Sex, Race, and the Development of Acute Lung Injury

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Background: Prior studies suggest that mortality differs by sex and race in patients who develop acute lung injury (ALI). Whether differences in presentation account for these disparities remains unclear. We sought to determine whether sexual and racial differences exist in the rate of ALI development and ALI-related mortality after accounting for differences in clinical presentations.

Methods: This was a multicenter, observational cohort study of 5,201 patients at risk for ALI. Multivariable logistic regression with adjustment for center-level effects was used to adjust for potential covariates.

Results: The incidence of ALI development was 5.9%; in-hospital mortality was 5.0% for the entire cohort, and 24.4% for those patients who developed ALI. Men were more likely to develop ALI compared to women (6.9% vs 4.7%, $P < .001$) and had a nonsignificant increase in mortality when ALI developed (27.6% vs 18.5%, $P = .08$). However, after adjustment for baseline imbalances between sexes these differences were no longer significant. Black patients, compared to white patients, presented more frequently with pneumonia, sepsis, or shock and had higher severity of illness. Black patients were less likely to develop ALI than whites (4.5% vs. 6.5%, $P = .014$), and this association remained statistically significant after adjusting for differences in presentation (OR, 0.66; 95% CI, 0.45-0.96).

Conclusions: Sex and race differences exist in the clinical presentation of patients at risk of developing ALI. After accounting for differences in presentation, there was no sex difference in ALI development and outcome. Black patients were less likely to develop ALI despite increased severity of illness on presentation.

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Abbreviations: ALI = acute lung injury; APACHE = Acute Physiology and Chronic Health Evaluation; IRB = institutional review board; LIP = lung injury prediction; PRBC = packed RBC

Acute lung injury (ALI) is a common and lethal critical care syndrome occurring after an acute illness or injury such as sepsis, shock, pneumonia, or aspiration¹⁻³ Evidence suggests that sex and racial disparities exist in ALI-related mortality.⁴ However, it is not clear whether blacks and men have higher rates of developing ALI or rather higher mortality from ALI. A study suggested that the racial disparities were mediated by increased severity of illness at the time of ALI development.⁵ To date, no study in a population with multiple risk factors has examined whether sex and racial differences exist in ALI development and related outcomes.

In a multicenter, observational cohort study, we evaluated the relationship between race and sex and ALI development in at-risk patients. Our goals were

to determine whether sex and racial differences exist at the time of presentation and to determine whether sex and racial differences exist in the rate of ALI develop-

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ment and outcomes in those who develop ALI. Results of the study were previously reported in abstract form.⁶

MATERIALS AND METHODS

Study Design

Ours was a planned substudy of a multicenter, observational cohort study designed to predict ALI development in at-risk

patients.⁷ Institutional review boards (IRBs) at all participating institutions approved the study with a waiver of informed consent for medical records review. The Mount Sinai School of Medicine IRB approved this substudy (No. 090-0019 0001 01). The Albert Einstein College of Medicine IRB exempted this substudy from full IRB review.

Study Population and Data Collection

The study enrolled consecutive patients prospectively at 19 hospitals and retrospectively at three hospitals over 6 months, beginning in March 2009. Adults admitted to the hospital were screened for one or more of the following study-defined ALI risk factors: sepsis, shock, pancreatitis, pneumonia, aspiration, high-risk trauma, or high-risk surgery.^{1,6-11} We excluded patients who were < 18 years of age, patients fulfilling the criteria for ALI at the time of ED presentation or admission for surgery,¹² outside-hospital transfers, and patients who expired in the ED or were admitted for comfort care only and subsequent visits. To focus on sex and race in the United States, we limited our study to the 20 US centers.

