Comorbid Disease and the Effect of Race and Ethnicity on In-Hospital Mortality from Aspiration Pneumonia

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Background: Racial and ethnic disparities in mortality have been demonstrated in several diseases. African Americans are hospitalized at a significantly higher rate than whites for aspiration pneumonia; however, no studies have investigated racial and ethnic disparities in mortality in this population.

Objective: To assess the independent effect of race and ethnicity on in-hospital mortality among aspiration pneumonia discharges while comprehensively controlling for comorbid diseases, and to assess whether the prevalence and effects of comorbid illness differed across racial and ethnic categories.

Design, Setting, and Participants: Retrospective cohort study of 41,581 patients admitted to California hospitals for aspiration pneumonia from 1996 through 1998, using principal and secondary diagnoses present on admission.

Measurement: The primary outcome measure was in-hospital mortality.

Results: The adjusted odds of in-hospital death for African-American compared with white discharges [odds ratio (OR)=1.01; 95% confidence interval (CI), 0.91–1.11] was not significantly different. The odds of death for Asian compared with white discharges was significantly lower (OR=0.83; 95% CI, 0.75–0.91). Hispanics had a significantly lower odds of death (OR=0.90; 95% CI, 0.82–0.988) compared to non-Hispanics. Comorbid diseases were more prevalent among African Americans and Asians than whites, and among Hispanics compared to non-Hispanics. Differences in effects of comorbid disease on mortality risk by race and ethnicity were not statistically significant.

Conclusion: Asians have a lower risk of death, and the risk of death for African Americans is not significantly different from whites in this analysis of aspiration pneumonia discharges. Hispanics have a lower risk of death than non-Hispanics. While there are differences in prevalence of comorbid disease by racial and ethnic category, the effects of comorbid disease on mortality risk do not differ meaningfully by race or ethnicity.

Key words: risk adjustment ■ health disparities ■ mortality

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INTRODUCTION

In-hospital mortality is very high among patients hospitalized for aspiration pneumonia, especially among the elderly.[1-3] Baine et al.,[3] using a 5% sample of Medicare claims, demonstrate that admissions caused by aspiration pneumonia have a case-fatality rate of 23.1%. They also demonstrate that in this population of patients over age 65 the rate of hospitalization for aspiration pneumonia is significantly higher for African Americans. While this evidence for racial disparities in hospitalization rates included adjustments for differences in age characteristics, no adjustments were made for differences in comorbid disease.[4]

Racial and ethnic disparities in hospitalization and case-fatality rates have been reported in many disease groups.[5] The evidence for these disparities comes primarily from studies using Medicare and other administrative data. According to a recent report by the Institute of Medicine,[5] most of the evidence for racial and ethnic disparities lacks adequate statistical adjustments for the effects of comorbid disease and other baseline characteristics on the risk of hospital death. Comorbid diseases, because they can influence the risk of hospital death, are likely to confound the observed effects of race and ethnicity.[6] To the extent that different racial and ethnic groups are unequally affected by comorbid disease, inadequate adjustment for the effects of comorbid disease undermines the validity of evidence for racial and ethnic disparities drawn from studies using administrative data.[7] Moreover, adjustments for comorbid disease usually assume that those effects are the same for individuals of different race and ethnicity. This investigation was motivated by the possibility that both the frequency and effects of comorbid disease on mortality risk from aspiration pneumonia may vary in important ways by race and ethnicity.

In this study, we examine the evidence for racial and ethnic disparities in hospital mortality among aspiration pneumonia discharges, using California hospital discharge data from 1996 through 1999.

The study was approved by the institutional review board at the University of Virginia Health System. California hospital discharge data identifies patient diagnoses that are present on admission, and we use these diagnoses to measure and control for differences in patient baseline health status. We divide these diagnoses into categories of comorbid disease and of conditions closely related to aspiration pneumonia, using a formal physician panel review process. California hospital discharge data classifies patient race using these six categories: white, African-American, Native American/Eskimo/Aleut, Asian/Pacific Islander, other, and unknown. Patient ethnicity is classified separately as either Hispanic, non-Hispanic, or unknown.

