Title:

Healthcare spending and utilization among privately insured children with medical complexity

Authors:

Angela Wangari Walter, Ph.D., M.P.H., M.S.W.,[a]

Randall P. Ellis, Ph.D.,[b]

Yiyang Yuan, M.P.H.,[c]

Affiliations:

[a]Department of Public Health, College of Health Sciences, University of Massachusetts Lowell, 61 Wilder Street, O'Leary Library Suite 540O, Lowell, MA 01854. Email: angela_walter@uml.edu;

[b]Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215. Email: ellisrp@bu.edu

[c]Clinical and Population Health Research Program, Graduate School of Biomedical Sciences, University of Massachusetts Medical School, 55 Lake Ave North, Worcester, Massachusetts 01655. Email: yiyang.yuan@umassmed.edu

Corresponding author:

Angela Wangari Walter, Ph.D., M.P.H., M.S.W., Assistant Professor, Department of Public Health, College of Health Sciences, University of Massachusetts Lowell, 61 Wilder Street, O'Leary Library Suite 540O, Lowell, MA 01854. Email: angela_walter@uml.edu Tel: 978-934-5374

Acknowledgements:

The authors thank Sara Bachman, PhD (Principal Investigator), Margaret Comeau (Co-Principal Investigator), Beth Dworetzky (Project Director), all at the Catalyst Center, Center for Advancing Health Policy and Practice at Boston University School of Public Health; and LT Leticia Manning, MPH (Project Officer), Maternal and Child Health Bureau within the Health Resources Services Administration for comments and suggestions on earlier versions of this manuscript.

Role of the funding source:

This study was supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) under grant number U41MC13618. This information or content and conclusions are those of the authors and should not be construed as the official position or policy of nor should any endorsements be inferred by HRSA, HHS, or the U.S. Government.

Disclosures:

The authors have indicated they have no financial or personal relationships relevant to this article to disclose.

Conflict of interest statement:

The authors have no conflicts of interests relevant to this article to disclose.

Contributors' Statement:

Dr. Angela Wangari Walter conceptualized the study, conducted the literature review, supervised the data analysis, drafted the initial manuscript, revised the manuscript, and approved the final manuscript as submitted.

Dr. Randall P. Ellis conceptualized the analysis, reviewed and interpreted analysis, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Ms. Yiyang Yuan performed the data analysis, revised the manuscript and approved the final manuscript as submitted.

All authors have critically reviewed the manuscript, approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

What's new

This study presents recent data from a high-quality commercial claims database on patterns of health service utilization, healthcare expenditures, and the magnitude of family financial impact for children with medical complexity who are enrolled in employer-sponsored health plans.

Abbreviations:

HMO - Health maintenance organization

PPO - Preferred provider organization

CDHP - Consumer-driven health plan

HDHP - High-deductible health plan

Key words: Children; Healthcare Spending; Healthcare Utilization; Medical Complexity

Abstract word count: 198

Main text word count: 3,659 (from introduction to conclusion)

Abstract

Objectives: Children with medical complexity have high health expenditures and health service utilization. This study examined patterns of annual health service utilization, out-of-pocket spending and family financial impact among children enrolled in private health plans.

Methods: We used IBM Watson /Truven Analytics℠ MarketScan® commercial claims and encounters data (2012-2014). Multivariate generalized linear regression models were used to test the difference in health service utilization and expenditure between insurance plans and between medical complexity levels. Multivariate logistic regression models were used to assess the likelihood of family financial impact with regard to family complexity levels.

Results: Children enrolled in health maintenance organizations (HMOs) had significantly lower out-of-pocket spending. Families were substantially more likely to experience spend more than $1000 on medical care within a year when enrolled in high-deductible (OR 2.70, 95%CI: (2.66, 2.74)) or consumer-driven (OR 1.69, 95%CI: (1.66, 1.72)) plans than those covered by PPO plans. Families in high-deductible and consumer-driven plans faced significantly greater out-of-pocket spending and cost-shares on hospitalizations, emergency room services, mental health services and prescription medications.

Conclusions: Families with children with chronic health needs and medical complexity need to be cognizant that the greater patient cost-sharing health plans can impose significant financial burdens.

Introduction

There is tremendous interest in reforms that create incentives for cost-effective, high quality care, but little attention has been given to the effects of these reforms on children. Children with medical complexity, a subset of children with special health care needs,(McPherson et al., 1998) refer to those with the most severe, complex, and life-threatening health problems,(Berry et al., 2015; Cohen et al., 2012) who have greater needs for healthcare services. Children with medical complexity have longer hospital stays(Gold et al., 2016) and use extensive critical care resources,(Chan et al., 2016) which leads to higher healthcare expenses.(Berry et al., 2014; Cohen et al., 2012; McPherson et al., 1998) This sub-population accounts for at least one-third of healthcare spending on children with private insurance.(Cohen et al., 2012)

Public and private healthcare expenditures have continued to increase.(Centers for Medicare and Medicaid Services, 2015) Out-of-pocket expenses, defined as the share of healthcare costs incurred by the patient, have drastically grown as health plans increase their deductibles, copayments, and coinsurance rates.(Centers for Medicare and Medicaid Services, 2015) As out-of-pocket expenses impact a patient's access to and utilization of healthcare services, high out-of-pocket expenditures have been associated with delayed and forgone healthcare services and nonadherence to prescription drugs, contributing to poor health outcomes.(Baughman et al., 2015; Wisk and Witt, 2012; Wiltshire et al., 2015) Further, families with multiple children are at particular risk of financial burdens due to children with special health care needs, a topic that has received relatively little attention.(Shattuck and Parish, 2008; Parish et al., 2012; Chen and Newacheck, 2006) Kuo et al., estimated nearly 50% of U.S. families with one or more complex children with special health care needs face financial burdens, including spending over $1,000 out-of-pocket on medical expenses.(Kuo et al., 2011)

Healthcare utilization and costs for children with medical complexity have been documented using Medicaid and Children's Health Insurance Plan enrollees, both of which historically have had very low out-of-pocket costs.(Cohen et al., 2012; Berry et al., 2014) The Marketplace health plans created by the Affordable Care Act of 2010, recent trends in private insurance, and even some recent legislation proposed for Medicaid, have all tended to increase deductibles and out-of-pocket costs on children. These changes have a particular importance on privately-insured families of children with medical complexity, an important and growing subpopulation.(Newacheck et al., 2000) Moreover, because medical complexity of children is often chronic, lasting for many years, the health savings account or health reimbursement account typically paired with such plans may be inadequate to protect families enrolled in such plans from significant financial hardship. This study examines the prevalence and size of these burdens on privately-insured children with medical complexity.

