Infectious Disease Hospitalizations Among American Indian and Alaska Native Infants

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ABSTRACT. *Objective.* **To describe the burden and trends in hospitalizations associated with infectious diseases among American Indian and Alaska Native (AI/AN) infants.**

Methods. **First-listed infectious disease hospitalizations and hospitalization rates among AI/AN infants and infants in the general US population from 1988–1999 were analyzed by using Indian Health Service/tribal hospital discharge data and the National Hospital Discharge Survey data, respectively.**

Results. **Infectious disease hospitalizations accounted for 53% of all AI/AN infant hospitalizations and approximately 43% of all US infant hospitalizations during 1988–1999. The annual hospitalization rate for infectious diseases among AI/AN infants declined from 27 486 per 100 000 infants in 1988 to 14 178 per 100 000 infants in 1999. However, the rates for AI/AN infants within the Alaska, Southwest, and Northern Plains regions remained higher than that for the general US infant population at the end of the study period. Lower respiratory tract infection hospitalizations accounted for almost 75% of AI/AN infant infectious disease hospitalizations, and the lower respiratory tract infection hospitalization rate for AI/AN infants was twice that for US infants.**

Conclusions. **Although infectious disease hospitalization rates for AI/AN infants have declined, AI/AN infants continue to have a higher infectious disease burden than the general US infant population.** *Pediatrics* **2003;111:e176–e182. URL: http://www.pediatrics.org/cgi/content/full/111/2/e176;** ***infants, American Indians, Alaska Natives, infectious disease, hospitalizations, epidemiology.***

ABBREVIATIONS. AI/AN, American Indian and Alaska Native; IHS, Indian Health Service; NHDS, National Hospital Discharge Survey; NCHS, National Center for Health Statistics; CI, confidence interval; SE, standard error; RR, risk ratio; LRTI, lower respiratory tract infection; RSV, respiratory syncytial virus.

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This article does not necessarily reflect the views of IHS.

Received for publication Jul 26, 2002; accepted Oct 2, 2002.

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Infectious disease continues to be an important health problem within the United States.[1–3] American Indians and Alaska Natives (AI/ANs) have incurred excessive mortality and morbidity attributed to infectious diseases for several decades.[4–10] In particular, AI/AN infants are at much greater risk for death than are non-AI/AN infants and have a higher mortality rate as a result of infectious disease.[3,9,11,12] Infectious disease morbidity, as measured through hospitalization rates, also seems to be greater among AI/AN infants than non-AI/AN infants.[10,13–15] AI/AN infants account for a disproportionate share of infectious disease hospitalizations among all AI/ANs.[9,10]

To understand better the infectious disease burden among AI/AN infants, we analyzed infectious disease hospitalizations among AI/AN infants who received Indian Health Service (IHS)/tribal medical care. Hospitalization rates and trends for overall infectious disease and for specific infectious disease groups for AI/AN infants and infants of the general US population were compared.

METHODS

Infant (<1 year of age) hospital discharge data from the IHS Direct and Contract Health Service Inpatient Dataset for AI/ANs and the National Hospital Discharge Survey (NHDS) for the general US population were analyzed for fiscal and calendar years 1988–1999, respectively.[16–18] The Direct and Contract Health Service Inpatient Dataset is maintained by IHS and consists of patient discharge records obtained from IHS-operated and tribally operated hospitals and from hospitals that have contracted with IHS or tribes to provide health care services to federally recognized AI/ANs within the United States.[9] The IHS California and Portland administrative areas were excluded because neither had any IHS or tribally operated hospitals. In addition, California does not report contract health services inpatient data by diagnosis, and Portland has limited contract health service funds for inpatient care.[19,20] The NHDS is a representative sample of discharge records from short-stay, nonfederal general and children's hospitals in the United States; it does not include hospitalizations in the IHS/tribal system.[18,21] US hospitalizations were weighted by using National Center for Health Statistics (NCHS) procedures to obtain national estimates.[18]

