous period. Owing to the difference in time periods, the spending numbers reported for both groups were inflation-adjusted to reflect the equivalent value of 2014 US dollars. Savings per patient reflect the average spending differential between the weighted comparison group and the intervention group. Medicaid spending in the first quarter was

Table III. Propensity score weighted Medicaid spending* per Medicaid patient, ED visits† per 1000 Medicaid patients, and readmissions‡ rate per 1000 Medicaid discharges

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6	Quarter 7	Quarter 8
Intervention group								
Spending ($)	90 780	2631	2508	2298	1220	1171	1541	1041
SD ($)	139 552	5312	8955	7681	2207	2084	3335	1581
Unique patients	321	255	186	157	122	94	56	24
ED visits	109	302	290	274	270	223	357	83
SD	457	863	673	560	587	509	666	276
Unique patients	321	255	186	157	122	94	56	24
Readmissions rate	26	163	294	0	0	0	0	0
SD	159	370	456	0	0	0	0	0
Total discharges§	271	49	17	6	5	1	2	1
Comparison group								
Spending ($)	90 826	7584	3314	2818	3043	2134	1872	1978
SD ($)	129 557	38 692	13 439	12 017	17 554	9697	7501	8796
Unique patients	364‖	357	348	342	336	324	323	320
ED visits	441	536	695	640	544	495	517	292
SD	1071	1168	1392	1351	1064	1230	1099	764
Unique patients	364‖	357	348	342	336	324	323	320
Readmissions rate	54	203	308	350	500	417	167	500
SD	225	403	462	477	500	493	373	500
Total discharges	336	59	26	20	18	12	6	8
Intervention group—comparison group¶								
Spending ($)	−45	−4953	−806	−520	−1822	−963	−331	−937
ED visits	−332	−234	−404	−366	−274	−272	−160	−209
Readmissions rate	−28	−40	−14	−350	−500	−417	−167	−500

*Spending is the total quarterized payments/number of unique patients.
†ED visits are: (Total quarterized ED visits and observation stays/number of unique patients) × 1000.
‡Readmissions rate is: (Sum of all eligible readmissions to eligible hospital within 30 d of discharges/all eligible discharges in quarter) × 1000.
§Total discharges include all eligible hospital discharges in each quarter. The number of total discharges in quarter 1 includes the initial NICU discharge.
‖One comparison patient was not eligible for Medicaid until 4 months of age; therefore, this patient did not appear until quarter 2.
¶Intervention group—comparison group is the average difference (intervention minus comparison patients) in outcome measures. Differences may not add up exactly owing to rounding.

much higher than the other quarters because of the high costs of delivery and NICU stay. The average spending differentials between the intervention and the comparison group per patient were negative in all 8 quarters, indicating that the average spending was lower in the intervention group.

According to **Table III**, the ED visit rates per quarter were <400 per 1000 patients for the intervention group in all 8 quarters, whereas the weighted ED visit rates for the comparison group were primarily >400 per 1000 patients. The unplanned readmissions rates after weighting were lower among the intervention group than the comparison group during the first 8 quarters, although the sample size decreased significantly starting in quarter 4.

Table IV shows the quarterly effects derived from the ordinary least squares regression with quarterly spending as the dependent variable. The coefficients represent the difference in quarterly spending in the 8 quarters after birth between the groups. The quarterly effects show that the savings in several quarters after birth are statistically significant at the 10% level, after controlling for covariates, namely, sex, race, gestational age, mother's age, birth weight, morbidity count, days in the NICU, cesarean delivery, multiple birth, and discharge on supplemental oxygen. In addition, the weighted average quarterly spending differential in the performance period, indicating savings, is −$4,591 (90% CI, −$8,397 to −$785). This estimate represents the differential spending per quarter in the performance period between intervention and comparison individuals, on average, weighted by the number of intervention beneficiaries in each quarter.