This study protocol was reviewed by the Institutional Review Board at Boston University Medical Center which determined that the study did not meet the definition of "human subject research".

Methods

Data: IBM Watson /Truven Analytics℠ MarketScan® commercial claims and encounter data 2012-2014 (the "claims database") were used. These data contain annual medical and prescription drug claims for employees and their dependents covered by employer-sponsored health insurance.(Hansen and Chang, 2011)

Study sample: Children aged 0 to 17 were included if in all three years (2012-2014), they: (1) had at least one medical encounter claim, and (2) were continuously enrolled for at least 12 months in one of the following four plan types: preferred provider organizations (PPO), health

maintenance organizations (HMO), consumer-driven health plans or high-deductible health plans. The latter two types of plans, which have gained much popularity in recent years, usually share a similar network of providers as PPO with lower premiums and are accompanied by options such as health savings account to help employees better plan their healthcare expenditures.

Outcome variables:

Healthcare service utilization: Analysis focused on inpatient hospitalizations, outpatient prescription medications, emergency room visits, mental health service visits, durable medical equipment (DME) uses, home health services, occupational/physical/speech therapies (OT/PT/ST), and laboratory and radiologic testing. Utilization of inpatient hospitalization was operationalized as the total number of admissions in one year. Number of outpatient prescription drug fills was calculated based on the number of days that a prescription had been filled, regardless of type, duration or dosage of the medication. Given that multiple claims are often generated for one patient during one visit, claims that occurred on the same date were compiled to generate one single day-episode of service utilization.

Healthcare service expenditure: We calculated three expense measures at the family and individual child level: (1) annual total out-of-pocket spending, defined as the total expenses (sum of deductibles, coinsurance, and copayments) for a given type of healthcare service; (2) annual total cost, defined as the gross payment to a provider for a specific type of service; and (3) cost-share, defined as the percentage of total cost that was paid out-of-pocket by the patient. The distributions of annual total out-of-pocket spending and annual total cost were both highly skewed. The extreme high values, corresponding to those in the top 0.1% percentile, were excluded from the analysis in order to limit the effect of outliers.(Youn et al., 2016; Ash and

Ellis, 2012) A family was regarded as having greater financial impact if it had spent over $1,000 on children's healthcare services in one year.(Kogan et al., 2008; Kuo et al., 2011)

Covariates:

Child-level covariates:

Child-level medical complexity measure: The Pediatric Medical Complexity Algorithm, a modification of the Chronic Disability Payment System, was used to identify and stratify children aged 0-17 by levels of medical complexity.(Simon et al., 2014) The algorithm assigns medical complexity levels to children according to progressiveness and malignancy of conditions while accounting for the number of body systems involved based on 3 consecutive years of medical claims data.(Simon et al., 2014) We used the more conservative version of the algorithm to classify children into three medical complexity levels: "Complex chronic", if more than one body system was involved, or at least one condition was progressive or malignant; "Non-complex chronic", if only one body system was involved and the condition was neither progressive nor malignant; and "Non-chronic", if the child did not meet any of the other two criteria.

Other child-level covariates include children's age, gender, and types of health insurance.

Family-level covariates:

Family-level medical complexity measure: Families were grouped into four categories according to the number of children with degrees of medical complexity: "No children with chronic condition", "One child with non-complex chronic condition", "One child with complex chronic condition", and "Two or more children with non-complex chronic and/or complex chronic conditions".

Statistical Analysis

We used multivariate generalized linear regression to test the difference in healthcare utilization and expenditure between insurance plan types and between medical complexity levels, controlling for data years, children's age and gender. We then used multivariate logistic regression to assess the likelihood of family financial impact by family complexity levels. We present estimates along with 95% confidence intervals (95% CI). We used P-value thresholds at 0.001 and 0.0001. In the results below, we first present the descriptive statistics on children's age, gender, medical complexity levels in addition to family complexity measures. Annual expenditure and utilization of healthcare services are described for the entire study sample, then by insurance plan types and children's medical complexity levels.

Results

Demographics

Demographics and plan characteristics are presented in Table 1. Over 7 million children (N=7,286,570) had at least one claim and were consistently enrolled in the same plan type from 2012 to 2014. Most children were enrolled in a PPO plan (73.2%), followed by HMOs (11.8%), consumer driven plans (7.8%) and high deductible plans (7.2%) plans. The mean age was 7.5 (SD 5.2) and 50.8% were male. The distribution of age and gender was consistent across plan types. Approximately 6.6% of the children had complex chronic conditions, 16.6% had non-complex conditions and 76.8% had non-chronic conditions. When stratified by plan types, 7.1% of children enrolled in HMO had complex chronic conditions, the highest proportion across all plan types. Children came from over 4 million families (N=4,389,281). Majority of the families had children with no chronic conditions (67.3%). Overall, 5.3% of all families had two or more children with complex chronic and/or non-complex chronic conditions; and HMOs had the highest percentage of their families with complex chronic conditions (5.9%).

