The Pediatric Home Care/Expenditure Classification Model (P/ECM): A Home Care Case-Mix Model for Children Facing Special Health Care Challenges

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ABSTRACT: Case-mix classification and payment systems help assure that persons with similar needs receive similar amounts of care resources, which is a major equity concern for consumers, providers, and programs. Although health service programs for adults regularly use case-mix payment systems, programs providing health services to children and youth rarely use such models. This research utilized Medicaid home care expenditures and assessment data on 2,578 children receiving home care in one large state in the USA. Using classification and regression tree analyses, a case-mix model for long-term pediatric home care was developed. The Pediatric Home Care/Expenditure Classification Model (P/ECM) grouped children and youth in the study sample into 24 groups, explaining 41% of the variance in annual home care expenditures. The P/ECM creates the possibility of a more equitable, and potentially more effective, allocation of home care resources among children and youth facing serious health care challenges.

KEYWORDS: case mix, home care, pediatrics, interRAI, Medicaid, PEDS HC

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Background

Children and youth using long-term home care. Most people correctly think of the nuclear or extended family as the sole source of care for children living in the community. This assumption is largely correct for children who do not face special health care challenges. For children facing chronic health challenges, the circumstances differ. Care in their home comes from some combination of family (informal care) and health professionals (formal care).

In the USA, many children facing serious health care challenges receive home care through Medicaid, a program jointly funded by the federal and state governments to provide health services to lower-income families. Medicaid's Early and Periodic Screening, Diagnostic, and Treatment (EPSDT) program was specifically designed to provide all medically necessary services for Medicaid recipients younger than 21 years of age who face special health care challenges.[1] EPSDT community-based services and supports include physician services, nursing services, therapies, medical supplies and equipment, assistance with instrumental activities of daily living (IADL), and activities of daily living (ADL), as well as a range of other services.[2]

Public expenditures for children who receive home care through EPSDT programs differ dramatically from expenditures for an "average" child receiving Medicaid services. The average annual expenditure for a child in Texas's Medicaid program in 2009 was <$1,900; for a child or youth in Texas's EPSDT program, it was more than 17 times greater, just >$35,600.[3]

Reasons for this difference become clear when the health challenges faced by clients in Texas's EPSDT program are reviewed: almost half of these children and youth faced intellectual or developmental challenges; more than one-third were incontinent of bowel or bladder; and almost half were totally dependent in the more complex, multistep ADLs, such as dressing and personal hygiene.[4]

Case-mix adjustment for payment. Like other Medicaid programs, home care in the EPSDT program has historically been paid on a fee-for-service basis. Services were authorized, and providers were paid for the services provided.[5] Fee-for-service in Medicaid is now, however, being steadily replaced with managed care programs. The future will see a continuing movement of more Medicaid services into managed care programs. As one element of this trend, the state of Texas recently mandated that many Medicaid children services become part of its managed care program by September 2016.[6]

When managed care supplants fee-for-service payment, prospective payment systems fall into place relatively quickly. With prospective payment comes a need for some type of case-mix system to adjust those prospective payments to recognize

important differences among care recipients. These case-mix classification models place individuals into groups of similar persons who require similar amounts of care and generate similar payments to providers.[7,8]

Case-mix payment models now have a long history in health care.[9–12] Medicaid long-term home care programs for children and youth, however, often lack an appropriate case-mix model. Case-mix adjustment for payment is not, however, completely absent in this area. State Medicaid programs, when seeking a case-mix model for children's services, often apply some variant of models developed for older adults.

For example, Texas's Medically Dependent Children Program provides services to those younger than 21 years of age who meet the medical necessity requirement for care in a nursing home.[13] To determine the payment rates for this program, the state agency uses a modified version of the Resource Utilization Groups (RUG) model developed for case-mix classification of adult nursing home residents, who are almost exclusively frail older persons.[14] Other states, such as Washington State, have developed somewhat more complex strategies for determining the need for home care on an "age-appropriate" basis.[15,16] The Washington model is very elaborate, but it is also based on a model developed primarily to pay for services rendered to older adults.

