Accuracy and Usefulness of the HEDIS Childhood Immunization Measures

WHAT'S KNOWN ON THIS SUBJECT: Healthcare Effectiveness Data and Information Set (HEDIS) measures are widely used to assess the reliability of pediatric immunization delivery. The extent to which these measures provide accurate ("is this child up-to-date on immunizations?") and useful ("is this child due for catch-up immunizations?") information is unclear.

WHAT THIS STUDY ADDS: Overall, HEDIS childhood immunization measures are accurate and useful. Users of HEDIS data should be aware, however, that certain immunizations (eg, hepatitis B, pneumococcal conjugate) and children (eg, those with a single overdue immunization) are more prone to HEDIS misclassification.

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KEY WORDS

immunizations, quality indicators, health care surveys

ABBREVIATIONS

ACIP—Advisory Committee on Immunization Practices

CDC—Centers for Disease Control and Prevention

DTaP—diphtheria/tetanus/acellular pertussis

EHR—electronic health record

HEDIS—Healthcare Effectiveness Data and Information Set

HepB—hepatitis B

HIB—*Haemophilus influenzae* type B

IPV—inactivated poliovirus

MMR—measles/mumps/rubella

NIS—National Immunization Survey

P4P—pay for performance

PCV—pneumococcal conjugate vaccine

UTD—up-to-date

VZV—varicella zoster virus

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abstract

OBJECTIVE: With the use of Centers for Disease Control and Prevention (CDC) immunization recommendations as the gold standard, our objectives were to measure the accuracy ("is this child up-to-date on immunizations?") and usefulness ("is this child due for catch-up immunizations?") of the Healthcare Effectiveness Data and Information Set (HEDIS) childhood immunization measures.

METHODS: For children aged 24 to 35 months from the 2009 National Immunization Survey, we assessed the accuracy and usefulness of the HEDIS childhood immunization measures for 6 individual immunizations and a composite.

RESULTS: A total of 12 096 children met all inclusion criteria and composed the study sample. The HEDIS measures had >90% accuracy when compared with the CDC gold standard for each of the 6 immunizations (range, 94.3%–99.7%) and the composite (93.8%). The HEDIS measure was least accurate for hepatitis B and pneumococcal conjugate immunizations. The proportion of children for which the HEDIS measure yielded a nonuseful result (ie, an incorrect answer to the question, "is this child due for catch-up immunization?") ranged from 0.33% (varicella) to 5.96% (pneumococcal conjugate). The most important predictor of HEDIS measure accuracy and usefulness was the CDC-recommended number of immunizations due at age 2 years; children with zero or all immunizations due were the most likely to be correctly classified.

CONCLUSIONS: HEDIS childhood immunization measures are, on the whole, accurate and useful. Certain immunizations (eg, hepatitis B, pneumococcal conjugate) and children (eg, those with a single overdue immunization), however, are more prone to HEDIS misclassification. *Pediatrics* 2012;129:648–656

There is an expanding movement in the United States to systematically measure the quality of health care delivery.^{1,2} The National Quality Forum, a leader in quality measure appraisal, uses 4 criteria to assess quality measures: importance to measure and report, reliability and validity, usability and relevance, and feasibility to collect.³ The extent to which quality measures score more favorably on these 4 axes theoretically improves the likelihood that their widespread use could lead to improvements in health care quality.

Childhood immunization delivery is a perennial target of quality measurement efforts.⁴ Childhood immunizations have been deemed the most important pediatric preventive service⁵ and are clearly important to measure and report. Although integration of practice-based paper records, electronic health records (EHRs), immunization registries, and payer data has been challenging, childhood immunization data have repeatedly been shown to be feasible to collect. Thus, 2 of the 4 National Quality Forum criteria are readily met (importance to measure and report; feasibility). Whether childhood immunization data, as currently measured, are reliable and valid or usable and relevant is less clear.

