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Identifying Adverse Drug Events in Rural Hospitals: An Eight-State Study

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Key Findings

- In 2013, Critical Access Hospitals (CAHs) in eight states had significantly lower rates of adverse drug events (ADEs) per 10,000 discharges involving anticoagulants (5.0) than rural Prospective Payment System (PPS) hospitals (9.8) or urban PPS hospitals (6.8).
- These CAHs also had significantly lower rates of ADEs involving steroids (16.0) than the rural (30.2) or urban PPS hospitals (24.2).
- Rates of ADEs involving antibiotics in these CAHs (18.2) were significantly lower than in the rural PPS hospitals (21.0), but did not differ significantly from the urban PPS hospitals (19.9).
- ADE rates involving opiates and narcotics did not differ significantly by type of hospital.

Background

Adverse drug events (ADEs) are one of the eleven areas of focus in the Partnership for Patients initiative, a public-private partnership working to improve the quality, safety, and affordability of health care nationwide. ADEs are defined as events involving patient injury resulting from medication use; some ADEs are side effects that may occur even when a medication is taken correctly, while others are medication errors that occur when a medication is incorrectly prescribed or administered.[1] ADEs result in significant patient morbidity, increase lengths of stay in the hospital, and are costly.[2-5]

Although medication safety in small rural hospitals is an important rural health policy issue, identifying ADEs in these settings can be challenging.[6,7] Limited pharmacist support in many small rural hospitals may make it less likely that ADEs are detected and reported.[8] Consequently, interest has grown in the use of hospital discharge databases as a means of identifying ADEs.[9]

An Agency for Healthcare Research and Quality study using hospital inpatient discharge data identified steroids, antibiotics, opiates and narcotics, and anticoagulants as the four most common categories of drugs that resulted in ADEs that occur during inpatient hospitalizations.[1] The study found the highest rates of ADEs involving opiates and narcotics in urban teaching hospitals, and higher rates of ADEs involving antibiotics in rural hospitals and urban teaching hospitals than in urban nonteaching hospitals.

Purpose

The purpose of this project was to analyze ADEs and identify opportunities to improve medication safety in rural hospitals, including both CAHs and rural PPS hospitals. The study addresses the following research questions:

- What rates of ADEs involving steroids, antibiotics, opiates and narcotics, and anticoagulants occurred during inpatient hospitalizations in rural hospitals in 2013?
- Did rural hospitals' ADE rates vary based on hospital characteristics?

Approach

This study used the 2013 Statewide Inpatient Databases (SID) for eight states (Iowa, Kentucky, North Carolina, New York, Oregon, Vermont, Washington, and Wisconsin) from the AHRQ Healthcare Cost and Utilization Project (HCUP). We selected these states because they have significant rural populations (ranging from 12% of the population in New York to 61% in Vermont),[10] are distributed across the four Census Regions, allow their SID data to be linked with American Hospital Association Annual Survey (AHA) data on hospital characteristics, and have a present-on-admission (POA) designation in their discharge records that allows exclusion of ADEs that occur prior to the inpatient hospitalization.

Table 1. Hospitals and discharges included in analysis by hospital type and state in 2013

	Critical Access Hospitals		Rural PPS Hospitals		Urban PPS Hospitals	
	Number of Hosptials	Number of Discharges	Number of Hosptials	Number of Discharges	Number of Hosptials	Number of Discharges
All	**211**	**153,514**	**144**	**595,770**	**425**	**4,875,954**
IA	40	26,386	14	44,808	21	219,115
KY	29	17,841	42	181,169	50	395,590
NC	18	13,328	32	166,818	61	838,854
NY	14	4,559	27	92,656	138	2,017,189
OR	25	21,969	5	25,463	30	309,611
VT	6	8,606	2	4,888	2	20,716
WA	21	14,654	5	18,324	51	574,556
WI	58	46,171	17	61,644	72	500,323

The SID contain the universe of all hospital discharges annually in a given state, regardless of payer. We used ICD-9 codes from an AHRQ study[1] to identify discharges involving adverse events related to the use of steroids, antibiotics, opiates and narcotics, and anticoagulants, which were not present on admission to the hospital.

