# Variation in Emergency Department Admission Rates in US Children's Hospitals

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**KEY WORDS**
hospitalization rates, variation in care, emergency department

**ABBREVIATIONS**
APR-DRG—All Patient Refined Diagnosis Related Groups
CI—confidence interval
ED—emergency department
NEC—not elsewhere classified
OR—odds ratio
PHIS—Pediatric Health Information System
RSV—respiratory syncytial virus

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**WHAT'S KNOWN ON THIS SUBJECT:** There is substantial variation in the medical care provided to pediatric patients across diverse clinical settings. This variation raises concerns about whether every patient is receiving optimal care and whether more standardized approaches around clinical decisions are needed.

**WHAT THIS STUDY ADDS:** We observed wide variation in admission rates for common pediatric conditions across US children's hospitals. Our findings highlight the need for greater focus on the standardization of decisions regarding hospitalization of patients presenting to the emergency department.

## abstract

**OBJECTIVE:** To measure the hospital-level variation in admission rates for children receiving treatment of common pediatric illnesses across emergency departments (EDs) in US children's hospitals.

**METHODS:** We performed a multi-center cross sectional study of children presenting to the EDs of 35 pediatric tertiary-care hospitals participating in the Pediatric Health Information System (PHIS). Admission rates were calculated for visits occurring between January 1, 2009, and December 31, 2012, associated with 1 of 7 common conditions, and corrected to adjust for hospital-level severity of illness. Conditions were selected systematically based on frequency of visits and admission rates.

**RESULTS:** A total of 1 288 706 ED encounters (13.8% of all encounters) were associated with 1 of the 7 conditions of interest. After adjusting for hospital-level severity, the greatest variation in admission rates was observed for concussion (range 5%–72%), followed by pneumonia (19%–69%), and bronchiolitis (19%–65%). The least variation was found among patients presenting with seizures (7%–37%) and kidney and urinary tract infections (6%–37%). Although variability existed in disease-specific admission rates, certain hospitals had consistently higher, and others consistently lower, admission rates.

**CONCLUSIONS:** We observed greater than threefold variation in severity-adjusted admission rates for common pediatric conditions across US children's hospitals. Although local practices and hospital-level factors may partly explain this variation, our findings highlight the need for greater focus on the standardization of decisions regarding admission. *Pediatrics* 2014;134:539–545

Pediatric patients may receive different care depending on the specific emergency department (ED) where they present. Among febrile neonates, for example, there is greater than twofold variation between EDs in the rate of patients who receive comprehensive laboratory testing and antibiotic treatment.[1] Similarly, substantial variation has been demonstrated in the diagnostic testing, treatment, and disposition of children presenting with a variety of other conditions, including gastroenteritis, asthma, headache, and febrile seizures.[2–6] Some of the variation in care may be related to patient-level differences in clinical presentation as well as to hospital-level factors, such as local availability of primary care physicians, hospital occupancy, or access to certain health care services.[7–9]

The wide variation in clinical management raises concerns about whether every patient is receiving the optimal care and whether the lack of a standardized approach is contributing to unnecessary health care costs.[10–12] Additional testing and treatment have not necessarily been found to correlate with more effective care, improved patient outcomes, or higher patient satisfaction.[4,13,14] In terms of health care costs, the decision to admit a patient represents one of the most costly decisions and reducing unnecessary admissions may contribute to substantial cost savings.[15]

There is limited information on admission rates for pediatric patients presenting to EDs nationally. We aimed to measure variation in hospital-level admission rates for children treated for common pediatric illnesses across EDs in US children's hospitals.

## METHODS

### Setting

We conducted a retrospective, cross-sectional study using patient information from the Pediatric Health Information System (PHIS) database. This administrative data source contains ED, inpatient, and ambulatory surgery data from 45 pediatric hospitals in the US participating hospitals are located in 17 of the 20 major metropolitan areas and are all tertiary-care institutions, with 93% designated as academic teaching hospitals.[16,17] Overall, these hospitals account for 46% of all discharges from pediatric hospitals.[17] The database captures patient demographics, diagnostic and screening tests obtained, medications administered, interventions and procedures performed, dates of services, and discharge diagnoses. In addition, within the PHIS data set, every patient encounter is assigned a single diagnosis using the All Patient Refined Diagnosis Related Grouping (APR-DRG) system.[18] The APR-DRG is a diagnostic and clinical severity grouping system in which the group assignment is based on a proprietary algorithm that takes into account patient age, gender, disposition, diagnoses (and separately the diagnosis that was determined to be the primary reason for the visit), and any procedures performed. PHIS data are deidentified at the time of submission and are subject to a number of reliability and validity checks before inclusion in the database. Our analysis was limited to the 35 hospitals that provided comprehensive ED data since 2009. This study was approved by the Institutional Review Board at Boston Children's Hospital with a waiver of informed consent.