Table 1. Characteristics of study sample

	All	Health maintenance organizations	Preferred provider organizations	Consumer-driven health plans	High-deductible health plans
Children (#)	(N = 7,286,570)	(N=860,071)	(N=5,333,274)	(N=564,899)	(N=528,326)
Age[1] Mean (SD)	7.2 (5.2)	7.4 (5.2)	7.5 (5.2)	7.5 (5.3)	7.4 (5.2)
Female[1] (%)	49.2	49.3	49.2	49.3	49.3
Child complexity levels					
Non-chronic (%)	76.8	74.9	76.4	79.7	80.9
Non-complex chronic (%)	16.6	18.0	16.9	14.7	13.8
Complex chronic (%)	6.6	7.1	6.7	5.6	5.3
Number of families (#)	(N=4,389,281)	(N=521,916)	(N=3,218,288)	(N=340,130)	(N=308,947)
Family complexity levels					
No children with chronic condition (%)	67.3	65.0	66.8	71.1	72.3
One child with non-complex chronic condition (%)	19.9	21.1	20.1	18.0	17.2
One child with complex chronic condition (%)	7.5	8.0	7.7	6.5	6.2
Two or more children with complex chronic and/or non-complex chronic condition (%)	5.3	5.9	5.4	4.3	4.3

Notes:
[1] Age and gender were calculated at the first appearance of a health claim in the claims database.

Healthcare services utilization

As shown in Table 2, among children with at least one visit of each type of service, children on average had at least one inpatient hospitalization (1.1, SD (0.6)) and at least one emergency room visit (1.4, SD (0.8)) per year. These rates were consistent across plan types and medical complexity levels. Children with complex chronic conditions had more inpatient admissions (1.5, SD (1.4)), more mental health services visits (10.6, SD (18.8)), and more prescriptions filled (9.1, SD (9.6)) in a year. It is interesting to note that the number of mental health services visits among children with complex chronic conditions was more than double that of children without chronic conditions (5.9, SD (7.5)). The distribution of the number of children that had ever used a given service category is listed in Supplmental Table A.

Using a multivariate generalized linear model we assessed the impact of insurance plan type and children's medical complexity levels on healthcare services utilization adjusting for children's age, gender and data year. As shown in Table 3a, estimated differences between plan

types were small, though significant in several service categories, including emergency rooms, mental health services and prescription drugs. Compared to children without any chronic conditions, children with non-complex chronic and complex chronic conditions had significantly higher utilization of all health services (Table 3a). Specifically, annual rate of hospitalizations in children with complex chronic conditions were 41.6% higher than those without any chronic conditions. Visits to emergency rooms in children with non-complex chronic conditions were 12.6% higher compared to children without any chronic conditions, and in children with complex chronic conditions 30.3% higher. Rate of mental health services of those with complex chronic conditions were close to twice of children without chronic conditions annually. Lastly, number of times that prescription drugs were filled in children with complex chornic conditions nearly tripled that in those without any chronic conditions.

The utilization of other types of health services i.e. durable medical equipment, home health services, laboratory and radiologic testing, and occupational/physical/speech therapies (OT/PT/ST) are shown in Supplemental Tables B and C-i.

Table 2. Healthcare services expenditure and utilization on hospitalization, emergency room, mental health and prescription drug services

	Use[a] (#)		OOP[b] ($)		Cost-share[c] (%)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Hospitalization						
All	1.1	(0.6)	914	(1192)	16.7	(19.1)
By insurance plan						
HMO	1.1	(0.7)	445	(854)	6.9	(12.6)
PPO	1.1	(0.6)	953	(1171)	17.4	(18.5)
Consumer-driven	1.1	(0.6)	1,036	(1278)	20.9	(22.9)
High-deductible	1.1	(0.8)	1,128	(1546)	19.6	(22.9)
By medical complexity level						
Non-chronic	1.0	(0.2)	732	(969)	19.0	(20.4)
Non-complex chronic	1.1	(0.5)	1,202	(1359)	15.0	(16.7)
Complex chronic	1.5	(1.4)	1,304	(1558)	9.6	(13.5)
Emergency room						
All	1.4	(0.8)	369	(478)	33.3	(32.1)
By insurance plan						
HMO	1.4	(0.8)	182	(258)	18.2	(21.2)
PPO	1.4	(0.9)	370	(450)	33.9	(30.8)
Consumer-driven	1.3	(0.8)	464	(602)	38.1	(38.2)
High-deductible	1.3	(0.8)	644	(748)	52.8	(42.8)
By medical complexity level						
Non-chronic	1.3	(0.7)	375	(477)	36.2	(33.3)
Non-complex chronic	1.4	(0.9)	366	(480)	30.2	(30.0)
Complex chronic	1.7	(1.3)	345	(480)	24.2	(26.6)
Mental health service						
All	8.5	(14.8)	276	(501)	33.8	(32.0)
By insurance plan						
HMO	8.9	(16.6)	156	(298)	19.2	(20.8)
PPO	8.4	(14.2)	283	(504)	34.3	(31.2)
Consumer-driven	8.2	(15.3)	294	(537)	38.4	(36.5)
High-deductible	8.8	(17.4)	432	(686)	54.6	(40.5)
By medical complexity level						
Non-chronic	5.9	(7.5)	218	(365)	38.3	(33.8)
Non-complex chronic	8.9	(15.4)	288	(516)	33.8	(31.9)
Complex chronic	10.6	(18.8)	316	(587)	28.8	(29.1)
Prescription drugs						
All	4.3	(5.3)	101	(223)	45.7	(34.6)
By insurance plan						
HMO	4.2	(5.1)	80	(164)	41.9	(32.1)
PPO	4.4	(5.3)	97	(209)	44.3	(33.6)
Consumer-driven	4.3	(5.2)	129	(292)	48.6	(39.0)
High-deductible	4.0	(5.1)	160	(350)	66.7	(38.5)
By medical complexity level						
Non-chronic	3.0	(3.1)	58	(132)	50.0	(35.5)
Non-complex chronic	6.5	(6.1)	177	(293)	37.1	(30.9)
Complex chronic	9.1	(9.6)	237	(396)	34.8	(29.9)