All infant hospital discharge records with an infectious disease listed as any 1 of the up to 6 diagnoses on the Direct and Contract Health Service Inpatient Dataset record and up to 7 diagnoses on the NHDS record were selected for the study. Hospital stays for newborns were excluded. Infectious diseases were categorized by using a previously described infectious disease classification method,[10,22] based on the *International Classification of Diseases, Ninth Revision, Clinical Modification,* with modifications related to the perinatal infectious group.[23] The following specific infectious disease groups were compared between AI/AN and US infants: meningitis (codes 027.0, 036, 320.0–321.3, and 321.8); septicemia (038 and 771.8); upper respiratory tract infections (032.0–032.3,

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034.0, 098.6, 101, 460–465, 473.0–474.0, and 475); lower respiratory tract infections (022.1, 031.0, 033, 095.1, 466, 480–487, 510, 511.1, 513, 517.1, and 770.0); kidney, urinary tract, and bladder infections (095.4, 099.4, 590, 595.0, 597, 598.0, and 599.0); cellulitis (680–686); enteric infections (001–009, and 022.2); and viral central nervous system infections (045–049). Infant hospitalizations with a first-listed diagnosis of an infectious disease are presented, unless otherwise indicated.

Hospital discharges were examined by age group, gender, geographic region, and infectious disease category. Age groups were defined as <28 days of life (neonatal) and 28 days through <1 year of age (postneonatal). Regions for the IHS areas were defined as follows: East (Nashville), Northern Plains (Aberdeen, Bemidji, and Billings), Alaska, Oklahoma, and Southwest (Albuquerque, Navajo, Phoenix, and Tucson).[19] The standard census regions—Northeast, Midwest, South, and West—were used for the US population.[24] Race was not examined for the general US population because race/ethnicity was missing from approximately 20% of the NHDS infant infectious disease discharge records.

Infant hospitalization rates were calculated as the number of infant hospitalizations per 100 000 infants. Annual rates with 95% confidence intervals (CIs) were calculated for total (all hospitalizations), first-listed infectious disease, any-listed infectious disease, and specific infectious disease group infant hospitalizations. AI/AN population denominators were determined for each year of the study by using the IHS fiscal year 2001 user population estimates and adjusting retrospectively for annual changes in the IHS service population (based on February 2002 IHS area estimates), excluding the IHS California and Portland areas.[9,25] The user population includes all registered AI/AN patients who received IHS-funded health care service at least once during the last 3 years.[9] The service population is an estimate of AI/ANs eligible for IHS funded health care. Approximately 1.4 million AI/ANs, approximately 60% of all AI/ANs, are eligible for medical care from the IHS, which operates and provides funds for a network of inpatient and ambulatory care facilities across the continental United States and Alaska.[9,25,26] AI/AN infants in this study represent AI/AN infants who received direct or contract health care through IHS or tribally operated facilities. Annual hospital fatality rates for both AI/AN infants and US infants were calculated as the number of infant deaths per 100 infant hospitalizations.

For the United States, rates for infants were calculated by using the NHDS with the US natality data as the denominator.[27] Annual and overall standard errors (SEs) of NHDS estimates for 95% CI estimation were calculated by using SUDAAN software to account for the stratified sampling techniques.[18,28] Denominators were considered free from sampling error.[18,27] For both the AI/AN and US infants, the neonatal population was assumed to be 1/12 of the infant population and postneonatal composed the remaining 11/12 of the infant population.

