Association of Home Respiratory Equipment and Supply Use with Health Care Resource Utilization in Children

Jay G. Berry, MD, MPH[1], Denise M. Goodman, MD, MS[2], Ryan J. Coller, MD, MPH[3], Rishi Agrawal, MD, MPH[2,4], Dennis Z. Kuo, MD, MHS[5], Eyal Cohen, MD[6], Joanna Thomson, MD, MPH[7], Danielle DeCourcey, MD, MPH[8], Neal DeJong, MD, MPH[9], Anna Agan, BA[1], Dipika Gaur, BS, MSc[10], Madeline Coquillette, MD[1], Charis Crofton, BA[1], Amy Houtrow, MD, MPH, PhD[11], and Matt Hall, PhD[12]

Objective To compare health care use and spending in children using vs not using respiratory medical equipment and supplies (RMES).

Study design Cohort study of 20 352 children age 1-18 years continuously enrolled in Medicaid in 2013 from 12 states in the Truven Medicaid MarketScan Database; 7060 children using RMES were propensity score matched with 13 292 without RMES. Home RMES use was identified with Healthcare Common Procedure Coding System and *International Classification of Diseases* codes. RMES use was regressed on annual per-member-per-year Medicaid payments, adjusting for demographic and clinical characteristics, including underlying respiratory and other complex chronic conditions.

Results Of children requiring RMES, 47% used oxygen, 28% suction, 22% noninvasive positive-pressure ventilation, 17% tracheostomy, 8% ventilator, 5% mechanical in-exsufflator, and 4% high-frequency chest wall oscillator. Most children (93%) using RMES had a chronic condition; 26% had ≥6. The median per-member-per-year payments in matched children with vs without RMES were $24 359 vs $13 949 ($P < .001$). In adjusted analyses, payment increased significantly ($P < .001$ for all) with mechanical in-exsufflator (+$2657), tracheostomy (+$6447), suction (+$7341), chest wall oscillator (+$8925), and ventilator (+$20 530). Those increased payments were greater than the increase associated with a coded respiratory chronic condition (+$2709). Hospital and home health care were responsible for the greatest differences in payment (+$3799 and +$3320, respectively) between children with and without RMES.

Conclusion The use of RMES is associated with high health care spending, especially with hospital and home health care. Population health initiatives in children may benefit from consideration of RMES in comprehensive risk assessment for health care spending. *(J Pediatr 2019;207:169-75).*

Children with medical complexity (CMC) have severe chronic conditions, significant limitations in functional abilities, and high health care costs.[1,2] Health system clinical, research, and policy initiatives seek to improve health and well-being for CMC and to contain spending. Methods and policies used in these initiatives commonly rely on chronic conditions from administrative health care claims to identify CMC and to assess risk of high health care use.[3,4] The initiatives rarely consider contributions of functional abilities and health care needs of CMC; those hallmarks of medical complexity have been difficult to assess from population-level health data.

Functional impairment in breathing that necessitates the use of respiratory medical equipment and supplies (RMES) is common for CMC, regardless of the organ system (eg, neuromuscular) affected by their primary, underlying chronic condition.[5,6] For these children, RMES use ranges from oxygen to

CCC	Complex chronic condition
CMC	Children with medical complexity
DME	Durable medical equipment
HCPCS	Healthcare Common Procedure Coding System
ICD-9-CM	*International Classification of Diseases, Ninth Revision, Clinical Modification*
NIPPV	Noninvasive positive pressure ventilation
PMPY	Per-member-per-year
RMES	Respiratory medical equipment and supplies

From the [1]Division of General Pediatrics, Department of Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA; [2]Department of Pediatrics, Ann & Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, IL; [3]Department of Pediatrics, University of Wisconsin School of Medicine and Public Health, Madison, WI; [4]Division of Hospital-Based Medicine, La Rabida Children's Hospital, Chicago, IL; [5]Department of Pediatrics, John R. Oishei Children's Hospital, University at Buffalo, Buffalo, NY; [6]Department of Pediatrics, Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada; [7]Department of Pediatrics, Cincinnati Children's Hospital Medical Center, University of Cincinnati College of Medicine, Cincinnati, OH; [8]Division of Medicine Critical Care, Department of Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA; [9]Division of General Pediatrics and Adolescent Medicine, University of North Carolina School of Medicine, Chapel Hill, NC; [10]Rush Medical College, Rush University, Chicago, IL; [11]Division of Pediatric Rehabilitation Medicine, University of Pittsburgh School of Medicine, Pittsburg, PA; and [12]Children's Hospital Association, Lenexa, KS

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chronic invasive mechanical ventilation and signifies deficiencies in the children's ability to oxygenate and ventilate, which may affect the need for more health services (eg, acute and preventive) to maintain their health.[7-11]

There may be important information conveyed in administrative health care claims that can distinguish RMES in children and help to assess how that use correlates with health care resource use and spending. For example, the Centers for Medicare and Medicaid Services' Healthcare Common Procedure Coding System (HCPCS) is used administratively by payors to reimburse durable medical equipment (DME) companies for dispensed items, including RMES.[12] Therefore, using the HCPCS, we conducted the present study to (1) characterize children using RMES and (2) compare health care resource use and spending across the care continuum for a propensity-matched group of children with and without RMES.

