Recognizing Differences in Hospital Quality Performance for Pediatric Inpatient Care

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abstract

BACKGROUND: Hospital quality-of-care measures are publicly reported to inform consumer choice and stimulate quality improvement. The number of hospitals and states with enough pediatric hospital discharges to detect worse-than-average inpatient care remains unknown.

METHODS: This study was a retrospective analysis of hospital discharges for children aged 0 to 17 years from 3974 hospitals in 44 states in the 2009 Kids' Inpatient Database. For 11 measures of all-condition or condition-specific quality, we assessed the number of hospitals and states that met a "power standard" of 80% power for a 5% level significance test to detect when care is 20% worse than average over a 3-year period. For this assessment, we approximated volume as 3 times actual 2009 admission volumes.

RESULTS: For all-condition quality, 1380 hospitals (87% of all pediatric discharges) and all states met the power standard for the family experience-of-care measure; 1958 hospitals (95% of discharges) and all states met the standard for adverse drug events. For condition-specific quality measures of asthma, birth, and mental health, 203 to 482 hospitals (52%–90% of condition-specific discharges) met the power standard and 40 to 44 states met the standard. One hospital and 16 states met the standard for sickle cell disease. No hospital and ≤27 states met the standard for the remaining measures studied (appendectomy, cerebrospinal fluid shunt surgery, gastroenteritis, heart surgery, and seizure).

CONCLUSIONS: Most children are admitted to hospitals in which all-condition measures of quality have adequate power to show modest differences in performance from average, but most condition-specific measures do not. Policies regarding incentives for pediatric inpatient quality should take these findings into account.

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WHAT'S KNOWN ON THIS SUBJECT: Hospital quality-of-care measures are publicly reported to inform consumer choice and stimulate quality improvement. The number of hospitals and states with a sufficient number of pediatric hospital discharges to detect worse-than-average pediatric inpatient care quality remains unknown.

WHAT THIS STUDY ADDS: Most children are admitted to hospitals in which all-condition measures of inpatient quality are powered to show differences in performance from average, but most condition-specific measures are not. Policy on incentives for pediatric inpatient quality should take these findings into account.

Since the 1980s, the Centers for Medicare & Medicaid Services (CMS) has publicly reported hospitals' performance on quality measures to inform consumer choice and stimulate quality improvement.¹⁻⁷ These and other measures have been used by federal agencies (eg, the Agency for Healthcare Research and Quality [AHRQ]), state and local governments, private accreditation organizations, health systems, and insurance plans to facilitate comparisons of hospital performance against other hospitals and established benchmarks (eg, the national average).^{3,8-12} Financial penalties are imposed on hospitals with worse-than-average performance.^{13,14}

An accurate assessment of performance requires that hospitals have enough discharges (ie, the measure's denominator) and enough measured events of quality (ie, the measure's numerator) to statistically test how their results compare with a standard (eg, the national average).¹⁵ When performance is measured for hospitals with too few discharges or events, the results may be misleading^{16,17} because random variation can substantially affect performance measures.¹⁸⁻²⁰ At such hospitals, statistical tests may have insufficient power to detect modest, yet clinically significant, differences in performance (eg, 20% worse than average), and suboptimal performances may not be recognized. For these reasons, CMS withholds public reporting of performance for hospitals with few adult discharges²¹ and aggregates selected performance data for state-level reporting.²²

Public reporting of hospital performance for adult patients has been performed for decades but is much newer for children. The Children's Health Insurance Program Reauthorization Act of 2009 calls for the development of new quality measures and the enhancement of existing ones to be used by Medicaid

and Children's Health Insurance Programs to assess hospital- and state-level performance.²³ The legislation requires that the pediatric measures apply to large populations and cover prevalent and consequential clinical events that indicate quality of care.²³⁻²⁵

It is currently unknown what effect public reporting of hospital performance for children will have on consumer choice and quality improvement. Because children experience fewer hospitalizations and consequential clinical events (eg, in-hospital mortality²⁶) than adults, many hospitals may have too few pediatric discharges to support accurate measurement and interpretation of their performance.²⁶⁻²⁸ Therefore, in this national study, we estimated the number of hospitals and states that have a sufficient number of pediatric hospital discharges to detect worse-than-average pediatric care quality on a variety of measures for all-condition discharges (ie, admission for any reason) and condition-specific discharges (ie, admission for a specific condition).