Tests for trend were performed for the AI/AN infant rates by using linear regression,[29] and a weighted least squares regression method was used for NHDS rates.[30] Comparisons of age group, gender, and region among AI/AN infants were made for the most recent period (1998–1999) by using risk ratios (RRs) and 95% CIs. Comparisons of hospital length of stay for AI/AN infants were analyzed by using the Wilcoxon rank-sum test.[31] For the US infants, length of stay was compared by using a *t* test based on ranks and adjusted for the survey design.[28]

RESULTS

Overall Rates and Trends

During 1988–1999, 35 793 infectious disease hospitalizations occurred among AI/AN infants. These hospitalizations represented 53.4% of total infant hospitalizations and 17.1% of infectious disease hospitalizations among all ages. For the general US population, infants accounted for 4 005 824 infectious disease hospitalizations, representing 43.0% (SE: 0.7%) of total infant hospitalizations and 8.2% (SE: 0.6%) of infectious disease hospitalizations for all ages. The annual hospitalization rate for infectious diseases among AI/AN infants declined 48.4% from 27 486 per 100 000 infants (95% CI: 26 742–28 242) in 1988 to 14 178 per 100 000 infants (95% CI: 13 672–14 699) in 1999 ($P < .001$; Fig 1A). The infectious disease rate among US infants did not change significantly during this period and ranged from 7284 (95% CI: 5514–9053) to 9640 (95% CI: 7470–11811) per 100 000 live births annually. The total hospitalization rate declined 51.0% for AI/AN infants and was stable for US infants (Fig 1A). The proportion of AI/AN hospitalizations attributable to infectious diseases was higher than that for the general US infant population during the study period, with 50.0% to 57.4% of AI/AN infant hospitalizations having an infectious disease compared with 36.8% (SE: 1.5%) to 47.4% (SE: 1.5%) of US infant hospitalizations (Fig 1B). During 1998–1999, the infectious disease hospitalization rate for AI/AN infants remained higher than that for the general US infant population (14 970 and 8996 per 100 000 infants, respectively; Tables 1 and 2). The infectious disease hospitalization rate for AI/AN infants was approximately 66% higher than that of the general US infant rate, whereas the overall hospitalization rate for AI/AN infants was also higher (37%) than the US infant estimate (Table 3). The hospitalization rate for any-listed infectious diseases during 1998–1999 was 18 186 per 100 000 AI/AN infants (95% CI: 17 787–18 592) and 11 175 per 100 000 US infants (95% CI: 8934–13 416).

Age, Gender, and Region

During 1988–1999, the annual rates of AI/AN infectious disease hospitalizations for neonates and postneonates declined similarly ($P < .001$; 48.7% and 41.8%, respectively; Table 1). The 1998–1999 infectious disease hospitalization rates for AI/AN neonates (16 217 per 100 000) and postneonates (14 856 per 100 000) were similar (RR: 1.09; 95% CI: 0.99–1.20). Furthermore, the hospitalization rate for AI/AN neonates was similar to that for US neonates during this period (14 154 per 100 000), whereas the rate for AI/AN postneonates was much higher than that for postneonates in the general US population (8527 per 100 000; Tables 1 and 2). The proportion of all hospitalizations with an infectious disease diagnosis was higher for AI/AN postneonates than for neonates (60.4% and 26.3%, respectively), and these proportions remained stable during the study period for both age groups.

In 1998–1999, the infectious disease hospitalization rate was higher for AI/AN male infants than for female infants (16 294 and 13 578 per 100 000, respectively; RR: 1.20; 95% CI: 1.14–1.27; Table 1). Rates for male AI/ANs and female AI/ANs were each approximately 40% higher than those for their US infant counterparts. The rate of infectious disease hospitalizations declined for both AI/AN male infants and female infants ($P < .001$), whereas the US infant rates did not change significantly during the study period. There was substantial variation in infectious disease hospitalization rates among AI/AN infants between regions (Table 1). The Alaska region had the highest hospitalization rate during 1998–1999, and, unlike all other regions, its rate did not change during the study period. Within the Alaska region, the

