Potentially Avoidable Hospitalizations in Tennessee: Analysis of Prevalence Disparities Associated with Gender, Race, and Insurance

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SYNOPSIS

Objectives. We determined (*1*) the relative rates of potentially avoidable hospitalizations (PAHs) in Tennessee; (*2*) relative rates of PAHs among gender, race, and insurance subgroups; and (*3*) adjusted population-based relative rates of PAHs, taking into account the influences of unobservable factors such as patient preferences, physician practice patterns, and availability of hospital beds that can also affect PAHs.

Methods. We applied the Agency for Healthcare Research and Quality's definitions of ambulatory care sensitive conditions (ACSCs) to Tennessee hospitalization records to identify PAHs. Patient discharge records for 2002 came from Tennessee's Hospital Discharge Data System. Population estimates came from the U.S. Census Current Population Survey. Hospital discharges with a complete record from all nonfederal acute-care hospitals in Tennessee were considered.

Results. The relative rates of PAHs in Tennessee were higher than the U.S. rates in each of the ACSC categories. The relative rates were sensitive to adjustment for unmeasured factors such as patient preferences, physician practice patterns, and the physician supply that were reflected implicitly in the hospitalization rates of each subgroup for all discharge conditions. Within Tennessee, the type of insurance each person held was the greatest determinant of the likelihood of having a PAH, particularly for a chronic condition.

Conclusions. The results indicate poor health of the general population in Tennessee and suggest opportunities to improve the provision of primary care for specific ACSCs and population subgroups to reduce PAHs, particularly the uninsured and individuals enrolled in Tennessee's Medicaid managed care program.

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Tennessee faces a wide range of health-care challenges. Rising health-care costs and the resulting efforts by businesses to control spending have added pressure to an already burdened health-care system to deliver more with less. The information provided in this article can make a small but concrete contribution in a critical area of the health-care system: the efficient delivery of primary care. By suggesting gender, racial, and insurance subgroups for which the quality of primary care could be improved, the care for ambulatory care sensitive conditions (ACSCs) can be shifted away from the inpatient setting.

Research suggests that hospitalizations for certain ACSCs are potentially avoidable.[1–3] These hospitalizations can be avoided when clinicians deliver timely and effective outpatient treatment to individuals who actively participate in their own care, follow a healthy lifestyle, and engage in responsible personal behavior.[4] Nationally, nearly five million inpatient admissions to U.S. hospitals in 2000 involved treatment for one or more of these ACSCs, resulting in a total cost of more than $26.5 billion.[5] Thus, high rates of hospitalizations for these conditions indicate the presence of opportunities for improving health system effectiveness and efficiency.

In this study, we applied the Agency for Healthcare Research and Quality's (AHRQ's) definitions of ACSCs[4] to Tennessee hospitalization records to identify potentially avoidable hospitalizations (PAHs). The purposes were to determine (*1*) the relative rates (RRs) of PAHs in Tennessee; (*2*) the population-based RRs of PAHs among gender, race, and insurance subgroups; and (*3*) the RRs adjusted for hospitalization patterns for all admissions to account for unobservable factors such as patient preferences, physician practice patterns, and availability of hospital beds that can also affect utilization.

WHAT IS A PAH?

This study used the definitions of PAHs proposed by AHRQ to measure the effectiveness and timeliness of primary care services provided in outpatient, clinic, and community settings. Published in 2004, the AHRQ definitions identify a set of specific ACSCs in three major diagnostic categories, including:

1. Chronic conditions: Comprised of diabetes (including uncontrolled diabetes, short-term diabetes complications, long-term diabetes complications, and lower-extremity amputations among patients with diabetes), circulatory diseases (congestive heart failure [CHF], hypertension, and angina without procedure), and respiratory diseases (adult asthma, pediatric asthma, and chronic obstructive pulmonary disease [COPD]);
2. Acute conditions: Including dehydration, bacterial pneumonia, urinary tract infection [UTI], perforated appendix, and pediatric gastroenteritis; and
3. Low birthweight births.

These ACSCs and the associated International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes were accessed from the AHRQ Guide to Prevention Quality Indicators: Hospital Admission for Ambulatory Care Sensitive Conditions.[4] Note that this study combined the four categories of diabetes recognized by the AHRQ document into a single category, "diabetes," thereby reducing the total number of ACSCs from the original 16 to 13.

METHODS

Data

The Tennessee Department of Health (TDH) requires that every licensed hospital report all claims data found on the UB-92 Hospital Claims Form to the TDH. The Division of Health Statistics in the Office of Policy Planning and Assessment of TDH established the Hospital Discharge Data System (HDDS) in 1997 to collect, compile, and disseminate patient-level, de-identified discharge information.