METHODS

Multivariable logistic regression was used to model the effects of both race and ethnicity on the risk of death. The effects of race and ethnicity were adjusted for variations in comorbid disease and for conditions related to aspiration pneumonia that are present on admission, as well as for demographic and hospitalization characteristics. We analyzed differences among racial and ethnic groups in the frequency of categories of comorbid disease. Finally, we compared the magnitude of the effects of selected categories of comorbid disease on the risk of in-hospital death in each racial and ethnic group.

Study Population

The study population included all patients discharged from California hospitals during the period from 1996 to 1999 with aspiration pneumonia (principal ICD-9-CM diagnosis code 507.0) listed as the principal cause of hospitalization.[8] The following information was gathered from each patient record: unique patient identifier, age, race, sex, month of admission, year of admission, emergency admission, status at discharge, principal diagnosis, all secondary diagnoses, and a present-on-admission indicator for each reported secondary diagnosis.

Defining Comorbid Disease and Other Characteristics

A panel of five physicians reviewed the collection of secondary diagnoses reported as present on admission for patients with a hospitalization caused by aspiration pneumonia. Panelists used a software-support Delphi process to identify which ICD-9-CM codes could be used as indicators of comorbid disease and which ICD-9-CM codes could be used as indicators of conditions closely related to aspiration.[9,10]

ICD-9-CM diagnoses reported as present on admission were organized into 260 clinically coherent categories using the structure of the Clinical Classification System (CCS)[11,12] The CCS was developed by the federal Agency for Healthcare Research and Quality to create mutually exclusive disease categories from the ICD-9 taxonomy.

Panelists reviewed 260 categories of ICD-9-CM diagnoses grouped by the CCS. Within each group, panelists independently scored each diagnosis code on a nine-point scale to indicate whether they considered the diagnosis as likely to be closely related,[1-3] equivocal,[4-6] or unlikely to be closely related[7-9] to the principal diagnosis of aspiration pneumonia. "Closely related" was conceptually defined as a condition likely to be a direct cause of aspiration pneumonia, directly caused by aspiration pneumonia, or related to aspiration pneumonia through a shared cause. Panelists could globally score all diagnoses within a group whenever appropriate.

Diagnosis codes for which the panel scores disagreed were reviewed and rescored by all panel members. We defined disagreement as any diagnosis code scored as both closely related and unlikely to be closely related by any two panel members,. Panelists independently rescored the diagnosis codes for which there was disagreement, using both their original score and the series of scores from all panel members as a guide. Panelists were blinded to the identity of all panelist scores except their own.

The results of the panelists' review were used to divide all present at admission diagnoses into categories of comorbid disease and categories of conditions closely related to aspiration pneumonia, using the CCS structure to categorize individual ICD-9-CM codes. Diagnosis codes that the panelists agreed were closely related to aspiration pneumonia were grouped into categories using the CCS structure. All of the remaining diagnoses were grouped into categories of comorbid disease also using the CCS structure. A complete listing the specific ICD-9-CM diagnoses and categories defined by the panelists is available upon request from the authors.

Modeling Effect of Race and Ethnicity

Multivariable logistic regression was used to model the independent effects of both race and ethnicity on the risk of hospital death, while controlling for the confounding effects of differences in comorbid disease, conditions closely related to aspiration pneumonia, and other covariates that influence mortality risk. The regression model included adjustments for differences in age, sex, whether the hospitalization was an emergency admission, and whether the admission followed transfer from another acute care hospitalization. The effects of age were included in the model by categorizing age into decades to account for nonlinear effects. African Americans,

Asians, and Native Americans were compared to white discharges for mortality outcomes. The effect of ethnicity was assessed by comparing Hispanics to non-Hispanics. The multivariable logistic regression model was developed using data from the 1996 through 1998 calendar years and validated by applying the fitted model equation to all discharges occurring in 1999,[13-15] thus accounting for the potential of overfitting the model.