METHODS

Study Design, Setting, and Population

This study used the Healthcare Cost and Utilization Project Kids' Inpatient Database (KID) 2009, the largest, multistate database of US hospitalizations for children aged 0 to 17 years. KID includes hospital discharges from 3974 acute care hospitals in 44 states. Discharges from the 147 nonacute care hospitals (eg, rehabilitation hospitals) in KID were excluded from analysis.

KID includes a 10% random sample of uncomplicated-birth discharges and an 80% random sample of complicated-birth and nonbirth discharges from each hospital. The numbers of uncomplicated-birth discharges as well as complicated-birth

and nonbirth discharges from each hospital were therefore adjusted in the data set by factors of 10 and 1.25, respectively, to obtain an estimate of each hospital's discharge volume.²⁹ The annual discharge volumes were then multiplied by 3 to obtain each hospital's estimated 3-year volume. Three years is a standard period of time for measuring and reporting inpatient quality indicators.^{20,30,31} We calculated the SE of each hospital's volume of discharges to account for the imprecision created by these adjustments. Children's and non-children's hospitals were included, distinguishing them with the 2009 specifications from the National Association of Children's Hospitals and Related Institutions (NACHRI).³² Hospitals with a missing NACHRI specification (9% of hospitals) were excluded when reporting hospital volumes specifically for children's and non-children's hospitals.

Discharge Diagnoses and Quality Measures

We analyzed discharge diagnoses for which there are pediatric inpatient quality measures by using published reports of the average measure performance across hospitals (Table 1). Measures of "never" events (ie, inexcusable events that should never happen such as wrong-site surgery^{33,34}) were not assessed because these events are extremely rare in children, and differences in event rates across hospitals are not discernible.²⁷ Hospital and state volumes were estimated for all-condition discharges (ie, hospitalizations that occurred for any reason other than births), as well as condition-specific discharges of appendectomy, asthma, birth, cardiac surgery, gastroenteritis, cerebrospinal fluid shunt surgery, mental health, seizure, and sickle cell anemia. Condition-specific discharges were identified with the instructions provided for each measure.³⁵⁻⁵¹ Depending on the measure, AHRQ's

TABLE 1 Pediatric Discharges, Quality Measures, and Average Performance

Admission Diagnosis	Quality Measure	Endorsing Organization ^a	Average Performance	
			Rate ^b	Setting ^b
All diagnoses	Adverse drug events ^{41,45,46,51,77}	NQF	11% ⁴¹	12 children's hospitals
	Family experience of care not rated as "excellent" ^{38,47,50}	NCQA, AHRQ	16% ^{50,c,d}	65 hospitals
Appendectomy for acute appendicitis	Negative appendectomy rate ^{36,37,78}	AHRQ	4% ⁷⁹	40 hospitals
Asthma	Asthma action plan not received ^{35,80}	AHRQ, JCAHO	35% ^{81,d}	~3000 hospitals
Births	Birth trauma ⁴⁸	AHRQ	3% ⁸²	~4000 hospitals
Gastroenteritis	Use of nonrecommended digestive medications ⁴²	None ^e	6% ⁴²	280 hospitals
Cerebrospinal fluid shunt surgery for hydrocephalus	Ventricular shunt malfunction ^{39,40,43,44}	NQF	14% ⁴³	37 children's hospitals
Pediatric heart surgery	In-hospital mortality after pediatric heart surgery ⁴⁹	AHRQ	4% ²⁷	381 hospitals in California
Mental health disorder	Patients with a mental health disorder discharged on multiple antipsychotic medications without appropriate justification ⁸³	NQF, JCAHO	30% ⁸⁴	~3000 hospitals
Seizure	30-d seizure readmission rate	CHA	7%	72 children's hospitals
Sickle cell anemia	30-d sickle cell readmission rate	CHA	17%	72 children's hospitals

CHA, Children's Hospital Association; JCAHO, The Joint Commission on Accreditation of Healthcare Organizations; NCQA, National Committee for Quality Assurance; NQF, National Quality Forum.

