Impact of the *Choosing Wisely®* Campaign Recommendations for Hospitalized Children on Clinical Practice: Trends from 2008 to 2017

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BACKGROUND: The *Choosing Wisely®* Campaign (CWC) was launched in 2012. Five recommendations to reduce the use of "low-value" services in hospitalized children were published in 2013.

OBJECTIVES: The aim of this study was to estimate the frequency and trends of utilization of these services in tertiary children's hospitals five years before and after the publication of the recommendations.

METHODS: We conducted a retrospective, longitudinal analysis of hospitalizations to 36 children's hospitals from 2008 to 2017. The "low-value" services included (1) chest radiograph (CXR) for asthma, (2) CXR for bronchiolitis, (3) relievers for bronchiolitis, (4) systemic steroids for lower respiratory tract infection (LRTI), and (5) acid suppressor therapy for uncomplicated gastroesophageal reflux (GER). We estimated the annual percentages of the use of these services after risk adjustment, followed by an interrupted time series (ITS) analysis to compare trends before and after the publication of the recommendations.

RESULTS: The absolute decreases in utilization were 36.6% in relievers and 31.5% in CXR for bronchiolitis, 24.1% in acid suppressors for GER, 20.8% in CXR for asthma, and 2.9% in steroids for LRTI. Trend analysis showed that one "low-value" service declined significantly immediately (use of CXR for asthma), and another decreased significantly over time (relievers for bronchiolitis) after the CWC.

CONCLUSIONS: There was some decrease in the utilization of "low-value" services from 2008 to 2017. Limited changes in trends occurred after the publication of the recommendations. These findings suggest a limited impact of the CWC on clinical practice in these areas. Additional interventions are required for a more effective dissemination of the CWC recommendations for hospitalized children. *Journal of Hospital Medicine* 2020;15:68-74. © 2020 Society of Hospital Medicine

The *Choosing Wisely®* Campaign (CWC) was launched in 2012. This ongoing national initiative encourages conversations among patients and clinicians about the need —or the lack thereof—for frequent tests, treatments, and procedures in healthcare. More than 80 professional societies have developed short lists of evidence-based recommendations aimed at avoiding unnecessary, "low-value" care. More than 550 recommendations are currently available.[1] The Society of Hospital Medicine (SHM) Pediatric Committee published a list of five recommendations for the CWC in 2013.[2]

After seven years, the campaign has posted several success stories highlighting the increase in clinicians' awareness about the recommendations. Several local, regional, and national initiatives and quality improvement (QI) projects have been inspired by the CWC and its tenants.[1,3] However, limited research has been performed on the true impact of these recommendations on avoiding "low-value" services. A more comprehensive approach is required to "measure wisely" the impact of the campaign on bedside clinical practice.[4] Stakeholders in healthcare value have been challenged to collaborate in creating high-impact lists of "low-value" interventions and designing effective tools to measure their impact on clinical practice and costs.[5]

We initially developed a report card with five metrics derived from the CWC-SHM pediatric recommendations to help individual institutions and group practices to measure their performance and benchmark their results with peers.[6] The report card is available for hospital members of the Children's Hospital Association (CHA).[7]

The current study analyzes the frequency of utilization and trends of five metrics included in the CHA/Pediatric Health Information System® (PHIS) CWC report card in tertiary children's hospitals in the United States. We analyzed data from five years before and five years after the CWC-PHM recommendations were published in 2013. We hypothesize that the publication and dissemination of the CWC-PHM recommendations—the intervention—will result in either an immediate decrease in the use of the "low-value" services studied and/or a change in the trend of utilization over time.

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METHODS

Study Design

We conducted an observational, longitudinal retrospective study aimed at evaluating the impact of the CWC-PHM recommendations on clinical practice in tertiary children's hospitals in the US.

Study Population

The population included inpatient and observation stays for children aged 0-18 years admitted to the 36 children's hospitals consistently providing data from 2008 to 2017 to the PHIS administrative database (CHA, Lenexa, Kansas). This database contains inpatient, emergency department, ambulatory, and observation encounter–level data from more than 50 not-for-profit, tertiary care pediatric hospitals and accounts for ~20% of all pediatric hospitalizations in the US every year.