A new home care case-mix model for children and youth. Regrettably, problems arise when programs for children and youth use models based on the analyses of conditions and impairments afflicting frail older persons. Serious health challenges faced by children that might complicate care provision (eg, cystic fibrosis, hydrocephaly or microcephaly, incontinence, or being bed bound or chair bound) are not included in these "transplanted" models. Yet, such conditions have important implications for providers attempting to properly care for a child and for the health and welfare of the child.

One element of this problem comes in the lack of a uniform assessment system across home care programs for children facing special health care challenges. A variety of other settings where vulnerable populations receive care mandate standard assessments or outcome measurement.[17,18] However, no standard assessment tool is now used to assess the home care needs of children. Some states have developed specific assessment tools for specific programs for children. Others simply fall back on assessment tools used with adults.

For example, Texas used the same assessment tool for determining the needs of adults and children for home care services, until a lawsuit filed by parents and advocates resulted in reform. The settlement agreement in *Alberto N. vs. Hawkins* demanded that the Texas Health and Human Services Commission develop an assessment tool specifically designed to assess the needs of children.[19] The settlement led to the development of the Personal Care Assessment Form (PCAF) instruments, the precursors of the interRAI Pediatric Home Care Assessment (PEDS HC). The PEDS HC is a more comprehensive revision of the PCAF that was revised and finalized by the members of interRAI, an organization of >90 health professionals working in 35 countries.[20]

The publication of the PEDS HC instrument and users' manual involved expanding the focus of the original PCAF instrument and modifying some items to assure consistency with common items in interRAI's suite of instruments.[21] The interRAI PEDS HC is described in greater detail in a recent commentary in *Health Services Insights*.[22] A review copy of the PEDS HC instrument can be obtained through a query to info@interrai.org.

The purpose of this research was to develop and present a case-mix classification model, the Pediatric Home Care/Expenditure Classification Model (P/ECM), specifically developed for use with children receiving long-term home care. The model was developed using data collected with an early version of the PEDS HC that was used in the Texas EPSDT program (PCAF 4-20). The model was then tested to determine:

- How well the model explained variance in home care expenditures for the entire sample of home care clients.
- How well the model explained variance in home care expenditures when tested with important sub-populations.
- How a variety of additional variables affected the model's explanatory power.
- Whether the model performed consistently well when tested with a series of random 50% sub-samples.
- How well the model predicted which clients had the lowest or highest home care expenditures.

Methods

Data collection. In September 2008, case managers in Texas' EPSDT program began using an early version of the interRAI PEDS HC assessment form, the PCAF 4-20. State case managers used the PCAF 4-20 to assess all children older than three years of age and younger than 21 years of age who received personal care services through Texas's EPSDT program. Children below the age of four years were assessed with a different instrument (PCAF 0-3). Ninety-three percent of all EPSDT home care program participants during that period were children or youth older than three years of age.

All data used in this research were collected using the PCAF 4-20. The PEDS HC includes all the PCAF 4-20 items used in these analyses. All project activities reported in this research were reviewed and approved by the institutional review board at Texas A&M University.

The PCAF assessment was completed in the client's residence, with both the client and their primary caregiver present. For six months, assessors submitted all completed assessments to a research team at Texas A&M University. The data included assessments for all new applicants for program services and all service recipients who were reassessed.

This research used the assessment data on the 2,578 children and youth from 4 to 20 years of age assessed

during that six-month study period and for whom Medicaid expenditure data were available (93.4% of all PCAF 4-20 assessments). The population below four years of age was not included in these analyses because of the differences in the two assessment instruments used for these populations (PCAF 0-3 vs. PCAF 4-20). Although collected as part of an administrative reform process, these data have proven their research-grade quality in peer-reviewed publications in a number of professional journals.[3,22–28]

Measurement. A quick review of case-mix modeling might be useful at this point. In case-mix models, the criterion variable is some measure of resource use, and assessment data comprise the independent variables. Assessment information and resource data are combined to create groups of care recipients who use relatively similar levels of care resources and share common characteristics.[7]

The dependent variable. The dependent variable in these analyses was Medicaid home care expenditures for one year following the assessment of a sample member. The expenditure data were obtained from the Texas Medicaid Program. All references to expenditures refer to US dollars. Other case-mix models have monetized and included an adjustment for informal care in the dependent variable.[11] Data on informal care were not, unfortunately, included in this data collection.