For the eight states, the SID contain 869 hospitals with 6,063,715 inpatient discharges in 2013. To limit our study to ADEs that occurred during the hospital stay rather than prior to hospitalization, we followed the exclusion criteria used in the AHRQ study[1] to exclude: 1) hospitals that reported all diagnoses and E codes as being present on admission, 2) hospitals with 20% or more discharges with a missing present-on-admission indicator for existing diagnoses or E codes, 3) hospitals that only used present-on-admission codes for Medicare patients, and 4) discharges with missing present-on-admission information. A total of 780 hospitals and 5,625,238 discharges in the eight states were included in the analysis (Table 1).

We linked the SID to FY 2013 AHA data to examine relationships between hospital characteristics and ADE rates. Summary statistics were calculated for the distribution of hospital characteristics, patient characteristics, and ADE rates per 10,000 discharges between CAHs, rural hospitals, and urban hospitals. Pearson's Chi-square tests were used to test differences in hospital and patient characteristics by hospital type and in ADE rates by hospital type and characteristics.

Limitations

Because this study uses administrative data, the results may be affected by differences in coding practices across hospitals. CAHs receive cost-based reimbursement from Medicare and thus have less of a financial incentive to code multiple diagnoses than PPS hospitals. Although the states in this study were chosen for having significant rural populations and regional diversity, the study results may not be representative of all CAHs or rural PPS hospitals nationally.

Results

Hospital and Patient Characteristics

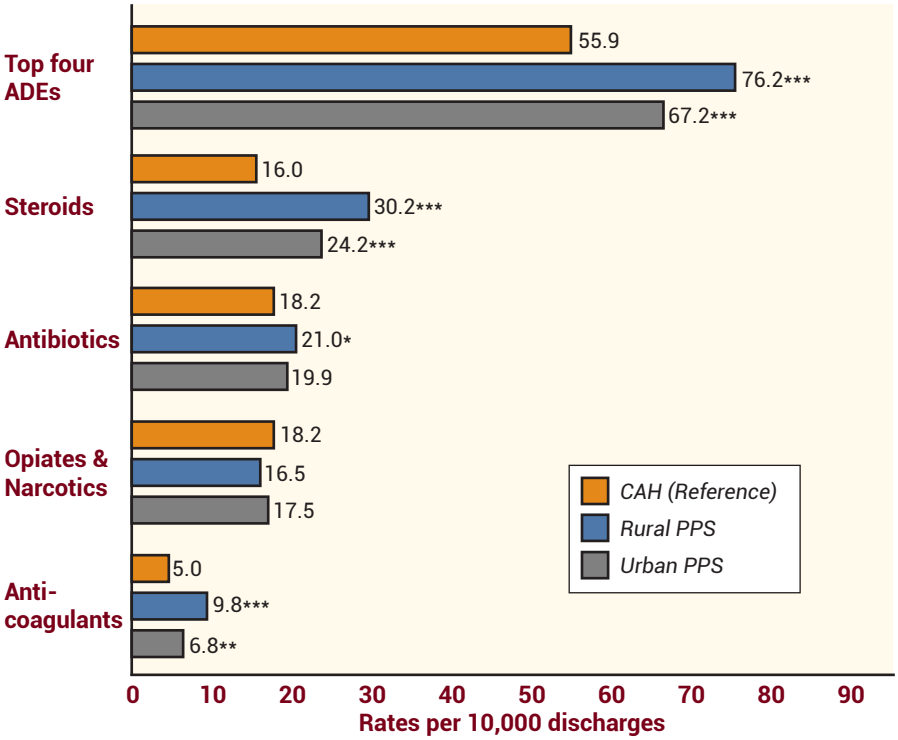
The 780 hospitals in the analysis included 211 CAHs, 144 rural PPS hospitals, and 425 urban PPS hospitals. Compared to the rural and urban hospitals, CAHs were significantly smaller in bed size and inpatient days, less likely to be accredited by either the Joint Commission or the American Osteopathic Association, and more likely to be publicly owned. Consistent with their smaller size, CAHs also had significantly fewer full-time pharmacists and registered nurses (all differences were significant at $p < .05$).

Patients who were discharged from CAHs in 2013 were significantly more likely to be aged 65 or older, female, and have Medicare as their primary expected payer, compared to those discharged from rural and urban PPS hospitals. Rural PPS hospital patients were also significantly more likely to be older, female, and have Medicare coverage than urban patients (all differences were significant at $p < .05$).