Table IV also shows the quarterly effects derived from a negative binomial count regression model on the number of ED visits. The equations were estimated using data on individual patients. To interpret these results in a standardized form, the coefficients and standard errors were multiplied by 1000, so that the adjusted estimates show ED visits per 1000 patients. All the quarterly coefficients are negative and statistically significant at the 10% level. In addition, the average quarterly difference estimate for ED visits is a decrease of 334 visits (90% CI, −389 to −279) per 1000 patients relative to the comparison group for the first 8 quarters after birth, weighted by the number of intervention patients in the quarter.

In addition, **Table IV** presents the results of a logistic regression model with the dependent variable set to 1 for hospitalized patients who had an unplanned readmission within 30 days. The average quarterly difference estimate for unplanned readmissions is −76 (90% CI, −123 to −29) per 1000 inpatient admissions or discharges, indicating that the THP group is 7.6 percentage points less likely to have an unplanned readmission during the first 8 quarters after birth.

Sensitivity analyses were conducted to examine whether Medicaid claims associated with NICU care could unduly influence the evaluation results. Weights constructed by the inverse probability of treatment were reproduced after excluding all the NICU-related health care expenses and use in both the THP

Table IV. Regression estimates of outcomes between the intervention and comparison groups for January 2011-December 2014

	Medicaid spending ($)		ED visits		Readmissions rate	
	Per patient		Per 1000 patients		Per 1000 discharges	
Quarter	Coefficient*	SE	Coefficient*	SE	Coefficient	SE
1	−944	10 543	−360†	64	NA	NA
2	−6324‡	2922	−260†	83	NA	NA
3	−3237	2275	−414†	92	NA	NA
4	−4141	2561	−404†	95	NA	NA
5	−6762‡	3071	−300†	93	NA	NA
6	−8415†	3230	−325†	96	NA	NA
7	−6319§	3467	−191§	105	NA	NA
8	−18 369†	6727	−239†	77	NA	NA
Average impact per quarter‖	−4591‡	2311	−334†	33	−76†	29

NA, Not applicable owing to small sample sizes.
*The regression coefficients are the quarterly difference estimates on the interaction terms of the intervention indicator and the quarterly indicators. Besides the quarterly fixed effects, the regression controls for the following variables: sex, race, gestational age, mother's age, birth weight, morbidity count, days in the NICU, cesarean delivery, multiple birth, and infant discharged on oxygen.
†$P < .01$.
‡$P < .05$.
§$P < .10$.
‖The average impact per quarter is the weighted average treatment effect per quarter during the performance period for intervention beneficiaries enrolled in THP as compared to their comparison group.

and comparison groups, and regression results for all infants post NICU discharge remained largely the same as the overall main analyses.

Finally, subgroup analyses were conducted focusing on the small subgroup of full-term infants. There were 66 infants in the THP group, and 112 in the comparison group. The analyses were limited to the first 5 quarters of data because the THP group had no observations in quarters 6 through 8. Even though the average impact per quarter for spending was no longer significant, the regression estimate on the second quarter was negative and significant at −$5650 ($P = .074$). The term subgroup results for ED visits and readmissions were similar to the main analysis results both in sign and magnitude and were statistically significant.

Discussion

In what is generally considered the most comprehensive assessment of premature birth costs in the US, a 2007 Institute of Medicine report estimated the financial burden of preterm birth at $26.2 billion each year.[4,23] In addition to NICU costs,[2,4,5,14,15,23] subsequent ED visits and readmissions in the first year of life are important contributors to health care costs. Furthermore, increased resource use has been shown to be associated with both medical risk factors and family, social, and environmental disparities including a need for Medicaid insurance.[7,15,24]

In the current study, adjusted analyses of the first 2 years of the THP program identified $4591 in total Medicaid savings per patient per quarter, indicating that the intervention could contribute to approximately $5.9 million in annual Medicaid savings for 321 high-risk preterm or full-term infants who require ≥5 days of NICU care. In 2015, preterm birth (≤$36^{6/7}$ weeks of gestation) affected about 1 of every 10 infants born in the US. With increasing health care costs, the potential savings of a transition home program are substantial.[25]

