

Associations of Coexisting Conditions with Healthcare Spending for Children with Cerebral Palsy

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Objective To determine which coexisting conditions have the strongest associations with healthcare use and spending among children with cerebral palsy (CP).

Study design Retrospective analysis of 16 695 children ages 0-18 years with CP – identified with *International Classification of Diseases, Ninth Revision, Clinical Modification* codes – using Medicaid from January 1, 2013 to December 31, 2013 from 10 states in the Truven MarketScan Medicaid Database. Using generalized linear models, we assessed which coexisting conditions (including medical technology) identified with Agency for Healthcare Research and Quality's Chronic Condition Indicators had the strongest associations with total healthcare spending across the healthcare continuum.

Results Median per-patient annual Medicaid spending for children with CP was \$12 299 (IQR \$4826-\$35 582). Most spending went to specialty (33.1%) and hospital (26.7%) care. The children had a median 6 (IQR 4-10) coexisting conditions; epilepsy was the most common (38.1%). Children with epilepsy accounted for 59.6% (\$364 million) of all CP spending. In multivariable analysis, the coexisting conditions most strongly associated with increased spending were tracheostomy (median additional cost per patient = \$56 567 [95%CI \$51 386-61 748]) and enterostomy (median additional cost per patient = \$25 707 [95%CI \$23 753-27 660]).

Conclusions Highly prevalent in children with CP using Medicaid, coexisting conditions correlate strongly with healthcare spending. Tracheostomy and enterostomy, which indicate significant functional impairments in breathing and digestion, are associated with the highest spending. Families, providers, payers, and legislators may leverage these findings when designing policies positioned to enable the best health and care for children with cerebral palsy. (*J Pediatr* 2018;■■■:■■■-■■■).

Cerebral palsy (CP) describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to nonprogressive disturbances that occurred in the developing fetal or infant brain.¹ With a prevalence of 2-4 per 1000 US children, CP is the most common activity-limiting motor/movement disorder and one of the most important causes of neurologic impairment and functional limitations in children.^{2,3} Advances in medical and surgical care have resulted in improved survival of children with CP, especially those with a higher severity of neuromuscular impairment (eg, Gross Motor Function Classification System [GMFCS] IV or V).^{4,5} This improved survival has been associated with a concomitant increase in the development of coexisting conditions as the children age.

Among children with CP are those with a high prevalence of significant coexisting conditions that are disabling and, at times, life-limiting. Nearly 50% of children with severe CP (eg, GMFCS IV or V) have coexisting conditions due to digestive, respiratory, urinary, and other health problems that preclude the ability to eat and drink, breathe, or urinate.⁶⁻⁸ Examples of these coexisting conditions include dysphagia, digestive dysmotility, chronic respiratory insufficiency, and urinary retention. The neurologic deficits associated with CP are directly related to these coexisting conditions. Because organs and physiologic systems are controlled, managed, and regulated by the brain, their functioning may be compromised when brain function is impaired.^{9,10}

Because of disabling health conditions, many US children enroll in a state Medicaid program to access health services and treatments designed to optimize their health and well-being.¹¹ These Medicaid programs are essential, as many private

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AHRQ	Agency for Healthcare Research and Quality
CART	Classification and Regression
CCI	Chronic condition indicator
CP	Cerebral palsy
DME	Durable medical equipment
GMFCS	Gross Motor Function Classification System
ICD-9-CM	<i>International Classification of Diseases, Ninth Revision, Clinical Modification</i>

insurance policies do not include all the services and treatments that children require (eg, durable medical equipment [DME] and home nursing).^{12,13} Current reforms to federal and state healthcare policies are considering funding cuts to Medicaid.^{14,15} These cuts could limit coverage of services and treatments for children with CP, which could limit the coverage of their health services as well as increase out-of-pocket medical expenses and caregiving burden to their families.^{16,17} Children with CP and coexisting conditions could be particularly affected by these policies because it is suspected that they have high resource use and spending.¹⁸⁻²⁰

Little is known about which coexisting conditions experienced by children with CP affect their healthcare resource use and spending the most. The objective of the present study was to assess which coexisting conditions in children with CP are associated with the greatest amount of healthcare use and spending across the care continuum.