The predictive accuracy of the multivariable logistic regression model was measured using both the C statistic and pseudo-R^2. The C statistic is equivalent to the area under the "receiver operating characteristic" curve for models with a dichotomous response variable, and it provides an estimate of the model's ability to discriminate between observed instances of inpatient death and survival.[16,17] A value of 0.5 indicates that the model provides no predictive discrimination, while a value of 1.0 indicates perfect discrimination by predicted risk of inpatient death. The pseudo-R^2 statistic measures the amount of variability explained by the model. Pseudo-R^2 is also the amount by which the average predicted probability of death for those discharges who died in the hospital exceeds the average predicted probability of death for those discharges who survived.[18] Our multivariable logistic regression model demonstrates greater predictive accuracy than existing models designed to adjust for comorbid disease conditions.[19]

Differences in lengths of stay by race or ethnicity have the potential to confound our analysis of mortality outcomes. To evaluate this possibility, we tested whether there were statistically significant differences in the mean length of stay by race or by ethnicity using single factor analysis of variance model.

Comorbid Disease Prevalence and Effects

Comorbid diseases are important predictors of in-hospital death, and controlling for these illnesses is essential for assessing the true effects of race and ethnicity. Differences in the prevalence and effects of comorbid disease by race and ethnicity were of particular interest. We hypothesized that the effects of race and ethnicity on mortality might be expressed in part by racial and ethnic differences in the effects of comorbid disease on mortality. To examine this possibility, we identified the 10 most commonly occurring categories of comorbid disease for which there were statistically significant differences in frequency by race and by ethnicity using the chi-square statistic. This test assesses only whether there is a statistically significant difference in the prevalence of the selected comorbid diseases by any race or ethnicity.

We measured the race-specific effects of each of the 10 selected categories of comorbid disease, respectively, by adding interaction terms to the original multivariable regression model for combinations of race and comorbid disease. We repeated this analysis for combinations of ethnicity and the 10 selected categories of comorbid disease. The statistical significance of the race- and ethnicity-specific effects was then calculated by a global test of the statistical significance of the interaction terms added to the model original model.

We supplemented the statistical tests of the interaction terms with an analysis of the specific effect of each of the 10 comorbid diseases in racial and ethnic subpopulations. Separate multivariable regression models were developed in subsets of the total population stratified by race and by ethnicity, respectively. In each subset, we compared the race-specific and ethnic-specific odds of in-hospital death for each category of comorbid disease adjusted for all of the covariates included in the original multivariable regression model.

RESULTS

Demographic and hospitalization-related characteristics of the study population are listed in Table 1. Discharges in the study population of 41,581 people were distributed by race as follows: white (78%), African-American (8%), and Asian (8%). The study population was divided ethnically into Hispanic (11%) and non-Hispanic (86%). More than one in five discharges (21.88%) died during their hospitalization. Half the study population (50%) was 80 years of age or older. We found no evidence that the mean lengths of stay differed by race ($p=0.82$). However, the differences in mean lengths of stay by ethnicity were statistically significant ($p=0.03$), with mean length of stay for Hispanics (11.6 days) higher than non-Hispanics (10.5 days).

Table 1 also lists the adjusted odds of hospital death associated with race and ethnicity. These odds are adjusted for differences in mortality risk by patient age group, sex, whether the hospitalization was an emergency admission, whether the patient was transferred from another hospital, and for the presence of 223 separate categories of comorbid disease and 36 separate categories of conditions related to aspiration pneumonia. Only categories of comorbid disease and conditions related to aspiration that occurred in 1% or more of the study population were included in the model.

The statistical performance of the regression model (c-index=0.74, pseudo-R^2=0.12) in the development population (1996-1998 discharges, numbering 41,581) declined only slightly (c-index=0.73, pseudo-R^2=0.11) in the validation population (1999 discharges, numbering 15,747).