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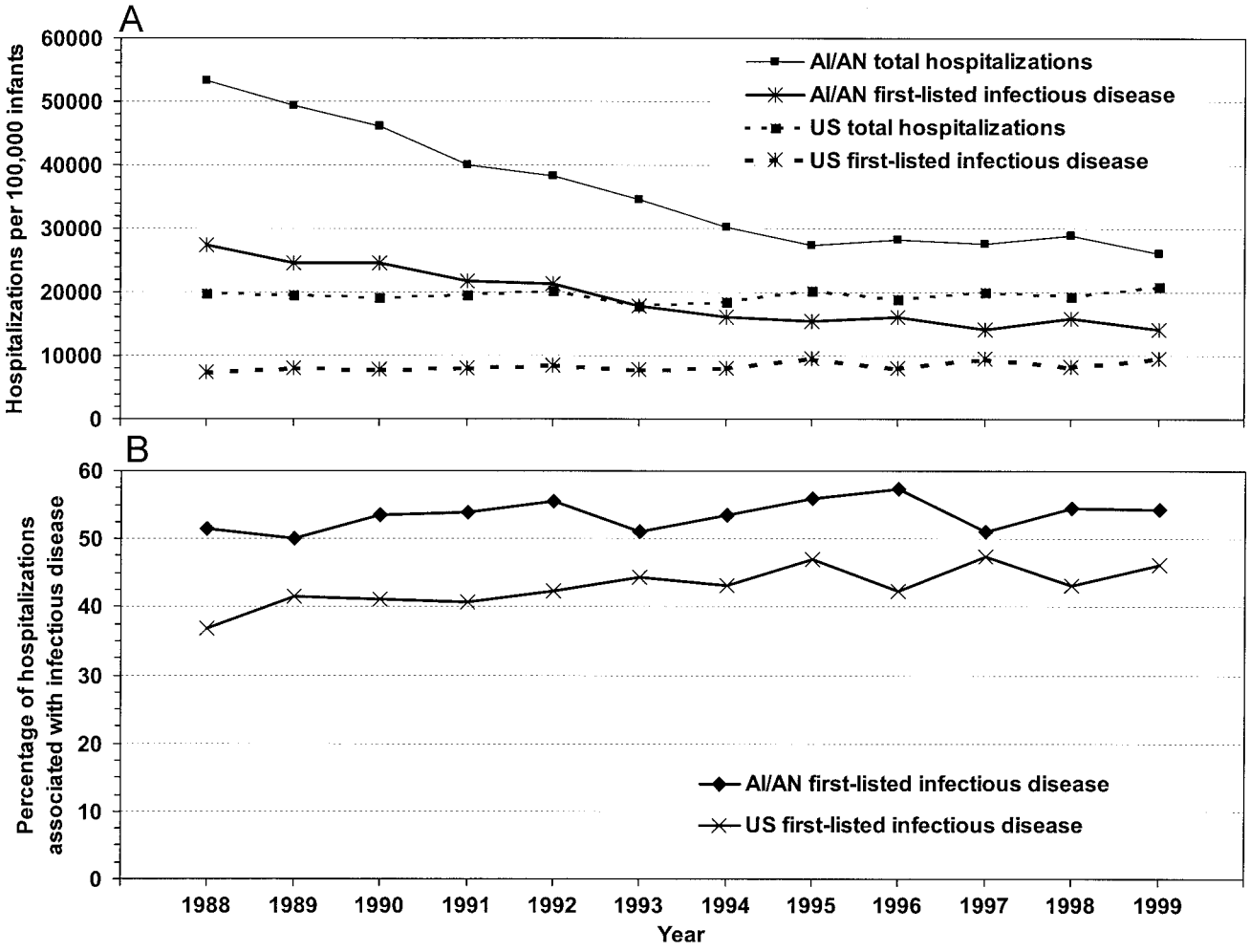

Fig 1. A, Total and first-listed infectious disease hospitalization rates among AI/AN (IHS/tribal) and US (NHDS) infants, 1988–1999. B, Percentage of first-listed infectious disease hospitalizations among AI/AN (IHS/tribal) and US (NHDS) infants, 1988–1999.