The National Committee for Quality Assurance has developed childhood immunization quality measures as part of its Healthcare Effectiveness Data and Information Set (HEDIS) program.^{6,7} HEDIS measures help employers assess the quality of care provided by the health insurance plans they offer; consumers are also occasionally provided with these data. More than 90% of US health plans use HEDIS measures, which allow benchmarking of immunization delivery across health plans. Additionally, federal “meaningful-use” criteria for EHRs include HEDIS childhood immunization measures.^{8,9}

HEDIS childhood immunization measures, however, were not designed to

precisely reflect the recommended immunization schedules developed annually by the Advisory Committee for Immunization Practices of the Centers for Disease Control and Prevention (CDC). These CDC schedules are the gold standard to guide immunization delivery for providers, parents, schools, and others.¹⁰ The consequences of these inconsistencies on measure reliability/validity (ie, accuracy) and usability/relevance (ie, usefulness) are incompletely understood. By using a nationally representative sample of 2-year-olds, our primary objectives were to (1) calculate the accuracy of the HEDIS immunization measures, compared with CDC recommendations, and (2) determine whether the HEDIS immunization measures provide useful data for providers.

METHODS

Data Source

We analyzed data from the 2009 National Immunization Survey (NIS).¹¹ The NIS is conducted annually by the CDC to assess immunization uptake by non-institutionalized US children aged 19 to 35 months.¹² The NIS uses a random-digit–dialing telephone survey to identify households containing children in the target age range and interviews the adult most knowledgeable about the child’s immunizations. With consent of the child’s parent, the NIS also contacts the child’s health care provider(s) to request immunization information from medical records. For the 2009 NIS, household interviews were conducted from January 2009 to February 2010; provider data collection extended through April 2010. NIS incorporates a complex sampling methodology that adjusts for household nonresponse, households with multiple or no telephone lines, and vaccination history nonresponse, yielding data that can be weighted to generate nationally representative estimates.¹²

Study Population

We included children residing in the 50 US states or Washington, DC with adequate provider-reported data to assess whether the child received all recommended immunizations, or zero immunizations reported on household interview. Publicly available NIS data categorize participants into 3 age groups: 19 to 23, 24 to 29, and 30 to 35 months. Because our study focused on whether immunizations were up-to-date (UTD) and/or due on the child’s second birthday, we limited our study to children aged 24 to 35 months.

Immunizations

In 2009, the CDC recommended the following immunizations for children in the first 2 years of life: hepatitis B (HepB), rotavirus, diphtheria/tetanus/acellular pertussis (DTaP), *Haemophilus influenzae* type B (HIB), pneumococcal conjugate (PCV), inactivated poliovirus (IPV), influenza, measles/mumps/rubella (MMR), varicella zoster virus (VZV), and hepatitis A.¹⁰ Of these, 7 were included in HEDIS 2009 measures (HepB, DTaP, HIB, PCV, IPV, MMR, and VZV).⁷ Our study analyzed 6 of these measures, excluding HIB. Production problems led to a global shortage of HIB from December 2007 to September 2009, prompting the CDC to recommend temporary suspension of the booster dose (after age 1 year) of HIB.^{13,14} Because we were unable to distinguish missed doses from intentionally suspended doses, HIB was excluded from all analyses. Only immunizations given in the first 2 years of life were analyzed.

Measures

We compared the performance of the 2009 HEDIS childhood immunization measures⁷ with the gold standard, CDC-recommended immunization schedule from 2009¹⁰ (see Supplemental Table 5) for both accuracy and usefulness.