The data used in this study were from the 2002 HDDS dataset. We used data from nonfederal acute-care hospitals, including general medical and surgical hospitals, women's or obstetrician/gynecological hospitals, and pediatric hospitals. Excluded were long-term-care, psychiatric, rehabilitation, and other specialty hospitals. The data from January 1, 2002, through December 31, 2002, are summarized in Table 1. Standard deviations for each ratio were computed using the formula provided in the Census Bureau's technical documentation for the Current Population Survey. These values and

Table 1. Potentially avoidable hospitalizations by gender, Tennessee, 2002

Gender	*Total number of hospitalizations*	*Number of potentially avoidable hospitalizations*	*Percent*
Female	504,982	77,289	15.3
Male	338,881	55,682	16.4
Unknown	19	2	10.5
Total	843,882	132,973	15.8

the sample sizes were supplied to Stata® Version 9.0[6] to calculate confidence intervals and *p*-values.

In 2002, 132,973 PAHs occurred in Tennessee, representing 15.8% of 843,882 inpatient hospitalizations for all conditions at nonfederal acute-care hospitals. Female patients were responsible for 504,982 (or 59.8% of the total) hospitalizations for all conditions except normal deliveries, while male patients were responsible for the remaining 338,881 hospitalizations (40.2% of the total). For PAHs, the female-to-male ratio was indistinguishable to that of the overall hospitalizations in the state, with females reporting 77,289 PAHs (58.1% of total) and males reporting 55,682 PAHs (41.9% of total).

Relative rates and adjusted relative rates

The RR of a PAH is defined as the number of hospitalizations for a particular ACSC per population at risk in a given year and is frequently referred to as the hospitalization rate. In this study, RRs for different PAHs were expressed as the number of hospitalizations per 100,000 general population, except for perforated appendix and low birthweight. The RR for perforated appendix was calculated per 100 admissions for appendicitis, while the rate for low birthweight was calculated per 100 live births.

The RR of PAHs between any two population subgroups was defined as:

$$\text{RR} = \frac{\text{PAH rate}_A}{\text{PAH rate}_B}$$

This is the ratio of the PAH rate of group A (the group of interest) over the PAH rate of group B (the comparison/reference group). If this ratio was greater than one, patients in group A were thought to be overrepresented among avoidable hospitalizations for a particular ACSC. To capture differences in age distributions among the population subgroups, we adjusted all the RRs for age and only the age-adjusted RRs are presented, except for diabetes. For diabetes, we present both the RRs and the age-adjusted RRs to illustrate our step-by-step calculation. The raw RRs not adjusted for age for all ACSCs can be obtained from the corresponding author.

Many factors such as physician supply, physician practice patterns, and patient preferences can also affect inpatient care utilization at the hospital level; these influences are reflected in the overall utilization rates at a hospital. Following the examples of previous studies,[7–11] we examined PAH rates in the context of hospitalizations for all conditions using the adjusted relative rate (ARR):

$$\text{ARR} = \frac{\text{PAH rate}_A/\text{PAH rate}_B}{\text{TH rate}_A/\text{TH rate}_B}$$

In this equation, PAH equals potentially avoidable hospitalizations and TH equals total hospitalizations.

We present RRs and ARRs for two gender groups (with males serving as the reference group) and two population subgroups (black vs. non-Hispanic white). We focused on the black/white comparison because the majority of people in Tennessee are either white or black. Finally, we compared the prevalence of PAHs among three different insurance groups—private, TennCare (Tennessee's Medicaid program), and uninsured—for individuals younger than 65 years of age, with the privately insured serving as the reference group. All adults with Medicare were considered separately: Medicare/TennCare dual-eligible individuals were compared with other Medicare enrollees. Medicare was considered separate from other insurers because there were too few individuals without Medicare older than 65 years of age to allow for age-adjusted comparison with the privately insured.

RESULTS

Relative rates

Table 2 shows the number of PAHs for each of the 13 ACSCs in 2002. Also presented are 13 PAH rates per 100,000 population for Tennessee and the U.S. The presented prevalence data, in addition to serving as a performance measure of the quality of primary care provision, are useful in providing a context for the calculation and interpretation of the RRs of ACSC hospitalizations.

As shown in Table 2, the leading diagnosis among the major ACSCs in 2002 was bacterial pneumonia, accounting for 31,722 PAHs (24%), followed by CHF (25,969, or 20%), and COPD (18,353, or 14%). Tennesseans experienced a higher rate of PAHs than did the broader U.S. population. The only exception was angina without procedure, where the U.S. rate (55.1 per 100,000 adults) was roughly equal to that of Tennessee (54.8 per 100,000 adults).

RRs and ARRs

The RRs and ARRs of PAHs for each of the 13 ACSCs are shown by gender, race, and insurance groups. The step-by-step process for calculating the RRs is illustrated in Tables 3 and 4, using diabetes as an example. Summary results for the RRs and ARRs for each population subgroup are presented for acute ACSCs (Table 5) and chronic ACSCs (Table 6). Low-birthweight births are

Table 2. Potentially avoidable hospitalizations in 2002, in Tennessee and the U.S.