TABLE 1. AI/AN Infant Infectious Disease Hospitalizations and Hospitalization Rates, IHS/Tribal, 1988–1999

Characteristic	1988–1989		1998–1999		Percentage Rate Change 1988–1989 Versus 1998–1999	Test for Trend (1988–1999) *P* Value
	No. of Hospitalizations	Rate (95% CI)*	No. of Hospitalizations	Rate (95% CI)*		
Age period						
Neonatal	737	31 617 (29 708–33 526)	481	16 217 (14 918–17 605)	−48.7	<.0001
Postneonatal	6542	25 535 (25 003–26 074)	4839	14 856 (14 473–15 248)	−41.8	<.0001
Gender						
Male	4148	28 993 (28 252–29 745)	2967	16 294 (15 762–16 840)	−43.8	<.0001
Female	3131	22 948 (22 246–23 665)	2353	13 578 (13 074–14 099)	−40.8	<.0001
Region†						
East	132	23 404 (20 014–27 164)	70	7503 (5933–9432)	−67.9	.03
Northern Plains	1547	26 481 (25 356–27 636)	804	10 180 (9526–10 873)	−61.6	<.0001
Alaska	715	20 198 (18 894–21 567)	1058	23 569 (22 339–24 844)	16.7	.12
Oklahoma	439	7325 (6685–8021)	411	5602 (5092–6159)	−23.5	.04
Southwest	4446	37 013 (36 145–37 881)	2977	20 005 (19 367–20 659)	−46.0	<.0001
Total	7279	26 042 (25 529–26 561)	5320	14 970 (14 601–15 346)	−42.5	<.0001

* Rate expressed as number of first-listed infectious disease hospitalizations per 100 000 American Indian/Alaska Native infants.
† Annual average user population by region for 1998–1999 as follows: East, 467; Northern Plains, 3949; Alaska, 2245; Oklahoma, 3669; and Southwest, 7441.

hospitalization rate did not change during the study period for postneonates, whereas the rate for neonates declined. The Southwest region had the next highest hospitalization rate. The East and Northern Plains regions had the greatest rate decreases among AI/AN infants. The Oklahoma region had the lowest hospitalization rate throughout the study period. The hospitalization rates for Alaska, Southwest, and Northern Plains regions were significantly higher than the rate for the general US infant population

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TABLE 2. US Infant Infectious Disease Hospitalizations and Hospitalization Rates, 1988–1999

Characteristic	1988–1989		1998–1999		Percentage Rate Change 1988–1989 Versus 1998–1999	Test for Trend (1988–1999) *P* Value
	No. of Hospitalizations	Rate (95% CI)*	No. of Hospitalizations	Rate (95% CI)*		
Age period						
Neonatal	82 267	12 417 (9176–15 657)	93 199	14 154 (10 553–17 756)	14.0	.22
Postneonatal	529 544	7266 (5716–8816)	617 574	8527 (6934–10 120)	17.4	.09
Gender						
Male	345 575	8487 (6634–10 339)	410 809	10161 (8212–12 110)	19.7	.05
Female	266 236	6864 (5351–8378)	299 964	7775 (6275–9276)	13.3	.17
Region†						
Northeast	112 577	7316 (5578–9054)	122 329	8883 (6379–11 386)	21.4	.15
Midwest	142 868	7811 (4454–11 167)	146 014	8287 (4840–11 734)	6.1	.52
South	186 964	6881 (5316–8445)	249 391	8723 (6126–11 319)	26.8	.16
West	169 402	9082 (3509–14 655)	193 039	10 145 (5646–14 645)	11.7	.44
Total	611 811	7695 (6048–9343)	710 773	8996 (7313–10 679)	16.9	.09

* Rate expressed as number of first-listed infectious disease hospitalizations per 100 000 infants.
† Annual average census population by region for 1998–1999 as follows: Northeast, 4 409 659; Midwest, 5 397 820; South, 8 307 519; West, 5 790 281.