^a The endorsing organizations listed for each quality measure have only endorsed the quality measures and have not endorsed the reported performance ratings.

^b Shown are the clinical settings from which the reported performance rates were obtained.

^c The reported performance rate of the percentage of families rating their child's inpatient care as "not excellent" was calculated from responses to questions taken from the Press Ganey Pediatric Inpatient National Database.

^d For consistency of presentation, we reversed the direction of the measures for family experience of care and receipt of an asthma action plan so that higher performance rates always indicated worse care quality (eg, the percentage of patients receiving an asthma action plan became the percentage of patients who did not receive an asthma action plan).

^e The concept of the quality measure has been endorsed; however, no measure has been endorsed by 1 of the organizations listed here.

Clinical Classification System, 3M Health Information System's All Patient Refined Diagnosis Related Groups, or individual *International Classification of Diseases, Ninth Revision, Clinical Modification*, principal diagnosis and procedure codes were used (Supplemental Table 4).⁵²

Main Outcome Measure

The main outcome measures are the numbers (and shares of discharges) of hospitals and states that had enough pediatric discharges to show relative differences in quality of care measures of 20%, 50%, and 100% from average. The relative differences from average were chosen based on the effect sizes used in clinical trials and in quality improvement studies. Average performance was chosen as the benchmark because CMS uses this method when publicly reporting hospital performance.³ Published studies and reports were used to identify average performance for each quality measure (Table 1).

For consistency of presentation, the direction of the measures for family experience of care and receipt of an asthma action plan were reversed so

that higher performance rates always indicated worse care quality (eg, the percentage of patients receiving an asthma action plan became the percentage of patients who did not receive an asthma action plan). For the measure of family experience of care, we used a standard response rate (33%) reported in the literature⁵³; we therefore multiplied by 3 the number of discharges needed to determine the number of hospitals and states that had enough discharges to show differences in quality.

Statistical Analysis

For each quality measure, the sample size (ie, the number of discharges for each measure) required at a hospital to detect a hypothesized difference from the national average was calculated by using a 1-sample 2-sided test at the 5% level with 80% statistical power when the actual performance rate on the quality measure is 20%, 50%, or 100% above (ie, worse than) the average (henceforth referred to as the power standard). The critical value and statistical power for the test were estimated from a normal

approximation with continuity correction because each quality measure in this study is a proportion that follows the discrete binomial distribution.^{54,55} The SE of each hospital's volume of discharges was used in a sensitivity analysis to help determine the best- and worst-case scenarios for the number of hospitals that had a sufficient number of discharges to meet the power standard for each of the quality measures. In the worst-case scenario, hospitals did not meet the standard if the SE of their volume of discharges overlapped with the sample size threshold. In the best-case scenario, hospitals met the SE if their volume of discharges overlapped with the threshold. The POWER procedure in SAS version 9.3 (SAS Institute, Inc, Cary, NC) was used for all analyses.

RESULTS

Study Cohort

There were 5 639 982 hospital discharges for children aged 0 to 17 years from 3974 hospitals in 2009 with an estimated 16 919 946 hospital discharges over 3 years.

In 2009, the mean $\pm$ SD age at admission was 2.4 ± 7.2 years; 73.3% of discharges were for infants <1 year old, 8.4% for 1- to 4-year-olds, 8.5% for 5- to 12-year-olds, and 9.8% for 13- to 17-year-olds. Fifty-one percent of admitted children were male, and 47% used public insurance. Twenty-one percent of discharges occurred at 141 children's hospitals, 70% occurred at 3482 non-children's hospitals, and 9% occurred at 351 hospitals of undetermined type.