Since the Centers for Medicare & Medicaid Services award ended, the THP program has continued as an expansion of services provided in the well-established NICU and Neonatal Follow-up Program at WIH. Regarding hospital costs, direct labor costs from THP (expressed as percent full-time equivalent) include 2 social workers (100% and 80%), 1 family resource specialist (50%), 1 nurse practitioner for home visits (per diem), 3 physicians (10% each), 1 data clerk (50%), and 1 data analyst for reports to Medicaid (10%). Currently, THP services are provided by capitation contracts for 95-100 high-risk infants who either weigh <1500 g or have significant maternal psychosocial risks and are followed to 7 months after discharge. WIH budget impact analyses indicate that the THP program is budget neutral.

Health care professionals acknowledge opportunities for improvement within Medicaid to reduce readmissions and neonatal transfers.[2] Our prior research has shown successful decreases in readmission rates in the first 90 days after discharge among a cohort of 954 preterm infants who had either Medicaid or private insurance and were admitted to the NICU for ≥5 days and supported by an individualized family-centered transition home program.[10] Medicaid, non–English-speaking, multiple pregnancies, and bronchopulmonary dysplasia were significantly associated with an increased risk of readmission. A Delaware study of all infants with Medicaid insurance identified that 41% used an ED by 6 months of age.[26] Medicaid and poverty are known risk factors for readmission,[10,26] and women from disadvantaged social environments are at increased risk to give birth prematurely.[27]

A number of studies have reported interventions implemented to decrease the number of unwarranted ED visits and readmissions.[9,10,13,14] The success of the THP program can be attributed to the model of a multidisciplinary transition care team that includes social workers and family resource specialists, and the provision of both before and after discharge multifaceted, individualized, and culturally sensitive support and

care. Both the mother and infant received care for their needs in the NICU and throughout the first 90 days after discharge with continuity of providers.

The family resource specialists were all parents of former NICU infants, and were paid employees who received training in parent and infant needs and hospital and community resources by the Rhode Island Parent Information Network (www.ripin.org) and the physician/nurse practitioner team at WIH. Each family resource specialist was matched with a mother–infant dyad with a common background and primary language, and played a key role by providing education and supportive intervention services under the supervision and guidance of licensed clinical social workers. Education and supportive services were particularly important, considering that THP served Medicaid beneficiaries, who face access to care and other social determinants of health challenges that are common among families with low income.[28] Family resource specialists and social workers helped THP families to address a wide range of social issues that affected their ability to care for a medically fragile infant, including substance abuse, domestic violence, food insecurity, housing, maternal depression, and mental health challenges. Success cannot be attributed to any single component of the THP intervention, but rather to the individualized, coordinated, and sustained support starting in the NICU and continuing to 90 days after discharge.

Strengths of the study are the inclusion of a contemporary cohort of early, moderate, late preterm, and full-term infants, the assessment of a comprehensive parent education and support program, comparison with a preintervention group, and analysis of Medicaid claims data for spending, ED visits, and rates of unplanned readmission. Planned admissions for surgery, which could not be impacted by the intervention were excluded.

This study is not without design limitations. Given the need to provide all eligible families with transition care and support, a randomized controlled study was not possible. Virtually all high-risk infants born in Rhode Island are treated in hospitals that implemented THP. Therefore, there was no option for comparing outcomes of WIH with other in-state hospitals, and the comparison group is a historical cohort from the same NICU. In addition, the sample size of term infants was small. Medicaid claims data were more limited for the THP group toward the end of the 2-year study period than the historical comparison group. Another limitation is that, although the regression model is robust, owing to data limitation in the comparison group, the model does not control for all baseline characteristics that might have been correlated with spending and use patterns, such as implementation of the Affordable Care Act, maternal socioeconomic status, whether intervention participants were the first preterm infant in a family, and whether they had congenital anomalies, apnea of prematurity, or gastroesophageal reflux. The propensity score model and the regression models do control for key predictors of risk which can potentially serve as a proxy for these unmeasured characteristics.