A joint effort between the CHA and the participating hospitals ensures the quality of the data submitted, as previously described.[8] These data are subjected to a routine quality check with each submission and within each report. Data were fully deidentified for this study. In total, 36 PHIS hospitals met the strict quality standards for inclusion of submitted data. The remaining hospitals were excluded because they did not have complete data or had incomplete billing information.

For external benchmarking purposes, PHIS participating hospitals provide encounter data, including demographics, diagnoses, and procedures (*International Classification of Diseases versions 9 and 10*).[9,10] The transition from ICD-9 to ICD-10 in the US took place during the study period. However, the CHA completed a process of translating and mapping all ICD-9 codes to every possible equivalent ICD-10 code in the PHIS database. Thus, the change from ICD-9 to ICD-10 should not have had any significant effect on population definition and data analytics, including trend analysis.

For each condition, the study population was divided into the following two cohorts for comparison of the trends: all admissions from January 1, 2008 to December 31, 2012 (before) and all admissions from January 1, 2013 to December 31, 2017 (after) the CWC-PHM recommendations were published.

This study was determined to be nonhuman subject research and was therefore exempted by Nicklaus Children's Hospital Human Research Protection Program.

Outcomes

The outcomes for this study were the percentages of patients receiving the not-recommended "low-value" services targeted by the CWC-PHM recommendations. For this purpose, four of the five recommendations were translated into the following five metrics, operationalized in the PHIS database and displayed in the "*Choosing Wisely*" report card:[6]

1. Percentage of patients with uncomplicated asthma receiving chest radiograph (CXR).
2. Percentage of patients with uncomplicated bronchiolitis receiving CXR.
3. Percentage of patients with uncomplicated bronchiolitis receiving bronchodilators.
4. Percentage of patients with lower respiratory tract infection (LRTI) receiving systemic corticosteroids (relievers).
5. Percentage of patients with uncomplicated gastroesophageal reflux (GER) receiving acid suppressor therapy.

The fifth recommendation—limiting the use of continuous pulse oximetry unless the patient is receiving supplemental oxygen—could not be operationalized in the PHIS database because of inconsistent reporting of these resources.[6]

The resulting percentages represent nonadherence to the recommendations, suggesting overuse of the specific "low-value" intervention. As such, a decreasing trend over time is the desired direction of improvement.

The definition of "uncomplicated" conditions and the metrics are presented in Table 1. A complete list of the inclusion and exclusion criteria to define "uncomplicated" conditions and the complete list of the clinical translation codes used in PHIS to identify the "low-value" services are presented as an electronic supplement.

Statistical Analyses

We compared the demographic and clinical characteristics of the various cohorts before and after the release of the CWC-PHM recommendations—the intervention—using chi-square statistics. To assess the individual hospital-level trends over time for each measure, we modeled the patient-level data of each hospital using generalized linear mixed effects models with a binomial distribution. These models were adjusted for patient demographic and clinical factors that were found to be significantly different ($P < .01$) before and after the intervention on bivariate analyses. From these models, we generated adjusted estimates for the quarterly percentages for each hospital. We then conducted an interrupted time series (ITS) using these estimates to compare trends in the five years before (2008-2012) and five years after (2013-2017) the publication of the CWC-PHM recommendations. For the ITS analysis, we used a generalized linear mixed effects model with the quarterly adjusted hospital-level utilization rates of "low-value" services for each cohort as the unit of analysis and a random intercept for each hospital. The model used an autoregressive(1) covariance structure to account for autocorrelation. The ITS allowed us to test our hypothesis by assessing the following two important features: (a) if a significant decrease occurred right after the CWC-PHM recommendations were published (level-change) and/or (b) if the intervention altered the secular trend (slope-change). All statistical analyses were performed using SAS v. 9.4 (SAS Institute, Cary, North Carolina), and *P* values <.01 were considered to be statistically significant.