Notes:

Table 3a. Multivariate generalized linear models: annual total number of uses of healthcare services [a] (hospitalization, emergency room, mental health and prescription drug services)

	Hospitalization		Emergency room		Mental health service		Prescription drugs	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Insurance plan								
PPO	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
HMO	1.001	(0.994, 1.009)	1.003	(1.000, 1.007)	1.056**	(1.054, 1.058)	0.933**	(0.932, 0.934)
Consumer-driven	0.998	(0.990, 1.006)	0.991**	(0.986, 0.995)	0.985**	(0.983, 0.988)	0.989**	(0.988, 0.990)
High-deductible	1.003	(0.994, 1.012)	0.974**	(0.970, 0.979)	1.052**	(1.049, 1.055)	0.935**	(0.934, 0.937)
Medical complexity level								
Non-chronic	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
Non-complex chronic	1.081**	(1.074, 1.088)	1.126**	(1.123, 1.129)	1.512**	(1.509, 1.515)	2.102**	(2.100, 2.103)
Complex chronic	1.416**	(1.407, 1.425)	1.303**	(1.299, 1.308)	1.808**	(1.804, 1.811)	2.950**	(2.947, 2.952)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to due to the Poisson distribution of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Annual total number of admissions (for hospitalization), number of visits to the given category of service (emergency room and mental health services), or number of days that prescription medications were filled.

Table 3b. Multivariate generalized linear models: out-of-pocket expenditure [a] on healthcare services (hospitalization, emergency room, mental health and prescription drug services)

	Hospitalization		Emergency room		Mental health service		Prescription drugs	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Insurance plan								
PPO	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
HMO	0.451**	(0.447, 0.454)	0.497**	(0.495, 0.499)	0.551**	(0.548, 0.555)	0.826**	(0.824, 0.828)
Consumer-driven	1.114**	(1.104, 1.124)	1.246**	(1.240, 1.252)	1.039**	(1.031, 1.048)	1.342**	(1.339, 1.345)
High-deductible	1.165**	(1.154, 1.177)	1.731**	(1.721, 1.740)	1.536**	(1.524, 1.549)	1.696**	(1.691, 1.701)
Medical complexity level								
Non-chronic	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
Non-complex chronic	1.400**	(1.390, 1.409)	0.997	(0.994, 1.001)	1.339**	(1.333, 1.345)	2.861**	(2.856, 2.865)
Complex chronic	1.538**	(1.528, 1.549)	0.949**	(0.945, 0.953)	1.470**	(1.462, 1.478)	3.881**	(3.871, 3.890)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to address skewness of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Annual out-of-pocket spending on the given category of service.

Table 3c. Multivariate generalized linear models: cost share [a] on healthcare services (hospitalization, emergency room, mental health and prescription drug services)

	Hospitalization		Emergency room		Mental health service		Prescription drugs	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Insurance plan								
PPO	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
HMO	0.414**	(0.411, 0.417)	0.541**	(0.539, 0.543)	0.562**	(0.559, 0.565)	0.951**	(0.949, 0.953)
Consumer-driven	1.176**	(1.166, 1.186)	1.118**	(1.113, 1.124)	1.112**	(1.103, 1.120)	1.098**	(1.095, 1.101)
High-deductible	1.120**	(1.109, 1.130)	1.537**	(1.529, 1.545)	1.575**	(1.562, 1.588)	1.500**	(1.496, 1.505)
Medical complexity level								
Non-chronic	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
Non-complex chronic	0.831**	(0.825, 0.837)	0.862**	(0.860, 0.865)	0.887**	(0.883, 0.891)	0.756**	(0.755, 0.757)
Complex chronic	0.537**	(0.533, 0.541)	0.698**	(0.695, 0.701)	0.764**	(0.760, 0.768)	0.713**	(0.711, 0.715)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to address skewness of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Annual percentage of cost-share of the given category of service, defined as the percentage of total cost that was paid out-of-pocket by the patient.

Healthcare services expenditure

Average out-of-pocket spending and cost-share are presented in Table 2. Overall, out-of-pocket spending on children averaged $914 (SD: 1,192), $369 (SD: 478), $276 (SD: 501), and $101 (SD: 223), respectively, on inpatient stays, emergency room visits, mental health services and prescription drugs (Table 2). In all of these types of services, out-of-pocket spending was lowest for those enrolled in an HMO, and highest for those enrolled in HDHPs.

The percentages of total cost of emergency room, mental health and prescription medications that were paid out-of-pocket by the children's families were highest for those enrolled in HDHPs, followed by CDHPs, PPOs, and lowest for those in HMOs. For those in HDHPs, results show that on average, over 50% of total cost of emergency room services (52.8%, SD (42.8%)), mental health services (54.6%, SD (40.5%)), and prescription drugs (66.7%, SD (38.5)), were paid out-of-pocket by the children's families. On the other hand, cost-share for hospitalization was lowest for those in an HMO (6.9%, SD (12.6%)), versus 17% of total hospitalization costs for the thre other plan types studied.

When stratified by children's medical complexity levels, average out-of-pocket expenses for children with complex chronic conditions on hospitalization ($1,304, SD (1,558)) and on prescription drugs ($237, SD (396)) were almost twice and four times, respectively, for children without chronic conditions. Children with complex conditions had the lowest cost-shares for all three types of services.

Using multivariate generalized linear models, we examined the difference in out-of-pocket expenses (Table 3b) and cost-shares (Table 3c) between private insurance plans and between medical complexity levels, controlling for children's age, gender and data years (Table 3b). Compared to children in PPO plans, those in HMO plans had significantly lower out-of-

pocket spending, and those in consumer-driven and high deductible plans had significantly higher out-of-pocket spending (Table 3b). We observe analogous pattern in cost shares of these services with regards to health insurance plans. On the other hand, except for emergency rooms, out-of-pocket expenses from hosptializations, mental health services and prescription drugs were significantly higher in children with complex chronic conditions compared to those without any chronic conditions. (Table 3b) In contrast, cost shares in all service categories for children with non-complex chronic conditions and those with complex chronic conditions were significantly lower than children with no chronic conditions (Table 3c).