In summary, transition home comprehensive support services show potential for decreasing Medicaid spending, readmissions, and ED visits for preterm and high-risk full-term infants. The decreases observed may be attributed to education, transitional services, and navigation support provided by the THP family resource specialists and social workers. It is feasible that the THP approach to recruiting and training family resource specialists, then incorporating them into the NICU care team could be adopted by NICUs in other hospitals.[29] Expansion of the medical team to include social workers and family resource specialists offers an effective approach for clinicians and policymakers to consider in addressing the psychosocial and socioeconomic needs of families caring for preterm and high-risk full-term infants. ■

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Appendix 1
Programming Specifications for Medicaid: Sample Selection, Rolling Treatment, and Outcome Measures

Sample Selection

Fee-for-service (or managed care) Medicaid eligibility. An individual will be included in the analysis if they are enrolled in fee-for-service (or managed care) Medicaid for ≥1 month after they enroll in the innovation.

Claims data availability. Include beneficiaries who enroll in the innovation ≥3 months before the end of the claims data. For example, if the claims data are available through March 31, 2014, we can include beneficiaries who enrolled in the innovation before January 31, 2014. Beneficiaries enrolling in the innovation in January will have a full quarter of data (January, February, and March).

Rolling Treatment

For an individual patient, time in treatment will be measured from the month that an individual enrolled in the innovation and outcomes will be calculated on a quarterly basis (eg, ED visits per quarter). For example, if a patient enrolls in Innovation X on February 12, 2012, then that patient's first intervention quarter contains the months of February, March, and April 2012. If another patient enrolls on July 27, 2012, then that patient's first intervention quarter is defined as July, August, and September.

Allowing for a rolling cutoff date. For each patient, the output tables will include all quarters beginning with 2010 and all full postintervention quarters. Every patient's last postintervention quarter should be a full quarter of data (ie, not 1 or 2 months). That is, we should not use a calendar date as the cutoff period to end the analysis. Stated differently, the start of each beneficiary's last quarter will be ≥4 months before the end of data availability in the CCW. If <4 months of claims data are available for a beneficiary's last quarter, then use the prior quarter as the final quarter.

The table below depicts this scenario assuming that the claims data ends on June 30 and the last postintervention quarter is Q5. There are not enough months to capture a full quarter's worth of data for individual 1 after March. So, individual 1's data period ends in February, with March acting as the follow-up month for calculating readmissions.

Individuals	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Q5	Q5	Q5	Readmissions	—	—	—
2		Q5	Q5	Q5	Readmissions	—	—
3			Q5	Q5	Q5	Readmissions	—
4				Q5	Q5	Q5	Readmissions

The exception to this rule is if a person dies during a quarter. Partial last quarters are allowed for deceased individuals.

Outcome Measures

Health Care Spending Per Patient. Health care spending per patient was reported for fee-for-service and managed care Medicaid beneficiaries. Beneficiaries were only included in the analysis for spending during periods when they were enrolled in Medicaid. Health care spending was reported on a per-person per-quarter basis. If a beneficiary was not enrolled for every month in a quarter because of a lapse or termination in coverage, spending (except for hospital inpatient spending) was prorated to a quarterly basis based on the number of months enrolled during the quarter. Because hospital inpatient admissions were both rare and expensive, spending was not prorated for hospital inpatient spending. Prorating was also not performed for beneficiaries who died during a quarter.

Spending for Medicaid eligibles should be based on total Medicaid payments to providers and should not be adjusted to reflect only the federal government's share. The mean and standard deviation of the quarterly spending rate will be the output required for this measure. The spending rate is calculated as the total quartered payments divided by the number of unique patients.