### Study Population

Children younger than 19 years who presented to the ED of a participating PHIS institution between January 1, 2009, and December 31, 2012 were eligible for inclusion. Children were excluded if they had a chronic comorbid condition (eg, cystic fibrosis, cerebral palsy).[19]

To examine conditions that are commonly encountered in the ED and have reasonable potential for admission, we selected from the 25 most prevalent APR-DRG categories those with a mean admission rate across the EDs $\geq$10%. The seven APR-DRG categories selected were asthma (admission rate of 23.2%), cellulitis and other bacterial skin infections (admission rate of 18.6%), bronchiolitis and respiratory syncytial virus (RSV) pneumonia (admission rate of 24.0%), pneumonia not elsewhere classified (NEC; admission rate of 29.7%), kidney and urinary tract infections (admission rate of 15.3%), seizure (admission rate of 18.4%), and concussion, closed skull fracture, uncomplicated intracranial injury (admission rate of 18.6%). Supplemental Appendix 1 provides a complete list of the principal diagnoses assigned to the patients in our sample with each of these seven APR-DRG groups. All ED encounters associated with these APR-DRG categories were eligible for inclusion.

### Measurements

For every ED encounter, we determined whether the patient was admitted to the hospital. An admission was defined as patient transfer to an inpatient unit or to observation status.[20,21]

A severity measure was applied to all ED encounters to account for patient acuity. This was performed using the Severity Classification System, an *International Classification of Diseases, Ninth Revision* diagnosis-based classification approach specifically designed and validated for use in pediatric emergency medicine.[22] The classification system assigns a severity rating on a 5-point scale with patients with >1 diagnosis receiving the highest of the assigned scores.

### Statistical Analysis

For each APR-DRG diagnostic group, we calculated the median and interquartile range of the hospital-level admission rate. We also performed an adjusted

analysis accounting for patient acuity based on the severity classification. Trends over time in median adjusted hospital-level admission rates were assessed using logistic regression models with admission as the dependent variable and time (in years, from 2009 through 2012) and the severity score as the independent variables. Variation in hospital-level admission rates was evaluated based on the range of the rates and on the coefficient of variation, which is defined as the standard deviation of the admission rate divided by the mean. The coefficient of variation is a unit-free statistic that provides a standardized measure of variability across a set of outcomes (in this case, the hospital-level admission rate of each diagnostic group), with higher values indicating greater variation. Thus, the coefficient of variation can be used to quantify the hospital-level variation in admission rates and compare this variation among diagnostic groups.

Hospitals were ranked based on their adjusted admission rate for each of the 7 diagnostic groups and categorized into deciles. The sum of a hospital's 7 decile rankings was used to assign an aggregate ranking to the hospital, indicating the overall rate of admission of a hospital relative to the other hospitals.

All analyses were performed by using Stata 12.1 (College Station, TX).

## RESULTS

### Hospital-Level Characteristics

Among 10 358 058 ED encounters by patients <19 years during the study period, 588 312 were excluded for chronic comorbid conditions, leaving 1 288 706 (13.2%) who met inclusion criteria and were assigned 1 of the 7 APR-DRG categories under study. Hospital-level demographic characteristics of the pediatric patients are shown in Table 1. Patient demographic and treatment characteristics did not materially differ between hospitals.

### Admission Rates Across Hospitals

There were small but significant decreases in the median hospital-level severity-adjusted admission rates over the study period among pediatric patients in a number of the diagnostic groups (Fig 1). Admission rates for cellulitis decreased from 19.8% to 18.3% (odds ratio [OR] 0.94, 95% confidence interval [CI] 0.91–0.98), for kidney and urinary tract infections from 17.5% to 14.1% (OR 0.87, 95% CI 0.82–0.92), and concussion from 24.0% to 16.0% (OR 0.86, 95% CI 0.80–0.93). Decreases for the other diagnostic groups were not significant.