	Tennessee		U.S.
Primary diagnosis	*Total number of hospitalizations*	*Hospitalization rate*[a]	*Hospitalization rate*[a]
Diabetes	11,484	274.5	224.5
Congestive heart failure	25,969	620.7	457.7
Hypertension	2,753	65.8	44.4
Angina, without procedure	2,291	54.8	55.1
Adult asthma	4,987	119.2	110.9
Pediatric asthma	3,123	217.9	188.8
Chronic obstructive pulmonary disease	18,353	438.6	248.6
Dehydration	11,012	196.0	139.9
Bacterial pneumonia	31,722	564.7	349.7
Urinary tract infection	11,832	210.6	137.9
Perforated appendix[b]	1,576	34.3	30.5
Pediatric gastroenteritis	1,846	128.8	87.7
Low birthweight birth[c]	6,053	8.0	5.9

[a]Rates are per 100,000 population. For diabetes, congestive heart failure, hypertension, and adult asthma, the population includes all people aged 18 years and older. For pediatric conditions, the population includes all people aged 0 to 17 years. The rates for chronic obstructive pulmonary disease, dehydration, bacterial pneumonia, and urinary tract infection were calculated using all state residents as the population. The U.S. rates were taken from: Agency for Healthcare Research and Quality (US). Guide to prevention quality indicators: hospital admission for ambulatory care sensitive conditions. AHRQ Pub. No. 02-RO203. Revision 4 (2004 Nov 24).

[b]The rate for perforated appendix was calculated per 100 admissions for appendicitis.

[c]The rate for low birthweight birth (<2,500 grams) was calculated per 100 births.

shown in Table 7. Additional tables with step-by-step details are available from the corresponding author upon request.

In Table 3, the RRs of PAHs for diabetes per 100,000 population were similar for male and female populations in Tennessee (280.6 vs. 270.0). The unadjusted RR of 0.96 for females and the failure to reject the null hypothesis that the RR is equal to one confirm the absence of gender differences in PAHs for diabetes among the adult population in Tennessee. After adjusting for differences in age distribution, however, the RR for females fell to 0.92 ($p \leq 0.01$), indicating that males in Tennessee actually face a higher risk for PAHs for diabetes and that the unadjusted RR for females may be pushed higher by a relatively older hospitalized population when compared with males.

Between white and black patients, the unadjusted RR shows that black patients were 136% more likely to be hospitalized for diabetes than non-Hispanic white patients. After adjusting for age, the differences become more dramatic: black patients were 336% more likely to be hospitalized for diabetes. Both ratios were statistically different from one at the 99% level.

Among the insurance groups, individuals younger than 65 years of age with TennCare fared worse than the uninsured and those with private insurance. The unadjusted RR for TennCare compared with private insurance was 9.11 ($p \leq 0.01$); after age adjustment, the ratio rose further to 10.06 ($p \leq 0.01$). By contrast, the uninsured had rates that were comparable with those of the privately insured before and after age adjustment. Among adults with Medicare, dual-eligible patients were only 83% as likely to be hospitalized for diabetes as other individuals covered by Medicare ($p \leq 0.05$). After adjusting for age, this rate fell to 0.28 because population-based age adjustment gave greater weight to younger age groups.

According to the RR values shown in Table 4, women seem to have a higher rate of hospital use for diabetes than men. Adjusting for the greater overall hospitalizations in the female population, however, the ARR for women dropped to 0.80 ($p \leq 0.01$), suggesting a 20% lower hospital use rate for diabetes by women. This rate rose slightly to 0.86 ($p \leq 0.01$) following additional adjustment for age, but was still statistically different from one. The ARR of 2.39 ($p \leq 0.01$) for black compared with white patients was essentially equal to the RR of 2.36 ($p \leq 0.01$) for black patients, as shown in Table 3. This insensitivity to adjustment is to be expected given that the rate of hospitalizations for all conditions, excluding deliveries, was comparable between the two races. However, the age-adjusted ARR was far lower than the age-adjusted RR for black patients (2.18 vs. 4.36). There remains evidence of a significant difference between the RRs of the two races after adjusting for total hospitalizations and differences in age.