Patient-level data were abstracted using predrafted case report forms from the medical record. Patient characteristics were collected using standardized predefined criteria during the first 6 h after initial ED presentation, or at the time of admission in high-risk surgical patients, and included demographics, comorbidities including alcohol and tobacco use, prehospitalization prescription medications, admission vital signs and laboratory measures, and ALI risk factors. Pertinent processes of care measures included the administration of packed RBCs (PRBCs) during the initial 4 hospital days and the use of ventilatory assistance at any time during the hospitalization. The study population and data collection have been described previously in greater detail.⁷

Exposure Variables

Patient race, ethnicity, and sex were assigned by study personnel based on review of the medical record. Race was categorized into one of four categories: white, black, Asian, and other. Ethnicity was coded as Hispanic or non-Hispanic.

Outcomes

The primary outcome was ALI development during the hospitalization. The American-European Consensus Conference definitions for ALI and ARDS were used: the presence of bilateral

pulmonary infiltrates on chest radiograph and the absence of left atrial hypertension as the primary explanation for pulmonary edema and hypoxemia (ratio of PaO_2 to FiO_2 < 300 for ALI and < 200 for ARDS).¹² Secondary outcomes included in-hospital mortality and hospital and ICU length of stay.

Statistical Analysis

We used multivariable logistic regression to adjust for potential confounding in the relationships between race and sex and ALI development and between race and sex and in-hospital mortality. We considered the following variables as potential confounders: age,¹³ BMI,^{14,15} cause of lung injury,^{6-9,11,16} comorbid conditions (alcohol abuse, tobacco use, diabetes, end-stage renal disease, class 4 congestive heart failure),¹⁷⁻¹⁹ prescription medications (aspirin)²⁰ and tidal volumes prescribed during initiation of mechanical ventilation,²¹ illness severity as measured by the baseline APACHE (Acute Physiology and Chronic Health Evaluation) II score,²² RBC transfusion,^{23,24} and lung injury prediction (LIP) score.⁷ Patients were dichotomized into having or not having received PRBC based on transfusion of any volume of PRBC during the first 4 hospital days. We included each potential confounder in the ALI development model. For the ALI-related mortality model, we added potential confounders associated with the outcome of interest in univariate analyses at a significance level < .20 to the base in-hospital mortality model and maintained the confounder if the OR estimate was altered by > 10%.²⁵ We did not adjust for the use of mechanical ventilation, because we considered such use to be in the causal pathway to ALI development.²¹

We assessed for center-level effects in the association between race and ALI development using the modified Breslow-Day test for homogeneity of ORs.²⁶ To account for center-level effects, we used mixed-effects multivariable logistic regression models with hospital-specific random effects.²⁷ To determine whether sex acted as an effect modifier in the associations with race, we included an interaction term in the logistic regression equation. In sensitivity analyses, to further examine the association between race and ALI development, we used conditional logistic regression models. Furthermore, we excluded subjects from centers that enrolled patients retrospectively from our hospital-specific random effects models. We present the results as ORs and 95% CIs. We defined significance as a *P* value < .05 and used Stata, version 10.0 software to perform statistical analyses (StataCorp LP).

RESULTS

Over 6 months, we studied 5,201 patients at high risk of ALI development, including 1,135 black patients (21.8%). Women comprised 45% of the cohort. The incidence of ALI development was 5.9% (95% CI, 5.2%-6.6%). In-hospital mortality was 5.0% for the entire cohort (95% CI, 4.4%-5.6%) and 24.4% for those patients who developed ALI (95% CI, 19.7%-29.6%).

Baseline Characteristics by Sex and Race

As shown in Table 1, men, compared with women, were younger ($P < .001$), more likely to be white ($P < .001$), and less likely to be obese ($P < .001$). Regarding risk modifiers for ALI development, men were more likely to be alcohol abusers ($P < .001$) and less likely to have diabetes ($P = .017$), and sex-based

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*A complete list of study participants is located in e-Appendix 1.

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differences in the predisposing conditions for ALI existed. Men had higher LIP scores ($P < .001$) and were more likely to receive mechanical ventilation ($P < .001$).