Adverse Drug Events in Critical Access, Rural, and Urban PPS Hospitals

CAHs had significantly lower rates of ADEs involving steroids (16.0%) and anticoagulants (5.0%) than rural PPS hospitals (30.2% for steroids and 9.8% for anticoag-

Figure 1. Rates of adverse drug events by hospital type, 2013



Note: Significant differences in rates between CAHs and other hospitals are noted at ***p<0.001, **p<0.01, and *p<0.05, derived from Pearson's Chi-square tests.

ulants) and urban PPS hospitals (24.2% for steroids and 6.8% for anticoagulants) (Figure 1).

Adverse Drug Events in Critical Access and Rural PPS Hospitals by Hospital Characteristics

Within CAHs, ADE rates varied by hospital characteristics (Table 2, next page). Accredited CAHs had significantly higher ADE rates involving opiates and narcotics (P<.001), and anticoagulants (P=0.04), than non-accredited CAHs did. CAHs with different levels of inpatient days did not have significantly different ADE rates involving antibiotics or opiates and narcotics, but those with fewer inpatient days had lower ADE rates involving anticoagulants (P<.001). Private, non-profit CAHs had higher ADE rates involving steroids and antibiotics than publicly owned CAHs did (P<.001). Within rural PPS hospitals (Table 3, next page), those with higher ADE rates were larger in bed size, accredited, and publicly owned (P<.05).

Discussion and Policy Implications

The opioid crisis, which has hit rural areas of the U.S. especially hard, has focused greater awareness on the importance of careful monitoring of opioid use and consideration of non-opioid alternatives to pain management in medical settings. In addition, continued rates of hospital-acquired infections and growing numbers of antibiotic-resistant bacteria have focused greater attention on the appropriate use of antibiotics and monitoring of ADEs involving antibiotics in hospitals and other health care settings.

Previous research has shown that the amount of pharmacist staffing in a rural hospital was significantly related to active pharmacist participation on key hospital committees that address medication issues, including pharmacy and therapeutics, medication safety or patient safety, and infection control committees, and that having a medication safety or patient safety committee with active pharmacist participation was in turn significantly related to implementation of four key medication safety practices.[6] A 2015 national survey conducted by the American Society of Health-System Pharmacists found that hospitals with less than 50 staffed beds, most of which are rural, are significantly less likely than larger facilities to have a multidisciplinary committee responsible for review, analysis, education, policy formulation, and corrective action related to ADEs.[11] Smaller hospitals were also significantly less likely to have an antimicrobial stewardship program: only 43% of hospitals with less than 50 staffed beds reported having such a program compared to more than 90% of hospitals with 300 or more staffed beds.[11]

The current study did not find a consistent relationship between either the number of full–time pharmacists or the number of full-time registered nurses and ADE rates by type of medication in CAHs and rural PPS hospitals. The study also found higher ADE rates among larger rural hospitals, compared to CAHs or urban PPS hospitals, and among accredited rural PPS hospitals and CAHs, compared to non-accredited facilities. There are several possible reasons for these results. Differences between CAHs and PPS hospitals in financial incentives to code multiple diagnoses as well as differences in coding practices may account for some differences in ADE rates, and are a limitation of using administrative data. Additional pharmacist oversight and nurse staffing, as well as policies implemented as part of the accreditation process, may result in identification of ADEs that might otherwise not have been identified. It is also possible that unmeasured differences in patient characteristics across hospitals may

Table 2. Rates of adverse drug events in CAHs per 10,000 discharges by hospital characteristics, 2013

	Critical Access Hospitals			
	Steroids	Antibiotics	Opiates & Narcotics	Anti-coagulants
Accreditation				
Yes	16.9	19.9	23.2***	6.2*
No	15.2	16.7	13.5	3.9
Inpatient Days				
≤ 4,000	13.8	19.5	18.5	4.0***
4,001-11,200	18.6	17.1	18.3	6.2***
11,201-40,000	11.3	11.3	3.8	7.5***
Hospital Ownership				
Government, Non-federal	9.3***	9.3***	15.8	4.0
Private, Nonprofit	18.6***	21.6***	19.2	5.4
Number of Full-Time Licensed Pharmacists				
None (N=60 CAHs)	16.0**	15.2	13.6***	4.1
One (N=69 CAHs)	19.3	19.3	18.2	7.0
Two (N=45 CAHs)	19.5	23.1	26.3***	4.7
Three or More (N=37 CAHs)	10.1**	14.8	13.9	3.9
Number of Full-Time Registered Nurses				
≤ 25 (N=53 CAHs)	19.0	19.0	6.7**	3.7*
26-40 (N=59 CAHs)	18.2	18.8	16.2	2.0*
41-60 (N=47 CAHs)	13.8	21.6	19.1	7.3
61+ (N=52 CAHs)	15.6	16.1	21.2**	5.5