We observed wide variation in severity-adjusted, hospital-level admission rates for patients with the 7 disease conditions (Table 2). The diagnostic group with the greatest range in severity-adjusted admission rates was concussion, with a range of 5% to 72%, followed by pneumonia NEC (range 19%–69%), and bronchiolitis and RSV pneumonia (range 19%–65%). The coefficient of variation was highest for concussion (0.68), Kidney and urinary tract infection (0.39), and seizure (0.39). Hospital-specific admission rates for each diagnostic group are included in Supplemental Appendix 2. Figure illustrates admission rates for the individual hospitals, with concussion as the exemplar condition (admission rates for other conditions included in Supplemental Appendix 3).

Variations in the admission rates across hospitals were further assessed based on the aggregate ranking assigned to each hospital (Fig 2). Although certain hospitals had consistently lower admission rates across the diagnostic groups, others consistently higher admission rates and some a mix of lower and higher rates relative to the other hospitals. Overall, 34% of hospitals ($n$ = 12)

**TABLE 1** Hospital-Level Demographic and Treatment Characteristics for Pediatric Patients With Select APR-DRG Diagnostic Groups Treated in the ED From 2009 Through 2012[a,b]

| APR-DRG Category | Median Age | Gender, % (Percent Female) | Percent Patients With Public Health Insurance, (%)[c] | Percent Patients Admitted to ICU, (%) | Mean Length of Stay (d) |
|---|---|---|---|---|---|
| Asthma ($n$ = 410 530) | 5 (4–5) | 38 (36–39) | 67 (60–77) | 1.5 (1.0–2.9) | 1.2 (1.1–1.2) |
| Cellulitis, other bacterial skin infections ($n$ = 225 304) | 4 (3–4) | 50 (49–52) | 67 (59–79) | 0.1 (0.0–0.1) | 1.2 (1.2–1.3) |
| Bronchiolitis and RSV pneumonia[d] ($n$ = 212 574) | 0 (0–0) | 41 (40–42) | 71 (63–82) | 1.6 (1.2–2.3) | 1.5 (1.4–1.6) |
| Pneumonia NEC ($n$ = 152 417) | 3 (3–3) | 47 (46–48) | 61 (51–74) | 1.6 (1.0–2.4) | 1.4 (1.3–1.6) |
| Kidney and urinary tract infections ($n$ = 120 997) | 4 (4–5) | 84 (80–87) | 64 (57–76) | 0.1 (0.1–0.3) | 1.3 (1.2–1.4) |
| Seizure ($n$ = 97 829) | 2 (2–2) | 43 (42–44) | 58 (48–70) | 0.6 (0.3–1.0) | 1.1 (1.1–1.1) |
| Concussion[e] ($n$ = 69 055) | 9 (8–10) | 35 (34–37) | 40 (28–51) | 0.9 (0.5–1.7) | 1.1 (1.0–1.1) |
| All patients | 3 (3–3) | 46 (45–47) | 65 (58–77) | 1.2 (0.7–1.6) | 1.3 (1.2–1.3) |

[a] Values in table represent hospital-level median (interquartile range).
[b] Patients aged 0–18 y without a complex chronic condition diagnosis.
[c] Excluding hospitals with >10% missing insurance data ($n$ = 5).
[d] Seventy-seven percent of patients were <12 mo old.
[e] Concussion, closed skull fracture, uncomplicated intracranial injury, coma <1 h, or no coma.