After comprehensively adjusting for baseline char-

acteristics, including comorbid disease, Asian discharges were found to have a probability of death significantly different from that of white discharges in the study population. The odds of death for Asian discharges were lower [adjusted odds ratio (OR), 0.83; 95% confidence interval (CI), 0.75–0.911] compared

Table 1. Frequency, Unadjusted Odds of Death, and Adjusted Odds of Death by Study Population Hospitalization Characteristics, Demographics, and Selected Comorbid Disease Categories:

	Frequency Percent	Unadjusted Odds of Death (95% CI)	Adjusted Odds of Death** (95% CI)
Race: White	77.99	reference group	reference group
Race: African-American	8.40	1.02 (0.94-1.11)	1.01 (0.91-1.11)
Race: Asian	7.87	0.95 (0.87-1.04)	0.83 (0.75-0.91)
Ethnicity: Non-Hispanic	86.02	reference group	reference group
Ethnicity: Hispanic	11.42	0.86 (0.80-0.93)	0.90 (0.82-0.98)
Died in hospital	21.88		
Emergency admission	88.29	1.09 (1.01-1.17)	0.97 (0.89-1.05)
Transferred patient	4.70	1.05 (0.94-1.17)	1.20 (1.06-1.35)
Male	54.50	0.95 (0.91-0.99)	1.02 (0.96-1.08)
Female	45.50	reference group	reference group
Age up to 9	1.72	reference group	reference group
Age 10–19	0.93	1.73 (0.96-3.13)	1.50 (0.81-2.78)
Age 20–29	1.27	2.61 (1.57-4.35)	2.14 (1.25-3.67)
Age 30–39	2.33	3.02 (1.91-4.79)	2.04 (1.24-3.35)
Age 40–49	3.68	4.20 (2.72-6.49)	2.61 (1.62-4.18)
Age 50–59	4.75	5.28 (3.45-8.07)	3.02 (1.90-4.80)
Age 60–69	9.97	7.28 (4.816-11.017)	4.26 (2.71-6.70)
Age 70–79	25.32	8.22 (5.46-12.37)	5.36 (3.42-8.42)
Age 80–89	35.62	9.49 (6.31-14.27)	6.92 (4.41-10.86)
Age 90–99	13.79	10.05 (6.66-15.16)	7.50 (4.77-11.82)
Age 100 and older	0.60	15.28 (9.43-24.76)	10.56 (6.22-17.90)
Septicemia *	12.31	2.34 (2.20-2.49)	1.91 (1.78-2.06)
Thyroid disorders	8.20	0.87 (0.80-0.95)	0.87 (0.79-0.95)
Diabetes mellitus without complication	11.40	1.06 (0.98-1.14)	1.03 (0.95-1.11)
Diabetes mellitus with complications *	7.95	1.41 (1.30-1.53)	1.22 (1.10-1.34)
Nutritional deficiencies	14.30	1.22 (1.14-1.30)	1.12 (1.04-1.20)
Fluid and electrolyte disorders	39.40	1.46 (1.40-1.53)	1.26 (1.19-1.33)
Anemia	24.04	0.99 (0.94-1.05)	0.83 (0.78-0.89)
Hypertension with complications	7.35	1.54 (1.42-1.67)	1.27 (1.16-1.40)
Coronary atherosclerosis	19.54	1.25 (1.18-1.32)	1.05 (0.99-1.12)
Cardiac dysrhythmias	20.36	1.52 (1.44-1.61)	1.20 (1.12-1.27)

* Each of these conditions are commonly occurring comorbid diseases in the study population with statistically significant differences in prevalence by race or by ethnicity. Each comorbid disease category was defined using diagnoses specified as present on admission that matched the Clinical Classification System ICD-9-CM diagnosis codes for that category, excluding all ICD-9-CM codes that the physician panel identified as likely to be closely related to aspiration pneumonia. The categories of "septicemia" and "diabetes mellitus with complications" were defined using ICD-9-CM codes that the physician panel considered unlikely to be related to aspiration pneumonia and ICD-9-CM codes with an equivocal relationship to aspiration pneumonia. The other categories of comorbid disease were identified using only ICD-9-CM diagnoses considered as unlikely to be related to aspiration pneumonia.