(Tables 1 and 2). In contrast to the IHS regions, the regional rates for US infants in the general population did not change significantly during the study period and did not differ by region.

Hospital Fatality Rate and Hospital Stay

The hospital fatality rate for infectious disease was 0.3% and was 0.5% for other hospitalizations among AI/AN infants, and both did not significantly change during 1988–1999. The hospital fatality rate for infectious disease was also 0.3% (SE: <0.1%) for infants in the general US population during the study period.

From 1988–1999, AI/AN infants and US infants accounted for 133 423 and 16 656 366 (SE: 1 562 150) days of infectious disease hospitalization, respectively. The median length of stay for infectious disease hospitalizations was 3 days for AI/AN infants during the study period. For other hospitalizations, the median length of stay decreased from 3 days in 1988–1989 to 2 days for 1998–1999 ($P < .001$). Among the general US infant population, the median length of stay for infectious disease hospitalizations decreased from 3 days in 1988–1989 to 2 days in 1998–1999 ($P < .001$). The proportion of hospital days associated with an infectious disease diagnosis among AI/AN infants increased from 44.0% in 1988–1989 to 52.2% in 1998–1999. This proportion did not significantly change among US infants (27.9% [SE: 1.5%] in 1988–1989 and 31.9% [SE: 1.7%] in 1998–1999).

Approximately 4.4% of AI/AN infant infectious disease hospitalizations and 5.8% of other-cause hospitalizations resulted in a transfer to another facility. Transfers could not be discriminated between placement in another IHS or tribal facility or to a facility outside the IHS or tribal facilities. Among the US infants, approximately 2.0% (SE: 0.2%) of infant infectious hospitalizations and 5.1% (SE: 0.3%) of other-cause hospitalizations resulted in transfer.

Infectious Disease Groups

The hospitalization rates among AI/AN infants for each infectious disease group decreased during 1988–1999, except for that of the kidney, urinary tract, and bladder infections diagnostic group (Table 3). The hospitalization rate for the kidney, urinary tract, and bladder infections group also increased for the general population of US infants. The rate of hospitalizations was higher for AI/AN infants than for the general population of US infants for all infectious disease diagnostic groups, except the enteric infections and the other infectious diagnoses groups. The greatest disparity in rates between AI/AN and US infants was for lower respiratory tract infection (LRTI) hospitalizations, with the rate among AI/AN infants double that for US infants (10 853 vs 5293 per 100 000, respectively). For both AI/AN and US infants, LRTI hospitalizations accounted for the greatest proportion of infectious disease hospitalizations (72.5% and 58.8% [SE: 1.2%] during 1998–1999, respectively). LRTIs also accounted for the greatest proportion of AI/AN infant infectious disease hospital deaths during the 12-year study period (62.9% of 89 AI/AN infant deaths). Additional infectious disease categories with at least 1 hospital death among AI/AN infants were sepsis (10); kidney, urinary tract, and bladder infection (9); other infectious disease diagnoses (8); meningitis (2); upper respiratory tract infections (2); enteric infections (1); and viral central nervous system infections (1).

DISCUSSION

Although infectious disease hospitalizations rates declined among AI/AN infants, these rates remained higher than those for the general US infant population, highlighting the need for additional efforts to decrease infectious disease morbidity among AI/AN infants. The rate for AI/AN neonates approached that of the general US neonatal population at the end of the study period, but the rate for the AI/AN postneonatal population remained higher than that for the US postneonatal population. Among AI/AN infants, the disparity in the hospitalization rates for neonates and postneonates decreased during the study period, and the rates were similar by 1998–1999. At the end of the study period, AI/AN infant infectious disease hospitalization rates

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TABLE 3. AI/AN and US Infant Hospitalizations and Hospitalization Rates by Infectious Disease Group, 1998–1999