RESULTS

Table 2 presents the demographic characteristics of the cohorts before (2008-2012) and after (2013-2017) the publication of the CWC-PHM recommendations. Hospitalizations due to asthma represented the largest cohort with 142,067 cases, followed by hospitalizations due to bronchiolitis with 94,253 cas-

TABLE 1. **Study Definitions of "Uncomplicated" Conditions and Metrics**
Based on the *Choosing Wisely*® Campaign (CWC) Report Card. PHIS.[a]

Condition	Inclusion Criteria	Exclusion Criteria	Metric
Asthma	Age: 3-17 years ICD-9 / ICD10 Codes: Asthma[b] LOS ≤ 5 days Patient Type: Inpatient and Observation	ICU Admission APR-DRG Severity of Illness (SOI) 4 ICD9s including: • Pneumonia • Malnutrition • Neurologically impaired children • CLD • Congenital lung anomalies • Congenital heart defects • Respiratory failure/acidosis • Orofacial anomalies • Presence of tracheostomy tube	% Receiving CXR
Bronchiolitis	Age: ≥1m & < 1 year ICD9/ICD10 Codes: Bronchiolitis[b] LOS ≤ 3 days Patient Type: Inpatient and Observation	ICU Admission APR-DRG (SOI) 4 ICD9s including: • Asthma • Malnutrition • Neurologically impaired children • CLD • Congenital lung anomalies • Congenital heart defects • Respiratory failure/acidosis • Orofacial anomalies • Presence of tracheostomy tube	% Receiving CXR % Receiving Bronchodilators
LRTI	Age: ≥1 m & <2 years ICD9/ICD10 Codes: Bronchiolitis, Pneumonia, other LRTI[b] Patient Type: Inpatient and Observation	ICU Admission APR-DRG (SOI) 4 ICD9s including: • Asthma • Malnutrition • Neurologically impaired children • CLD • Congenital lung anomalies • Congenital heart defects • Respiratory failure/acidosis • Oro-facial anomalies • Presence of tracheostomy tube	% Receiving Systemic Corticosteroids
GER	Age: ≤1 year ICD9/ICD10 Codes: Gastroesophageal reflux[b] Patient Type: Inpatient and Observation	ICU Admission APR-DRG (SOI) 4 ICD9 codes: • Malnutrition/failure to thrive • Apnea/ALTE • Esophagitis • Peptic ulcer disease • Gastritis/duodenitis	% Receiving Acid Suppression Therapy

[a]Based on the Society of Hospital Medicine-Pediatric recommendations (2013)
[b]Complete list of ICD9/ICD10 of inclusion and exclusion codes is available as an online supplement.
Also available upon request. Contact: analytics@childrenshospitals.org
Abbreviations: ALTE, apparent life-threatening event; APR-DRG, All Patients Refined Diagnosis Related Groups; CLD, chronic lung disease; CXR, chest radiograph; ICU, intensive care unit; LOS, length of stay; LRTI, lower respiratory tract infection; SOI, severity of illness.

es. Hospitalizations due to GER comprised the smallest cohort with 13,635 cases. Most of the children had government insurance and had "minor" severity according to the All Patient Revised Diagnosis Related Group (APR-DRG) system.

We found statistically significant differences in most of the demographic characteristics for the cohorts when comparing cases before and after the introduction of the CWC-PHM recommendations.

After adjusting for demographic characteristics, we estimated the percentages of the utilization of the "low-value" services from 2008 to 2017. We observed a steady decrease in overutilization of all services over time. The absolute percentage decrease was more evident in the reduction of the utilization of relievers by 36.6% and that of CXR by 31.5% for bronchiolitis. We also observed a 20.8% absolute reduction in the use of CXR for asthma.

TABLE 2. **Summary of Demographics before and after the Publication of CWC-PHM Recommendations**