Annual Hospital Volume

The estimated median hospital volume for all-condition discharges ($n = 16\,919\,946$) at all hospitals over 3 years was 1623 (interquartile range [IQR]: 120–5301) (Table 2). Nearly two-thirds (64.0%) of all-condition discharges were births ($n = 10\,833\,006$). The median hospital volumes for birth discharges and nonbirth ($n = 6\,086\,940$), all-condition discharges were 2328 (IQR: 915–5370) and 300 (IQR: 72–1089), respectively. The median volumes for the condition-specific discharges ranged from 9 to 36. Children's hospitals had median hospital volumes across the different types of discharges that were 4 to 49 times higher than in non-children's hospitals; these differences were significant ($P < .001$ for all).

Sample Size Needed for Hospitals to Meet the Power Standard

For adverse drug events, the number of discharges that a hospital needed to detect a 20%, 50%, and 100% difference in quality worse than average was 1694, 298, and 85, respectively (Table 3). For family experience of care, 3307, 579, and 164 discharges were needed. For condition-specific discharges, receipt of an asthma action plan was the measure with the fewest number of discharges needed for a hospital to detect a difference worse than average (385 to detect a 20% difference, 66 to detect a 50% difference, and 17 to detect a 100%

TABLE 2 Hospital Volume of Pediatric Discharges According to Hospital Type

Diagnosis ^b	Admission Type	3-Year Hospital Volume of Pediatric Discharges ^a									
		All Hospitals ^c			Children's Hospitals ^d			Non-Children's Hospitals			States
		No. of Discharges	No. of Hospitals	Hospital Volume, Median (IQR)	No. of Hospitals	Hospital Volume, Median (IQR)	No. of Hospitals	Hospital Volume, Median (IQR)	No. of States ^e	State Volume, Median (IQR)	
All admissions		16 919 946	3974	1623 (120–5301)	141	22 797 (17 145–34 071)	3482	1524 (114–4617)	44	277 872 (131 364–398 469)	
Births		10 833 006	2782	2328 (915–5370)	110	10 392 (5826–13 194)	2443	2220 (909–5040)	44	161 073 (85 482–262 539)	
Nonbirth		6 086 940	3971	300 (72–1089)	141	13 155 (9219–22 797)	3480	279 (69–927)	44	97 083 (46 956–157 740)	
Appendectomy for acute appendicitis		210 045	2995	27 (12–69)	141	339 (144–606)	2630	27 (12–57)	44	2547 (1347–5217)	
Asthma		347 304	2633	36 (9–111)	141	657 (351–1182)	2264	30 (9–90)	44	4701 (2058–9132)	
Gastroenteritis		294 561	2776	36 (9–114)	141	414 (276–819)	2386	30 (9–99)	44	4824 (1953–8373)	
Hydrocephalus		24 990	340	27 (9–96)	134	99 (51–180)	164	9 (6–18)	42	429 (111–714)	
Pediatric heart surgery		240 270	1935	21 (9–72)	141	690 (294–1347)	1649	15 (6–51)	44	3786 (1410–6087)	
Mental health disorder		380 847	1408	9 (6–57)	137	99 (42–1014)	1151	9 (6–36)	44	4650 (2418–13 248)	
Seizure		175 242	1849	12 (6–39)	141	576 (342–1035)	1546	12 (6–27)	44	2405 (1026–4428)	
Sickle cell		42 627	691	12 (6–51)	135	117 (45–279)	479	9 (6–21)	41	414 (132–1464)	

^a ICD includes a 10% random sample of uncomplicated-birth discharges and an 80% random sample of complicated-birth and nonbirth discharges from each hospital. We therefore adjusted the numbers of uncomplicated-birth as well as complicated-birth and nonbirth discharges from each hospital in the data set by factors of 10 and 1.25, respectively, to obtain an estimate of each hospital's discharge volume.²³ The annual discharge volumes were then multiplied by 3 to obtain each hospital's estimated 3-year volume. Each hospital volume has an SE (not shown in the table) indicative of the imprecision created by these adjustments.

^b Condition-specific discharges were identified with the instructions provided for each measure. Depending on the measure, AHRQ's Clinical Classification System, 3M Health Information System's All Patient Refined Diagnosis Related Groups, or individual *International Classification of Diseases, Ninth Revision, Clinical Modification*, principal diagnosis and procedure codes were used. The codes used to identify the discharges are provided in Supplemental Table 4.