The differences between the RR and ARR values were more dramatic across the insurance groups than

those found for the previous gender and race comparisons. The ARR for TennCare enrollees compared with the privately insured was 2.18 ($p \leq 0.01$) for diabetes and fell to 2.09 ($p \leq 0.01$) after additional adjustment for differences in age distribution. These stand in sharp contrast to the much higher RR values of 9.11 ($p \leq 0.01$) and 10.06 ($p \leq 0.01$) found for TennCare enrollees in Table 3, suggesting that the true underlying hospital use for diabetes by TennCare enrollees was not nearly as dramatic as it first appeared once the overall hospitalization patterns were taken into account. The ARR for the uninsured, however, rose substantially to 2.21 ($p \leq 0.01$) in Table 4 from the unadjusted RR of 0.99 in Table 3. This suggests that the uninsured are actually 121% more likely than privately insured patients to be hospitalized for diabetes and are not at par with those privately insured as originally suggested by the unadjusted RR value. Further adjustment for age left the ARR essentially unchanged at 2.11 ($p \leq 0.01$) for the uninsured. The comparable ARR values for the uninsured and TennCare enrollees suggest that the two groups face similar challenges in obtaining timely and effective ambulatory treatment for diabetes.

Medicare is an insurance program for the elderly, but certain disabled and severely ill individuals may be covered prior to age 65. We considered all Medicare enrollees, regardless of age, collectively. For individuals dually eligible for TennCare and Medicare, the ARR for diabetes, unadjusted for age, was 1.40 ($p \leq 0.01$), suggesting a significant TennCare effect on PAH. However, after adjusting for age, the ARR for dual-eligible individuals fell to 0.91 ($p \leq 0.01$). This age-adjusted ARR was much lower than the 2.08 age-adjusted ARR observed for TennCare enrollees compared with the privately insured. The similarity between relatively affluent and low-income individuals within the Medicare population may indicate that income is not as important a factor for older patients and the very ill as

Table 3. Relative rates of potentially avoidable hospitalizations for diabetes by gender, race, and insurance, Tennessee, 2002

Characteristic	*Adult population*[a]	*Number of PAHs for diabetes*	*Diabetes PAH rate*[b]	*RR*[c] *(95% CI)*	*Age-adjusted RR (95% CI)*
Gender					
Male	1,971,051	5,531	280.6	Ref.	Ref.
Female	2,212,924	5,976	270.0	0.96 (0.90, 1.02)	0.92[d] (0.88, 0.96)
Race					
White	3,431,624	7,662	223.3	Ref.	Ref.
Black	626,775	3,307	527.6	2.36[d] (2.16, 2.57)	4.36[d] (4.20, 4.52)
Insurance, population <65 years of age					
Private	2,375,544	1,994	83.9	Ref.	Ref.
TennCare	310,568	2,376	765.0	9.11[d] (8.01, 10.22)	10.06[d] (9.48, 10.63)
Uninsured	660,746	547	82.8	0.99 (0.90, 1.07)	1.01 (0.93, 1.10)
Insurance, Medicare					
Medicare	541,284	4,937	912.1	Ref.	Ref.
Dual-eligible	155,264	1,172	754.8	0.83[e] (0.68, 0.98)	0.28[d] (0.27, 0.29)

[a]The adult population was defined as all individuals aged 18 years and older.

[b]The rate was per 100,000 people.

[c]This ratio was each subgroup's PAH rate compared with that of the first-listed group in each category.

[d]$p \leq 0.01$

[e]$p \leq 0.05$

PAH = potentially avoidable hospitalization

CI = confidence interval

RR = relative rate

Ref. = reference group

Table 4. Adjusted relative rates of potentially avoidable hospitalizations for diabetes by gender, race, and insurance, Tennessee, 2002

Characteristic	*Number of adult hospitalizations*[a]	*Total hospitalization rate*[b]	*Diabetes PAH rate*[b]	*ARR*[c] *(95% CI)*	*Age-adjusted ARR (95% CI)*
Gender					
Male	272,753	13,837.9	280.6	Ref.	Ref.
Female	370,629	16,748.4	270.0	0.80[d] (0.73, 0.86)	0.86[d] (0.82, 0.89)
Race					
White	514,431	14,990.9	223.3	Ref.	Ref.
Black	92,752	14,798.3	527.6	2.39[d] (2.09, 2.69)	2.18[d] (2.10, 2.26)
Insurance, population <65 years of age					
Private	148,766	6,262.4	83.9	Ref.	Ref.
TennCare	81,185	26,140.8	765.0	2.18[d] (1.81, 2.56)	2.09[d] (1.97, 2.21)
Uninsured	18,448	2,798.0	82.8	2.21[d] (1.93, 2.48)	2.11[d] (1.93, 2.29)
Insurance, Medicare					
Medicare	308,393	56,974.3	912.1	Ref.	Ref.
Dual-eligible	52,355	33,720.0	754.8	1.40[e] (1.04, 1.76)	0.91[d] (0.87, 0.95)

[a]Adult was defined as all individuals aged 18 years and older. Hospitalizations for delivery only were excluded.

[b]Rate is per 100,000 people.

[c]This ratio is each subgroup's PAH rate, adjusted for total hospitalizations, compared with that of the first-listed group in each category.