Accuracy

Accuracy was assessed by measuring the proportion of children whose HEDIS-derived UTD status was concordant with their CDC-derived UTD status for the 6 individual immunizations and a composite. The composite measure was evaluated for each child (UTD for all immunizations versus not UTD) with possible concordance of HEDIS and CDC composite results even if individual immunizations were discordant. For the HEDIS measure, a child was UTD if they received the measure-specified number of immunizations on or before their second birthday, regardless of age at administration or dosing intervals. For example, a child receiving 4 doses of PCV by 2 years of age was UTD; a child receiving 3 doses was not. For the CDC measure, a child was considered UTD if, regardless of the number of previously administered immunizations, no catch-up immunizations were recommended either at age 2 years or after. For example, a child receiving 3 doses of PCV at ages 2, 4, and 14 months was UTD (fourth catch-up dose not recommended by CDC); a child receiving 3 doses of PCV at ages 2, 4, and 6 months was not UTD (fourth catch-up dose recommended by CDC). Per CDC guidance, a grace period of 4 days was applied to all minimum intervals and ages for the CDC measure.¹⁵ Doses 5 or more days earlier than recommended were not counted; repeat doses were only counted if they were spaced after the invalid dose by the recommended minimum interval. No grace periods were applied to the HEDIS measures, consistent with HEDIS specifications.

Usefulness

We postulated that a childhood immunization measure would be useful to providers if it identified which children required which catch-up immunization(s) based on the CDC recommendations. We therefore calculated the weighted proportion of children due for each

immunization and the composite by the HEDIS and CDC standards. Next, we calculated the proportion of children for whom this classification was discordant across the 2 schema, broken down into HEDIS false-positives (HEDIS = due, CDC = not due) and false-negatives (HEDIS = not due, CDC = due), the sum of which represented the overall mismatch rate. In contrast to the accuracy composite, the usefulness composite measure was considered at the immunization level, not the patient level. Therefore, the composite measure was deemed to be mismatched when the HEDIS and CDC measures disagreed on the status of any immunization for a child. For the HEDIS measure, a child was due for immunization on the second birthday if he had had fewer than the measure-specified number of immunizations by that time. By definition, the proportion due for immunizations equaled 1 minus the proportion deemed UTD by the accuracy measure. For the CDC measure, a child was due for immunization if the missing immunization was still recommended for “catch-up” administration at age 2 years and a sufficient interval had passed since administration of the previous dose. For example, a child receiving 3 previous doses of DTaP would be due for immunization by the HEDIS measure. This same child would be due for immunization by the CDC measure only if 6 months had elapsed since the administration of the third dose. In the usefulness analyses, grace periods were applied to the CDC rules only for previous immunizations and not the current immunization. Although the CDC criteria accept previously administered immunizations within the grace period, we felt that most providers would not purposefully offer future immunizations earlier than recommended.

Analysis

Sampling weights were applied to the data to generate nationally representative

estimates. Descriptive analyses were performed by using both unweighted and weighted data. We then calculated the proportion of children UTD according to the HEDIS measure and CDC gold standard for individual immunizations and the composite. We conducted a similar analysis for usefulness and characterized the sources of error when the HEDIS and CDC measures were discordant. Last, we assembled 2 logistic regression models to identify factors associated with the likelihood of a child being accurately assessed by the HEDIS measure as UTD and as due for immunization, compared with the CDC standard. This study of deidentified, publicly available data was approved by the Johns Hopkins University School of Medicine Institutional Review Board.

RESULTS

Of 25 241 children for whom household interviews were completed during the 2009 NIS, 12 096 met all inclusion criteria and composed the study sample. Children were evenly split by age and gender; half of children were white (Table 1). Interviews were most often with the child's mother (78%); 15% were conducted in Spanish. Forty-six percent of families comprised 5 or more members; nearly one-third lived below the poverty line. A majority of children had received WIC benefits in their lifetime, and more than 90% were currently insured. A majority of immunization providers reported to an immunization registry and ordered immunizations from a health department.