Methods

This retrospective cohort analysis used the Truven MarketScan Medicaid Multistate Database (Truven Health Analytics, Inc, Ann Arbor, Michigan) from 2012 to 2014. The database contains health care claims across the continuum of child Medicaid enrollees from 12 contributors (7 state contributors and 5 Medicaid health plans) from multiple geographically dispersed states. Participants were children ages 1-18 years, used RMES in 2013, and were continuously enrolled in Medicaid for at least 11 of 12 months before and after the first RMES health care claim in 2013. Infants age 0 in 2013 were excluded because they were not old enough for a prior full year of claims. Because this study did not involve the collection, use, or transmittal of identifiable data, institutional review board approval was waived.

The use of RMES was identified with *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis and procedure codes, and the HCPCS[7,13] (**Table I**; available at www.jpeds.com). ICD-9-CM codes are predominately used by hospital administrative staff when submitting diagnoses and procedures from an inpatient health care encounter to payors for payment. Examples of ICD-9-CM codes included were tracheotomy (31.2), home mechanical ventilator (v46.1), and oxygen (v46.2; **Table I**). HCPCS codes, which are submitted to payors for reimbursement of dispensed DME, were categorized into the following respiratory equipment and supplies: apnea monitor, mechanical in-exsufflator, noninvasive positive pressure ventilation (NIPPV), oxygen, suction, tracheostomy, mechanical ventilator, and high-frequency chest wall oscillator (**Table I**). The use of a nebulizer machine to administer respiratory medications was not included; this classification enabled the derivation of a study cohort that was not preponderate to children with asthma.

Main Outcome Measures

The main outcomes were health care spending and use over 12 months. To ensure the inclusion of a complete 12-month period with RMES, outcomes were assessed during the 12 months after either the first RMES claim in 2013 for children without a claim in the preceding 12 months (including back to 2012), or January, 1, 2013, for children with an RMES claim in 2012. We assessed the outcomes overall (ie, the total across all health services) and by specific health services (eg, DME, emergency department, home health [eg, skilled nursing visits and extended hour home care nursing]). Inpatient care that occurred during the first use of RMES (eg, hospitalization when tracheotomy occurred) were excluded to avoid influence on spending by long, expensive hospitalizations at the onset of RMES use. Spending was reported for each health service as the total gross payment.

Demographic and Clinical Characteristics of the Children

Demographic characteristics included age, sex, and race/ethnicity (ie, white, non-Hispanic; black, non-Hispanic; Hispanic; and other). These characteristics were measured at the time of each child's first health care claim for RMES in 2013. Clinical characteristics included the type and number of chronic conditions, measured across all health services encounters up to 12 months before and after the first health care claim for RMES in 2013. To identify the presence and number of chronic conditions, we used the Agency for Healthcare Research and Quality Chronic Condition Indicator system, which categorizes more than 14 000 ICD-9-CM diagnosis codes into chronic vs nonchronic conditions.[14,15] Chronic Condition Indicators define chronic conditions as those lasting 12 months or longer that place limitations on self-care, independent living, and social interaction and/or are associated with the need for ongoing intervention with medical products, services and special equipment.[14,15] Children with a chronic condition were further classified as having a complex chronic condition (CCC) using the ICD-9-CM diagnosis classification scheme by Feudtner et al. CCCs represent diagnosis groupings expected to last 12 months or longer, and involve either a single organ system severely enough to require specialty pediatric care and hospitalization or multiple organ systems.[13]

Statistical Analyses

We used propensity score matching to assess differences in health care use and spending for children using vs not using RMES (ie, cases vs controls).[16,17] Attempting a 1:2 of cases to controls, children were matched using a greedy matching algorithm with weights for demographic and clinical characteristics associated with both RMES use and health care use and spending.[18] The characteristics (and their corresponding weights) were age at the beginning of the study period (weight 20%), presence of a respiratory CCC (weight 20%), and presence of the use of medical technology in organ systems other than respiratory (eg, digestive, neurologic, etc; weight 20%). The remaining weights (40% total) were used for matching on the type and number of chronic conditions (20%) and reason for Medicaid enrollment (20%; disability vs other). Standardized mean differences in these attributes were used to assess the performance of the matching methods, referencing an optimal mean difference of 0.1 or less.[19]

In bivariable analysis, we used Wilcoxon rank-sum tests to compare health care use and spending between cases and controls. In multivariable analysis, we used median regression for this comparison with annual per-member-per-year (PMPY) spending as the outcome and fixed effects for each type of RMES (eg, NIPPV), demographic characteristics not included in the propensity matching (eg, race/ethnicity), and the characteristics listed that were used for the propensity matching (eg, respiratory CCC). All statistical analyses were performed using SAS v.9.4 (SAS Institute, Cary, North Carolina). The threshold for statistical significance was set at $P < .05$.