^c Includes hospitals with missing data on hospital type (ie, children's or non-children's hospitals).

^d Children's hospital designation was given to hospitals based on specifications from NACHRI. Children's hospitals included freestanding children's hospitals, children's hospitals within adult general hospitals, and children's specialty hospitals.

^e Total of 44 states.

TABLE 3 Number of Hospitals With a Sufficient Number of Discharges to Detect a Difference in Quality From Average Performance

Quality Measure	No. of Hospitals With a Sufficient No. of Discharges to Detect a Difference in Quality From Average Performance					
	Performance 20% Worse Than Average		Performance 50% Worse Than Average		Performance 100% Worse Than Average	
	No. of Admits Needed ^b	No. of Hospitals ^a	No. of Admits Needed ^b	No. of Hospitals ^a	No. of Admits Needed ^b	No. of Hospitals ^a
		Children's Hospitals ^c	Non-Children's Hospitals	Children's Hospitals ^c	Non-Children's Hospitals	Children's Hospitals ^c
Adverse drug events	1694	140	1669	141	2410	141
Family experience of care	3307 ^d	139	1134	141	2219	141
Negative appendectomy rate	5682	0	0	10	0	79
Receipt of asthma action plan	385	100	81	137	755	141
Birth trauma	7106	72	372	105	1622	106
Nonrecommended gastroenteritis medications	3321	0	0	54	24	128
Heart surgery mortality	5371	0	0	55	1	106
Mental health unjustified medications	488	43	148	71	227	125
Seizure 30-day readmission	2859	0	0	80	5	132
Sickle cell 30-day readmission	1037	1	0	48	9	97
Ventricular shunt malformation	1308	0	0	26	0	86
						8

^a Shown are the number of hospitals in KID 2009 with a sufficient number of pediatric discharges over 3 years to detect a difference in performance worse than average. There were 3974 acute care hospitals in KID 2009.

^b Shown are the minimum number of discharges required at a hospital to detect a statistically significant difference in performance worse than the national average by using a 1-sample 2-sided test at the 5% level with 80% statistical power.

^c Children's hospital designation was given to hospitals based on specifications from NACHRI. Children's hospitals included freestanding children's hospitals, children's hospitals within adult general hospitals, and children's specialty hospitals. KID includes 141 children's hospitals. Hospitals with a missing NACHRI specification were excluded.

^d Number of returned surveys needed to detect a significant difference in performance from average for the family experience of care measure.

difference); birth trauma was the measure with the greatest number of discharges needed for a hospital to detect a difference worse than average (7106 for a 20% difference, 1258 for a 50% difference, and 361 for a 100% difference).

Hospitals That Met the Power Standard for All-Condition Measures

For adverse drug events (Table 3), 1958 hospitals met the power standard to show a difference in performance that was 20% worse than average; these hospitals had 95% of all-condition discharges (Fig 1). There were 2766 and 3082 hospitals that met the power standard to show a difference in performance that was 50% and 100%, respectively, worse than average; these hospitals had 99% of all-condition discharges. For family experience of care, 1380 hospitals met the power standard to show a difference in performance that was 20% worse than average; these hospitals had 87% of all-condition discharges. There were 2552 and 2904 hospitals that met the power standard to show a difference in performance that was 50% and 100%, respectively, worse than average; these hospitals had 99% of all-condition discharges. For family experience of care and adverse drug events, all 44 states (Fig 2) and all but 2 children's hospitals met the power standard to show differences in performance that were 20%, 50%, or 100% worse than average.