Variables for potential inclusion in the classification model. Assessors completed the assessment with information from a variety of sources: client medical records, other Medicaid agency records, and responses from informal caregivers and, when possible, from the child or youth being assessed. These data included, but were not restricted to, information on medical diagnoses, health conditions, cognitive function, behaviors, continence, nursing needs, treatments and therapies, and the performance of ADLs.

An important aspect of the measurement strategy for the instruments came in measuring functional performance. All ADL items used six response codes that ranged from total independence to total dependence. The summary ADL scale used in these analyses, for purposes of some consistency with ADL scale in the RUG III Home Care (RUG-III/HC) model, summed the scores for only four ADLs[11]—eating, bed mobility, transfer, and toilet use ($\alpha = 0.83$). A more lengthy discussion of the strategy used for functional measurement in the PEDS HC is available elsewhere.[22,27]

The measure of incontinence indicated whether a child or youth was always, or almost always, incontinent of bowel or bladder. The measure of cognitive issues focused on the child or youth's ability to make independent decisions. The child or youth was considered to be receiving habilitative services if she or he was receiving physical or occupational therapy.

Many behaviors observed with children facing special health care challenges are troubling to observers or caregivers. However, only three of 17 indicators of problem behavior in the PEDS HC significantly affected annual expenditures: resisting assistance with personal care, resisting therapies or treatments, or harming oneself (nonsuicidal). The occurrence of any of these behaviors in seven days before the assessment was considered indicative of a behavior problem.

Analysis strategy.

Using the RUG-III/HC model as a starting point. The availability of the RUG-III/HC case-mix model, which is widely used in adult home care, provided a strong foundation for the development of a pediatric classification model.[10,11] The RUGIII/HC model includes the following seven general categories:

- special rehabilitation (based on the provision of therapies)
- extensive services (parenteral feeding, suctioning, or use of a ventilator/respirator)
- special care (the presence of intravenous medications, tube feeding, or multiple sclerosis)
- clinically complex (the presence of aphasia, cerebral palsy, pneumonia, or stasis ulcer)
- impaired cognition (largely based on memory, comprehension, and decision making)
- behavior problems (wandering, inappropriate behavior, abusive actions, or hallucinations)
- reduced physical function (functional impairment among those who qualify for no other category).

The RUG-III/HC system is hierarchical; a person may fit the first category (special rehabilitation). If they do, they are considered a member of that category; if not, then the researcher determines whether the person fits into the next category (extensive services). This process continues until the person is placed in a category or resides in the lowest category (reduced physical function). The P/ECM is also a hierarchical model, one that uses five of the seven RUG-III/HC categories. The RUG-III/HC category definitions were the starting point for the P/ECM category definitions.

The P/ECM category definitions were, however, also based on the analyses of a wide range of PEDS HC items. Bivariate analyses compared expenditures for those with a specific condition or impairment included in the PEDS HC to expenditures for those without the condition or impairment. The results of these analyses were used to modify the RUG-III/HC categories, making them more appropriate for a pediatric home care population.

The P/ECM also clearly deviates from the RUG-III/HC model in that it contains no special rehabilitation category. Among the adult home care populations, the special rehabilitation category is populated with a relatively small percentage of the older adults who are receiving assistance in recovering from an acute episode (eg, joint or limb replacement and stroke). That is not the case for children or youth. Therapies (rehabilitation or habilitation) are provided to a much larger and more diverse population of children receiving home care. Creating a special rehabilitation category in the P/ECM would have placed roughly half the study sample in the first major classification category.

