From Volume to Value: Comparative value, quality, and cost between three treatment modalities for early childhood caries

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INTRODUCTION

In recent decades there has been a shift from a reimbursement system based upon treatment "volume" to "value."

In 2016, Professors Michael Porter and Elizabeth Teisberg at the Harvard Business School describe a detailed value-based health care model for meeting the "Triple Aim" objectives by focusing on specific medical conditions over cycles of care, measuring the patient-perceived quality of care, and measuring the direct cost of care expended by health care delivery institutions and providers.[7]

Specifically, Porter and Teisberg defined "Value" of care as the quotient of "Quality" and "Cost" (V = Q/C) and they further challenged the U.S. health care system, government, institutions, payers, and providers of health care to align structures, processes, and outcomes in order to increase value to patients.[8]

PURPOSE

The purpose of this study is to utilize a simplified adaptation of the Porter-Teisberg model to compare quality, cost, and value between three ECC treatment modalities; surgical care under general anesthesia (**GA**), surgical care without GA, and non-surgical care with disease management.

The hypothesis is that non-surgical care with disease management treatment would yield higher value than the two surgical modalities.

METHOD

- Through prospective cohort design, data was collected from 487 pediatric subjects treated at health centers in seven states. Nearly 95% of the subjects were beneficiaries of the United States government Medicaid health insurance program, which supports families with low socioeconomic status.
- Quality was measured with a Parental-Reported Symptom and Service Quality questionnaire, adapted from the validated Early Child Oral Health Impact Scale, Child-Oral Impacts on Daily Performance, and Dental Consumer Assessments of Healthcare Providers and Systems surveys.
- Cost was measured by the labor cost for clinicians and adjusted by total relative value units for all treatment procedures.
- Value was calculated as the quotient of the weighted quality score and the adjusted cost, multiplied by a coefficient.
- Comparisons of sample demographic characteristics; survey responses; and quality, cost, and value of care by treatment modalities (surgical with GA, surgical without GA, and non-surgical) were performed by the chi-square test for categorical variables and the ANOVA test (or the Kruskal-Wallis test, as appropriate) for continuous variables. Natural Log-transformed (**ln**) value scores, which have an approximately normal distribution, were also included in the comparison.

TABLE 1: Summary of sample characteristics by treatment modalities.

	Overall	Surgical with GA	Surgical without GA	Non-Surgical	p
N (%)	487 (100.0)	260 (53.4)	156 (32.0)	71 (14.6)	
Age (mean (sd))	3.99 (1.22)	3.94 (1.18)	4.55 (1.08)	2.94 (0.90)	<0.001
Gender = male (%)	243 (49.9)	137 (52.7)	68 (43.6)	38 (53.5)	0.16
Ethnicity = Hispanic (%)	272 (56.2)	119 (45.8)	104 (68.0)	49 (69.0)	<0.001
Race (%)					<0.001
White	135 (27.7)	74 (28.5)	54 (34.6)	7 (9.9)	
Black	80 (16.4)	47 (18.1)	26 (16.7)	7 (9.9)	
Asian	21 (4.3)	10 (3.8)	5 (3.2)	6 (8.5)	
Native Hawaiian/Other Pacific Islander	31 (6.4)	31 (11.9)	0 (0.0)	0 (0.0)	
American Indian/Alaskan Native	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Other	220 (45.2)	98 (37.7)	71 (45.5)	51 (71.8)	
Payer source (%)					<0.001
Federal Medicaid	462 (94.9)	254 (97.7)	137 (87.8)	71 (100.0)	
*CHIP	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Employer paid commercial insurance	1 (0.2)	1 (0.4)	0 (0.0)	0 (0.0)	
Individually paid commercial insurance	1 (0.2)	0 (0.0)	1 (0.6)	0 (0.0)	
Self-pay	22 (4.5)	4 (1.5)	18 (11.5)	0 (0.0)	
Other	1 (0.2)	1 (0.4)	0 (0.0)	0 (0.0)	

Means (standard deviations) are presented for continuous variables; frequencies (%) are presented for categorical variables.
*CHIP = Children's Health Insurance Program [28]
** ASA = American Society of Anesthesiologists Physical Status Classification System [29]