Accuracy

The proportion of children UTD for each of the 6 immunizations ranged from 78% (PCV) to 91.5% (HepB) according to the HEDIS measures and 79.4% (DTaP) to 90.8% (IPV) according to the CDC gold standard (Table 2). Approximately two-thirds of children (HEDIS, 67%; CDC,

TABLE 1 Study Sample Characteristics (Unweighted $n = 12\,096$; Weighted $N = 4\,380\,689$)

Attributes	Unweighted n (weighted %)
Child	
Age	
24–29 mo	6035 (48)
30–35 mo	6061 (52)
Race and ethnicity	
Non-Hispanic white	7637 (50)
Hispanic	2051 (28)
Non-Hispanic black	1205 (13)
Non-Hispanic other or multiple races	1203 (9.1)
Gender	
Male	6213 (51)
Female	5883 (49)
Respondent	
Relationship of respondent to child	
Mother or female guardian	9803 (78)
Father or male guardian	1756 (15)
Grandparent	469 (6.5)
Other or unknown	68 (1.2)
Interview language	
English	11 127 (83)
Spanish	840 (15)
Other	129 (1.8)
Household	
No. of people in household	
2	179 (1.7)
3	2265 (17)
4	4647 (34)
5	2773 (24)
6	1273 (12)
7	512 (5.5)
8 or more	447 (4.9)
Census region	
Northeast	2086 (16)
Midwest	2880 (21)
South	4332 (38)
West	2798 (25)
Maternal	
Education	
Less than high school graduate	1239 (20)
High school graduate, no college	2148 (32)
High school graduate, college but less than college graduate	3122 (18)
College graduate	5587 (30)
Age	
≤ 19 y	186 (2.9)
20–29 y	3800 (38)
≥ 30 y	8110 (59)
Financial and insurance	
Poverty status ^a	
Below poverty	2422 (31)
Above poverty, $\leq \$75\,000/\text{y}$	4731 (37)
Above poverty, $> \$75\,000/\text{y}$	4557 (27)
Unknown	386 (5.0)
Child ever received WIC	
Yes	4865 (55)
No	7175 (45)
Unknown	56 (0.44)
Child's current insurance ^b	
Employer-sponsored	7457 (49)
Medicaid or SCHIP	3915 (46)
Indian Health Service, military health care	577 (3.6)
Other insurance	894 (7.3)
Uninsured, unknown	635 (6.6)

65%) were UTD for the composite measure. The HEDIS measure had $>90\%$ accuracy when compared with the CDC gold standard for each of the 6 immunizations (range, 94.3%–99.7%) and the composite (93.8%). The HEDIS measure was most accurate for VZV, IPV, MMR, and DTaP and least accurate for HepB and PCV.

Usefulness

The 2 immunizations most likely to be due at age 2, consistent across both the HEDIS and CDC measures, were DTaP and PCV (Table 3). Approximately one-third of children were due for at least 1 immunization at age 2 (HEDIS, 32.9%; CDC, 34.2%). Across the 6 immunizations, the proportion of children for which the HEDIS measure yielded an incorrect result ranged from 0.33% (VZV) to 5.96% (PCV). The predominant source of mismatch for the 2 immunizations with the highest mismatch rates was different. For HepB, the majority of mismatches derived from HEDIS false-negatives, confirming a finding observed previously by using NIS data.¹⁶ This occurred most commonly when the third HepB dose was administered too close to the second dose (minimum interval = 8 weeks) or at too young an age (minimum age = 24 weeks). For PCV, the majority of mismatches derived from HEDIS false-positives (<4 PCV immunizations had been administered, but CDC recommendations were to administer no additional immunizations). Overall, the HEDIS composite result was inaccurate (ie, incorrectly categorizing at least 1 immunization in the composite) for 1 in 9 children (11.7%).

Factors Associated With HEDIS Measure Accuracy and Usefulness

The accuracy and usefulness of the HEDIS immunization measures varied little by patient, household, financial/insurance, or provider attributes (Table 4). The only

TABLE 1 Continued

Attributes	Unweighted <i>n</i> (weighted %)
Provider	
No. of providers identified by respondent	
0 ^c	31 (0.12)
1	7755 (60)
2	3480 (32)
3 or more	830 (8.2)
Providers report to an immunization registry	
All providers	6451 (52)
Some but not all providers	1065 (9.5)
No providers	2489 (19)
Unknown/missing	2091 (19)
Providers order immunizations from the state or local health department	
All providers	8735 (72)
Some but not all providers	956 (8.2)
No providers	1272 (9.4)
Unknown/missing	1133 (10)

a Based on 2008 Census poverty thresholds.