Unlike the RUG-III/HC model, behavior problems were not included as a major category in the P/ECM. A measure of behavior problems was used, instead, to determine whether behaviors had a significant effect within each P/ECM group that emerged in the initial classification analysis. This analysis led to additional "splits" in preliminary groups in two P/ECM categories.

Building the P/ECM. Placing members of the five general P/ECM categories into smaller sets (groups) was an inductive process that often demanded that the researcher use professional judgment to augment the statistical results. In building these types of models, a researcher tries various combinations of indicators to form groups and reviews the results. Some splits made by grouping software may be reasonable; others may not. Some splits may make logical or clinical sense; others may not. Thus, some measure of researcher judgment was exercised in building the case-mix model presented here.

Within each of the five basic categories used in the P/ECM, four sets of variables were considered for the possibility of developing useful groups: ADL status, continence, the presence of behavior problems, and the provision of habilitation services. The term "habilitation" is used, rather than rehabilitation, because it is more appropriate for a younger population. IADL status was initially included in the testing, but the results indicated that it had little utility in the modeling process.

Developing case-mix indices. Each P/ECM group's average expenditure was translated into a case-mix index (CMI).[7] The CMIs were calculated by dividing the average group expenditure by the average expenditure for the sample. For example, the sample average in this instance was roughly $12,000. Thus, any group with a mean of $36,000 would have a CMI of three (3.0).

The use of a CMI creates the possibility that the model can be used across settings, where the average resource allocation varies from that in the development site. Average resource allocation may vary across settings or populations. However, *relative* payment or resource use differences among groups (CMIs) should largely remain stable. This assumption will be tested when additional data from other settings are available.

Assessing the P/ECM's explanatory power. The most basic test of the quality of a classification model is the percentage of variance (adjusted R^2) the case-mix groups explain in the criterion variable.[7] To evaluate the P/ECM, ordinary least squares (OLS) models were estimated using the 24 P/ECM groups as independent variables.

These models were estimated for the sample as a whole and for important sub-populations in the sample. In addition, a variety of variables (age, gender, specific conditions, and the DSHS regional office involved in the assessment) were added to the multivariate models to determine whether these variables had significant effects on expenditures over and above the P/ECM groups.

The quality of the P/ECM was also tested using logistic regression. These analyses provided information on how well the P/ECM predicted membership in the highest or lowest deciles or quartiles of expenditures. The logistic regressions speak to two issues. First, they provide information on the potential usefulness of the P/ECM categories as a screener. Second, they help pinpoint where predictions based on the P/ECM may be strongest or weakest.

Assessing the potential external validity of the P/ECM. A common strategy when building classification models is to use one-half of the data to build the model and test the model on the remaining half to evaluate the model's external validity.[7] The relatively small number of persons in some important groups in these analyses forced the abandonment of that strategy. Thus, in this effort, the P/ECM was developed using the entire sample. In order to develop relatively stable expenditures estimates a minimum group size (20) was specified. To approximate the split-sample approach to examining the model's external validity, however, the model was tested using 10 randomly generated 50% sub-samples.

Details of the analysis. The groups within the five classification categories were developed with the classification and regression tree procedure in XLSTAT 2015, using the Chi-Square Automatic Interaction Detection method developed by Kass.[29] Basic data manipulation, bivariate analyses, and multivariate analyses were performed using STATA 14.

Results

The average annual Medicaid home care expenditure for the sample of 2,578 children or youth in the Texas EPSDT program was $12,121, with a standard deviation of $17,999; expenditures ranged from a low of $110 to $174,870. Fifty-eight percent of the sample was male, and the average sample member was just older than 12 years of age.

Table 1 provides information on the inclusion criteria for the five major P/ECM categories, which were developed on the basis of the bivariate analyses. The table also displays information on additional indicators used in defining P/ECM groups. Over one-third (41%) of sample members were incontinent of bowel or bladder. One in two (50%) received some type of habilitation. The average ADL scale score was 8.62. Twenty-seven percent of the sample was classified as having a behavior problem.