** Adjusted odds of death is the independent effect of the selected patient characteristics on the risk of in-hospital death, controlling for all other patient characteristics included in the multivariable logistic regression model.

to whites. The odds of death for Hispanics were lower (adjusted OR=0.90; CI, 0.816–0.981) compared to non-Hispanics. The numbers of discharges whose racial category was listed as "Native American," "other," or "unknown," or whose ethnicity was recorded as "unknown" were too small to provide meaningful statistics about their odds of death.

Table 2 lists the 10 most commonly occurring comorbid diseases represented in the complete multivariable logistic regression model for which statistically significant differences existed in prevalence across any racial or ethnic categories. Septicemia, diabetes, nutritional deficiencies, fluid and electrolyte disorders, anemia, and hypertension were all more prevalent among Asians and African Americans. Asians and African Americans both had lower frequencies of thyroid disorders, coronary atherosclerosis, and cardiac dysrhythmias. Similar differences in the prevalence of comorbidities were demonstrated for Hispanic versus non-Hispanic discharges, with the exception of nutritional deficiencies and anemia. Specific frequencies, unadjusted, and adjusted odds of death for these 10 categories of comorbid disease are included in Table 1.

While there were differences in prevalence, we did not find evidence that the effects of these categories of comorbid disease were different by race or ethnicity. The interaction terms measuring the race or ethnicity specific effects of comorbid disease on mortality risk were not statistically significant in any of the models we tested.

Figure 1 lists odds ratios for in-hospital death by racial category for each of the 10 comorbid diseases, adjusted for patient age, sex, hospitalization characteristics, other categories of comorbid disease, and conditions related to aspiration pneumonia. Differences by racial group are demonstrated for several categories of comorbid disease. Thyroid disorders are associated with a statistically significant increased risk of death among African Americans but not among either whites or Asians. In the total study population, thyroid disorders are associated with a statistically significant reduced risk of death. Diabetes mellitus with complications and hypertension with complications both represent a statistically significant increased risk of death for all discharges, except Asians. Anemia represents a statistically significant lower risk of death for all discharges, except for African Americans.

Figure 2 lists adjusted odds ratios for the effects of the 10 comorbid disease categories on the risk of in-hospital death by ethnic category. Differences in the effects of some categories of comorbid disease by ethnic group were also demonstrated. While thyroid disorders and anemia were associated with decreased risks of death for all discharges, the decreased risk was not statistically significant for Hispanics. Statistically significant increased risks of death were associated with both nutritional deficiencies and diabetes mellitus, with complications for all discharges except Hispanics.

Comment

We found differences—but not those we expected—in the adjusted risk of death by race and ethnici-

Table 2. Ten Comorbid Illnesses Common among Aspiration Pneumonia Discharges that Have Statistically Significant Differences in Prevalence by Race or by Ethnicity

	Asian	Black	White	P Value	Hispanic	Non-Hispanic	P Value
Septicemia*	13.63	17.34	11.56	<0.0001	13.24	12.14	0.0254
Thyroid disorders	3.94	4.32	9.25	<0.0001	5.89	8.53	<0.0001
Diabetes mellitus without complication	15.83	15.03	10.42	<0.0001	14.08	11.11	<0.0001
Diabetes mellitus with complications*	10.39	13.02	6.88	<0.0001	13.39	7.24	<0.0001
Nutritional deficiencies	17.14	17.89	13.82	<0.0001	13.54	14.41	0.2651
Fluid and electrolyte disorders	39.78	42.70	39.22	<0.0001	37.79	39.52	0.0068
Anemia	24.29	33.09	23.19	<0.0001	23.94	24.07	0.8760
Hypertension with complications	12.19	13.62	6.11	<0.0001	9.28	7.10	<0.0001
Coronary atherosclerosis	17.97	15.17	20.37	<0.0001	17.16	19.94	<0.0001
Cardiac dysrhythmias	18.91	14.22	21.57	<0.0001	14.36	21.16	<0.0001