Additional healthcare expenditure for other types of services are shown in Supplemental Tables B, C-ii and C-iii. As expected, out-of-pocket expenses and cost-shares on these additional service categories were highest in high deductible plans and lowest in HMO, except in home health services.

Family financial impact

Using $1,000 as the threshold for family financial impact, 8.4% of families exceeded this amount on their children's care in 2012. This percentage steadily increased over the years to 9.6% in 2013 and 10.4% in 2014 (Table 4). By insurance plan type, only about 4% of families enrolled in HMOs had spent out-of-pocket over $1,000 on their children's medical care from 2012 to 2014, while approximately 14% of families in consumer-driven health plans and 17% of families in high deductible health plans had to cope with financial impact from children's healthcare expenditure of over $1,000 (Table 4).

The percentage of families that would be impacted financially due to high expenditures on children's healthcare services increases as the number of medically complex children grows. In 2012 to 2014, while less than 7% of families of no children with chronic conditions would

experience financial impact, over 19% of families with two or more children with non-complex chronic and/or complex chronic conditions would experience such situation. Proportions of families that would experience such financial impact increased over the years, regardless of their complexity levels.

Lastly, we used multivariate logistic regression to examine the association of insurance plans and family medical complexity levels with family financial impact, controlling for data year. As indicated in Table 5, compared to families enrolled in PPO, families enrolled in HMO plans were significantly less likely (OR: 0.34, 95%CI: (0.33, 0.35)) to have spent annually over $1,000 on their children's medical care services, while those in consumer-driven plans (OR: 1.69, 95%CI: (1.66, 1.72)) and high deductible plans (OR: 2.70, 95%CI: (2.66, 2.74)) were significantly more likely to do so. In contrast to families without any complex children, families with any level of complexity were significantly more likely to experience financial impact. Those with two or more children with complex chronic and/or non-complex chronic conditions were 3.63 (95%CI: (3.57, 3.69)) times more likely to pay over $1,000 on children's medical care services.

Table 4. Percentage of families that had financial impact (total expenses over $1,000 on any medical services) in one year, by plan types and family complexity levels

	Year 2012	Year 2013	Year 2014
	%	%	%
All	8.4	9.6	10.4
Insurance plan			
HMO	3.4	4.1	4
PPO	8.1	9.4	10.3
Consumer-driven	13.8	14.4	13.7
High-deductible	16.6	17	16.8
Family complexity levels			
No children with chronic condition	4.9	5.8	6.7
One child with non-complex chronic condition	9.6	11.5	13.8
One child with complex chronic condition	15.8	18.4	20.4
Two or more children with complex chronic and/or non-complex chronic condition	19	21.5	23.7

Table 5. Predictors for family financial impact (total expenses over $1,000 on any medical services)

	Adjusted odds ratio	95% Wald confidence interval
Insurance plan		
PPO	(REFERENCE)	
HMO	0.34**	(0.33, 0.35)
Consumer-driven	1.69**	(1.66, 1.72)
High-deductible	2.70**	(2.66, 2.74)
Family complexity levels		
No children with chronic condition (%)	(REFERENCE)	
One child with non-complex chronic condition (%)	1.94**	(1.91, 1.97)
One child with complex chronic condition (%)	3.82**	(3.77, 3.88)
Two or more children with complex chronic and/or non-complex chronic condition (%)	3.63**	(3.57, 3.69)

Notes:
* P-value < 0.001
** P-value < 0.0001
Multivariate logistic regression model adjusted for insurance plan type, family complexity level and data year.

Discussion

Among privately-insured children with medical complexity, findings demonstrate that children with complex chronic conditions had higher out-of-pocket expenditure and utilization of most healthcare services categories, in particular on inpatient hospitalizations, mental health

services and prescription medications. Children with chronic complex conditions had the lowest cost shares. For these children, the projected rise in cost share over the next several years either through employee premiums, deductibles, coinsurance or copayments(Centers for Medicare and Medicaid Services, 2015; Gaal et al., 2014; Thomas et al., 2014) could have a negative impact on health service utilization and access to care, which can exacerbate health outcomes for children with medical complexities, and ultimately result in higher overall costs of care.

This study contributes to the research on family financial impact experienced by privately-insured families of children with medical complexity.(Lindley and Mark, 2010; Kuo et al., 2011; Davidoff, 2004; Kuhlthau et al., 2005) As the levels of family-level complexity increases, proportion of families that would experience substantial financial impact increases. Greater financial impact was observed in more than 18% of families with two or more children of complex chronic and/or non-complex chronic conditions, consistent over the data years we assessed. As shown above, these findings are consistent with other research that has shown that families in high deductible health plans and who have chronic conditions have considerable financial burdens.(Galbraith et al., 2011)

Parents and/or family caregivers of children with medical complexity may have to reduce working hours or even quit employment to take care of them.(Kogan et al., 2008; Kuhlthau et al., 2005; Kuo et al., 2011) Although we have only assessed the family financial impact from children's medical services, our findings show that families of children with medical complexity are about nearly 1.9 to 3.8 times more likely than those without to spend over $1,000 on children's medical services annually. Future studies could further investigate the magnitude of family impact in terms of parents and/or caregivers' financial, physical and mental health

burden. Moreover, it is salient to evaluate how strategies such as case management and medical homes could be implemented to alleviate such family burdens.

Some may argue that the financial burden measures we calculate are not meaningful, because relatively few people have chronic, complex conditions, which we show impose the greatest financial burdens. This misses the point that it is precisely how well a health plan affects the most vulnerable that is most important to consider. A parallel argument would be that we don't have to worry about the financial impact of incomplete homeowners insurance because so few people have their house burn down in a given year. But this is precisely the group for whom adequate insurance is the most important.