A graphical representation of the estimated P/ECM appears in Figure 1. In the figure, the five basic categories are arrayed along the left margin of the classification tree. The "branches" of the tree within each category are groups that exhibit differences in average expenditures related to the use of habilitative services, continence, behavior, or, most often, ADL status.

As the figure indicates, for the first category (extensive services) in the classification tree, the provision of habilitative services generated the initial splits. For other major categories, major differences in expenditures were best reflected in differences in ADL status. The presence of behavior problems played a role in defining groups in the special care and complex care categories.

Table 1. Definitions of Pediatric Home Care/Expenditure Classification Model categories and distributions of supplementary variables used to create groups within these categories (n = 2,578).

CATEGORY	PERCENT OF SAMPLE	DEFINITION
Extensive services	10%	Any of the following: IV feeding, suctioning, tracheostomy care, oxygen, ventilator, or coma
Special care	6%	Any of the following: cystic fibrosis, IV medication, hospice, restorative nursing, hospital admission in last 30 days, or uncontrolled seizure disorder and ADL scale > 9
Complex care	18%	Any of the following: cerebral palsy, explicit terminal prognosis, contractures, hydro/microcephaly, bed or chair bound, pressure ulcer or skin lesion, recurrent aspiration, or any plegia, and ADL scale > 9
Cognitive	25%	Severely dependent in decision-making
Reduced physical function	41%	ADL scale score
SUPPLEMENTARY VARIABLES USED TO DEVELOP GROUPS	**DISTRIBUTION**	**DEFINITION**
Incontinence	41%	Always/almost always incontinent of urine or bowels
ADL scale	Mean = 8.62 SD = 6.83	ADL scale (0–20) Sum of eating, bed mobility, toilet use, transfer
Habilitation	50%	Receives physical or occupational therapy
Behavioral problems	27%	Resists personal care, treatments, or therapies, or harms self (non-suicidal attempt)