Results

Study Population

Of the 3 060 221 children ages 1-18 years continuously enrolled in Medicaid, there were 12 861 (0.4%) that had an RMES claim, of which 7060 cases (54.8%; ie, children using RMES) were matched with 13 292 controls (ie, children not using RMES); 88.3% of cases were matched with 2 controls and 11.7% were matched with 1 control. For the cohort overall, median (IQR) age at the beginning of the study period was 9 years (IQR, 4-15 years). Regarding demographic characteristics, 55.3% were male and 44.6% were non-Hispanic white; 26% were enrolled in Medicaid because of a disability and 57% were enrolled in Medicaid managed care. The majority (59.5%) had 1 or more CCCs; neuromuscular (26.9%), digestive (21.7%), and congenital/genetic (18.1%) CCCs were the most common. Multiple chronic conditions (of any complexity) were prevalent; 51.1% had 4 or more chronic conditions (**Table II**).

Children Using RMES

Overall, 84% of cases used 1 RMES, 10.7% used 2, 5.4% used 3 or more. Among the most common types of RMES used among the cohort were oxygen (47.2%), suction (27.9%), NIPPV (21.9%), and tracheostomy (16.5%). Most RMES were identified with HCPCS codes alone (79.8%). Only 4.7% of RMES were identified with ICD-9-CM codes alone. Regarding chronic respiratory diseases, apnea (central and obstructive; 6.5%), cystic fibrosis (6.1%), and chronic respiratory insufficiency and failure (5.7%) were the most common in children using RMES. The standardized mean differences were less than 0.1 for all the demographic and clinical characteristics used for matching cases and controls (**Table II**).

Table II. Demographic and clinical characteristics of the propensity-matched, Medicaid-enrolled children using and not using RMES

Characteristics	Overall cohort	Use of RMES*		
		Yes	No	Standardized difference
n	20 352	7060	13 292	
Age, years				
1-4	6020 (29.6)	2077 (29.4)	3943 (29.7)	–0.01
5-12	7698 (37.8)	2687 (38.1)	5011 (37.7)	0.01
13-17	4251 (20.9)	1469 (20.8)	2782 (20.9)	0.00
≥18	2383 (11.7)	827 (11.7)	1556 (11.7)	0.00
Basis of Medicaid eligibility				
Disability	7321 (36.0)	2623 (37.2)	4698 (35.3)	0.04
Other reason (eg, income)	13 031 (64.0)	4437 (62.8)	8594 (64.7)	–0.04
Number of chronic conditions				
0	1439 (7.1)	481 (6.8)	958 (7.2)	–0.02
1	2763 (13.6)	935 (13.2)	1828 (13.8)	–0.02
2	2751 (13.5)	944 (13.4)	1807 (13.6)	–0.01
3	2984 (14.7)	989 (14.0)	1995 (15.0)	0.00
4	2873 (14.1)	975 (13.8)	1898 (14.3)	–0.01
5	2651 (13.0)	880 (12.5)	1771 (13.3)	–0.02
≥6	4891 (24.0)	1856 (26.3)	3035 (22.8)	0.08
CCCs				
Any	12 106 (59.5)	4317 (61.1)	7789 (58.6)	0.05
Neuromuscular	5483 (26.9)	1994 (28.2)	3489 (26.2)	0.04
Digestive	4425 (21.7)	1706 (24.2)	2719 (20.5)	0.09
Congenital/genetic	3676 (18.1)	1390 (19.7)	2286 (17.2)	0.06
Technology assistance	3290 (16.2)	1353 (19.2)	1937 (14.6)	0.12
Cardiovascular	3073 (15.1)	1162 (16.5)	1911 (14.4)	0.06
Malignancy	2224 (10.9)	856 (12.1)	1368 (10.3)	0.05
Metabolic	1970 (9.7)	706 (10.0)	1264 (9.5)	–0.4
Respiratory	1459 (7.2)	601 (8.5)	858 (6.5)	0.08
Hematology/immunologic	940 (4.6)	356 (5.0)	584 (4.4)	–0.03
Neonatal	763 (3.7)	318 (4.5)	445 (3.3)	0.06
Renal	818 (4.0)	310 (4.4)	508 (3.8)	0.03
Transplant	115 (0.6)	46 (0.7)	69 (0.5)	0.03

*Propensity matching was attempted with a 1:2 of cases (children using RMES with controls [children not using RMES]). Demographics and clinical characteristics used for the matching process were weighted as follows: age at the beginning of the study period (20%), presence of a respiratory CCC (20%), and presence of the use of medical technology in organ systems other than respiratory (eg, digestive, neurologic, etc; 20%). The remaining weights (40% total) were used for matching on the type and number of chronic conditions (20%) and reason for Medicaid enrollment (20%; disability vs other).

Health Care Use and Spending of Children Using vs Not Using RMES

Health Care Use. The percentages of children using specific types of health services were significantly different ($P < .001$ for all) between propensity-matched children using vs not using RMES. For example, higher percentages of children using RMES used hospital services (19.3% vs 11.9%), home health nursing care (22.2% vs 17.0%), and therapies (55.6% vs 40.4%). A lower percentage of children using RMES used dental services (49.5% vs 58.3%; Figure 1).