Another highlight of the study is that our extremely large sample allows us to separately evaluate impacts of four major health plans. Results show that a similar proportions of complex children are found in each plan type, and that utilization conditional on complexity level is also fairly similar. While healthcare utilization was constant across plan types, there were significant differences in out-of-pocket expenditures, with children enrolled in high deductible and consumer driven plans having the highest out-of-pocket spending and probability of significant financial impact within a year.

Over the past few years, higher deductibles have gradually gained in popularity for private insurance plans provided by employers, aiming to reduce the soaring healthcare expenses.. Future studies should examine in-depth the effectiveness of HDHP features at containing expenditure for families with children of complex medical needs.

Roughly a third of families have at least one child with a chronic condition, consistently distributed across plan types. This emphasizes the concerns about healthcare expenditure and financial burden could be of widespread interest to all families with children, and not merely

families whose children are enrolled in Medicaid or Children's Health Insurance Program. Now more than ever, as the healthcare marketplace expands with greater reliance on high deductible options, it is critical that information in the insurance marketplace be provided in plain language and to meet the health literacy needs of the general population. In the special case for children, parents and/or caregivers need to understand not only the options available to their children but also the implications of the health plan choice on out-of-pocket expenses.

Strengths and Limitations

Strengths of our study are that using the MarketScan database, we obtained a very large sample size (N=7.3 million) with up-to-date data on privately-insured children's actual healthcare utilization and expenditure that enabled us to examine patters with more precision than previous studies using less than 100,000 children. We assessed children enrolled in PPO, HMO, consumer-driven and high-deductible health plans, which represented approximately 85% of all children in the database during the study period. While most studies on health services utilization and expenditure in children with medical complexity focused on those enrolled in Medicaid or other public insurance programs, our findings contribute to the literature as it pertains to children enrolled in commercial insurance programs, which compose 48% of all children aged 0 to 18.(Kaiser Family Foundation, 2015) Moreover, we applied Pediatric Medical Complexity Algorithm, a publicly available algorithm, to identify children of different medical complexity levels, stratified by whether the conditions are chronic. This is the first study to have the power to compare rates of utilization across different plan types by specific types of services, in particular inpatient hospitalizations, emergency room services, mental health services and outpatient prescription medications.

A few limitations should be noted. The large sample size would substantially increase the power of any regular statistical tests, hence statistical significance should be interpreted while also considering whether the effects are meaningful from a policy perspective. The MarketScan data includes primarily very large, relatively well-insured plan enrollees, and hence may not be nationally representative. We only focused on those who remained in the same insurance plans over the study period. Change in plan types were not examined, which may result from high expenditure on certain services. There was also limited information on specific differences between plans of the same type, the amount of monthly premiums that families would need to pay upfront, and if the child had Medicaid as a secondary supplemental insurance program. In addition, we only adjusted for age and gender in the models, as the claims database did not include other relevant sociodemographic variables. Other critical factors that could impact children's use of services include families' income level, additional sources of financial assistance for medical services besides private insurance plans, etc. Lastly, given the design of the study, we can only demonstrate the association of insurance plan types and of family complexity levels with family financial impact, without implication for a causal relationship.

Conclusion

This study adds to the limited literature on healthcare utilization and spending among privately-insured children. Children with non-complex and those with complex chronic medical conditions had significantly higher utilization and out-of-pocket spending on hospitalization, mental health services and prescription medications. Their enrolling families were found to be at a much higher risk of experiencing financial impact due to expenses on their children's medical care.

References

Ash AS and Ellis RP. (2012) Risk-adjusted payment and performance assessment for primary care. *Med Care* 50(8): 643-653.

Baughman KR, Burke RC, Hewit MS, et al. (2015) Associations between Difficulty Paying Medical Bills and Forgone Medical and Prescription Drug Care. *Popul Health Manag* 18(5): 358-366.

Berry JG, Hall M, Cohen E, et al. (2015) Ways to Identify Children with Medical Complexity and the Importance of Why. *J Pediatr* 167(2): 229-237.

Berry JG, Hall M, Neff J, et al. (2014) Children with medical complexity and medicaid: spending and cost savings. *Health Aff (Millwood)* 33(12): 2199-2206.

Centers for Medicare and Medicaid Services. (2015) National Health Expenditure Projections 2014 – 2024.

Chan T, Rodean J, Richardson T, et al. (2016) Pediatric Critical Care Resource Use by Children with Medical Complexity. *J Pediatr* 177: 197-203 e191.

Chen AY and Newacheck PW. (2006) Insurance coverage and financial burden for families of children with special health care needs. *Ambul Pediatr* 6(4): 204-209.

Cohen E, Berry JG, Camacho X, et al. (2012) Patterns and costs of health care use of children with medical complexity. *Pediatrics* 130(6): e1463-1470.

Davidoff AJ. (2004) Insurance for children with special health care needs: patterns of coverage and burden on families to provide adequate insurance. *Pediatrics* 114(2): 394-403.

Gaal MJ, Gomberg J and Filipek TM. (2014) Impact of Health Insurance Marketplace on Participant Cost Sharing for Pharmacy Benefits. Brookfield, WI: Milman, Inc.,.

Galbraith AA, Ross-Degnan D, Soumerai SB, et al. (2011) Nearly half of families in high-deductible health plans whose members have chronic conditions face substantial financial burden. *Health Aff (Millwood)* 30(2): 322-331.

Gold JM, Hall M, Shah SS, et al. (2016) Long length of hospital stay in children with medical complexity. *J Hosp Med* 11(11): 750-756.

Hansen LG and Chang S. (2011) Health Research Data For The Real World: The Marketscan Databases. . In: MarketScan® THAS (ed).

Kaiser Family Foundation. (2015) *Health Insurance Coverage of Children 0-18*. Available at: http://www.kff.org/other/state-indicator/children-0-18/.