Black patients, compared with whites, were younger ($P < .001$), more likely to be women ($P < .001$), and

more likely to be obese ($P < .05$) and presented with higher APACHE II scores ($P < .001$). White patients were more likely to consume alcohol ($P < .001$) and less likely to have diabetes ($P < .001$) and had higher LIP scores than did black patients ($P < .001$). During the hospitalization, whites were more likely to receive PRBC transfusion and mechanical ventilation ($P < .001$) despite lower APACHE II scores. The frequency of risk conditions differed significantly by race (Fig 1, Table 2).

A total of 409 patients were categorized as “other” race. Compared with whites, these patients were younger ($P < .001$), more likely to be Hispanic and to have diabetes and sepsis as risk modifiers, and less likely to have pneumonia (Table 2). They also had lower LIPS and APACHE II scores ($P < .001$).

Outcomes by Sex and Race

As shown in Table 3, baseline characteristics, predisposing conditions, and ALI risk modifiers differed depending on whether ALI developed. Men, compared with women, were more likely to develop ALI (6.9% vs 4.7%, $P < .001$) and experienced a longer ICU ($P = .002$) but not hospital ($P = .10$) length of stay (Table 4). Men who developed ALI had a non-significant increase in in-hospital mortality (27.6% vs 18.5%; $P = .08$; 95% CI, 0.94%-2.99%).

Whites, compared with blacks, were more likely to develop ALI (6.5% vs 4.5%, $P = .014$); however, there was no difference in ALI-associated mortality (24.8% vs 21.6%, $P = .63$) (Table 4). Hispanic ethnicity was associated with neither ALI development (5.6% in Hispanics [27 of 478] and 6.6% in non-Hispanics [259 of 3,928], $P = .43$), nor ALI-associated mortality ($P = .84$).

There was no evidence of effect modification by sex in the relationship between race and ALI development ($P = .35$) or mortality ($P = .90$). When stratified by race and sex, we found that the rate of ALI development was highest among white men at 7.3%, followed by black men at 5.8%, white women at 5.4%, and then black women at 3.2%. Regarding ALI-associated mortality, in-hospital mortality was highest among white men at 27.1%, followed by black men at 24.2%, white women at 20.5%, and then black women at 16.7%.

In multivariable analyses, sex was not associated with ALI development after adjustment. However, black race, compared with white, was independently associated with a decreased likelihood of developing ALI after adjustment (Table 5). Because the modified Breslow-Day test for OR homogeneity across centers was significant ($P = .08$), suggesting significant heterogeneity across centers, we adjusted for center-level effects. The association between race

Table 1—Baseline Characteristics by Sex

Characteristics	Male (n = 2,886)	Female (n = 2,315)	P Value ^a
Demographics			
Age, y	55 (42-69)	58 (44-72)	< .001
Hispanic ethnicity	251 (10.3)	227 (11.5)	.19
Race			
White	1,974 (70.3)	1,445 (64.7)	Ref
Black	569 (20.3)	566 (25.3)	< .001
Asian	39 (1.4)	41 (1.8)	.11
Other	226 (8.1)	183 (8.2)	.34
Admission source			
Home	2,288 (80.4)	1,828 (80.1)	.816
Outside facility	559 (19.6)	454 (19.9)	
Comorbidities			
CHF class 4	83 (2.9)	78 (3.4)	.31
Diabetes	627 (21.7)	568 (24.5)	.02
ESRD	112 (3.9)	96 (4.2)	.63
COPD	306 (10.6)	249 (10.8)	.86
Asthma	148 (5.1)	277 (12.0)	< .001
Metastatic solid cancer	142 (4.9)	126 (5.4)	.40
Chest radiation	26 (0.9)	43 (1.9)	.003
GERD	320 (11.1)	365 (15.8)	< .001
Alcohol abuse ^b	166 (8.3)	36 (2.0)	< .001
Obesity ^c	681 (23.6)	630 (27.2)	.003
Tobacco use			
None	1,194 (45)	1,259 (58.2)	< .001
Former or current	1,458 (55.0)	904 (41.8)	< .001
ALI predisposing conditions			
Shock	236 (8.2)	163 (7.0)	.13
Aspiration	135 (4.7)	69 (3.0)	.002
Sepsis	886 (30.7)	917 (39.6)	< .001
Pancreatitis	156 (5.4)	154 (6.7)	.06
Pneumonia	622 (21.6)	574 (24.8)	.006
High-risk surgery ^d	831 (28.8)	602 (26.0)	.025
Emergency surgery	184 (6.4)	118 (5.1)	.05
High-risk trauma	615 (21.3)	319 (13.8)	< .001
ALI risk modifiers			
APACHE II	9 (5-14)	9 (5-13)	.90
LIPS	3 (2-4.5)	2.5 (1.5-4.0)	< .001
LIPS > 4	740 (25.6)	473 (20.4)	< .001
Process of care			
PRBC transfusion	440 (15.2)	331 (14.3)	.34
Noninvasive ventilation	274 (10.1)	245 (11.0)	.32
Mechanical ventilation	911 (32.8)	28.7 (9.6)	< .001