Quarterizing, downweighting, and rolling entry. For patients with less than a full quarter's eligibility, their spending is multiplied (quarterized, prorated) by the ratio: 3/months of eligibility. For example, a patient with $10 000 of spending over 1 eligible month before dropping out would have their quarterly cost estimate increased by 3-fold to $30 000. It is important to prorate spending upwards for nondeceased dropouts in both the intervention and comparison groups.

In the case of "right" censoring of eligibility owing to death, no quarterizing should be done on the grounds that no further spending would be incurred outside of the demonstration. Patients who die would also be given full weight for the quarter. Also, in partial recognition of the lumpiness and costliness of hospitalizations, we do that prorate upward any inpatient payments for the quarter. If an inpatient stay spanned 2 quarters, all hospital costs should be assigned to the subsequent quarter based on "to dates."

Hospital Emergency Department Visit Rate Per 1000 Patients. The rate includes emergency department (ED) visits not resulting in an inpatient admission (potentially avoidable visits) and includes overnight or observation stays with subsequent discharge home. Inclusion criteria for the analyses of ED visits were the same as for spending, and ED visits were also subject to the same prorating formula as for spending. The mean quarterly ED visit rate per 1000 patients is reported.

Numerator. Report quarterly all outpatient ED visits for any reason (all-cause). ED visits resulting in a hospitalization should be excluded because (a) they presumably represent an unavoidable visit and (b) they are counted in hospital admissions. Multiple ED visits on the same day should be counted as 1 ED visit. Overnight ED visits without a hospital admission should be included in the all-cause ED visit count. If an ED and observation visit claim is reported for the same date, count them as 1 ED visit.

Denominator. The denominator of the ED visit rate should include all identified patients in the intervention or comparison groups in a particular quarter. For many awardees, patient counts will be based on all eligible Medicaid patients.

Quarterizing. Because of their very short duration, ED visit rates should be quarterized, or factored up for ineligibility, on a quarterly basis unless a person dies during the quarter.

Hospital All-Cause Unplanned Readmissions Per 1000 Discharges. Readmissions were defined as unplanned readmissions to any short-term acute general or long-term care hospital, within 30 days of a discharge from another hospital of the same type. Planned admissions for surgical procedures (n = 4) and admissions resulting in death (n = 2) were excluded. The measure is an indicator that takes the value of 1 if there is a follow-up readmission to the index hospital discharge and zero otherwise. Index hospital discharges that start in a 3-month quarter in the study period are included in the denominator, and are followed for 30 days, regardless of whether the follow-up period extends beyond the 3-month quarter in question. However, if a patient was no longer covered by Medicaid in the 30 days after the discharge, that index hospital discharge (and hence any associated readmission) was not included in the measure (n = 6). Inclusion criteria for analysis were the same as for spending. The unplanned readmission rate reported is the number of quarterly mean readmission rates per 1000 admissions.

Numerator. "Readmission" is defined for most Awardees as a follow-up admission to any "eligible" short-term acute general or long-term care hospital within 30 days of a discharge from any short- or long-term hospital. Follow-up admissions to psychiatric and rehabilitation hospitals should not be counted as readmissions unless the awardee's intervention is targeted at high users of these hospitals, for example, behavioral health interventions. In determining whether a readmission has occurred, exclude patients who died in the first admission and those who were transferred to another hospital within one day. Count all admissions to another eligible hospital within 30 days of discharge as readmissions. Persons discharged from a short- or long-term hospital within 30 days of the end of the quarter should have their subsequent quarter's claims examined to determine if a readmission has occurred. If so, the subsequent admission should be counted as a readmission in the previous quarter through a correction in earlier reporting. The subsequent readmission should also be counted as the first admission in the subsequent quarter.

Readmissions should be limited to those that were not planned.

Denominator. The number of index discharges from any hospital by beneficiaries during the reporting period. Index hospitalizations are defined using an iterative process where a readmission becomes the index hospitalization for comparison with the next hospitalization. Thus, the index hospitalizations are essentially all eligible hospitalizations with a discharge occurring within the reporting period.