Notes: Significant differences between categories of hospital characteristics were noted at ***p<0.001, **p<0.01, and *p<0.05, derived from Pearson's Chi-square tests.

Table 3. Rates of adverse drug events per 10,000 discharges in rural PPS hospitals by hospital characteristics, 2013

	Rural PPS Hospitals			
	Steroids	Antibiotics	Opiates & Narcotics	Anti-coagulants
Accreditation				
Yes	31.7***	21.0	17.1**	10.4***
No	19.2***	20.5	12.4**	5.6***
Inpatient Days				
≤ 4,000	32.7	6.5	6.5	16.3***
4,001-11,200	22.2***	21.7	23.9***	7.1***
11,201-40,000	29.8***	20.2	13.3***	9.0***
40,001+	36.2***	22.1	17.3***	12.9***
Hospital Ownership				
Government, Non-federal	32.3***	22.6***	25.3***	9.8**
Private, Nonprofit	31.6	21.8	16.3***	10.5
Private, For-profit	18.0***	13.2***	8.4***	5.1**
Number of Full-Time Licensed Pharmacists				
0-2 (N=39)	31.5	21.4	22.8	11.0
3-4 (N=46)	22.9***	21.7	17.4	7.8***
5-9 (N=37)	28.8***	21.1	15.1	9.1**
10+ (N=22)	35.4***	20.3	14.4	11.2**
Number of Full-Time Registered Nurses				
≤ 90 (N=41)	23.2***	19.4	16.1	7.0
91-125 (N=31)	23.4***	21.5	20.5*	7.1
126-200 (N=37)	27.1***	21.8	15.1	8.5***
201+ (N=35)	35.4***	20.8	16.3	11.9***

Notes: Significant differences between categories of hospital characteristics were noted at ***p<0.001, **p<0.01, and *p<0.05, derived from Pearson's Chi-square tests.

explain some of these results, as certain risk factors (such as older age, use of multiple medications, renal impairment, and decline in cognition) are associated with higher ADE rates among hospitalized patients.[12]

The Joint Commission (JC) recently adopted a new Medication Management Standard on antimicrobial stewardship for hospitals and CAHs, effective January 1, 2017. The JC standard aligns with proposed CMS regulations governing Medicare Conditions of Participation (CoP) for hospitals, including CAHs, which would require that each hospital implement facility-wide infection prevention and antibiotic stewardship programs in coordination with its Quality Assurance and Performance Improvement (QAPI) program.[13] The proposed regulations would require hospitals to "demonstrate adherence to nationally recognized infection control guidelines, where applicable, for reducing the transmission of infections, as well as best practices for improving antibiotic use and reducing the development and transmission of [hospital-acquired infections] and antibiotic-resistant organisms."[13]

The proposed regulations do not require any specific staffing models for the infection prevention and antibiotic stewardship programs, noting that CAHs use a variety of staffing models including direct employment, contracted services, and shared service agreements, and that the CAHs' staffing for these programs should be appropriate to the scope and complexity of the services offered at the hospital.[13] While implementation of facility-wide infection prevention and antibiotic

stewardship programs may present challenges for CAHs and other smaller hospitals that do not currently have these programs, these could improve patient safety and reduce overall costs to the health care system by decreasing the incidence of hospital-acquired infections and antibiotic resistance.

Conclusions

This study found that ADE rates for the most common categories of medications involved in ADEs that occur during inpatient hospitalizations varied across CAHs, rural PPS and urban PPS hospitals. All hospitals, including CAHs and rural PPS hospitals, could benefit from the many resources available to help hospitals identify and prevent ADEs as described in a companion policy brief, "Resources to Reduce Adverse Drug Events in Rural Hospitals." ■

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