Hospitals That Met the Power Standard for Condition-Specific Measures

Between 203 and 482 hospitals met the power standard to show a difference in performance on each of the quality measures for asthma (receipt of asthma action plan), birth (birth trauma), and mental health (use of multiple antipsychotic medications without appropriate justification) that was 20% worse than average (Table 3); these hospitals had 52% to 90% of all discharges for these

FIGURE 1 Patients discharged from hospitals with enough discharges to detect worse-than-average performance on inpatient quality. The figure presents the extent to which children are discharged from hospitals that had a sufficient number of discharges over 3 years to detect significant differences in performance worse than average. For example, of all children admitted with sickle cell crisis, 5% were admitted to a hospital that was able to detect a 20% difference in performance on 30-day readmission. The asterisk indicates that no hospitals had enough discharges to detect a significant difference in performance worse than average.

conditions (Fig 1). Between 326 and 1864 hospitals met the power standard to show a difference in performance that was 50% worse than average; these hospitals had 90% to 96% of discharges, respectively. Between 523 and 2471 hospitals could show a difference that was 100% worse than average; these hospitals had 97% to 99% of discharges. For these conditions (asthma, birth, and mental health), 40 to 44 states could show a difference in performance that was 20% and 50% worse, respectively, than

average; all states could show a difference in performance that was 100% worse than average (Fig 2).

For sickle cell disease, only 1 hospital met the power standard to show a difference in performance that was 20% worse than average; this hospital had 3% of all discharges. Only 79 hospitals could show a difference for sickle cell disease that was 50% worse than average and 175 hospitals could show a difference that was 100% worse than average. These hospitals had 61% and 84%, respectively, of all discharges (Fig 1).

Although only 16 states met the power standard to show a difference in performance for sickle cell disease that was 20% worse than average, 29 states met the power standard to show a 50% difference worse than average and 33 states could show a 100% difference worse than average in performance (Fig 2).

No hospitals met the power standard to show a difference in performance that was 20% worse than average for appendectomy, cerebrospinal fluid shunt surgery, gastroenteritis, heart surgery, and seizure measures. For these measures, ≤ 96 hospitals met the power standard to show a difference that was 50% worse than average; these hospitals had $\leq 57\%$ of all discharges. Between 115 and 465 hospitals met the power standard to show a 100% difference worse than average; these hospitals had 38% to 84% of all discharges (Fig 1). For these measures, ≤ 27 and ≤ 41 states met the power standard to show a significant difference in performance that was 20% and 50% worse, respectively, than average; at least 39 states met the power standard to show a 100% difference in performance (Fig 2).

In the sensitivity analysis, when incorporating the SE of each hospital's volume of condition-specific discharges, the best- and worst-case scenarios of the number of hospitals, share of patients, and states with a sufficient number of discharges to meet the power standards were similar to the results without using SEs (Supplemental Table 5).

Assessing Quality of Care With 3 Years Versus 1 Year of Pediatric Discharges

For each quality measure, using 3 years of discharge data increased the number of hospitals that met the power standard (Supplemental Fig 3). This method led to an additional 865 and 927 hospitals that met the power standard to show a 20% difference in

FIGURE 2 States with enough discharges to detect worse-than-average performance on inpatient quality. The figure presents the extent to which states had sufficient number of discharges over 3 years across all of their hospitals to detect significant differences in performance worse than average. For example, 42% of states had enough hospital discharges over 3 years to detect a 20% difference in performance on 30-day readmission for seizure. KID 2009 contains hospitalizations from 44 states.

performance worse than average when measuring family experience of care and adverse drug events, respectively; an additional 122, 151, and 460 hospitals when measuring mental health, asthma, and birth; and 1 additional hospital when measuring sickle cell disease. For the remaining 5 measures, no hospital met the power standard to show a 20% difference in performance worse than average when using 3 years of discharges. However, for these measures, an additional 13 to 85 hospitals met the power standard to show a 50% difference in performance from average.

Assessing Better-Than-Average Quality of Care

In general, for each quality measure at each level of performance (ie, 20%, 50%, and 100% different from average), fewer hospitals and states met the power standard to identify better-than-average performance compared with the number of hospitals and states that met the power standard to identify worse-than-average performance (Supplemental Fig 4).