* Each of the 10 comorbid disease categories were defined using diagnoses specified as present on admission that matched the Clinical Classification System ICD-9-CM diagnosis codes for that category, excluding all ICD-9-CM codes that the physician panel identified as likely to be closely related to aspiration pneumonia. The categories of "septicemia" and "diabetes mellitus with complications" were defined using ICD-9-CM codes that the physician panel considered unlikely to be related to aspiration pneumonia and ICD-9-CM codes with an equivocal relationship to aspiration pneumonia. The other categories of comorbid disease were identified using only ICD-9-CM diagnoses considered as unlikely to be related to aspiration pneumonia.

ty. We found that the adjusted risk of death for African-American discharges was not significantly different from that of white discharges, but that Asian discharges had a significantly lower risk of death compared to whites.

Many studies using hospital administrative data[20-24] have found racial and ethnic disparities in morbidity and mortality in other disease groups. As noted by the recent Institute of Medicine review of racial and ethnic health disparities,[5] the majority of the evidence for racial and ethnic disparities in health outcomes is derived from studies utilizing administrative data for which risk adjustment for comorbid disease and other patient characteristics was often inadequate. We assessed the independent effect of race and ethnicity after comprehensive adjustment for comorbid illness and other baseline patient characteristics by including all diagnoses reported as present on admission, grouped into categories of comorbid disease and conditions related to aspiration pneumonia.

Our multivariable logistic regression model contained 223 predictor variables for comorbid disease categories and an additional 36 predictor variables for categories of conditions closely related to aspira-

Figure 1. Adjusted odds of in-hospital death and their 95% confidence intervals for aspiration pneumonia discharges with 10 most common comorbid illnesses stratified by race. For each comorbid illness, the odds of in-hospital death is depicted for whites, blacks, and Asians.