Distribution of Health Care Spending Across the Care Continuum. The distribution of Medicaid spending across health service types was similar for children using vs not using RMES. For example, hospital and home health care accounted for the greatest percentages of total spending for both groups of children. Hospital care accounted for 30.5% and 26.0% of spending for children using vs not using RMES, respectively. Home health nursing care accounted for 23.0% and 16.4% of spending for children using vs not using RMES, respectively. DME (ie, all DME including RMES and other types) accounted for a smaller percentage of total spending than hospital and home nursing—10.3% vs 5.8%—for children using vs not using RMES, respectively.

PMPY Spending. PMPY spending was significantly higher in children using vs not using RMES ($24 358 vs $13 949; $P < .001$; Table III). Among the greatest differences in PMPY spending across health services were hospital care, which was 2.0 times higher in children using vs not using RMES ($7425 vs $3625; $P < .001$); home health care, which was 2.5 times higher in children using vs not using RMES ($5604 vs $2284; $P < .001$); and DME, which was 3.1 times higher in children using vs not using RMES ($2500 vs $815; $P < .001$; Table III).

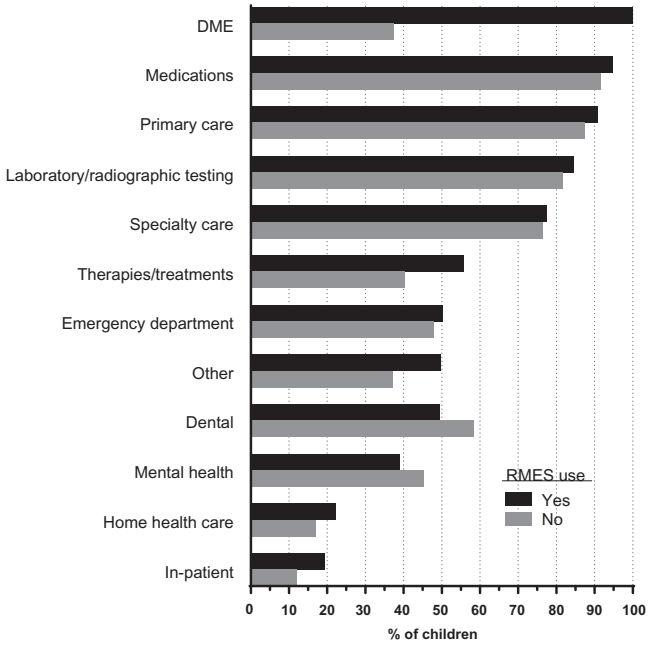

Figure 1. Types of health service use of propensity-matched Medicaid-enrolled children using and not using RMES. Presented are the percentages of children with 1 or more annual encounters for each health service. All comparisons between children using respiratory equipment vs not are statistically significant ($P < .001$ for all).

Table III. PMPY Medicaid payment for propensity-matched children using and not using RMES

Health services	Overall cohort	Use of RMES		
		Yes	No	Difference†
All health services	$9110	$24 349	$13 949	$10 410
Inpatient*	$4943	$7425	$3625	$3799
Home health nursing care	$3436	$5605	$2285	$3320
Medications	$2117	$2672	$1823	$849
Therapy/treatment	$1448	$1898	$1209	$689
DME	$1400	$2501	$815	$1686
Mental health	$1305	$1038	$1447	–$409
Specialty care	$885	$1011	$819	$192
Laboratory/radiographic testing	$516	$559	$493	$66
Emergency department	$490	$511	$479	$32
Primary care	$461	$492	$445	$48
Other	$342	$417	$302	$115
Dental	$215	$231	$207	$23

*Inpatient health services did not include hospital use when RMES was initiated (eg, hospitalization for tracheotomy).
†All spending differences between children using vs not using RMES were statistically significant at $P < .001$.

In adjusted analyses, the median PMPY spending increased significantly ($P < .001$) with the use of each type of RMES: NIPPV (+$928), apnea monitor (+$977), oxygen (+$1931), mechanical in-exsufflator (+$2657), tracheostomy (+$6447), suction (+$7341), high-frequency chest wall oscillator (+$8925), and ventilator (+$20 530). Those payment increases were greater than the increase associated with the presence of a coded respiratory CCC (+$2709; Figure 2). Other patient demographic and clinical characteristics were also significantly associated with increased PMPY spending. For example, as the number of chronic conditions increased from 1 to 6 or more, PMPY spending increased from $3671 to $6110, respectively ($P < .001$). Increases for PMPY spending associated with neuromuscular and renal CCC were +$4659 and +$5484, respectively ($P < .001$ for both).