To illustrate this, the table below provides an example of a fictional patient reported by a hospital during the reporting quarter from January 1, 2012, through March 31, 2012. In this example, an individual was discharged on January 8 and had three subsequent admissions during the calendar quarter, two of which would be counted for the numerator of the 30-day readmission measure. However, all 4 admissions would be counted as index stays in the denominator.

Example of quarterly data for a hypothetical beneficiary for 30-day readmissions:

Admit dates	Discharge date	Index stay	Readmission (numerator)
1/1/12	1/8/12	1	0
1/10/12	1/12/12	1	1
1/13/12	1/14/12	1	1
3/17/12	3/31/12	1	0

The January 1, 2012, stay is the initial index stay whose discharge date will be used to start the clock to look out a specific number of days for a readmission. The admission on January 10 is the first readmission after the index admission and would be flagged as a numerator (because it is within 30 days of index discharge) and an index case, resetting the 30-day readmission clock. The admission on January 13 occurs within 30 days of the last index discharge and would be considered a numerator case (corresponding to January 10 admission, not January 1 admission). The admission on March 17 falls outside the 30-day postdischarge period for the previous index admission and, therefore, would be counted only as a new index admission with its own 30-day postdischarge follow-up period (ie, it is not an eligible readmission that would be counted in the numerator). For beneficiaries with readmissions to >1 hospital within 30 days from an index discharge, the last discharging hospital in the reporting quarter will be held accountable for the readmission.

Denominator Exclusion(s). The following hospitalizations are excluded from denominator calculations:

1. For Medicaid patients: Hospitalizations by patients who were not enrolled in fee-for-service (or managed care, if you have data for that population) Medicaid for the month of admission. The rationale for this exclusion is to ensure that patients without complete administrative data are not included in the denominator.
2. Hospitalizations by patients who died during the index hospitalization. Therefore, we exclude individuals with no opportunity for readmission.
3. Hospitalizations that are at the beginning or middle of a transfer sequence (only use last discharge of transfer sequence). This criterion ensures that the last hospital to care for a patient is included in the denominator. Exclusion is based on the values of Patient Discharge Status Code associated with the hospital claim (see below).

Patient Discharge Status Codes identifying discharges that are in the beginning or middle of transfer sequence:

Patient discharge status codes	Description
02	Discharged/transferred to other short-term general hospital for inpatient care.
04	Discharged/transferred to intermediate care facility
05	Discharged/transferred to another type of institution for inpatient care (including distinct parts)
43	Discharged/transferred to a federal hospital
63	Discharged/transferred to a long-term care hospitals.
66	Discharged/transferred to a critical access hospital

Quarterizing. Readmissions should not be quarterized.

Appendix 2
Inverse Probability of Treatment Weighting Using the Propensity Score

Run the logistic regression model

A logistic regression model was estimated to predict the likelihood that a beneficiary is enrolled in the THP program as a function of sex, race, gestational age, mother's age, birth weight (in kilograms), morbidity count, days in the NICU, cesarean delivery, multiple births, and infant discharged on oxygen.

Calculate the propensity score and inverse probability of treatment weight

The predicted value of each comparison beneficiary's probability of being enrolled in the intervention is called the propensity score and was used to construct the corresponding propensity score weights. The impact of group differences on outcomes were ameliorated by weighting comparison beneficiaries by the inverse of their estimated propensity score.

The inverse probability of treatment weight is calculated as PS/(1-PS), where PS denotes a comparison beneficiary's predicted propensity score. Weights are set to 1 for all beneficiaries of the THP group.

Cap and normalize propensity score weights

In operationalizing propensity score weighting, inverse probability of treatment weights were capped at a value of 5 to prevent any particular beneficiary from unduly influencing the results. Comparison beneficiary weights were also normalized to have a mean of 1 so that the weighted size of the comparison group was equal to the unweighted size.