[d]$p \leq 0.01$

[e]$p \leq 0.05$

PAH = potentially avoidable hospitalization

CI = confidence interval

ARR = adjusted relative rate

Ref. = reference group

it is for younger, healthier groups. Alternately, it may indicate that Medicare affords access to ambulatory diabetes care not available to TennCare enrollees and the uninsured.

For the remaining six chronic ACSCs, the pattern was much the same. The results are shown in Table 5, where only age-adjusted RRs and ARRs are presented. Chronic ACSCs include CHF, hypertension, angina without procedure, adult asthma, pediatric asthma, and COPD.

It should be noted that female patients' unadjusted rates for chronic ACSCs other than pediatric asthma were either similar to or higher than those of male patients. After adjusting for total hospitalization patterns, women's RRs were higher only for adult asthma (2.49, $p \leq 0.01$) and hypertension (1.65, $p \leq 0.01$). These rates illustrate, once again, the need to adjust for the underlying causes of gender differences in ACSC hospitalizations. For pediatric asthma, the RR and ARR values—0.63 and 0.74, respectively—indicate that PAHs are less prevalent for females than for males.

Before adjusting for total hospitalizations, the RRs of PAHs for chronic conditions were universally higher for non-Hispanic black than for non-Hispanic white patients. Following adjustment, black patients had higher ARRs for hypertension (2.43, $p \leq 0.01$), pediatric asthma (2.19, $p \leq 0.01$), CHF (2.01, $p \leq 0.01$), and adult asthma (1.45, $p \leq 0.01$). The ARR for angina without procedure was not statistically different from one. The adjusted rate for COPD was significantly less than one (0.63, $p \leq 0.01$).

Without exception, the RRs for TennCare were significantly greater than one. The greatest values were observed for COPD (15.91, $p \leq 0.01$) and CHF (11.17, $p \leq 0.01$). Like diabetes, the magnitude of difference decreased substantially after PAH rates were adjusted for total hospitalizations. For COPD, the ARR of 3.31 was statistically significant ($p \leq 0.01$), suggesting that TennCare enrollees were 231% more likely to have a PAH for COPD. The smaller ARR compared with the RR was the result of a greater rate of hospitalizations among the TennCare population for all conditions. For the remaining chronic conditions, the degree of difference between TennCare enrollees and the

privately insured was smaller after adjusting for total hospitalizations, but still significantly higher than one. For example, the ARR was 2.32 ($p \leq 0.01$) for CHF, 1.57 ($p \leq 0.01$) for adult asthma, 1.37 ($p \leq 0.01$) for hypertension, 1.35 ($p \leq 0.01$) for pediatric asthma, and 1.32 ($p \leq 0.01$) for angina without procedure.

Comparing the uninsured with the privately insured, the RRs for PAHs for chronic ACSCs were in most cases significantly lower than one. This was true for pediatric asthma (0.38, $p \leq 0.01$), angina without procedure (0.61, $p \leq 0.01$), COPD (0.66, $p \leq 0.01$), and adult asthma (0.75, $p \leq 0.01$). For CHF (0.96) and hypertension (0.91), the RRs were not significantly different from one. After adjusting for the lower use of inpatient services, the uninsured were significantly more likely to have a PAH for pediatric asthma as evidenced by the ARR of 1.13 ($p \leq 0.05$) for the "uninsured to private" insurance category. For adults, the greatest difference was observed for hypertension, where the ARR was 2.14 ($p \leq 0.01$). In order of magnitude, the ARRs for the remaining adult conditions were 1.96 ($p \leq 0.01$) for CHF, 1.55 ($p \leq 0.01$) for asthma, 1.45 ($p \leq 0.01$) for angina without procedure, and 1.36 ($p \leq 0.01$) for COPD, with all ARRs statistically different from one at the 99% or higher level.

Table 5 presents the RRs and ARRs for Medicare/Medicaid dual-eligible enrollees using the Medicare-only beneficiaries as the reference group. Note that the Medicare-only group comprised disabled individuals younger than 65 years of age plus their dependents, while the dual-eligible group included mostly low-income seniors who also qualified for TennCare. For

Table 5. Relative rates and adjusted relative rates for chronic ACSCs (age-adjusted version only), Tennessee, 2002