b Sums to >100% since categories were not mutually exclusive.

c Children not receiving any immunizations are included in the National Immunization Survey.

important predictor of HEDIS measure accuracy and usefulness was the CDC-recommended number of immunizations due at age 2 years. For both accuracy and usefulness, the HEDIS measures performed best at the extremes, when either zero or all 6 immunizations were due. When some, but not all, of the 6 immunizations were due, HEDIS measure accuracy dropped to 86.8% (odds ratio of being correctly classified, compared with zero immunizations due, 0.22 [95% confidence interval 0.16–0.31]) and usefulness to 70.8% (odds ratio, 0.10 [0.08–0.13]). For accuracy, the decrement for the “some but not all

immunizations due” category was driven entirely by a drop in performance when only a single immunization was due (Fig 1). For usefulness, the same decrement was driven by drops in performance across the number immunizations due, with a U-shaped distribution.

DISCUSSION

We used a nationally representative database of child-level, provider-reported immunizations to assess the accuracy and usefulness of the HEDIS childhood immunization measures. Overall, we

found the HEDIS measures to be quite accurate. Among the only 2 immunizations with < 98% accuracy, HEDIS measures tended to overclassify children as UTD for HepB and underclassify children as UTD for PCV. These same 2 immunizations were also the 2 most likely to be misclassified with respect to whether a catch-up immunization would be due at age 2. We found the HEDIS measures to be the most accurate when zero or >1 immunization was due and most useful when zero or all 6 immunizations were due.

Systematic measurement of immunization delivery serves a variety of purposes.^{4,17} First, national, state, and local governments conduct immunization surveillance to identify targets for immunization outreach. Second, payers use immunization delivery data for pay-for-performance (P4P) efforts that reward physicians or organizations for achieving immunization goals. Third, individual providers and practices use immunization measurement to improve the quality of day-to-day delivery of immunizations. Last, individual providers and practices may implement immunization measurement to satisfy meaningful-use requirements for their EHRs. The results of our study have implications for each of these approaches to immunization measurement.

TABLE 2 Is the Child Up-to-Date on the Second Birthday? Accuracy of HEDIS Measures, Compared With CDC Recommendations (Unweighted *n* = 12 096)

Immunization	Up-to-date ^a per HEDIS Measure, Weighted % (95% CI)	Up-to-date ^b per CDC Recommendations, Weighted % (95% CI)	Accuracy of HEDIS Measure Compared With CDC, Weighted % (95% CI)
DTaP	80.3 (79.0–81.6)	79.4 (78.1–80.8)	98.7 (98.4–99.1)
IPV	90.8 (89.8–91.7)	90.8 (89.9–91.8)	99.6 (99.4–99.8)
MMR	90.5 (89.6–91.4)	90.1 (89.1–91.1)	99.6 (99.4–99.9)
HepB	91.5 (90.6–92.4)	87.3 (86.2–88.4)	95.8 (95.1–96.4)
VZV	89.2 (88.2–90.1)	88.8 (87.8–89.8)	99.7 (99.5–99.8)
PCV	78.0 (76.6–79.4)	82.0 (80.7–83.3)	94.3 (93.6–95.0)
Composite ^c	67.1 (65.6–68.6)	65.3 (63.7–66.8)	93.8 (93.0–94.7) ^d

CI, 95% confidence interval.

a UTD per HEDIS measure implies the measure-endorsed number of immunizations were given on or before the second birthday.

b UTD per CDC measure implies that catch-up immunizations are neither due today nor in the future. UTD does not necessarily imply that all immunizations were received in a timely fashion in accordance with the CDC-recommended schedule.

c To be UTD for the composite, a child must be UTD on each of the 6 individual immunizations listed above.

d For the composite, HEDIS is considered accurate when it yields the same overall, patient-level result as CDC recommendations (UTD versus not UTD), regardless of whether HEDIS yields the same result for each individual immunization. For example, a child deemed not UTD for MMR and PCV by HEDIS and deemed not UTD for only MMR by CDC is considered to be not UTD on the composite for both HEDIS and CDC, and therefore accurate, despite the differing underlying result for PCV.