Data are presented as No. (interquartile range) or No. (%). ALI = acute lung injury; APACHE = Acute Physiology and Chronic Health Evaluation; CHF = congestive heart failure; ESRD = end stage renal disease; GERD = gastroesophageal reflux disease; LIPS = lung injury prediction score; PRBC = packed RBC. Ref = reference.

^aFor comparisons, whites are baseline.

^bAlcohol abuse is defined as > 14 drinks/wk.

^cObesity is defined as BMI > 30.

^dHigh-risk surgery is defined as cardiac, aortic, thoracic, spinal, and acute abdominal procedures.

FIGURE 1. Development of lung injury by racial category and selected risk conditions. Total column height represents the percentage of patients within each racial group with the ALI risk factor. The light gray portion on top of each column represents the proportion who went on to develop ALI, and the bottom dark gray portion represents the proportion who did not develop ALI. For all seven risk categories, $P < .05$ by χ^2 test comparing the proportion of subjects within each risk category by race. For the risk factor of sepsis alone, $P < .05$ by χ^2 for ALI development by race. ALI = acute lung injury.

and ALI development persisted after adjusting for center-level effects with hospital-specific random effects ($n = 5,043$; adjusted OR, 0.66; 95% CI, 0.45-0.97; $P = .033$) and when we used conditional logistic regression ($n = 5,008$; adjusted OR, 0.65; 95% CI, 0.44-0.96; $P = .029$). Further, the association persisted after excluding subjects from the three retrospective centers in our random effects models ($n = 4,744$; adjusted OR, 0.67; 95% CI, 0.45-0.99; $P = .04$).

In multivariable analyses, neither sex nor race was independently associated with ALI-related mortality after adjusting for potential confounders (Table 6). The relationships remained nonsignificant after adjusting for center-level effects (data not shown).

DISCUSSION

In this multicenter cohort study of patients at high risk of ALI, we found that sex-based differences existed at clinical presentation prior to ALI development. After accounting for these differences, there existed no sex-based disparities in the rate of ALI development or ALI-related mortality. We found

that race-based differences existed at presentation and during the hospitalization that modified the risk of ALI development. After accounting for these differences, we found that blacks remained significantly less likely to develop ALI compared with similarly at-risk whites.

This study has a number of strengths. First, this is a large multicenter study of patients at risk of ALI that used a valid definition to identify ALI cases. Prior studies relied on *International Classification of Diseases, Ninth Revision* codes, which have a low sensitivity for detecting ALI.^{4,28,29} Second, this cohort contained patient-level data, allowing for the assessment of baseline clinical differences and process-of-care differences. Last, this cohort examined the development of and mortality from ALI, allowing for a better understanding of where sex and racial disparities may lie.