		Asthma			Bronchiolitis			GER			Lower Resp Tract Infection		
		2008-2012	2013-2017	*P* Value	2008-2012	2013-2017	*P* Value	2008-2012	2013-2017	*P* Value	2008-2012	2013-2017	*P* Value
N		68,842	73,225		45,490	51,763		8,794	4,841		14,164	11,358	
Age	<1				100%	100%	1.000	92.6%	91.9%	.128	49.9%	44.0%	
	1-4	29.6%	29.0%	<.001				7.4%	8.1%		50.1%	56.0%	<.001
	5-9	44.6%	46.3%										
	10-18	25.8%	24.8%										
Gender	Male	62.7%	62.0%	.004	59.4%	60.0%	.062						
	Female	37.3%	38.0%		40.6%	40.0%							
Race	Non-Hispanic White	25.4%	25.0%	<.001	41.9%	45.0%	<.001						
	Non-Hispanic Black	48.8%	47.7%		21.0%	21.3%							
	Hispanic	16.8%	18.6%		26.4%	21.9%							
	Other	9.0%	8.6%		10.7%	11.8%							
Payor	Government	59.3%	66.5%	<.001	64.9%	67.2%	<.001						
	Private	34.4%	30.4%		28.4%	30.6%							
	Other	6.3%	3.2%		6.7%	2.2%							
Severity	Minor	84.4%	77.7%	<.001	82.4%	72.5%	<.001						
	Moderate	15.6%	22.3%		17.6%	27.5%							

Footnote: 36 hospitals were included in the study

P < .01 implies that the distribution of demographic characteristics was significantly different in cohorts before and after the CWC.
Significant changes reflect potential changes in risk that need to be adjusted for the trend analysis.
Abbreviations: CWC, *Choosing Wisely*® Campaign; GER, gastroesophageal reflux; PHM, Pediatric Hospital Medicine.

The use of systemic steroids in LRTI revealed the lowest utilization among the "low-value" services studied, with 15.1% in 2008 and 12.2% in 2017, a 2.9% absolute reduction. However, the prescription of acid suppressors for GER showed the highest utilization among all the overuse metrics studied, ie, 63% in 2008 and 48.9% in 2017, with an absolute decrease of 24.1%. The yearly adjusted estimated percentages of utilization for each "low-value" service are presented in Appendix Table A.

Table 3 and the Figure (attached as supplemental online graphic) respectively present the risk-adjusted ITS parameter estimates and the graphic representation before and after the inception of the CWC-PHM recommendations for the trend analysis.

During the five years preceding the intervention (2008-2012), a statistically significant decrease ($P < .01$) was already noted in the trend of utilization of relievers and CXR in bronchiolitis and CXR in asthma. However, we found no significant change in the trend of the use of systemic corticosteroids in cases with LRTI or the use of acid suppression therapy for GER.

The immediate effect of the intervention is represented by the level change. We found a statistically significant ($P < .01$) reduction according to the CWC-PHM recommendations only for the use of CXR in hospitalized children with uncomplicated asthma.

During the five years after the CWC-PHM recommendations were published (2013-2017), a sustained, significant decrease in the trend of the use of CXR in asthma and bronchiolitis and the use of relievers in bronchiolitis ($P < .01$) was observed. However, there was no significant change in the trend of the use of systemic corticosteroids in cases with LRTI or in the use of acid suppression therapy for GER during this period.

Comparison of the trends before and after the publication of the CWC-PHM recommendations revealed that only the decreasing trend in the use of relievers for bronchiolitis over time significantly correlated with the campaign ($P < .01$).

DISCUSSION

We found a steady reduction in the frequency of overutilization of five "low-value" services described in the CWC-PHM recommendations from 2008 to 2017 in 36 tertiary children's hospitals in the US. This trend was more evident in the utilization of relievers and CXR for bronchiolitis. The ITS analysis demonstrated that immediately after the publication of the CWC-PHM recommendations, only the use of CXR for asthma decreased significantly. Then, only the use of relievers for bronchiolitis decreased significantly over time in comparison with the secular trend.

These results support our hypothesis for two of the five metrics studied, suggesting that the publication of the CWC-PHM recommendations had a modest impact in clinical practices related to those services in tertiary children's hospitals.