TABLE 3 Is the Child Due for Immunizations on the Second Birthday? Usefulness of HEDIS Measures, Compared With CDC Recommendations (Unweighted *n* = 12 096)

Immunization	Due for Immunization per HEDIS measure, ^a Weighted % (95% CI)	Due for Immunization per CDC Recommendations, ^b Weighted % (95% CI)	HEDIS/CDC Mismatch		
			HEDIS = Due CDC = NOT Due, Weighted % (95% CI)	HEDIS = NOT Due CDC = Due, Weighted % (95% CI)	Overall Mismatch Rate, Weighted % (95% CI)
DTaP	19.7 (18.4–21.0)	19.2 (17.9–20.5)	1.47 (1.07–1.87)	0.92 (0.64–1.20)	2.39 (1.91–2.87)
IPV	9.24 (8.27–10.2)	9.10 (8.12–10.1)	0.31 (0.10–0.52)	0.16 (0.03–0.29)	0.46 (0.22–0.71)
MMR	9.49 (8.54–10.4)	9.88 (8.90–10.8)	0	0.39 (0.13–0.64)	0.39 (0.13–0.64)
HepB	8.47 (7.56–9.38)	12.5 (11.4–13.6)	0.16 (0.05–0.28)	4.24 (3.55–4.92)	4.40 (3.70–5.09)
VZV	10.8 (9.86–11.8)	11.2 (10.2–12.2)	0	0.33 (0.17–0.50)	0.33 (0.17–0.50)
PCV	22.0 (20.6–23.4)	17.7 (16.4–19.0)	5.12 (4.44–5.80)	0.84 (0.57–1.12)	5.96 (5.23–6.70)
Composite	32.9 (31.3–34.4)	34.2 (32.6–35.7)	N/A	N/A	11.7 (10.6–12.7) ^c

CI, 95% confidence interval; N/A, not applicable.

a By HEDIS criteria, children are due for immunization if they have previously received fewer than the measure-recommended number of immunizations of that type. For example, a child with 3 previous PCV immunizations is due today, because the measure expects 4 (or more) previous immunizations. By definition, therefore, it is equal to (1 – up-to-date percentage [see Table 2]).

b By CDC criteria, children are due for immunization if (1) the immunization they are lacking is still recommended for “catch-up” administration by age 2 y and (2) a sufficient interval has passed since the administration of the most recent previous immunization of the same type.

c For composite, a mismatch occurs when HEDIS and CDC disagree on any of the listed immunizations regarding due for immunization today versus not due for immunization.

Immunization Surveillance

Our data provide reassurance that population-level, HEDIS-based estimates are likely to be quite accurate, contradicting results from 2 smaller studies that used similar methodologies.^{18,19} Because a substantial fraction of the total misclassification tends to be in opposing directions (HepB overclassified as UTD; PCV underclassified as UTD), population estimates of children UTD for the composite are accurate within 2%, despite an overall HEDIS accuracy of 94%. Additionally, previous research suggests that variability in health plan performance on HEDIS childhood immunization measures may result, in part, from variability in patient-level characteristics (eg, race, poverty, urbanicity) across plans.^{20,21} Our data suggest that this variability is unlikely to be driven by differences in measure accuracy across these variables. Therefore, observed immunization disparities identified via HEDIS-based immunization surveillance likely reflect true underlying disparities in immunization delivery, and not differential measure accuracy.