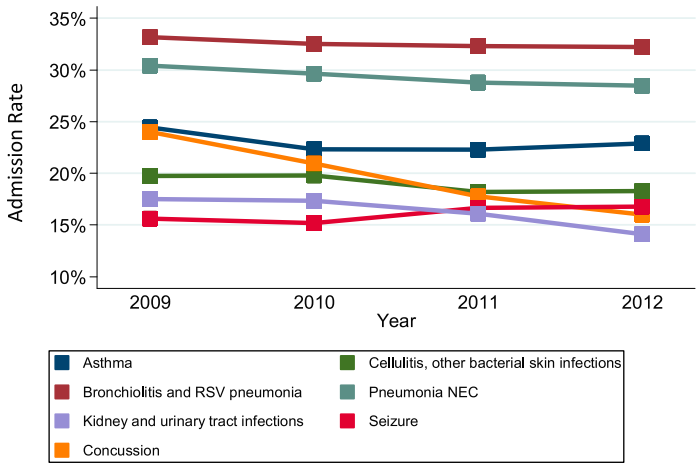


**FIGURE 1**

Trends over the study period in median hospital-level severity-adjusted admission rates for select APR-DRG diagnostic groups. There were significant decreases in admission rates among pediatric patients with cellulitis (OR 0.94, 95% CI 0.91–0.98), kidney and urinary tract infections (OR 0.87, 95% CI 0.82–0.92), and concussion (OR 0.86, 95% CI 0.80–0.93). Decreases for the other diagnostic groups were not significant (asthma: OR 0.95; 95% CI 0.90–1.01; bronchiolitis: OR 0.97, 95% CI 0.92–1.03; pneumonia NEC: OR 0.96, 95% CI 0.91–1.02; seizure: 0.99, 95% CI 0.95–1.05).

were ranked in the lowest admission rate decile for at least 1 diagnostic group, and 31% of hospitals ($n$ = 11) were ranked in the highest decile at least once (Fig 3). The mean admission rate across the 5 hospitals with the lowest overall admission rates was 15.8% (95% CI 13.7%–18.0%) compared with 36.7% (95% CI 31.6%–41.8%) among the 5 hospitals with the highest admission rates.

## DISCUSSION

In this large sample of children's hospitals across the United States, we observed wide variation in hospital-level admission rates among children presenting to the ED. After adjusting for hospital-specific illness severity, admission rates varied more than threefold among children presenting with bronchiolitis and pneumonia and as much as 14-fold among those diagnosed with a concussion. Certain hospitals had consistently lower severity-adjusted rates of admission across the conditions examined, whereas others demonstrated consistently higher rates of admission.

Variation in hospitalization rates across institutions may be related to differences in hospital attributes, local and regional primary care systems, or physician practice patterns. The lack of access to primary care physicians in the local community has been found to be associated with higher ED admission rates, as have greater ED volume, trauma designation, metropolitan location, and teaching status.[7,9,23] At the ED level, physicians appear to be strongly influenced by local standards of care in their decision-making as well as by personal attitudes toward risk tolerance and malpractice fear.[7,24–26] One study examining physician level variation in admission rates in adult EDs found a greater than twofold variation in admission rates within single institutions.[27] The hospitals examined in this study were fairly homogenous, all representing free-standing, tertiary-care pediatric hospitals in urban locations. Although there may be additional system and infrastructure factors that influence physician decisions to hospitalize a patient, our observation of the wide variation in admission rates raises concerns over whether some of these hospitalizations may have been unwarranted. Conversely, it is also possible that certain patients were discharged when in fact they would have benefited

**TABLE 2** Admission Rate Variation Across US Children's Hospitals for Select APR-DRG Diagnostic Groups Among Pediatric Patients Treated in the ED From 2009 Through 2012 ($n$ = 1 288 706)[a]

| APR-DRG Category | No. Cases | Hospital-Level Admission Rate | | | Adjusted Hospital-Level Admission Rate[b] | | |
|---|---|---|---|---|---|---|---|
| | | Median (IQR) | Range | Coefficient of Variation[c] | Median (IQR) | Range | Coefficient of Variation[c] |
| Asthma | 410 530 | 24 (15–26) | 13–50 | 0.40 | 24 (19–29) | 13–52 | 0.32 |
| Cellulitis and other bacterial skin infections | 225 304 | 19 (14–22) | 10–41 | 0.38 | 18 (14–22) | 5–37 | 0.38 |
| Bronchiolitis and RSV pneumonia | 212 574 | 30 (26–37) | 17–77 | 0.36 | 32 (27–39) | 19–65 | 0.31 |
| Pneumonia NEC | 152 417 | 29 (25–37) | 15–74 | 0.40 | 31 (24–35) | 19–69 | 0.31 |
| Kidney and urinary tract infections | 120 997 | 18 (12–21) | 5–48 | 0.54 | 16 (13–20) | 6–37 | 0.39 |
| Seizure | 97 829 | 17 (12–23) | 7–38 | 0.41 | 16 (12–23) | 7–37 | 0.39 |
| Concussiond | 69 055 | 17 (12–29) | 4–73 | 0.68 | 19 (13–28) | 5–72 | 0.64 |

IQR, interquartile range.