Characteristic	*Angina without procedure*	*Asthma, adult*	*Asthma, pediatric*	*Chronic obstructive pulmonary disease*	*Congestive heart failure*
Female to male					
RR	1.04	2.67[a]	0.63[a]	1.02[b]	0.98
(95% CI)	(0.96, 1.13)	(2.48, 2.87)	(0.60, 0.66)	(1.00, 1.05)	(0.96, 1.00)
ARR	0.97	2.49[a]	0.74[a]	0.95[a]	0.92[a]
(95% CI)	(0.89, 1.05)	(2.31, 2.67)	(0.70, 0.78)	(0.93, 0.98)	(0.90, 0.94)
Black to white					
RR	1.92[a]	2.91[a]	2.23[a]	1.27[a]	4.02[a]
(95% CI)	(1.76, 2.08)	(2.73, 3.08)	(2.11, 2.34)	(1.23, 1.31)	(3.94, 4.09)
ARR	0.96	1.45[a]	2.19[a]	0.63[a]	2.01[a]
(95% CI)	(0.88, 1.04)	(1.37, 1.54)	(2.07, 2.30)	(0.62, 0.65)	(1.97, 2.05)
TennCare to private					
RR	6.10[a]	7.56[a]	2.59[a]	15.91[a]	11.17[a]
(95% CI)	(5.45, 6.75)	(7.00, 8.11)	(2.46, 2.73)	(15.10, 16.71)	(10.58, 11.77)
ARR	1.32[a]	1.57[a]	1.35[a]	3.31[a]	2.32[a]
(95% CI)	(1.18, 1.47)	(1.45, 1.69)	(1.27, 1.42)	(3.14, 3.47)	(2.20, 2.45)
Uninsured to private					
RR	0.61[a]	0.75[a]	0.38[a]	0.66[a]	0.96
(95% CI)	(0.50, 0.73)	(0.66, 0.83)	(0.34, 0.43)	(0.59, 0.72)	(0.86, 1.03)
ARR	1.45[a]	1.55[a]	1.13[c]	1.36[a]	1.96[a]
(95% CI)	(1.18, 1.72)	(1.37, 1.73)	(1.00, 1.26)	(1.23, 1.50)	(1.79, 2.13)
Medicare/Medicaid dual-eligible to Medicare					
RR	0.34[a]	0.25[a]	NA	0.40[a]	0.30[a]
(95% CI)	(0.30, 0.38)	(0.24, 0.27)		(0.39, 0.41)	(0.29, 0.31)
ARR	1.11[c]	0.82[a]	NA	1.30[a]	0.98
(95% CI)	(0.98, 1.24)	(0.76, 0.88)		(1.25, 1.34)	(0.95, 1.02)

[a] $p \leq 0.01$

[b] $p \leq 0.05$

[c] $p \leq 0.10$

ACSC = ambulatory care sensitive condition

RR = relative rate

ARR = adjusted relative rate

CI = confidence interval

NA = not applicable

the five adult chronic conditions, the RRs were substantially lower than one. However, after adjusting for the overall hospitalization patterns, the dual-enrolled patients were more likely to have a PAH for COPD (1.30, $p \leq 0.01$) and angina without procedure (1.11, $p \leq 0.10$). For adult asthma and hypertension, dual-enrolled patients (0.82, $p \leq 0.01$) were less likely to have a PAH than individuals with Medicare only (0.72, $p \leq 0.01$). There was no statistically significant difference in the rates for CHF.

Table 6 shows unadjusted and adjusted PAH rates for the five acute ACSCs. For bacterial pneumonia, the RR for females was 0.90 ($p \leq 0.01$) and the ARR was 0.85 ($p \leq 0.01$), suggesting that females were statistically less likely to have a PAH than their male counterparts. For the two major racial groups, black patients were more likely to be hospitalized for bacterial pneumonia prior to adjustment for total hospitalizations, but were actually 12% less likely to be hospitalized after adjustment. Those with TennCare and the uninsured had slightly higher rates than individuals covered by private insurance plans.

For the other four acute ACSCs (dehydration, UTI, perforated appendix, and pediatric gastroenteritis), females had higher rates of PAHs than males, after adjustment. With the exception of pediatric gastroenteritis, where there was no difference, females also had higher unadjusted RRs for the four acute conditions. Non-Hispanic white patients had higher rates than non-Hispanic black patients for pediatric gastroenteritis. For the other acute conditions, dehydration (1.52, $p \leq 0.01$), perforated appendix (1.28, $p \leq 0.01$), and UTI (1.47, $p \leq 0.01$), black patients were more likely to have a PAH. Among the various insurance groups, the differences were not as extreme or unidirectional as were those observed for chronic conditions. For dehydration, the uninsured and TennCare enrollees were less likely than the privately insured to have a PAH. For perforated

Table 6. Relative rates and adjusted relative rates for acute ACSCs (age-adjusted rates only), Tennessee, 2002