TABLE 2: Summary of sample comparisons by treatment modalities

	Overall	Surgical with GA	Surgical without GA	Non-Surgical	p
Sum ECOHIS[α] (mean (sd))	57.45 (7.61)	55.59 (7.10)	58.19 (8.57)	62.66 (3.25)	<0.001
Average ECOHIS[α] (mean (sd))	4.42 (0.58)	4.28 (0.55)	4.48 (0.66)	4.82 (0.25)	<0.001
Sum D-CAHPS[β] (mean (sd))	40.30 (4.52)	40.07 (3.92)	39.13 (5.24)	43.68 (3.09)	<0.001
Average D-CAHPS[β] (mean (sd))	4.48 (0.50)	4.45 (0.44)	4.35 (0.58)	4.85 (0.34)	<0.001
Sum C-OIDP[χ] (mean (sd))	19.30 (2.31)	19.63 (1.62)	18.53 (3.32)	19.79 (1.01)	<0.001
Average C-OIDP[χ] (mean (sd))	4.83 (0.58)	4.91 (0.40)	4.63 (0.83)	4.95 (0.25)	<0.001
Quality					
Total PRSSQ[δ] (mean (sd))	117.05 (10.48)	115.28 (8.22)	115.85 (13.21)	126.13 (5.20)	<0.001
** Average PRSSQ[δ] (mean (sd))	4.57 (0.37)	4.55 (0.28)	4.49 (0.49)	4.87 (0.20)	<0.001
Cost					
Total cost care (mean (sd))	381.91 (343.57)	635.61 (275.75)	110.80 (99.58)	48.59 (26.33)	<0.001
RVUs[ε] (mean (sd))	29.77 (21.06)	46.15 (13.02)	12.49 (11.36)	7.76 (3.59)	<0.001
† Cost per RVUs[ε] (mean (sd))	12.66 (9.60)	14.23 (6.22)	12.71 (14.09)	6.82 (3.68)	<0.001
Value					
‡ Value score (mean (sd))	58.19 (56.92)	40.82 (30.08)	70.45 (70.61)	94.83 (72.76)	<0.001*
Ln-value score (mean (sd))	3.79 (0.69)	3.57 (0.49)	3.90 (0.84)	4.40 (0.52)	<0.001

* p < 0.001 by the Kruskal-Wallis test.
** Quality = Average PRSSQ, with higher score indicating higher quality
† Cost = Cost per RVUs, with lower score indicating lower cost
‡ Value = Value score = 100 times Quality (**) divided by Cost (†), with higher score indicating higher value
α ECOHIS: Early Childhood Oral Health Impact Score [14]
β D-CAHPS: Dental Consumer Assessments of Healthcare Providers and Systems [15]
χ C-OIDP: Child-Oral Impacts on Daily Performance [16]
δ PRSSQ: parental-reported symptom and service quality questionnaire
ε RVUs: Relative Value Units [18]
Means (standard deviations) are presented for continuous variables; frequencies (%) are presented for categorical variables.

RESULTS

- The analytic sample included 487 pediatric patients. Overall, 49.9% of the patients were male, 56.2% were Hispanic, and the mean (standard deviation (**SD**)) age was 3.99 (1.22) [Table 1].
- When compared to the two surgical treatment modalities, patients treated with non-surgical treatment demonstrated higher, indicating better, average scores for ECOHIS, C-OIDP, and D-CAHPS; and lower average total cost per RVU [Table 2].
- Based upon quality, non-surgical treatment had the highest, indicating best, average PRSSQ score (mean=126.13, SD=5.20) compared surgical treatments with GA (mean=115.28, SD=8.22) and without GA (mean=115.85, SD=13.21) [Table 2].
- More important, significant differences in the value of treatment were observed between the three treatment modalities, with non-surgical treatment having the highest value scores (mean=94.83, SD=72.76) for geometric value and log-transformed value (mean=4.40, SD=0.52) [Table 2].

CONCLUSIONS

1. Across the three treatment modalities; non-surgical, surgical without GA, and surgical with GA; there is a significant difference in overall value, cost, and quality.
2. Dentists should consider the value hierarchy when developing informed consent treatment options for the management of ECC; with non-surgical treatment demonstrating higher "value" than surgical without GA treatment, which in turn is higher than surgical with GA treatment.
3. Payers and consumers would benefit by comparing treatment "value," as available, when choosing institutions and providers for the management of early childhood caries.