Discussion

The main findings from the current study suggest that annual Medicaid payments were nearly twice as high in a propensity-matched cohort of children using vs not using home RMES. In adjusted analysis, each type of RMES—from oxygen to home ventilator—was independently associated with increased payment, suggesting that the array across the hierarchy of RMES used in the home can predict additional health care spending, independent of chronic diagnoses. The majority of this additional spending was due to an increased use of hospital care and home health care. Most children using RMES were identified by HCPCS, the system used by DME vendors to dispense RMES, rather than ICD-9-CM codes, which are used predominately by clinicians and their billing personnel when submitting health care claims. Population health initiatives for

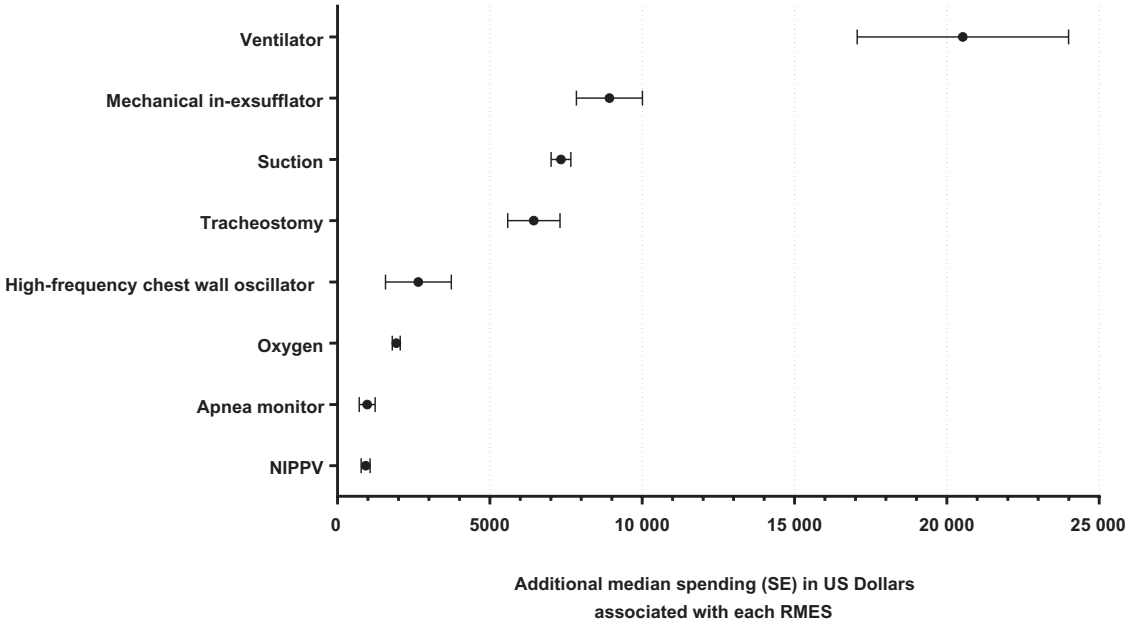

Figure 2. Multivariable analysis of annual Medicaid payment and types of RMES for Medicaid-enrolled children. Presented are the adjusted medians of additional payment across the care continuum issued for children using each type of respiratory medical equipment and supply (RMES) compared with propensity-matched controls of children not using RMES. The medians were adjusted for age, basis of Medicaid eligibility, race/ethnicity, number of chronic conditions (of any complexity), and type of CCC.

CMC may benefit from consideration of RMES use in comprehensive risk assessments for health care spending.

This study assessed the usefulness of Centers for Medicare and Medicaid Services' HCPCS to identify children using RMES at home. The vast majority of children using RMES in the current study were identified with HCPCS rather than ICD-9-CM claims. HCPCS claims are not included in most population health systems designed to categorize the complexity of children's health problems, including those systems that advertise the ability to distinguish children assisted with medical technology; most of those systems rely solely on ICD-9-CM codes.[1,13,20] Although the newer ICD-10 diagnosis codes may have enhanced capability of detecting some RMES use, their coding validity may be limited with inconsistent use by clinicians and their billing staff. As observed in the current study, complementing ICD-9-CM-based systems with HCPCS claims may enhance the ability to abstract important population-based patient information about physiologic function, especially when equivalent clinical data (eg, use of RMES abstracted from chart review) cannot be feasibly obtained.[21-23]

It is important to recognize that all types of RMES in the current study were associated with increased health care spending. This finding is complemented by prior studies demonstrating increased health resource use and cost associated with tracheostomy use in children.[7-10] In the current study, oxygen, suction, NIPPV, and other RMES were used substantially more often than tracheostomy. Because all of the types of RMES contributed independently to associations of increased health care spending, it may be important for population health initiatives in children (eg, accountable care organizations, complex care programs) to consider distinguishing the use of any RMES type when projecting and assigning risk for high health care resource use and spending.

In the current study, RMES themselves were not primarily responsible for the additional health care spending in children who used them. Rather, inpatient and home health care accounted for most of the additional spending in children using RMES. It is important to remember that inpatient care when RMES was instituted (eg, hospitalization for tracheotomy) was not included for this measurement in the current study; therefore, that type of inpatient care did not account for the observed additional hospital spending The additional spending could imply that RMES may be an important indicator of functional impairments and medical fragility that require increased care across the continuum, especially in hospital and at home, to optimize health.