These findings align with a limited number of published

TABLE 3. **Severity-adjusted ITS Parameter Estimates**

	Before CWC Slope	*P* Value	Level Change at CWC	*P* Value	After CWC Slope	*P* Value	Change in Slope After-Before	*P* Value
Asthma Chest Radiograph	-0.68 (-0.78, -0.58)	<.001	-4.12 (-5.77, -2.46)	<.001	-0.45 (-0.54, -0.37)	<.001	0.22 (0.08, 0.37)	.002
Bronchiolitis Chest Radiograph	-0.73 (-0.9, -0.56)	<.001	-4.61 (-7.4, -1.82)	.001	-0.88 (-1.03, -0.73)	<.001	-0.15 (-0.4, 0.09)	.21
Bronchiolitis Relievers	-0.39 (-0.53, -0.24)	<.001	2.73 (0.42, 5.04)	.02	-1.42 (-1.56, -1.28)	<.001	-1.04 (-1.24, -0.84)	<.001
LRTI Systemic Steroids	0 (-0.13, 0.13)	>.99	-1.22 (-3.37, 0.94)	.27	-0.13 (-0.27, 0)	.06	-0.13 (-0.32, 0.05)	.16
GER Acid Suppressors	-0.24 (-0.48, 0.01)	0.06	-3.73 (-7.77, 0.32)	.07	-0.26 (-0.54, 0.02)	.07	-0.03 (-0.39, 0.33)	.87

Severity adjusted for significant factors in Table 1.
Abbreviations: CWC, *Choosing Wisely*® Campaign; GER, gastroesophageal reflux; ITS, interrupted time series; LRTI, lower respiratory tract infection.

studies that have consistently found a modest decrease in the use of "low-value" services before 2012[11-13] and a limited impact of the CWC in clinical practices on the use of "low-value" services after the inception of the campaign.[14-17]

For instance, in a cross-sectional analysis of the 1999 and 2009 samples of ambulatory care practices in the US, only two of 11 overuse quality indicators showed improvement.[11] The authors recognized that reducing inappropriate care will require the same attention to guideline development and performance measurement that was directed at reducing the underuse of needed therapies. However, determining whether a patient received inappropriate care generally requires a much more detailed analysis of clinical information than what is required for assessments of underuse.[11]

Another study designed claims-based algorithms to measure the prevalence of 11 *Choosing Wisely*-identified "low-value" services in fee-for-service Medicare patients aged >65 years from 2006 to 2011.[12] The annual prevalence of selected CWC "low-value" services ranged from 1.2% (upper urinary tract imaging in men with benign prostatic hyperplasia) to 46.5% (preoperative cardiac testing for low-risk, noncardiac procedures). The study concluded that identifying and measuring "low-value" health services is a prerequisite for improving quality and eliminating waste.[12]

In pediatric medicine, the authors investigated a large cohort of infants aged one to 24 months hospitalized with bronchiolitis to 41 tertiary children's hospitals reporting data to the PHIS database from 2004 to 2012.[13] The trend analysis revealed a decrease in the utilization of diagnostics and treatment interventions before the publication of the American Academy of Pediatrics 2006 Bronchiolitis Guidelines.[18] There was an additional reduction in the use of CXR, steroids, and bronchodilators after the publication of the guidelines.[13]

After the CWC was launched in 2012, several surveys have demonstrated a tangible increase in awareness of the CWC and its goals, mostly among primary care physicians and subspecialists. Clinicians who were aware of the campaign found the recommendations to be useful as a legitimate source of guidance and were more likely to reduce the indication of unnecessary care and "low-value" clinical services included in the CWC.[1,3,19,20]

Few studies in adults have focused on measuring the trends in overuse metrics derived from the CWC recommendations.[14-16] The initial studies have found limited reduction on the use of "low-value" care after the inception of the CWC. They suggest that clinician education, awareness, and public promotion alone do not appear to be sufficient to achieve widespread changes in clinical practice. Additional interventions are necessary for the wider implementation and success of the CWC recommendations.[11,14,15,19,21,22]

However, a more recent study was conducted in 91 academic centers from 2013 through 2016, before and after the publication of a CWC recommendation on the use of troponin-only testing for the diagnosis of acute myocardial infarction. Hospitals with low rates of troponin-only testing before the publication of the recommendation demonstrated a statistically significant increase over time in the rate of adherence. The authors postulated that the impact of the CWC might have been significant because of the increase in the institutional and provider attention to "high-value" care as a result of the campaign.[16]