DISCUSSION

The present study found that most children are admitted to hospitals in

which measurement of general inpatient quality (ie, using all-condition measures) is precise enough to show a modest (eg, 20%) difference in performance from average. This finding occurs because pediatric inpatient care is concentrated in a subset of hospitals that have sufficient patient populations to reveal this difference. For condition-specific measures, most hospitals have volumes that are orders of magnitude smaller than the number of hospital discharges needed to distinguish their performance. Therefore, a much smaller percentage of children are admitted to hospitals in which measurement of condition-specific quality is sensitive enough to show a modest difference. Condition-specific measures are more sensitive for showing a modest difference at the state level than at the hospital level. Aggregating data across hospitals to the state level may show differences for some measures in which the number of pediatric discharges is insufficient in individual hospitals.

The threshold at which the difference from average in a hospital's performance becomes clinically meaningful may be controversial. A 20% difference is routinely used in clinical trials to detect when 1 treatment is superior or inferior to another.^{56,57} Although most hospitals in our study did not meet the power standard to show a 20% difference in performance from average for condition-specific quality, many hospitals could show a much larger (eg, 50% or 100%) difference. A 100% difference worse than average has been used as a conservative threshold to detect outlier hospitals.^{27,58} Hospitals may strive to improve their quality of care well before their performance reaches 100% worse than average.

There may be ways to structure the measurement of pediatric inpatient quality to achieve adequate statistical power for comparison with average performance. Some hospitals with

a small number of pediatric discharges might be part of a network of hospitals.^{59–61} In this situation, the networked hospitals may share many of the same inpatient pediatric providers, practice guidelines, and patients,^{62–64} making it appropriate to combine the data from the hospitals for quality measurement. Smaller hospitals without an opportunity to collaborate with a hospital network may need to explore other options to achieve adequate statistical power. For example, enhanced statistical power might be achieved when combining condition-specific measures into a composite measure of pediatric inpatient quality. Composite measures could be appropriate when they are used to assess a particular aspect of quality (eg, patient safety) that is already contained in each condition-specific measure.^{65–67}

Performance comparisons at the state level might be more feasible. CMS reports health care utilization and spending on Medicare beneficiaries according to state.²² AHRQ reports state-specific performance of outpatient quality of care for adult patients with comparisons versus the national average.^{12,68,69} Less is known about reporting state-level performance on the quality of pediatric care.^{70,71} Although the Maternal and Child Health Bureau reports state-level outpatient quality measures (eg, access to care) for children with special health care needs,⁷² it does not publicly report pediatric inpatient quality of care measures. Further investigation is needed to interpret and use a state's performance on pediatric inpatient measures and to determine whether state-level reporting can stimulate action to improve pediatric quality. In some situations, state-level reporting might be too far removed from frontline clinical care to affect change. Alternative strategies that do not rely on comparison with average performance might help hospitals

interpret their quality of pediatric inpatient care. Some government agencies and hospital systems publicly report how individual hospitals compare with the “best practice” cohort of hospitals instead of the average performance. For example, the AHRQ Achievable Benchmark of Care⁷³ and the Australian Council on Healthcare Standards⁷⁴ use the top 10th and 20th percentiles, respectively, as target performance values. These targets are meant to encourage hospitals to improve their performance and to shift average performance toward the best practice target.

This study has several limitations. KID contains information on hospital discharges but not individual patients. Because all of the discharges in the KID hospitals and consecutive years of KID data are unavailable, the estimates of 3-year volumes for the number of patient discharges and hospital and state volumes have some imprecision. To affect the study results, extremely large amounts of imprecision would be necessary, however. In fact, the imprecision for cardiac surgery would need to be 255 times larger than the estimated hospital volume to approach the sample size needed to show a 20% difference in performance from average and therefore affect the results. In addition, measuring hospital quality over 3 years may conflate recent with more distant performances. However, this method can more accurately discern better or worse performance compared with measurement over shorter periods of time.²⁰ The 2009 H1N1 influenza pandemic could have transiently increased the number of hospital discharges assessed in our study.^{75,76} We compared the number of all-condition and condition-specific discharges in the KID 2009 versus discharges in prior years by using KID data in 2000, 2003, and 2006. An atypical increase in discharges during 2009 was not observed.⁷⁶ There may be variation in *International Classification of Diseases, Ninth*

Revision, Clinical Modification, coding practices across hospitals. We relied on previous literature to assess rates of events for each quality measure because most of these events could not be determined from the data set. Accordingly, we were unable to account for case-mix differences across hospitals.