Pay-for-Performance

Immunization delivery has been a target of P4P efforts.^{22–28} Payers considering

the merits of immunization-related P4P initiatives should be aware that population estimates derived from HEDIS are likely to be quite accurate, whereas estimates at the patient or provider level (in the case of providers with low patient numbers) may or may not be, as has been found for other HEDIS measures.^{29,30} P4P efforts relying on HEDIS immunization measures should be recognized as specifically incentivizing the timely delivery of immunizations, rather than on achieving an overall UTD population of children. For example, a child that does not present to clinic between ages 6 and 12 months may receive PCV at 2, 4, and 13 months. By CDC criteria, this child, although delayed in receiving immunizations, is fully immunized by age 2. In contrast, HEDIS measures will classify this child as not UTD. Indeed, providers in such a case could have a financial incentive to offer the fourth PCV immunization before age 2, despite the fact that it is not recommended by the CDC, to bring the child into compliance with the HEDIS measure. As a result, more nuanced P4P approaches may be warranted, in particular, at the provider level and potentially involving visit-based (ie, “missed opportunities”) analyses. Such a missed opportunities strategy would assess the proportion of visits at which all due

immunizations were delivered, with the CDC recommendations forming the gold standard against which immunization delivery is measured.

Provider- or Practice-Level Quality Improvement and “Meaningful Use”

For those using HEDIS measures to guide clinical care or for quality improvement purposes, the observed usefulness error rate (1 in 9 children) makes a HEDIS-derived immunization prompt more useful as a screening tool than as definitive decision support. Providers should be especially vigilant for children due for HepB who are not flagged by HEDIS-derived prompts, as well as children flagged by HEDIS-derived prompts for PCV who are not due for catch-up. Although they are technically much more complex to code than the HEDIS measures, direct coding of CDC immunization rules into clinical decision support is a natural next step in the evolution of EHRs and would result in nearly error-free prompting of providers regarding which children are due for which immunizations.³¹ Nonetheless, federal meaningful-use standards are currently based on the HEDIS immunization measures.^{8,9} Therefore, practices wishing to meet these standards will still need to measure

TABLE 4 Factors Associated With Accuracy and Usefulness of Composite HEDIS Immunization Measure, Compared With Gold Standard CDC Recommendations

Factor	HEDIS Measure Accuracy (Overall Weighted Accuracy = 93.8%)		HEDIS Measure Usefulness (Overall Weighted Usefulness = 88.3%)	
	Correctly Classified, ^a Weighted %	Adjusted ^b Odds Ratio (95% CI)	Correctly Classified, ^c Weighted %	Adjusted ^b Odds Ratio (95% CI)
Age				
24–29 mo	93.6	1.0	87.5	1.0
30–35 mo	94.1	1.08 (0.81–1.45)	89.1	1.21 (0.97–1.51)
Race and ethnicity				
Non-Hispanic white	94.6	1.0	90.4	1.0
Hispanic	93.5	0.91 (0.63–1.32)	88.7	1.02 (0.75–1.32)
Non-Hispanic black	93.7	1.04 (0.66–1.66)	84.7	0.74 (0.53–1.03)
Non-Hispanic other race	91.1	0.62 (0.37–1.04)	80.9	0.46 (0.32–0.66) ^d
Gender				
Male	93.9	1.0	87.9	1.0
Female	93.8	0.93 (0.69–1.25)	88.7	1.01 (0.81–1.26)
No. of people in household				
3 or fewer	91.9	1.0	87.5	1.0
4–6	94.4	1.53 (1.05–2.22) ^d	89.0	1.20 (0.89–1.61)
7 or more	93.8	1.75 (0.90–3.38)	85.2	1.14 (0.73–1.78)
Poverty status				
Below poverty	93.0	1.0	85.6	1.0
Above poverty, ≤\$75 000/y	93.8	1.12 (0.74–1.70)	88.8	1.18 (0.86–1.62)
Above poverty, >\$75 000/y	95.3	1.36 (0.84–2.18)	91.2	1.27 (0.88–1.83)
Unknown	91.6	0.76 (0.38–1.54)	86.8	0.94 (0.55–1.62)
Child's current insurance				
Has employer-sponsored	94.3	1.0	90.2	1.0
No employer-sponsored, but has Medicaid/SCHIP	93.1	1.00 (0.67–1.50)	86.0	0.83 (0.61–1.13)
Neither employer-sponsored nor Medicaid/SCHIP, but has insurance	95.0	1.24 (0.74–2.10)	90.1	1.06 (0.67–1.68)
Uninsured	94.0	1.15 (0.59–2.27)	87.1	0.92 (0.59–1.44)
No. of immunization providers identified by respondent				
0	100	— ^e	100	— ^e
1	94.1	1.0	88.8	1.0
2	94.0	1.00 (0.70–1.45)	88.2	0.93 (0.71–1.22)
3 or more	91.1	0.70 (0.40–1.20)	85.1	0.70 (0.46–1.07)
Immunization providers report to an immunization registry				
All providers	93.4	1.0	87.5	1.0
Some but not all providers	93.1	0.94 (0.53–1.65)	88.4	0.99 (0.64–1.53)
No providers	95.0	1.28 (0.85–1.93)	89.1	1.10 (0.83–1.46)
Unknown/missing	94.2	1.14 (0.79–1.65)	89.4	1.25 (0.94–1.66)
No. of immunizations due at age 2, by CDC recommendations				
0	96.7	1.0	95.9	1.0
1–5 (ie, some but not all)	86.8	0.22 (0.16–0.31) ^d	70.8	0.10 (0.08–0.13) ^d
6 (ie, all)	100	— ^e	95.3	0.75 (0.40–1.38)