Infectious Disease Group	AI/AN (IHS/Tribal)			United States		Average Annual Rate Change, 1988–1999
	N (%)	Rate (95% CI)*	Average Annual Rate Change, 1988–1999‖	*N* (%)†	Rate (95% CI)*	
Meningitis	22 (0)	62 (40–95)	−7.7	4052 (1)	51 (27–76)	−5.8‖
Septicemia	239 (4)	673 (591–764)	−4.2	50 466 (7)	639 (485–792)	0.5
Upper respiratory tract infections	279 (5)	785 (697–884)	−4.1	45 113 (6)	571 (414–728)	−1.1
LRTIs	3857 (73)	10 853 (10 533–11 182)	−3.0	418 173 (59)	5293 (4331–6254)	3.7‖
Kidney, urinary tract, and bladder infections	330 (6)	929 (833–1035)	4.0	47 513 (7)	601 (429–774)	7.8‖
Cellulitis	70 (1)	197 (155–250)	−5.3	9317 (1)	118 (75–161)	−0.6
Enteric infections	113 (2)	318 (263–384)	−6.4	40 689 (6)	515 (389–641)	−1.0
Viral central nervous system infections	56 (1)	158 (120–206)	−4.2	12 169 (2)	154 (94–214)	−0.3
Other infectious diagnoses‡	354 (7)	996 (897–1106)	−5.2	83 281 (12)	1054 (835–1273)	−2.1§
Total infectious disease	5320 (54)	14 970 (14 601–15 346)	−3.5	710 773 (45)	8996 (7312–10 679)	1.4
Total hospitalizations	9768	27 486 (27 023–27 954)	−3.9	1 589 014	20 112 (16 007–24 217)	0.2

* Rate expressed as number of first-listed infectious disease hospitalizations per 100 000 infants.
† US hospitalization estimates <10 000 are not considered reliable.
‡ The 2 most frequent diagnoses within the other infectious category with their proportion contributed to 1998–1999 were IHS, unspecified viral infection (079.99; 2.0%) and bronchitis (490; 0.7%); NHDS, unspecified viral infection (079.99; 2.0%) and candidiases of the mouth (112.0; 0.5%; unreliable estimate).
§ $P < .01$.
‖ $P < .001$.

remained higher for the Alaska and Southwest regions, whereas the other regions had rates comparable to the overall rate for the general US infant population. The rate for the Oklahoma region was similar to that for the general US infant population throughout the study period, and the East region had a rate similar to that of the general US infant population by the end of the study period. The lower rates among AI/AN infants in the Oklahoma region are consistent with those described in other infectious disease-related studies of AI/ANs.[10,13–15] Given the lower infectious disease hospitalization rates for the Oklahoma region, studies to investigate and explain regional disparities in infectious diseases among AI/ANs may be useful. The high regional rates in the Alaska and Southwest regions were also found in studies of bronchiolitis-associated hospitalizations among AI/AN infants and otitis media-associated outpatient visits and hospitalizations among AI/AN children.[14,15] In addition, a high rate for diarrhea-associated hospitalizations among AI/AN children was reported in the Southwest region.[13] The higher rates in the Alaska and Southwest regions may be associated with household crowding and the lack of sanitation facilities that have been reported among some tribes in the Southwest and rural Native villages in Alaska.[10,32–34] Moreover, lack of access to outpatient facilities may contribute to the higher rates in Alaska.[15] In contrast to the IHS regions, infant infectious hospitalization rates did not differ by region for the general US population.