It is important to recognize that the vast majority (ie, >90%) of children using RMES in the current study did not have an underlying respiratory CCC coded in their administrative health care claims. It is likely, however, that the majority of these children had a chronic respiratory condition that necessitated the use of RMES. This discrepancy underscores the deficiency of diagnosis codes, when used exclusively, to distinguish complex respiratory disease in populations of children. Variation in coding practices across providers and institutions as well as limitations in the number of codes permitted for a health care claim (eg, a maximum of 2 diagnosis codes for an outpatient claim) likely contribute to the problem. Those involved with health system initiatives should use caution when relying on diagnosis codes alone to distinguish children with complex respiratory diseases and to assess their risk for high health care use and spending.

Further investigation is needed to assess whether the increased home health care in children using RMES is sufficiently meeting their home health care needs. We observed that only 22% of children using RMES received home health care. In a post hoc analysis, we observed—as expected—higher rates of suctioning, tracheostomy, and ventilation use in children receiving home health care. Of course, not all children using RMES may actually require home health care; thus, the ideal percentage of these children using home care services should not be 100%. However, prior studies report insufficient home and community providers to administer and manage RMES in children,[24,25] with much of the caregiving burden falling to parents and other family members[26]; this burden can be associated with negative familial and social consequences.[27,28]

This study has several limitations. We cannot account for all the potential confounders between children using vs not using RMES, especially those related to social, familial, and environmental attributes that are not readily available in claims databases like the Truven Medicaid MarketScan Database. Infants less than 1 year of age were excluded from our cohort; further study of infants using RMES is warranted. We could not distinguish the frequency and duration of RMES use from the Medicaid claims data. For example, the oxygen HCPCS claims do not contain sufficient information to distinguish how much oxygen was actually prescribed (eg, 2 L of oxygen used only while sleeping for 1 year). False negatives of RMES are possible, especially for equipment and supplies associated with an infrequent claim (eg, a 1-time claim to dispense an apnea monitor). HCPCS codes change over time and some of them used the current study may be obsolete if used with contemporary claims data. Relatedly, the current study used ICD-9-CM codes; ICD-10 codes may permit improved capture of chronic respiratory disease, which might dampen the association of high health care spending with RMES. Spending over 1 year was measured in the current study. Multiple years of spending will be necessary and important to assess whether RMES use is associated with persistently high health care spending. Although we used median regression to estimate adjusted increases in spending with RMES, some health care policymakers may prefer analytic methods that use conditional means; there may be merit to exploring the latter approach in future economic analyses of RMES use in children. The findings on spending from the Medicaid claims may not reflect the total cost of the patients' health care. The findings may not generalize to children with private insurance, who may—in general—have lower medical complexity and fragility. Additional indirect costs such as family out-of-pocket expenses, lost wages, missed school, and the like could not be measured with the administrative data.

Despite these limitations, findings from the current study support the consideration of home RMES use, in addition to chronic diagnoses (including respiratory ones), when projecting health care use and spending for CMC. Further exploration and investigation is needed to assess the influence of RMES use on longitudinal health care use and spending. Additionally, medical equipment and supplies associated with other organ systems (eg, digestive and urologic) may also prove important in assessing the relationship between children's functional limitations and their health care use and spending. Ultimately, population-based initiatives in children should strive to maximize use of all available health-related information, not just limited to chronic diagnoses coded with administrative health care claims, when projecting health care use and spending and when targeting children with complex medical needs for clinical and health services interventions to optimize their health and well-being. ■

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Reprint requests: Jay G. Berry, MD, MPH, Division of General Pediatrics, Boston Children's Hospital, Harvard Medical School, 21 Autumn St, Rm 212.2, Boston, MA 02115. E-mail: jay.berry@childrens.harvard.edu

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50 Years Ago in *The Journal of Pediatrics*

Cortisol Secretion in Acidotic and Nonacidotic Juvenile Diabetes Mellitus

Garces LY, Kenny FM, Drash A, Preeyasombat C. J Pediatr 1969;74:517-22.

The pathogenesis of juvenile diabetes, now called type 1 diabetes mellitus (T1DM), has long been a topic of investigation. In the late 1950s, patients with T1DM were known to have insulin deficiency, but insulinopenia alone was not thought to adequately explain the variation in clinical presentation. Other diabetogenic hormones were theorized to play a role. Cortisol seemed a promising culprit because of the association of glucocorticoids and Cushing syndrome with hyperglycemia. Garces et al compared cortisol secretion in children with and without T1DM and found no difference, leading to the conclusion that cortisol was not involved in T1DM pathogenesis.

We also now understand that T1DM is caused by autoimmune destruction of insulin-producing pancreatic β-cells.[1] There is a strong genetic component with close association with certain HLA haplotypes. Numerous autoantibodies have been discovered in children with T1DM including antibodies against insulin, glutamic acid decarboxylase, islet antigen-2, and the ZnT8 transporter. However, these autoantibodies are believed to be markers of autoimmune disease, rather than pathogenic.