Characteristic	*Bacterial pneumonia*	*Dehydration*	*Pediatric gastroenteritis*	*Perforated appendix*	*Urinary tract infection*
Female to male					
RR	0.90[a]	1.23[a]	1.00	0.90[a]	2.00[a]
(95% CI)	(0.88, 0.92)	(1.18, 1.28)	(0.94, 1.07)	(0.89, 0.91)	(1.95, 2.08)
ARR	0.85[a]	1.16[a]	1.18[a]	NA	1.89[a]
(95% CI)	(0.83, 0.87)	(1.11, 1.21)	(1.10, 1.25)		(1.81, 1.97)
Black to white					
RR	1.70[a]	2.94[a]	0.50[a]	1.28[a]	2.85[a]
(95% CI)	(1.66, 1.75)	(2.83, 3.05)	(0.46, 0.53)	(1.26, 1.30)	(2.75, 2.95)
ARR	0.88[a]	1.52[a]	0.49[a]	NA	1.47[a]
(95% CI)	(0.86, 0.90)	(1.46, 1.57)	(0.45, 0.53)		(1.42, 1.52)
TennCare to private					
RR	5.55[a]	3.69[a]	1.74[a]	1.04[a]	5.21[a]
(95% CI)	(5.60, 6.10)	(3.44, 3.95)	(1.70, 1.93)	(1.02, 1.05)	(4.83, 5.58)
ARR	1.27[a]	0.85[a]	0.91[a]	NA	1.19[a]
(95% CI)	(1.21, 1.33)	(0.79, 0.90)	(0.85, 0.96)		(1.10, 1.24)
Uninsured to private					
RR	0.58[a]	0.38[a]	0.36[a]	1.08[a]	0.50[a]
(95% CI)	(0.53, 0.62)	(0.33, 0.43)	(0.32, 0.41)	(1.06, 1.10)	(0.43, 0.57)
ARR	1.25[a]	0.82[a]	1.06	NA	1.09
(95% CI)	(1.15, 1.35)	(0.71, 0.93)	(0.93, 1.20)		(0.94, 1.24)
Medicare/Medicaid to Medicare					
RR	0.40[a]	0.36[a]	NA	1.64[a]	0.45[a]
(95% CI)	(0.39, 0.42)	(0.34, 0.38)		(1.61, 1.67)	(0.42, 0.47)
ARR	1.30[a]	1.16[a]	NA	NA	1.44[a]
(95% CI)	(1.25, 1.34)	(1.09, 1.23)			(1.36, 1.51)

[a] $p \leq 0.01$

ACSC = ambulatory care sensitive condition

RR = relative rate

ARR = adjusted relative rate

CI = confidence interval

NA = not applicable

Table 7. Low birthweight birth relative rates

Characteristic	*Total number of births*[a]	*Number of LBW births*	*LBW PAH rate*[b]	*Relative rate (95% CI)*
Gender				
Male	38,967	3,060	7.9	Ref.
Female	36,562	2,945	8.1	1.03[c] (1.03, 1.03)
Race				
White	51,129	3,572	7.0	Ref.
Black	14,653	1,625	11.1	1.59[c] (1.59, 1.59)
Insurance				
Private	37,295	2,693	7.2	Ref.
TennCare	31,414	2,575	8.2	1.14[c] (1.13, 1.14)
Uninsured	2,517	189	7.5	1.04[c] (1.04, 1.04)

[a]Only births recorded in the hospital discharge dataset were counted. Extramural births and births in non-Tennessee hospitals were excluded.

[b]The rate was calculated per 100 live births.

[c]This ratio was each subgroup's PAH rate compared with that of the first-listed group in each category.

LBW = low birthweight

PAH = potentially avoidable hospitalization

CI = confidence interval

Ref. = reference group

appendix, the uninsured and TennCare enrollees were more likely to have a PAH, but the magnitude of the difference was much smaller than that observed for chronic conditions. For TennCare enrollees, the RR was 1.04 ($p \leq 0.01$), indicating an increased likelihood of only 4% for perforated appendix following hospitalization for appendicitis. The uninsured had an RR of 1.08 ($p \leq 0.01$).

It is useful to compare the RRs of PAHs for two pediatric conditions: pediatric asthma (a chronic condition shown in Table 5) and pediatric gastroenteritis (an acute condition shown in Table 6). Boys had higher PAH rates for asthma, while girls had slightly higher rates for gastroenteritis. Among the racial groups, non-Hispanic black children had twice the rate of PAHs for asthma as non-Hispanic white children, while the reverse was true for pediatric gastroenteritis. Those with TennCare, once again, had higher PAH rates than privately insured patients for pediatric asthma and gastroenteritis. In contrast with the previous patterns of higher rates of PAHs for uninsured adults, adjusted PAH rates for asthma and gastroenteritis were indistinguishable between uninsured and privately insured children.

Finally, the RRs for low birthweight are shown in Table 7. Note that the ARR values were not calculated because adjusting the birth rate for total hospitalizations was deemed inappropriate, as the prevalence of births in hospitals is not significantly related to disease burden, physician practice, or patient preferences.