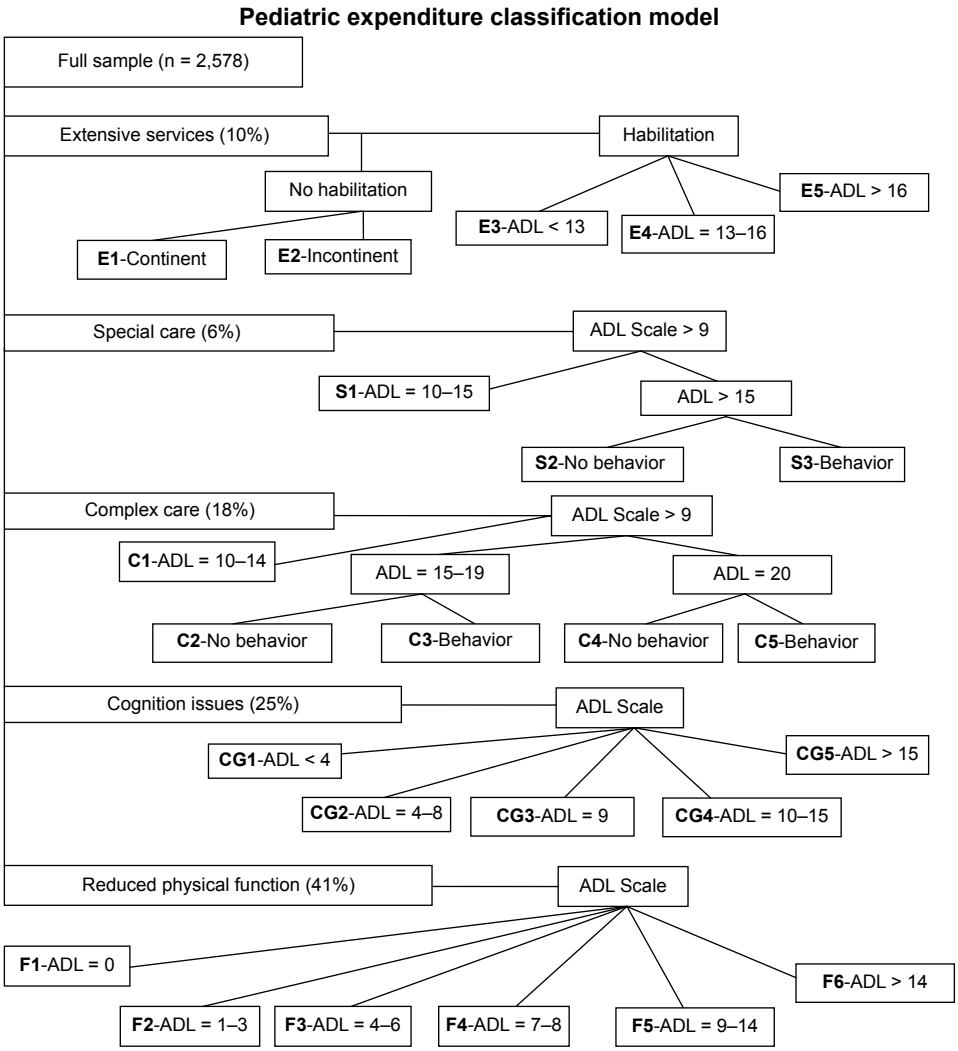

Figure 1. The Pediatric Home Care Expenditure Classification Model (P/ECM).

Table 2 presents information on each of the 24 groups in the P/ECM. The average CMIs among the five major groups are, as hoped, monotonic:

- Extensive services = 3.54
- Special care = 1.66
- Complex care = 1.09
- Cognitive issues = 0.60
- Reduced physical function = 0.51.

The highest CMI (4.37) was applied to those 114 children or youth in Group E5. They were receiving habilitation services, and they scored very high on assistance with ADLs. The lowest CMIs were applied to those who did not meet the definitions of extensive services, special care, complex care, or cognitive issues. For example, those in Group F1 (CMI = 0.34) received very limited ADL assistance and had low annual expenditures and, thus, the lowest CMI.

Table 2. Twenty-four P/ECM groups, case-mix indices, coefficients of variation, and group size (n = 2,578).

CATEGORY	GROUP	*CMI*	*CV*	*N*	*%*
Complete sample		1.00	1.48	2,578	100
Extensive services		3.54	0.93	253	10
	E1	1.90	1.09	23	1
	E2	3.21	0.93	44	2
	E3	1.98	1.10	38	1
	E4	4.05	0.74	34	1
	E5	4.37	0.84	114	4
Special care		1.66	0.94	146	6
	S1	1.34	1.01	61	2
	S2	1.83	0.90	65	3
	S3	2.05	0.86	20	1
Complex care		1.09	0.73	467	18
	C1	0.89	0.77	134	5
	C2	1.04	0.74	135	5
	C3	1.26	0.85	34	1
	C4	1.21	0.65	139	5
	C5	1.56	0.73	25	1
Cognitive issues		0.60	0.64	647	25
	Cg1	0.47	0.63	147	6
	Cg2	0.57	0.55	326	13
	Cg3	0.67	0.54	57	2
	Cg4	0.77	0.52	88	3
	Cg5	1.01	0.85	29	1
Reduced physical function		0.51	0.76	1,065	41
	F1	0.34	0.61	264	10
	F2	0.47	0.59	306	12
	F3	0.52	0.58	296	11
	F4	0.63	0.71	98	4
	F5	0.81	0.94	76	3
	F6	1.11	0.52	25	1

The table also presents the coefficient of variation (CV) for each group. The CV is a standardized measure of dispersion developed by dividing the standard deviation in expenditures for the group by the group's mean expenditure. The CV for the entire sample was 1.49. Group CVs should be significantly smaller than the CV for the sample as a whole. This proved true for all groups created in the P/ECM. In fact, only the CVs for three groups (E1, E3, and S1) marginally exceeded one.