We now recognize the asymptomatic presence of β-cell autoimmunity (defined by the presence of 2 or more autoantibodies) with normoglycemia as the first stage in a predictable sequence in the development of T1DM. These stages were set forth in 2015 as part of a joint scientific statement from the Juvenile Diabetes Research Foundation, the Endocrine Society, and the American Diabetes Association.[2] Stage 2, which is also presymptomatic, is identified by β-cell autoimmunity and dysglycemia. Stage 3 marks the onset of symptomatic T1DM.

Another ongoing area of investigation is the proposed environmental triggers that lead to T1DM. Infections with enteroviruses, particularly coxsackieviruses B, rotavirus, rubella infections, and alterations in gut microbiota have all been implicated.

Even now, much remains unknown about the pathogenesis of T1DM. Continued investigation is required to identify patients early in the disease process and to develop better treatment options and interventions to prevent or delay disease progression.

Holly C. Cooper, MS, MD
David M. Maahs, MD, PhD
Department of Pediatrics
Division of Pediatric Endocrinology and Diabetes
Stanford University School of Medicine
Stanford, California

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Table I. HCPCS and ICD-9-CM codes for RMES used in the current study

Codes*	RMES type	Code description
E0483	High-frequency chest wall oscillator	High-frequency chest wall oscillation air-pulse generator system (includes hoses and vest), each
E0480	High-frequency chest wall oscillator	Percussor, electric or pneumatic, home model
E0481	High-frequency chest wall oscillator	Intrapulmonary percussive ventilation system and related accessories
A7025	High-frequency chest wall oscillator	High-frequency chest wall oscillation system vest, replacement for use with patient owned equipment, each
A4483	Ventilator	Moisture exchanger, disposable, for use with invasive mechanical ventilation
E0463	Ventilator	Pressure support ventilator with volume control mode, may include pressure control mode, used with invasive interface (eg, tracheostomy tube)
E0464	Ventilator	Pressure support ventilator with volume control mode, may include pressure control mode, used with a noninvasive interface (eg, mask)
E0450	Ventilator	Volume control ventilator, without pressure support mode, may include pressure control mode, used with an invasive interface (eg, tracheostomy tube)
A4611	Ventilator	Battery, heavy duty; replacement for patient owned ventilator
A4613	Ventilator	Battery charger; replacement for patient-owned ventilator
E0461	Ventilator	Volume control ventilator, without pressure support mode, may include pressure control mode, used with a noninvasive interface (eg, mask)
3485	Ventilator	Implantation of diaphragmatic pacemaker
V461†	Ventilator	Respirator
A7526	Tracheostomy	Tracheostomy tube collar/holder, each
A7520	Tracheostomy	Tracheostomy/laryngectomy tube, noncuffed, polyvinylchloride (PVC), silicone or equal, each
A7525	Tracheostomy	Tracheostomy mask, each
A4629	Tracheostomy	Tracheostomy care kit for established tracheostomy
A7521	Tracheostomy	Tracheostomy/laryngectomy tube, cuffed, polyvinylchloride (PVC), silicone or equal, each
L8501	Tracheostomy	Tracheostomy speaking valve
A7507	Tracheostomy	Filter holder and integrated filter without adhesive, for use in a tracheostoma heat and moisture exchange system, each
S8189	Tracheostomy	Tracheostomy supply, not otherwise classified
A4623	Tracheostomy	Tracheostomy, inner cannula
A7509	Tracheostomy	Filter holder and integrated filter housing, and adhesive, for use as a tracheostoma heat and moisture exchange system, each
A4625	Tracheostomy	Tracheostomy care kit for new tracheostomy
A7527	Tracheostomy	Tracheostomy/laryngectomy tube plug/stop, each
A7504	Tracheostomy	Filter for use in a tracheostoma heat and moisture exchange system, each
A4626	Tracheostomy	Tracheostomy cleaning brush, each
A7503	Tracheostomy	Filter holder or filter cap, reusable, for use in a tracheostoma heat and moisture exchange system, each
A7522	Tracheostomy	Tracheostomy/laryngectomy tube, stainless steel or equal (sterilizable and reusable), each
A7523	Tracheostomy	Tracheostomy shower protector, each
312‡	Tracheostomy	Permanent tracheostomy
3121‡	Tracheostomy	Mediastinal tracheostomy
3129‡	Tracheostomy	Other permanent tracheostomy
3141‡	Tracheostomy	Tracheoscopy through artificial stoma
3174‡	Tracheostomy	Revision of tracheostomy
3321‡	Tracheostomy	Bronchoscopy through artificial stoma
9655‡	Tracheostomy	Tracheostomy toilette
9723‡	Tracheostomy	Replacement of tracheostomy tube
519†	Tracheostomy	Tracheostomy complications
V440†	Tracheostomy	Artificial opening status—tracheostomy
V550†	Tracheostomy	Attention to artificial openings—tracheostomy
A7002	Suction	Tubing, used with suction pump, each
A7000	Suction	Canister, disposable, used with suction pump, each
A4624	Suction	Tracheal suction catheter, any type other than closed system, each
E0600	Suction	Respiratory suction pump, home model, portable or stationary, electric
A4605	Suction	Tracheal suction catheter, closed system, each
A7001	Suction	Canister, nondisposable, used with suction pump, each
V460†	Suction	Aspirator
E1390	Oxygen	Oxygen concentrator, single delivery port, capable of delivering 85% or greater oxygen concentration at the prescribed flow rate
E0431	Oxygen	Portable gaseous oxygen system, rental; includes portable container, regulator, flowmeter, humidifier, cannula or mask, and tubing
E0445	Oxygen	Oximeter device for measuring blood oxygen levels noninvasively
A4606	Oxygen	Oxygen probe for use with oximeter device, replacement
E0565	Oxygen	Compressor, air power source for equipment which is not self-contained or cylinder driven
E0424	Oxygen	Stationary compressed gaseous oxygen system, rental; includes container, contents, regulator, flowmeter, humidifier, nebulizer, cannula or mask, and tubing
K0738	Oxygen	Portable gaseous oxygen system, rental; home compressor used to fill portable oxygen cylinders; includes portable containers, regulator, flowmeter, humidifier, cannula or mask, and tubing