[a] Patients aged 0–18 y, inclusive, without a complex chronic condition diagnosis.

[b] Adjusted for patient severity.

[c] Coefficient of variation (SD/mean) represents a standardized metric to compare the variability between measurements with different means, with higher values indicating greater variation.

[d] Concussion, closed skull fracture, uncomplicated intracranial injury, coma <1 h, or no coma.

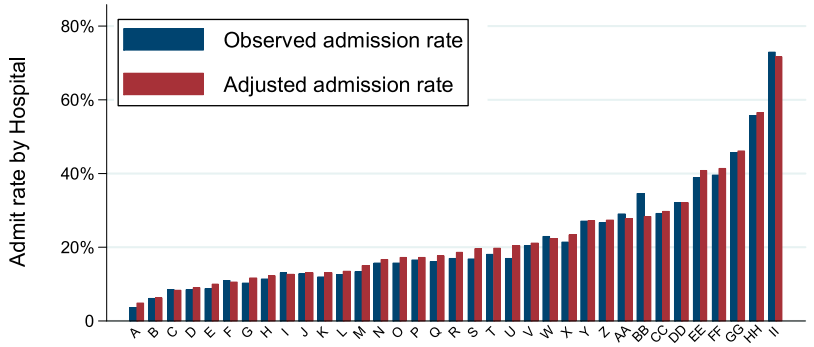


**FIGURE 2**

Hospital-level admission rates among pediatric patients assigned the concussion APR-DRG diagnostic grouping. Each letter represents a hospital. Adjusted admission rates are corrected for patient-level severity, as measured by an *International Classification of Diseases, Ninth Revision* diagnosis-based Severity Classification System. Hospitals are sorted by severity-adjusted admission rates.

from hospitalization. Delineating the factors influencing physician admission decisions for pediatric emergency patients represents a critical first step to reducing unwarranted variation and to ensuring optimal decisions in the health care delivery for these children.

Because the majority of pediatric admissions occur via the ED, this routine decision represents an important opportunity for the examination of standardization of care, resource utilization, and cost containment.[28] Considerations around cost-effective care are likely to become increasingly important as health care reform continues to tackle strategies to reduce health care spending. The median charge for a pediatric hospital admission was >$3000 per day in 2006.[15] Two recent investigations have demonstrated the significant impact on costs associated with the decision to hospitalize a patient. Among children with isolated skull fractures cared for in the ED, the median cost of medical treatment was more than threefold higher among admitted compared with discharged patients ($2064 vs $619).[29] For children with viral meningitis, the median medical cost was ~$4000 higher for children who were hospitalized versus discharged from the ED ($5363 vs $1371).[30] Although higher resource utilization is associated with higher health care costs, increased diagnostic testing, treatment, and hospitalization have not been shown to correlate with improved outcomes.[4,12,14,31] In the 2 studies examining hospitalizations among children with skull fractures and viral meningitis, minimal interventions occurred during the hospitalization, suggesting that some of the hospitalizations may not have been medically necessary. If unwarranted hospital admissions could be identified through careful assessment of outcomes among both discharged and admitted patients, there is the potential for substantial cost savings among these patients presenting to the ED.