Kogan MD, Strickland BB, Blumberg SJ, et al. (2008) A national profile of the health care experiences and family impact of autism spectrum disorder among children in the United States, 2005-2006. *Pediatrics* 122(6): e1149-1158.

Kuhlthau K, Hill KS, Yucel R, et al. (2005) Financial burden for families of children with special health care needs. *Matern Child Health J* 9(2): 207-218.

Kuo DZ, Cohen E, Agrawal R, et al. (2011) A National Profile of Caregiver Challenges of More-Complex Children with Special Health Care Needs. *Archives of pediatrics & adolescent medicine* 165(11): 1020-1026.

Lindley LC and Mark BA. (2010) Children with special health care needs: Impact of health care expenditures on family financial burden. *J Child Fam Stud* 19(1): 79-89.

McPherson M, Arango P, Fox H, et al. (1998) A new definition of children with special health care needs. *Pediatrics* 102(1 Pt 1): 137-140.

Newacheck PW, McManus M, Fox HB, et al. (2000) Access to Health Care for Children With Special Health Care Needs. *Pediatrics* 105(4): 760-766.

Parish SL, Rose RA, Dababnah S, et al. (2012) State-level income inequality and family burden of U.S. families raising children with special health care needs. *Soc Sci Med* 74(3): 399-407.

Shattuck PT and Parish SL. (2008) Financial burden in families of children with special health care needs: variability among states. *Pediatrics* 122(1): 13-18.

Simon TD, Cawthon ML, Stanford S, et al. (2014) Pediatric medical complexity algorithm: a new method to stratify children by medical complexity. *Pediatrics* 133(6): e1647-1654.

Thomas S, Bachman D, Khuperkar A, et al. (2014) Dig Deep: Impacts and Implications of rising out-of-pocket health care costs. Washington, DC: Deloitte.

Wiltshire JC, Elder K and Allison JJ. (2015) Differences in Problems Paying Medical Bills between African Americans and Whites from 2007 and 2009: the Underlying Role of Health Status. *J Racial Ethn Health Disparities*.

Wisk LE and Witt WP. (2012) Predictors of delayed or forgone needed health care for families with children. *Pediatrics* 130(6): 1027-1037.

Youn B, Soley-Bori M, Soria-Saucedo R, et al. (2016) Patient cost-sharing and insurance arrangements are associated with hospital readmissions after abdominal surgery: Implications for access and quality health care. *Surgery* 159(3): 919-929.

Legend for Tables

Table 1. Characteristics of study sample

Table 2. Healthcare services expenditure and utilization on hospitalization, emergency room, mental health and prescription drug services

Table 3a. Multivariate generalized linear models: annual total number of uses of healthcare services (hospitalization, emergency room, mental health and prescription drug services)

Table 3b. Multivariate generalized linear models: out-of-pocket expenditure on healthcare services (hospitalization, emergency room, mental health and prescription drug services)

Table 3c. Multivariate generalized linear models: cost share on healthcare services (hospitalization, emergency room, mental health and prescription drug services)

Table 4. Percentage of families that had financial impact (total expenses over $1,000 on any medical services) in one year, by plan types and family complexity levels

Table 5. Predictors for family financial impact (total expenses over $1,000 on any medical services)

Supplemental Tables

Supplemental Table A. Distribution of use of healthcare services

	N[a]	%[b]
Hospitalization	629,531	8.64
Emergency room	1,907,127	26.17
Mental health service	717,116	9.84
Prescription drugs	4,616,852	63.36
Durable medical equipment	314,025	4.31
Home health services	1,609	0.02
Laboratory and radiologic testing	5,446,864	74.75
Occupational/physical/speech therapies	652,432	8.95

Notes:
[a] Total number of children that had ever used the given category of services during the study period (2010-2014).
[b] The entire study sample (N = 7,286,570) was the denominator.

Supplemental Table B. Healthcare services expenditure and utilization on durable medical equipment, home health, laboratory and radiologic testing and occupational/physical/speech therapies.

	Use (#)		OOP ($)		Cost-share (%)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Durable medical equipment						
All	2.0	(3.4)	97	(286)	36.0	(41.5)
By insurance plan						
HMO	2.1	(3.6)	45	(210)	15.1	(29.1)
PPO	2.0	(3.4)	102	(282)	38.7	(42.0)
Consumer-driven	2.0	(3.4)	110	(328)	37.4	(41.5)
High-deductible	2.0	(3.4)	142	(406)	48.5	(44.0)
By medical complexity level						
Non-chronic	1.4	(1.5)	59	(154)	41.7	(43.7)
Non-complex chronic	1.7	(2.1)	103	(291)	36.6	(41.4)
Complex chronic	3.6	(6.1)	165	(434)	23.6	(33.8)
Home health services						
All	23.0	(52.0)	336	(905)	26.6	(34.6)
By insurance plan						
HMO	37.7	(73.2)	246	(486)	11.7	(20.1)
PPO	18.7	(45.2)	364	(1032)	30.8	(36.3)
Consumer-driven	34.3	(55.2)	327	(591)	22.5	(33.2)
High-deductible	11.7	(21.0)	279	(545)	29.4	(38.1)
By medical complexity level						
Non-chronic	5.3	(14.7)	162	(522)	36.1	(39.2)
Non-complex chronic	22.9	(47.5)	277	(537)	29.5	(35.0)
Complex chronic	24.1	(55.6)	380	(1079)	24.4	(33.8)
Laboratory and radiologic testing						
All	2.2	(2.1)	59	(166)	32.0	(39.8)
By insurance plan						
HMO	2.1	(2.0)	23	(102)	10.4	(25.4)
PPO	2.2	(2.1)	61	(163)	33.5	(39.8)
Consumer-driven	2.1	(2.0)	69	(193)	36.3	(41.1)
High-deductible	2.1	(2.0)	94	(238)	51.8	(43.8)
By medical complexity level						
Non-chronic	1.9	(1.4)	45	(129)	33.1	(41.0)
Non-complex chronic	2.4	(2.0)	73	(185)	30.9	(38.1)
Complex chronic	3.6	(4.1)	129	(283)	27.0	(34.2)
Occupational/physical/speech therapies						
All	10.7	(15.8)	336	(587)	36.0	(34.0)
By insurance plan						
HMO	9.8	(14.3)	211	(398)	23.5	(25.8)
PPO	10.8	(15.9)	338	(582)	36.2	(33.5)
Consumer-driven	10.7	(16.0)	360	(618)	38.0	(36.6)
High-deductible	10.7	(17.0)	475	(782)	50.5	(40.8)
By medical complexity level						
Non-chronic	7.2	(9.1)	240	(407)	39.9	(36.2)
Non-complex chronic	11.7	(16.3)	373	(616)	35.4	(32.9)
Complex chronic	16.2	(22.3)	472	(777)	29.2	(29.7)