Nevertheless, our findings have implications for the assessment of performance on measures of quality of pediatric inpatient care. Sample size and statistical power calculations are routinely used when designing analyses that compare the health outcomes between populations of patients. The findings from the present study suggest that thousands of US hospitals are adequately powered to show differences in pediatric quality of care from average performance for all-condition discharges such as family experience of care and adverse drug events because the sample size of children in the hospitals is sufficient. Therefore, publicly reporting hospitals' performance compared with the average on inpatient quality for all-condition measures may aid consumers in selecting hospitals for children and stimulate improvements in pediatric quality of care.

For some hospitals, the all-condition measures may be too general to affect change; these hospitals may prefer to focus their quality improvement efforts on specific conditions. Most hospitals will not admit enough patients with a specific condition to distinguish their performance. Aggregating data across hospitals (eg, on a network or state level) might help increase the number of children eligible to have their condition-specific quality of care measured and help improve the value of public reporting. Until these conventions are evaluated further, performance may not be judged equally across hospitals when assessing pediatric inpatient quality; the subset of large hospitals that have enough pediatric patients to

detect modest differences in quality of care compared with the average will more likely be affected by performance policy than smaller hospitals with an insufficient number of patients. Policy on incentives for pediatric inpatient quality should take these findings into account.

Consideration of statistical power might be helpful when interpreting differences or the lack of differences in performance on pediatric hospital quality across hospitals. This assessment may be particularly important to perform when a hospital with a small number of admissions reports a clinically meaningful relative difference in performance with a negative test of statistical

significance against a standard (eg, a smaller hospital's pediatric surgery mortality rate is twice as high as the national average, but the difference is not statistically significant). Even with the best or worst performance possible, insufficient statistical power may preclude such hospitals from distinguishing themselves. Future studies should assess the prevalence of these occurrences and what approach is best for hospitals to respond to it.

CONCLUSIONS

Most children are admitted to hospitals in which all-condition measures of quality have adequate power to show modest

differences in performance from average, but most condition-specific measures do not. Policies regarding incentives for pediatric inpatient quality should take these findings into account.

ABBREVIATIONS

AHRQ: Agency for Healthcare Research and Quality

CMS: Centers for Medicare & Medicaid Services

IQR: interquartile range

KID: Kids' Inpatient Database

NACHRI: National Association of Children's Hospitals and Related Institutions

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A DANGEROUS POWDER: *Much to my wife and children's chagrin, I will periodically consume an "energy" drink containing caffeine. While they are a bit horrified that I drink these mass marketed products, my argument for doing so is that it is not much different from drinking one to two cups of coffee. I can say that because the label on the can identifies how much caffeine is in the product, and as a physician, I know how much caffeine is in a cup of coffee.*

As reported in The New York Times (Well: May 18, 2015), however, a much scarier and potentially deadly scenario involves the use of caffeine powder. While most of us think of caffeine as a reasonably safe compound derived from and found in coffee or tea, purified caffeine (easily made in manufacturing plants) is a potent compound with a myriad of effects. Amazingly, almost anyone can buy purified caffeine in stores or online for very little money. A cup of coffee has roughly 100-200 mg of caffeine in an 8 ounce serving, while soft drinks may have approximately 30 mg in a serving. A tablespoon of caffeine powder (about 10 g) is a lethal dose in adults and equivalent to drinking more than 1200 energy drinks or 3,000 cans of soda. Unfortunately, several people have accidentally overdosed using powdered caffeine with lethal complications. Because the powder is so easily purchased and potentially lethal, attempts have been made to restrict sales. The Food and Drug Administration advises consumers to avoid the powder. Advocacy groups have petitioned the FDA to ban retail sales. Some counties in the US have banned sales of powdered caffeine to minors. Caffeine in tea or coffee is consumed by more than 80% of the world's population. That form of caffeine, in moderation, seems reasonably well tolerated. Caffeine powder, however, is a dangerous drug – one that should not be available for retail sale.

Noted by WVR, MD