Methods

This is a retrospective analysis of children with CP ages 0-18 years continuously enrolled in Medicaid in 2013 from 10 states in the Truven MarketScan Medicaid Dataset. Children are followed longitudinally across healthcare encounters in the dataset using a unique identifier. Although the data usage agreement precludes the names of the states to be publicly revealed, the states reside in all geographic regions of the US (correspondence with Truven). Children qualified for Medicaid enrollment based on disability or family income. The Institutional Review Board at Boston Children's Hospital declared this study exempt from review.

Children with CP were identified using the Agency for Healthcare Research and Quality (AHRQ)'s open-source, publicly available chronic condition indicator (CCI).^{21,22} The AHRQ CCI uses *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis codes to identify chronic conditions from health administrative claims data. The ICD-9-CM diagnosis codes included for CP in the AHRQ scheme are 343.0-343.9 ("infantile CP") and 344.0-344.9 ("spastic paralysis specified as noncongenital or noninfantile").

Healthcare cost and utilization across the care continuum in 2013 for children with CP were the main outcome measures. Healthcare cost was reported in the dataset as the Medicaid spending for every healthcare encounter (eg, primary care visit, emergency department visit, hospitalization, etc), pharmacy claim, DME claim, therapy (eg, physical, speech, and occupational), and home/community health service (eg, home healthcare).

To assess the coexisting conditions experienced by each child with CP in the cohort, we used AHRQ CCI introduced above.²¹⁻²³ CCI classifies all ~14 000 ICD-9-CM diagnosis codes as chronic or not chronic. The scheme defines a chronic condition as a condition that lasts 12 months or longer and meets 1 or both of the following criteria: it places limitations on self-care, independent living, and social interactions; and it results in the need for ongoing intervention with medical products, services, or special equipment. AHRQ's Clinical Classifica-

tion System groups the chronic ICD-9-CM codes identified from the CCI into a clinically comprehensive, mutually exclusive set of coexisting conditions (eg, multiple ICD-9-CM codes for epilepsy are grouped in the epilepsy CC). Coexisting conditions also include assistance with medical technology, such as gastrostomy and tracheostomy. All ICD-9-CM codes recorded for each child across every healthcare encounter during the study period were used to assess information on coexisting conditions.

Demographic characteristics reported for the cohort were age in years at the beginning of the study period, race/ethnicity as categorized in the database (non-Hispanic white, non-Hispanic black, Hispanic, and other), sex, and reason for enrollment in Medicaid (disability vs other reason [eg, low family income]). We also assessed use of wheelchair (including parts and accessories) and other mobility devices (eg, posterior walker, lower extremity orthotics, adaptive seating and stroller, etc) dispensed during the study year, identified from the Healthcare Common Procedure Coding System.²⁴ Healthcare Common Procedure Coding System is used by DME companies when submitting payment requests to payers for dispensed items.

Statistical Analyses

To identify the coexisting conditions with the strongest associations with healthcare spending and utilization in children with CP, we employed a 3-step process. We used a Pareto principle approach to rank the coexisting conditions in descending order by their total healthcare spending across the healthcare continuum. With this approach, we identified the CC that, when present, accounted for the greatest proportion of healthcare spending of all children within the subcohort of children with CP. We then used χ^2 and Wilcoxon rank sum tests to compare healthcare use and spending between children with and without that CC. For children with that CC, we assessed total and itemized (eg, inpatient) healthcare use and spending for all of their claims (ie, not just those claims with a code for that CC).

We then derived a generalized linear model regressing 15 of the coexisting conditions with the greatest impact on total spending (Figure 1) on median total Medicaid spending per patient, controlling for patients' other characteristics including age, race/ethnicity, sex, and use of wheelchair and other mobility devices. The final model articulated the individual contribution (ie, additional cost) associated with each CC that had a statistically significant effect on spending.

We used a machine learning method, Classification and Regression Tree (CART) analysis, to explore and identify systematically the most consequential interactions of the 15 prioritized coexisting conditions in children with CP.¹⁷ CART empirically assessed the vast (ie, thousands of) combinations of rare, heterogeneous coexisting conditions experienced by many children with CP to determine which combinations have the strongest associations with healthcare spending.

All statistical analyses were performed using SAS v 9.4 (SAS Institute, Cary, North Carolina). *P* values <.05 were considered statistically significant.

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