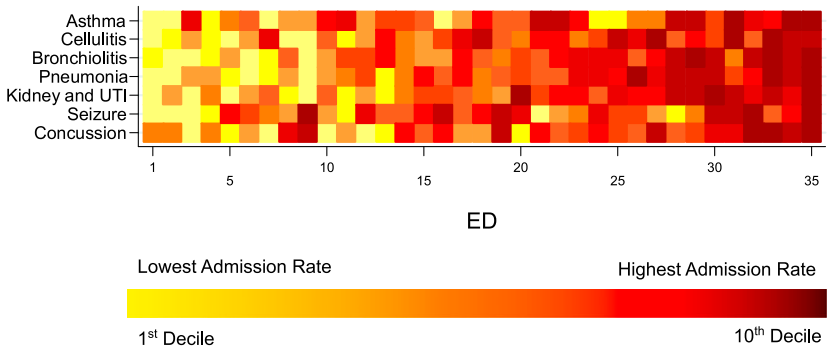


**FIGURE 3**

Hospital-level, severity-adjusted admission rates for select APR-DRG diagnostic groups among pediatric patients treated in the emergency department from 2009 through 2012. For each diagnostic group, hospitals were ranked according to severity-adjusted admission rate and categorized into deciles. Hospitals were assigned an aggregate ranking based on the sum of its 7 decile rankings. Hospitals are ordered in the figure according to their aggregate ranking. Thus, hospital 1 had the lowest aggregate admission rate across the 7 diagnostic groups, and hospital 35 had the highest. UTI, urinary tract infection.

Clinical practice guidelines and protocols have been implemented in both the ED and inpatient settings to guide the management of a number of pediatric conditions including bronchiolitis, pneumonia, and urinary tract infections.[32–34] Many of these guidelines aim to reduce unnecessary diagnostic tests and interventions and have been associated with marked reduction in resource utilization and hospital charges.[32,34,35] Similar guidelines could be implemented in the ED setting focusing on or including admission requirements for specific illnesses and providing evidence-based criteria to support and standardize physician decision-making. Such protocols should be prospectively assessed by using balancing measures including ED bounce rates and other outcome measures to ensure that the guideline criteria are appropriately developed to provide safe and effective care.

Our study was conducted among tertiary-care pediatric institutions, and thus, our findings may not be generalizable to nonpediatric, community-based institutions. However, given the many differences expected between EDs in tertiary care versus community-based hospitals, it would generally be preferable to consider and analyze these settings separately, and it is likely that the variation

would be higher among nonpediatric facilities, which are less apt to implement pediatric-specific clinical guidelines and protocols.[3] We were also unable to further examine factors that might contribute to variation in admission rates, including hospital- and physician-level characteristics, because these are not consistently available in the PHIS database. We could not examine the appropriateness of hospitalization for a given patient because we were unable to ascertain the outcomes for patients who were admitted versus those who were discharged. Finally, although the hospitals were fairly homogeneous (all tertiary-care pediatric institutions in urban settings) and we corrected for hospital-level severity using a validated approach, it is possible that there were still unmeasured differences in severity between the patient populations that contributed to the variation in admission rates.

## CONCLUSIONS

We observed greater than threefold variation in severity-adjusted admission rates for common pediatric conditions treated across US children's hospitals. Although local environments and infrastructure may partly dictate decisions around hospital admission, this degree of variation raises concerns about potential unwarranted variations and resource utilization. Our findings suggest that further examination of the factors driving this variation and greater focus on the standardization of decisions regarding hospital admission for pediatric patients is needed.

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***THE SIZE GAP:*** *We live in a nice home in a small town in Vermont. When we moved into the house in 1996, we had approximately 1,700 square feet of living space. Initially, there seemed plenty of space for the six of us, but as the kids got older and engaged in more activities, we slowly added onto the house. After a lot of what my wife and I call "sweat equity," we topped off at a grand total of 2,300 square feet. It seems huge to us. Interestingly, however, our house would be considered small by new building standards in the United States.*

*According to CNN (Money Moves: June 5, 2014), the average-sized house built in the United States has steadily increased over the last few decades: from 1,725 square feet in 1983, to 2,095 in 1993, to 2,330 in 2003, and to 2,598 in 2013. One explanation for the increasing size of new homes is that the wealthy are quite wealthy indeed and can purchase very large homes. Very large homes, defined as those with more than 4,000 square feet, now make up 9% of all new houses built – compared to 6.6% as recently as in 2005. The percentage of new homes that are between 3,000 and 4,000 square feet has also jumped from 15.6% in 2005 to 21.7% in 2013. These large homes tend to have home offices, dens, and playrooms.*

*At the other end, fewer first-time homebuyers (those that tend to buy smaller houses) are able to make a purchase. This may be because of student debt or inability to obtain a mortgage. The result is that only 4% of new houses built have less than 1,400 square feet compared to 9% in 2005. Regardless of whether our house is bigger or smaller than new houses built in the US, I am quite happy and think it is the right size for us.*

*Noted by WVR, MD*

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