For low birthweight, a condition closely associated with preterm birth and a major cause of infant mortality, we observed a small but significant gender difference in the PAH rate shown in Table 7. Note that the denominator for preterm births is all live births. We used the count of births from the HDDS for 2002 as an estimate of state births, which is extremely close to a census. As a result, the confidence intervals were extremely narrow and even small differences were statistically significant. Compared with non-Hispanic white infants, non-Hispanic black infants had higher rates of low birthweight births. In terms of insurance, TennCare-insured infants and the uninsured had higher rates than patients with private insurance. The RR for TennCare compared with private insurance was 1.14 ($p \leq 0.01$), while the RR for the uninsured was 1.04 ($p \leq 0.01$).

DISCUSSION

Our analysis showed that the RRs of PAHs for the population of Tennessee were considerably higher than the national rates across all of the ACSCs, except angina without procedure. We also found consistent variations of avoidable hospitalization among the major racial groups with, for example, non-Hispanic black patients

in Tennessee being 4.36 times as likely as similarly aged non-Hispanic white patients to enter the hospital with ambulatory care sensitive diabetes. However, after adjusting for total hospitalizations, non-Hispanic black patients' likelihood moderated somewhat to 2.18 times as compared with non-Hispanic white patients.

While the gender and racial differences were important, we found the differences among various insurance categories to be substantial, particularly between those with TennCare and the privately insured. After adjusting for overall hospitalization patterns, the RRs for individuals with TennCare were reduced significantly but not noticeably for gender and racial differences in the RRs of PAHs.

The uninsured had the lowest RRs of avoidable hospitalizations. After adjusting for total hospitalizations and the implied unobservable factors that could also influence inpatient care utilization, the RRs of PAHs of the uninsured exceeded those of the privately insured by a large margin for most conditions. The low unadjusted RRs of the uninsured might reflect the reality of not having health insurance and the resulting lack of access to inpatient services. Alternately, it may be an indication that the uninsured in Tennessee are generally healthy individuals, but that for those who are not healthy, there is a significant barrier to adequate ambulatory care. For the conditions we examined, it is clear that insurance alone will not reduce the likelihood of a PAH. Even after adjusting for age and overall hospital use, TennCare enrollees did not fare much better than the uninsured relative to the privately insured and in some cases fared worse than the uninsured. Although socioeconomic factors are the most logical reason, we believe that the smaller RRs and ARRs for low-income Medicare enrollees indicate that the explanation of this observation is more complex.

We cannot know from hospital discharge data the myriad underlying factors that ultimately resulted in a PAH. However, taken as a whole, the variations in the RRs of PAHs among the different insurance groups reported in this study suggest that, particularly with respect to chronic conditions, the uninsured and low-income groups are prime candidates for medical homes, where they can be treated and educated in a timely and efficient manner in the primary care setting.[12] Medical home development will take time and policy changes. Insurers, particularly those who serve the Medicaid population, need to modify the payment incentives for physicians to reward those who provide high-quality preventive medicine rather than volume. Tennessee's legislature should consider legislation that not only provides funding for "safety net" hospitals (i.e., hospitals of last resort) and health clinics, but also for primary care physicians who may not be able to bear the cost of providing ongoing care to the uninsured. In the meantime, practitioners interacting with uninsured individuals and TennCare enrollees, particularly those on the front lines of emergency departments and urgent care clinics, should take every opportunity to educate their patients about effective management of their health.

Limitations

There were several limitations of this study. First, the racial and insurance categories used in this study were broad and can at most serve as a crude representation of the heterogeneity in the underlying factors that affect health-care utilization and outcomes. Another limitation of our study stems from the method for adjusting the RRs. Although used extensively in previous studies with credible results,[7–9,11] this relatively simple, non-regression-based method may fail to control for factors that have greater influence on ACSC hospitalizations than on non-ACSC hospitalizations. Finally, the interaction of gender, race, and insurance cannot be adequately captured by the descriptive techniques used here. Future studies using multivariate techniques such as logistic regression may increase the precision of estimation and our understanding of the causes of avoidable hospitalizations and the associated variations in hospitalization rates among gender, race, and insurance groups.

CONCLUSIONS

We analyzed Tennessee patient discharge records to explore the rates of PAHs that are sensitive to timely and effective ambulatory care. To explore the variations of these rates across different gender, racial, and insurance categories, we also calculated the RRs of PAHs for males and females, black and white Tennesseans, and major insurance subgroups. We also adjusted the RRs of PAHs two ways: (*1*) for age (to reflect the age distribution for the general population in the state) and (*2*) for the overall hospitalization patterns across the entire state (to capture the unobservable factors that can also significantly affect the rates of hospitalizations, such as differences in patient preferences, perceived health-care needs, physician practice patterns, and availability of care including supply of primary care physicians). The results indicate poor health of the general population in Tennessee and suggest opportunities to improve the provision of primary care for specific ACSCs and population subgroups to reduce PAHs, particularly the uninsured and individuals enrolled in Tennessee's Medicaid managed care program.

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