Notes:

N: number of children that had ever used the given service in 2012 to 2014.
Use: annual total number of medical encounters (in days) using the given category of service.
OOP: annual out-of-pocket spending in dollar amount on the given category of service.
Cost-share: annual percentage of cost-share of the given category of service

Supplemental Table C-i. Multivariate generalized linear models: annual total number of uses of healthcare services [a] (durable medical equipment, home health, laboratory and radiologic testing and occupational/physical/speech therapies)

	Durable medical equipment		Home health service		Laboratory and radiologic testing		Occupational/physical/speech therapies	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Insurance plan								
PPO	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
HMO	1.071**	(1.063, 1.078)	1.956**	(1.916, 1.997)	0.956**	(0.955, 0.957)	0.879**	(0.877, 0.881)
Consumer-driven	1.014	(1.005, 1.024)	1.832**	(1.780, 1.885)	0.989**	(0.988, 0.991)	0.998	(0.995, 1.000)
High-deductible	1.004	(0.993, 1.014)	0.676**	(0.639, 0.716)	0.950**	(0.948, 0.952)	0.987**	(0.984, 0.989)
Medical complexity level								
Non-chronic	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
Non-complex chronic	1.243**	(1.235, 1.250)	3.967**	(3.569, 4.410)	1.257**	(1.256, 1.259)	1.549**	(1.547, 1.552)
Complex chronic	2.707**	(2.692, 2.722)	4.410**	(3.970, 4.899)	1.876**	(1.874, 1.878)	2.066**	(2.063, 2.070)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to due to the Poisson distribution of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Total number of times (in days) the given category of service was used.

Supplemental Table C-ii. Multivariate generalized linear models: out-of-pocket expenditure [a] on healthcare services (durable medical equipment, home health, laboratory and radiologic testing and occupational/physical/speech therapies)

	Durable medical equipment		Home health service		Laboratory and radiologic testing		Occupational/physical/speech therapies	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Insurance plan								
PPO	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
HMO	0.421**	(0.417, 0.426)	0.692**	(0.614, 0.780)	0.371**	(0.370, 0.372)	0.626**	(0.622, 0.630)
Consumer-driven	1.067**	(1.053, 1.081)	0.950	(0.806, 1.121)	1.131**	(1.128, 1.134)	1.101**	(1.092, 1.110)
High-deductible	1.393**	(1.372, 1.413)	0.828	(0.679, 1.010)	1.563**	(1.559, 1.567)	1.427**	(1.415, 1.439)
Medical complexity level								
Non-chronic	(REFERENCE)		(REFERENCE)		(REFERENCE)		(REFERENCE)	
Non-complex chronic	1.874**	(1.859, 1.889)	1.588**	(1.231, 2.048)	1.540**	(1.537, 1.542)	1.418**	(1.411, 1.425)
Complex chronic	3.192**	(3.165, 3.220)	2.141**	(1.671, 2.743)	2.826**	(2.819, 2.832)	1.719**	(1.709, 1.728)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to address skewness of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Annual out-of-pocket spending on the given category of service

Supplemental Table C-iii. Multivariate generalized linear models: cost share [a] on healthcare services (durable medical equipment, home health, laboratory and radiologic testing and occupational/physical/speech therapies)

	Durable medical equipment			Home health service			Laboratory and radiologic testing			Occupational/physical/speech therapies		
	Estimate	95% CI		Estimate	95% CI		Estimate	95% CI		Estimate	95% CI	
Insurance plan												
PPO	(REFERENCE)			(REFERENCE)			(REFERENCE)			(REFERENCE)		
HMO	0.401**	(0.397,	0.404)	0.386**	(0.344,	0.434)	0.312**	(0.312,	0.313)	0.657**	(0.653,	0.662)
Consumer-driven	0.957**	(0.944,	0.970)	0.727**	(0.619,	0.853)	1.084**	(1.081,	1.087)	1.040**	(1.032,	1.049)
High-deductible	1.246**	(1.227,	1.264)	0.905	(0.741,	1.105)	1.539**	(1.535,	1.543)	1.381**	(1.369,	1.393)
Medical complexity level												
Non-chronic	(REFERENCE)			(REFERENCE)			(REFERENCE)			(REFERENCE)		
Non-complex chronic	0.905**	(0.898,	0.912)	0.756	(0.586,	0.976)	0.945**	(0.943,	0.946)	0.896**	(0.891,	0.900)
Complex chronic	0.607**	(0.602,	0.613)	0.624**	(0.486,	0.801)	0.833**	(0.831,	0.834)	0.745**	(0.741,	0.749)

Notes:
Multivariate generalized linear model adjusted for children's age, gender, data year, insurance plan type and medical complexity level. Log link function was used to address skewness of the dependent variable.
* P-value < 0.001
** P-value < 0.0001
[a] Annual percentage of cost-share of the given category of service, defined as the percentage of total cost that was paid out-of-pocket by the patient.