Initially, evaluating the usefulness of the P/ECM requires estimating the P/ECM's 24 categories level of explained variance in expenditures. Table 3 presents the data from OLS models using the P/ECM's 24 categories as independent variables. The 24 categories explained 41% of the variance in annual expenditures.

For purposes of comparison, the RUG-III/HC model explained 34% of the variance in total (formal and informal) home care costs with the Michigan sample.[11] When the RUG-III/HC model was applied to home care data from Ontario, Canada, the model explained 37% of the variance in total per diem costs but only 21% of the variance in formal per diem care costs.[30]

To demonstrate that the model's ability to explain variance did not depend heavily on outliers, the dependent variable was logged. An OLS model with the 24 groups was then estimated using this transformed dependent variable. The explanatory power of the P/ECM fell (R^2 = 0.38) relatively little in this analysis.

Table 3 also displays how well the P/ECM explained variance in sub-populations within the sample. Sample members were categorized as facing challenges derived solely from medical conditions, as facing challenges deriving solely from psychological or developmental conditions, facing both types of challenges, or having a diagnosis of an intellectual or developmental disability. OLS models using the 24 P/ECM categories were then estimated for each group. As those results indicate, the P/ECM worked well for all four sub-populations.

With all case-mix models, observers often raise reasonable concerns about seemingly important characteristics, diagnoses, or conditions not included in the model. For example, muscular dystrophy (MD) is a devastating condition that is not given special attention in the P/ECM; in addition, autism spectrum disorders are not emphasized in the model. The reason for such omissions is often relatively simple. The variance in expenditures generated by such conditions is captured by other elements already included in the model.

This assumption is relatively easily tested. For illustrative purposes, two OLS models were estimated using the 24 P/ECM groups. A binary variable representing MD was added to one model; a binary variable representing autism spectrum disorders was added to the other. The coefficients

Table 3. Predicting individual annual Medicaid home care expenditures using the Pediatric Expenditure Classification Model.

DEPENDENT VARIABLE	MODEL	ADJUSTED R^2	
The Model's Overall Explanatory Power			
Annual home care expenditures	OLS: 24 PECM groups	.41	
Logged home care expenditures	OLS: 24 PECM groups	.38	
Annual Medicaid home care expenditures (ten 50% random samples)	OLS: 24 PECM groups	Mean = .41 Range = .37–.44	
Explanatory Power of the Model with Sub-Populations			
SUB-POPULATION	**MODEL**	**ADJUSTED R^2**	**N**
Medical conditions only	OLS: 24 PECM groups	.40	596
Psychological or developmental health conditions only	OLS: 24 PECM groups	.38	271
Both medical and psychological or developmental conditions	OLS: 24 PECM groups	.40	1,362
Intellectual or developmental disability	OLS: 24 PECM groups	.39	1,320
The Robustness or External Validity of the Model			
Annual Medicaid home care expenditures (ten 50% random samples)	OLS: 24 PECM groups	Mean = .41 Range = .37–.44	
How Well the Model Predicts Upper and Lower Decile and Quartile Membership			
DEPENDENT VARIABLE	**MODEL**	**C-STATISTICS**	
Top ten percent of annual home care expenditures	Logistic regression: extensive services, special care, complex care, cognitive issues, and ADL scale	c = .91 pseudo-R^2 = .39	
Top 25 percent of annual home care expenditures	Logistic regression: extensive services, special care, complex care, cognitive issues, and ADL scale	c = .86 pseudo-R^2 = .30	
Bottom 25 percent of annual home care expenditures	Logistic regression: extensive services, special care, complex care, cognitive issues, and ADL scale	c = .75 pseudo-R^2 = .13	
Bottom ten percent of annual home care expenditures	Logistic regression: extensive services, special care, complex care, cognitive issues, and ADL scale	c = .70 pseudo-R = .07	

for neither of these variables were statistically significant ($p > 0.05$).