In pediatrics, a cross-sectional study defined 20 "low-value" services from a list of more than 400 items from the CWC and other sources of highly regarded, evidence-based pediatrics healthcare recommendations. The list included six diagnostic tests, five imaging tests, and nine prescription drugs ordered in a robust cohort of 4.4 million children nationwide in 2014. The study concluded that approximately one in 10 children received a "low-value" service. The majority (59.4%) were related to prescription drugs, specifically the inappropriate use of antibiotics for a variety of conditions. The estimated combined cost of these unnecessary services was approximately $27 million, with one-third of the cost being paid out of pocket, arguing for significant financial harm. However, this study did not perform a trend analysis.[17]

Our results are comparable with these studies, reporting an initial increase in awareness and beliefs, followed by progressive changes in clinical practice among pediatric hospital-based clinicians in delivering evidence-based, high-value care after the CWC.

The attribution of the steady reduction in the absolute percentages of overuse/waste in the five metrics related to the CWC observed in this study, including the significant chang-

es noted in two of the overuse indicators after the publication of the CWC-PHM recommendations, should be interpreted with caution. For example, the significant decrease in the use of "low-value" services in bronchiolitis could be attributed to multiple factors such as national guidelines released in 2014 after the campaign,[23] national multicenter QI collaborative projects,[24,25] and multiple local QI efforts.[26,27] The increase in the awareness and impact of the CWC recommendations among pediatric providers could also be a contributing factor, but this association cannot be established in the light of our findings.

On the other hand, despite extensive evidence for the lack of efficacy and the potential harm associated with the use of acid suppressors for uncomplicated GER in infants,[28-30] the frequency of this "low-value" therapeutic intervention remains high (~50%). The trend in utilization was not impacted by the CWC-PHM recommendations. This finding could be explained by several factors, including the possibility that several hospitalized patients may suffer from GER disease requiring acid suppressors. Another possibility is that acid suppressors are generally prescribed as an outpatient medication, and physicians treating inpatients may be reluctant to discontinue it during hospitalization. Nevertheless, this recommendation represents a target for review, update, and QI interventions in the near future.

The delivery of inappropriate "low-value" care represents the most significant dimension of waste in healthcare.[31] The development of quality measures of "low-value" services representing overuse and waste is the most needed step toward assessing the magnitude of the problem. Overuse metrics could be incorporated into QI interventions to decrease the provision of such services. However, systematic efforts aimed at developing quality indicators of overuse based on the CWC recommendations have been limited. To our knowledge, this is the first study on the trends of metrics derived from the CWC recommendations in pediatric medicine.

Future research is needed to develop overuse metrics further to assess the specific outcomes related to the implementation of the CWC. How much has clinical practice changed as a result of the campaign? What are the outcomes and savings attributable to these efforts? These are critical questions for the immediate future that should be answered to sustain the ongoing efforts and results and to validate that the efforts are worthwhile.

This study has several limitations. First, this is a retrospective and observational study. It cannot prove a direct causal relationship between the publication of the CWC-PHM and the observed trends, as other potential factors may have contributed to the outcomes. Second, in administrative databases, the data quality is dependent on proper documentation and coding that may vary among reporting institutions. These data lack clinical information, and a fair assessment of "appropriateness" could be questioned. In addition, the study included only 36 academic, tertiary children's hospitals. Because approximately two-thirds of all pediatric hospitalizations in the US occur in community settings,[32] this study may not fully represent clinical practice in the majority of pediatric hospitalizations in the US. Finally, the validity of the ITS analysis has inherent limitations due to the variability of the data in some metrics that may affect the power of the analysis. This fact could lead to inaccurate conclusions regarding intervention effectiveness due to the data-driven model applied, as well as the lack of control for other time-varying confounders.[33]

CONCLUSIONS

After seven years, the CWC faces important challenges. Critical to the success of the campaign is to "measure wisely" by developing quality indicators of overuse and operationalizing them into administrative and clinical data sources to assess the impact on clinical practice. Our study highlights some limited but steady reduction in the use of some "low-value" services before the campaign. It also demonstrates a modest impact of the campaign on clinical practices in tertiary care children's hospitals in the US. Clinicians and institutions still have a long way to go in reducing the use of "low-value" interventions in pediatric medicine. These observations challenge us to step up our efforts to implement QI interventions aimed at incorporating these professional, society-endorsed recommendations into our clinical practice.

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