REFERENCES

1. Dye BA, Hsu K-LC, Afful J. Prevalence and Measurement of Dental Caries in Young Children: Ingenta Connect. *Pediatric Dentistry*. 2015;37(3):200-216.
2. Agency for Healthcare Research and Quality. Dental Services-Mean and Median Expenses per Person With Expense and Distribution of Expenses by Source of Payment. Accessed February 12, 2020. https://meps.ahrq.gov/mepsweb/data_stats/MEPS_topics.jsp?topicid=22-1
3. Fleming E. Prevalence of Total and Untreated Dental Caries Among Youth: United States, 2015–2016. 2018;(307):8.
4. Giovannelli J, Lucia KW, Corlette S. Implementing the Affordable Care Act: Revisiting the ACA's Essential Health Benefits Requirements. *Issue brief*. 2014;28:1-10. doi:10.15868/socialsector.25014
5. Berwick DM, Nolan TW, Whittington J. The Triple Aim: Care, Health, And Cost. *Health Affairs*. 2008;27(3):759-769. doi:10.1377/hlthaff.27.3.759
6. Porter ME, Teisberg EO. *Redefining Health Care: Creating Value-Based Competition on Results*. Harvard Business Press; 2006.
7. Okuji DO, Jivraj A, Wu Y. From Volume to Value: Comparative value, quality, and cost between three treatment modalities for early childhood caries. [Manuscript submitted for publication]. Division of Dental Medicine-Advanced Education in Pediatric Dentistry, NYU Langone Health.
8. Austin JM, Jha AK, Romano PS, et al. National Hospital Ratings Systems Share Few Common Scores And May Generate Confusion Instead Of Clarity. *Health Affairs*. 2015;34(3):423-430. doi:10.1377/hlthaff.2014.0201.
9. Lingsma HF, Steyerberg EW, Eijkemans MJC, Dippel DWJ, Scholte Op Reimer WJM, Van Houwelingen HC. Comparing and ranking hospitals based on outcome: results from The Netherlands Stroke Survey. *QJM*. 2010;103(2):99-108. doi:10.1093/qjmed/hcp169.
10. Austin PC, Ceyisakar IE, Steyerberg EW, Lingsma HF, Marang-van de Mheen PJ. Ranking hospital performance based on individual indicators: can we increase reliability by creating composite indicators? *BMC Medical Research Methodology*. 2019;19(1):131. doi:10.1186/s12874-019-0769-x/
11. Pahel BT, Rozier RG, Slade GD. Parental perceptions of children's oral health: the Early Childhood Oral Health Impact Scale (ECOHIS). *Health Qual Life Outcomes*. 2007;5:6. Published 2007 Jan 30. doi:10.1186/1477-7525-5-6.
12. Brown JA, Hays RD, Crall J. Summary of Cognitive Interviews for CAHPS Dental Care Project: Published 2004. Accessed March 25, 2020. https://www.rand.org/pubs/working_papers/WR101.html.
13. Yusuf H, Gherunpong S, Sheiham A, Tsakos G. Validation of an English version of the Child-OIDP index, an oral health-related quality of life measure for children. *Health Qual Life Outcomes*. 2006;4:38. doi:10.1186/1477-7525-4-38.
14. Pahel BT, Rozier RG, Slade GD. Parental perceptions of children's oral health: the Early Childhood Oral Health Impact Scale (ECOHIS). *Health Qual Life Outcomes*. 2007;5:6. doi:10.1186/1477-7525-5-6.
15. American Dental Association Survey Number. *2010 Survey of Dental Practice: Pediatric Dentists in Private Practice*.; 2011. https://nyu-dentalpractice.weebly.com/uploads/2/1/6/9/21693380/pediatric_dental_practice_report_ada_2010.pdf.
16. Relative Value Studies Inc. *Relative Value for Dentists*.; 2014. Accessed March 25, 2020. http://www.rvsdata.com/products/.
17. R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing; 2013. http://www.R-project.org/.
18. Lenth RV. Least-Squares Means: The R Package lsmeans. *Journal of Statistical Software*. 2016;69(1):1-33. doi:10.18637/jss.v069.i01.
19. Ogle D. *FSA: Fisheries Stock Analysis*.; 2020. Accessed June 24, 2020. https://github.com/droglenc/FSA.
20. DeAngelis CD. How Helpful Are Hospital Rankings and Ratings for the Public's Health? *Milbank Q*. 2016;94(4):729-732. doi:10.1111/1468-0009.12227.
21. Emmert M, Meszmer N, Schlesinger M. A cross-sectional study assessing the association between online ratings and clinical quality of care measures for US hospitals: results from an observational study. *BMC Health Serv Res*. 2018;18. doi:10.1186/s12913-018-2886-3.
22. Children's Health Insurance Program (CHIP). Medicaid. https://www.medicaid.gov/chip/index.html. Accessed February 26, 2021.
23. ASA Physical Status Classification System. ASA Physical Status Classification System. American Society of Anesthesiologists (ASA). https://www.asahq.org/standards and-guidelines/asa-physical-status-classification-system. Accessed February 26, 2021.

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