Respiratory disease was among the most prevalent infectious disease group associated with hospitalizations for infants and has been previously described as an important contributor to AI/AN infant morbidity and mortality.[8,9,14,35–37] LRTIs accounted for almost 75% of AI/AN infant infectious disease hospitalizations and for >50% of infant hospitalizations in the general US population. Although the LRTI hospitalization rate for AI/AN infants declined and the rate for US infants increased, the rate for LRTI hospitalizations for the AI/AN infant population was more than double that for the general US infant population at the end of the study period. The disparity suggests a need for additional studies to identify risk factors for LRTI hospitalizations and potential prevention strategies among AI/AN infants. Previous studies have found that lack of breastfeeding and household crowding increased the risk of respiratory syncytial virus (RSV) hospitalization among Alaska Native children[32] and that cooking with a wood-burning stove was associated with LRTI hospitalization among Navajo children.[38] Interventions such as the recently licensed pneumococcal conjugate vaccine, RSV monoclonal antibody for high-risk infants, and a vaccine for RSV when available may reduce the burden of LRTIs among AI/AN infants.[14,39–41] The increase in the LRTI hospitalization rate among US infants is notable and might be explained by reasons discussed in an earlier study regarding a similar increase of bronchiolitis-associated hospitalizations among US infants.[39]

In contrast to the rates for the other infectious disease groups as well as the overall infectious dis-

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ease hospitalization rate for AI/AN infants, the rate of hospitalization for the kidney, urinary tract, and bladder infections group increased by almost 50% during the study period. Among US infants, the rate for these infections increased 94%. Infections of these types are often suspected when an infant presents with a fever without other symptoms.[42] It is not clear whether the increase in hospitalization rates for these types of infections reflect improved detection by physicians or represent a real increase among infants. However, the difference in the rate increase between the AI/AN and US infants is interesting and may warrant additional study. Another interesting finding was the lower enteric infections hospitalization rate for AI/AN infants as compared with US infants, which may be a result of the aggressive use of oral rehydration therapy in the IHS population.[13]

The data used in this study have limitations. AI/AN infants eligible for IHS/tribal services may obtain medical care outside the non–IHS-funded care, and this access may lead to an underestimate of the infectious disease burden among AI/AN infants. However, medical care accessibility, rural location, and free comprehensive care would encourage AI/ANs to seek IHS-funded medical care rather than non–IHS-funded care.[9,13,25,26,43] The hospital fatality rate for AI/AN infants may underestimate the actual rate, because it does not reflect infants who may have died after being transferred to non–IHS-funded hospitals. IHS/tribal and US hospital diagnoses may be incomplete, inaccurate, or varied by region. In addition, hospital admission criteria may have varied within the IHS/tribal system, as well as between the IHS/tribal and the US populations. The US infant hospitalization rates are estimates derived from the NHDS, a complex, nationally representative sample of hospital discharges. These estimates necessarily have variability, and for some specific infectious disease groups, the estimates did not have a sufficient sample size to be considered reliable.[21] Finally, AI/AN infants who received IHS-funded health care may not be representative of all AI/AN infants in the United States.

This study indicates the need for additional health services and early prevention measures for infectious diseases among AI/AN infants, such as those suggested in other studies.[14,15,36,44–46] The increased infectious disease burden among AI/AN infants may be affected by lower socioeconomic status and limited access to health care in some IHS regions.[4,12,32–34,47,48] It is likely that improved access to health services and continued emphasis in programs to promote childhood immunization,[44–46,49,50] breastfeeding,[32,46,51,52] and cessation of maternal smoking[11,12,53] will reduce infectious disease hospitalizations in regions with high rates. Overall improvement in the socioeconomic status of AI/ANs is also likely to decrease infant infectious disease hospitalizations.[4,9]

This study described a decrease in the impact of infectious disease on AI/AN infant health during 1988–1999. However, infectious disease hospitalization rates among AI/AN infants within the Alaska and Southwest regions remained higher than that for the general US infant population. The disparities in hospitalization rates indicate that additional reductions in infectious disease hospitalizations among AI/AN infants are needed to obtain levels similar to that of the general US infant population and highlight an opportunity to improve the health status of AI/AN populations.

ACKNOWLEDGMENTS

We thank Phillip Smith (IHS) and Mary Chamberland (CDC) for manuscript review; Linda Querec, Karen Carver, Yolinda Cadman, Lisa Petrakos, Stephen Kaufman, (IHS) and Maria Owings (CDC) for technical assistance; and John O'Connor (CDC) for editorial assistance.

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