(*continued*)

Table I. Continued

Codes*	RMES type	Code description
E0441	Oxygen	Oxygen contents, gaseous (for use with owned gaseous stationary systems or when both a stationary and portable gaseous system are owned), 1 month's supply = 1 unit
E0439	Oxygen	Stationary liquid oxygen system, rental; includes container, contents, regulator, flowmeter, humidifier, nebulizer, cannula or mask, and tubing
E0550	Oxygen	Humidifier, durable for extensive supplemental humidification during IPPB treatments or oxygen delivery
E0434	Oxygen	Portable liquid oxygen system, rental; includes portable container, supply reservoir, humidifier, flowmeter, refill adaptor, contents gauge, cannula or mask, and tubing
E0443	Oxygen	Portable oxygen contents, gaseous (for use only with portable gaseous systems when no stationary gas or liquid system is used), 1 month's supply = 1 unit
E1392	Oxygen	Portable oxygen concentrator, rental
E1353	Oxygen	Regulator
E0560	Oxygen	Humidifier, durable for supplemental humidification during ippb treatment or oxygen delivery
E0442	Oxygen	Oxygen contents, liquid (for use with owned liquid stationary systems or when both a stationary and portable liquid system are owned), 1 month's supply = 1 unit
E0430	Oxygen	Portable gaseous oxygen system, purchase; includes regulator, flowmeter, humidifier, cannula or mask, and tubing
E0444	Oxygen	Portable oxygen contents, liquid (for use only with portable liquid systems when no stationary gas or liquid system is used), 1 month's supply = 1 unit
V462†	Oxygen	Supplemental oxygen
A7035	NIPPV	Headgear used with positive airway pressure device
A7038	NIPPV	Filter, disposable, used with positive airway pressure device
E0601	NIPPV	Continuous airway pressure (CPAP) device
A7037	NIPPV	Tubing used with positive airway pressure device
E0562	NIPPV	Humidifier, heated, used with positive airway pressure device
A7030	NIPPV	Full face mask used with positive airway pressure device, each
A7034	NIPPV	Nasal interface (mask or cannula type) used with positive airway pressure device, with or without head strap
A7039	NIPPV	Filter, non disposable, used with positive airway pressure device
A7046	NIPPV	Water chamber for humidifier, used with positive airway pressure device, replacement, each
A4604	NIPPV	Tubing with integrated heating element for use with positive airway pressure device
E0561	NIPPV	Humidifier, nonheated, used with positive airway pressure device
A7036	NIPPV	Chinstrap used with positive airway pressure device
A7027	NIPPV	Combination oral/nasal mask, used with continuous positive airway pressure device, each
A7044	NIPPV	Oral interface used with positive airway pressure device, each
E0482	Mechanical in-exsufflator	Cough stimulating device, alternating positive and negative airway pressure
E0471	Mechanical in-exsufflator	Respiratory assist device, bilevel pressure capability, with back-up rate feature, used with noninvasive interface, for example, a nasal or facial mask (intermittent assist device with continuous positive airway pressure device)
E0470	Mechanical in-exsufflator	Respiratory assist device, bilevel pressure capability, without backup rate feature, used with noninvasive interface, eg, nasal or facial mask (intermittent assist device with continuous positive airway pressure device)
E0484	Mechanical in-exsufflator	Oscillatory positive expiratory pressure device, nonelectric, any type, each
E0472	Mechanical in-exsufflator	Respiratory assist device, bilevel pressure capability, with backup rate feature, used with invasive interface, eg, tracheostomy tube (intermittent assist device with continuous positive airway pressure device)
E0619	Apnea Monitor	Apnea monitor, with recording feature
A4556	Apnea Monitor	Electrodes, (eg, apnea monitor), per pair
A4557	Apnea Monitor	Lead wires, (eg, apnea monitor), per pair
E0618	Apnea Monitor	Apnea monitor, without recording feature

IPPB, intermittent positive pressure breathing.
*Codes are from the HCPCS unless indicated otherwise.
†ICD-9-CM, diagnosis code.
‡ICD-9-CM procedure code.