The same process indicated that the characteristics included in the model also captured any differences that might be attributable to age or gender. When used in an OLS model in conjunction with P/ECM groups, neither gender nor age was statistically significant predictors ($p > 0.05$) of Medicaid annual home care expenditures.

To determine whether some organizational factors might be affecting the results, an additional model was estimated. The assessments were completed in one of 16 regional offices. A series of binary variables representing these offices were added to the model containing the 24 P/ECM groups. The adjusted R^2 increased by only 0.0045 when these variables were added to the model.

To examine the external validity or robustness of the P/ECM, a series of 10 random 50% sub-samples were drawn from the larger sample. The P/ECM was then retested on each sub-sample. The explained variance (R^2) for those 10 sub-samples ranged from 0.37 to 0.44 and averaged 0.41. While arguably not as convincing evidence of robustness as might be achieved using split samples, the results bode well for the external validity of the P/ECM.

For additional insight into the model's predictive capabilities and possible utility as a screener, logistic regression models were estimated. The first model focused on predicting which sample members had expenditures in the top 10%. The independent variables in the model were four of the five basic case-mix categories (extensive services, special care, complex care, and cognitive issues) and the ADL scale. Estimating that model resulted in a *c*-statistic of 0.91. Completing the same exercise with those in the top quartile of expenditures resulted in a *c*-statistic of 0.86. The model predicting which children or youth would have expenditures in the lowest quartile produced a *c*-statistic of 0.75. This same exercise with the lowest decile in expenditures resulted in a *c*-statistic of 0.70, which is at the low end of the range of acceptable predictive power for such models.[31]

Conclusions

Some of the basic elements of an effective and equitable model of needs assessment and resource allocation remain

in their infancy in home care for children. The development of the interRAI PEDS HC assessment tool and the P/ECM are preliminary efforts to redress this imbalance. The goal of these efforts was to assist in moving the level of standardization and sophistication in programs providing home care services to children or youth to something approximating that found in home care services provided to adults and frail older persons.

Within that broader policy context, the research results presented here seem worthy of note. The P/ECM explained considerable variation (41%) in annual Medicaid home care expenditures for children or youth facing special health care challenges. The results provided by the analyses of random sub-samples indicate that the model may lay claim to some good measure of external validity.

The P/ECM exhibited a similar level of explanatory power in analyses performed with important sub-populations. The model worked almost equally well with children whose conditions were purely medical, purely psychological or developmental, or some combination of those two categories. It is especially noteworthy that model worked well when tested on only those children with developmental or intellectual challenges.

As the exercise using logistic regression demonstrated, the P/ECM model's usefulness was greatest when identifying those with the highest utilization. In essence, the major categories used in the model, in conjunction with the ADL scale, may allow a provider or payor to create a successful screener that identifies those children and youth who will make the greatest demands on home care resources.

The model's predictive power declined as testing moved away from identifying those with the highest utilization. However, even when predicting membership in the lowest decile of utilization, the model's usefulness "bottomed-out" at a level of predictive success (0.70) generally considered at least adequate.[31] Thus, confidence in the modeling results may diminish as one moves to those groups including children and youth who receive the least services. The variation in resource use in these groups is often limited, and this makes for less clear differentiation among clients.

This research has obvious limitations. It focused on children in one Medicaid program in one state. In addition, the model rests on a combination of statistical results and researcher judgment. Future research is required in order to determine how robust these results may be when tested in different settings.

It is also important to remember that case-mix models tell one about differences in the care received, not necessarily differences in the care needed.[7] Finally, the development of a case-mix model is only a step, albeit an important one, in an extended process of implementing an operational case-mix-based prospective payment model. The P/ECM is, in essence, a foundational framework that programs can implement and modify as evidence on system equity and effectiveness accumulates.

Despite these limitations, this research presents what promises to be a useful model for identifying and grouping children with similar service needs in programs such as the Medicaid EPSDT program. The model does so based on an assessment tool (PEDS HC) specifically tailored to meet the needs of those seeking to provide appropriate home care services to children and youth in the community facing special health care challenges.

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Author Contributions

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