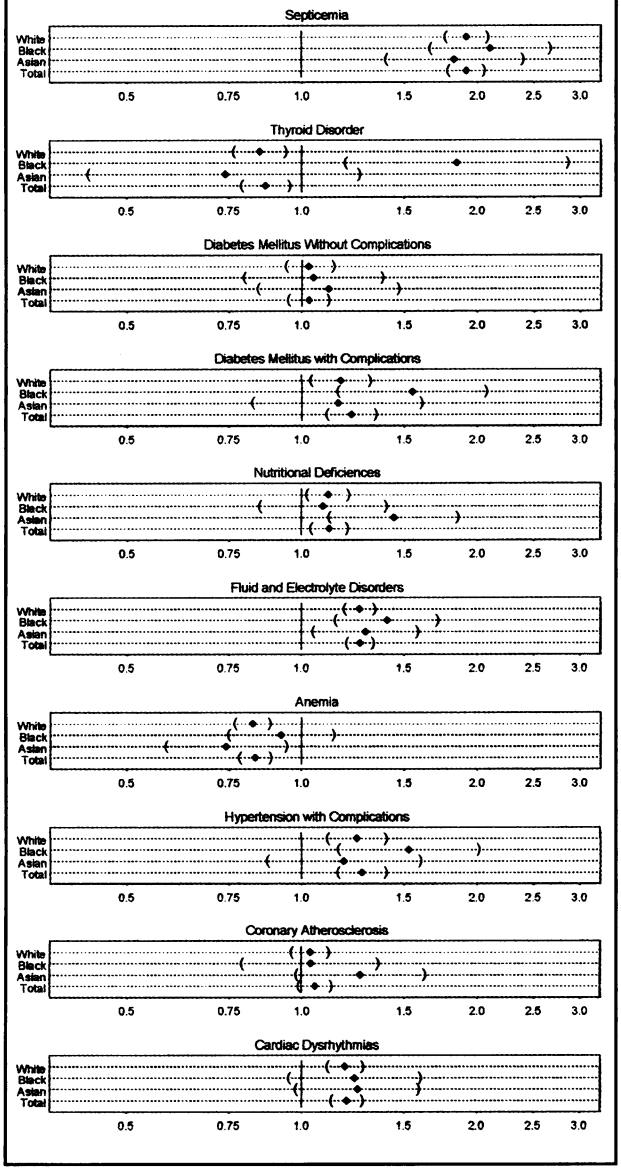
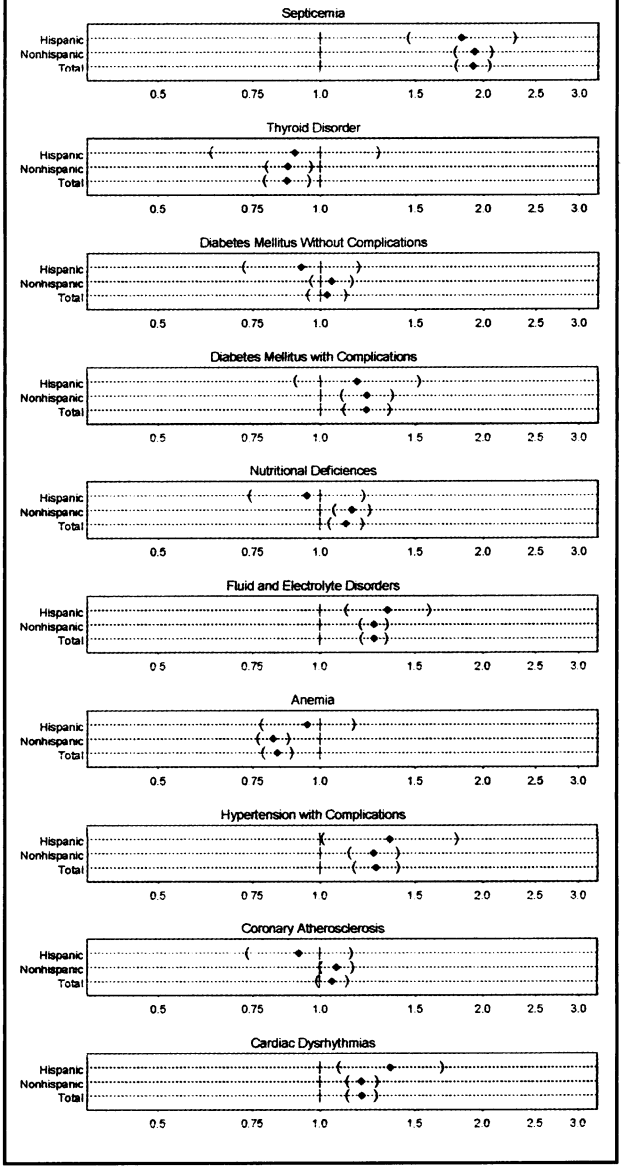


Figure 2. Adjusted odds of in-hospital death and their 95% confidence intervals for aspiration pneumonia discharges with 10 most common comorbid illnesses stratified by ethnicity. For each comorbid illness, the odds of in-hospital death is depicted for Hispanics and non-Hispanics.



tion pneumonia. This comprehensive adjustment for baseline characteristics improved predictive accuracy over existing risk adjustment models; however, this improved statistical performance was not without tradeoffs. Specifically, the CCS groups were dichotomized into either comorbid categories or categories of closely related conditions—an "either/or" decision that did not accommodate "gray" areas. For example, the CCS category "septicemia" included ICD-9 codes that some panel members scored as "equivocal," meaning they may be related to the principal diagnosis of aspiration pneumonia. However, the overall CCS category, like the few others that included ICD-9 codes considered "equivocal," was modeled as most likely a comorbid condition.