CI, 95% confidence interval.

a For accuracy, “correctly classified” refers to UTD versus not UTD on second birthday. For this measure, the overall result at the child level must be classified correctly for the composite to be considered classified correctly.

b Each variable adjusted for all other variables listed in the table.

c For usefulness, “correctly classified” refers to due for immunizations on second birthday versus not due for immunizations on second birthday. For this measure, each individual immunization in the composite must be classified correctly (due versus not due) for the composite to be considered classified correctly.

^d $P < .05$.

^e Category omitted, because HEDIS measure classified 100% of observations correctly for accuracy and/or usefulness.

and report HEDIS immunization measures, even if they use a more refined, CDC-derived decision support tool to guide clinical care.

Our study has several limitations. First, HEDIS measures were not developed for use as point-of-care indicators of

whether a child needs catch-up immunizations. Nonetheless, we chose to analyze HEDIS measure usefulness, in addition to accuracy, because this best captures the provider/patient point of view. Second, we analyzed each child only on their second birthday. HEDIS

childhood immunization measures are not designed for use at other ages, so their accuracy and usefulness at other ages cannot be assessed. Third, we used CDC-recommended grace periods to determine whether immunizations should be counted. Schools, childcare

FIGURE 1

Accuracy and usefulness of HEDIS immunization measures, by number of CDC-recommended immunizations due on second birthday.

agencies, and other parties may not accept immunizations that fall within the grace period. Fourth, the NIS data themselves are subject to limitations, including possible residual bias despite adjustments made to account for non-response and households without land-line telephones.¹² Finally, immunization measurement is highly dependent on

patient (ie, denominator) selection.^{17,32–35} HEDIS measures, in particular, examine children who were continuously enrolled in a single health plan during the measurement year.⁷ Our analyses were independent of health plan enrollment. Results for children meeting other inclusion criteria could be different.

CONCLUSIONS

Given the profound health and societal benefits associated with the reliable delivery of childhood immunizations, efforts to measure and improve immunization delivery processes are essential. HEDIS immunization measures have served for years as an important means of comparing immunization delivery across patient populations, providers, and health plans, and will continue to do so. Nonetheless, the HEDIS measures were not designed as a perfect mirror to the CDC recommendations upon which they are based. As a result, users of immunization delivery data must be aware of the strengths and weaknesses of HEDIS-based approaches, until advances in electronic health information technology permit more precise, reliable, and nuanced measurement of immunization delivery.

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