We found differences in the frequencies of comorbidities across racial and ethnic categories. Except for thyroid disorders, coronary atherosclerosis, and cardiac dysrhythmias, all the comorbid illnesses we studied were more prevalent among African Americans and Asians than among whites. Among Hispanics, all the comorbidities except thyroid disorders were more prevalent.

Given these differences, we considered the possibility that the effects of race and ethnicity on mortality may be expressed indirectly through differences in the prevalence and effects of comorbid diseases. Seven of the 10 most commonly occurring comorbid diseases in the study population with statistically significant differences in prevalence by race or ethnicity were more prevalent among African Americans and Asians than among whites and more prevalent among Hispanics than among non-Hispanics. However, when we tested the statistical significance of the interactions between these common comorbid diseases and racial and ethnic categories, we failed to find any that were statistically significant. We also examined these relationships in subgroups of the population. Though some of the differences found in our subgroup analyses were statistically significant, these may have occurred by chance because of the multiple comparisons considered in the sequences of the multivariable logistic regression model.

Limitations

Several limitations in the study attend our findings. Differences in the prevalence and incidence rates of aspiration pneumonia in the general population may be different by race and by ethnicity. This possibility is not addressed in this study of hospitalized patients because the baseline population rates are unknown.

This study included only California hospitalization and may not be generalizable to other populations. Hospital administrative data may be incomplete regarding the list of comorbid conditions, and using such lists may still overlook baseline differences in health status. Our measures of mortality risk did not include adjustments for potentially important socioeconomic factors, such as occupation, income, or social.

Our use of in-hospital death as an outcome measure is also limited by potential systematic differences by race and ethnicity in hospital length of stay (LOS) that could bias results. While there were no statistically significant differences in mean length of stay by race, we did find statistically significant differences by ethnicity. However, we found the mean LOS for Hispanics was significantly less than that for non-Hispanics, which strengthens our finding that in-hospital mortality for Hispanics was lower than that for non-Hispanics.

The study populations in our supplemental analysis of the effects of comorbid disease in race and ethnic subgroups include small numbers of cases, and these subgroups may be too small to generate statistically significant results. Finally, other factors, such as choice of antibiotics, hospital characteristics, variances in physician practices, and other unmeasured or unknown influences, may have affected the risk of inpatient death in this population.

CONCLUSION

Racial and ethnic disparities in hospital mortality have been reported in many disease groups. While other research has demonstrated that patients hospitalized with aspiration pneumonia are at high risk of death, the effects of race on this risk had not been addressed. Our research indicates that compared to whites, Asians have a lower risk of death, and the risk of death for African Americans is not significantly different than that of whites. Our research also demonstrates that while the prevalence of comorbid diseases varies by race and ethnicity, these differences do not appear to confound the effect of race on mortality risk. Race- and ethnic-specific effects of comorbid diseases on the risk of death were not statistically significant.

Reviews of the evidence for racial disparities in studies of other disease groups using administrative data suggest that this evidence is limited by the adequacy of adjustments for comorbid disease and other patient characteristics. The adequacy of mortality risk adjustment in studies of racial and ethnic disparities is a key methodological issue that deserves greater attention. We plan to assess the effects of race and ethnicity on the risk of in-hospital mortality in discharges hospitalized with other conditions for which the risk of inpatient death is high, including acute myocardial infarction and lung cancer, where prior research has shown racial and ethnic disparities in mortality outcomes.[25-28] Optimal adjustments

for comorbid disease will improve the quality of evidence about racial and ethnic disparities in in-hospital mortality.

ACKNOWLEDGEMENT

This project was supported by grant numbers R01 HS10134 AS1, R01 HS10134, and K02 HS11419 from the Agency for Health Care Research and Quality.

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