Our study is the first, to our knowledge, to focus on the relationship between sex and race and ALI development in a population with one or more ALI risk factors. Prior studies focused on patients in whom ALI had developed or were limited to patients with trauma.^{30,31} Our finding that race-based differences exist in the rate of ALI development support findings in the

Table 2—Baseline Characteristics by Race

Characteristics	White (n = 3,419)	Black (n = 1,135)	P Value ^a	Asian (n = 80)	P Value ^a	Other Race (n = 409)	P Value ^a
Demographics							
Age, y	60 (45-73)	52 (42-65)	< .001	58 (38-70)	.08	46 (34-62)	< .001
Male sex	1,974 (57.7)	569 (50.1)	< .001	39 (48.8)	.11	226 (55.3)	.34
Hispanic ethnicity	86 (3.0)	14 (1.5)	.01	0	.14	277 (79.6)	< .001
Admission source							
Home	2,613 (77.3)	953 (85.3)	< .001	69 (86.3)	.06	360 (88.5)	< .001
Outside facility	768 (22.7)	164 (14.7)	< .001	11 (13.8)	.06	47 (11.5)	< .001
Comorbidities							
CHF class 4	86 (2.5)	61 (5.4)	< .001	1 (1.3)	.47	8 (2.0)	.49
Diabetes	686 (20.1)	338 (29.8)	< .001	21 (26.3)	.17	105 (25.7)	.008
ESRD	69 (2.0)	121 (10.7)	< .001	2 (2.5)	.76	13 (3.2)	.13
COPD	412 (12.1)	101 (8.9)	.004	2 (2.5)	.009	28 (6.9)	.002
Asthma	238 (7.0)	126 (11.1)	< .001	4 (5.0)	.49	39 (9.5)	.06
Metastatic solid cancer	184 (5.4)	61 (5.4)	.99	4 (5.0)	.88	11 (2.7)	.019
Chest radiation	50 (1.5)	15 (1.3)	.73	0	.31	2 (0.5)	.11
GERD	499 (14.5)	128 (11.3)	.005	6 (7.5)	.07	41 (10.0)	.012
Alcohol abuse ^b	156 (6.1)	31 (4.0)	.02	0 (0)	.046	11 (3.8)	.11
Obesity ^c	859 (25.1)	320 (28.2)	.04	11 (13.8)	.02	91 (22.2)	.20
Tobacco use							
None	1,609 (50.0)	485 (47.3)	.14	61 (82.4)	< .001	216 (60.8)	< .001
Former or current	1,610 (50.0)	540 (52.7)	.14	12 (17.6)	< .001	139 (39.2)	< .001
ALI predisposing conditions							
Shock	248 (7.3)	105 (9.3)	.03	11 (13.8)	.03	30 (7.3)	.95
Aspiration	154 (4.5)	27 (2.4)	< .001	6 (7.5)	.21	8 (2.0)	.016
Sepsis	1,005 (29.4)	556 (49.0)	< .001	26 (33.0)	.55	160 (39.1)	< .001
Pancreatitis	160 (4.7)	72 (6.3)	.03	5 (6.3)	.51	63 (15.4)	< .001
Pneumonia	742 (21.7)	324 (28.6)	< .001	16 (20.0)	.71	68 (16.6)	.018
High-risk surgery ^d	1,065 (31.2)	198 (17.4)	< .001	22 (27.5)	.49	98 (24.0)	.003
Emergency surgery	179 (5.2)	74 (6.5)	.1	7 (8.8)	.17	22 (5.4)	.9
High-risk trauma	688 (20.1)	152 (13.4)	< .001	17 (21.3)	.8	58 (14.2)	.004
ALI risk modifiers							
APACHE II	8 (5-13)	9 (5-15)	< .001	8 (4-14)	.93	7 (4-13)	.0011
LIPS	2.5 (2-4.5)	2.5 (1.5-3.5)	< .001	3 (1.8-4.3)	.85	2 (1-3.5)	< .001
LIPS > 4	856 (25.0)	222 (19.6)	< .001	20 (25.0)	.99	74 (18.1)	< .001
Process of care							
PRBC transfusion	556 (16.3)	148 (13.0)	.009	14 (17.5)	.77	37 (9.1)	< .001
Noninvasive ventilation	398 (12.3)	84 (7.7)	< .001	5 (7.4)	.21	21 (5.3)	< .001
Mechanical ventilation	1,084 (32.8)	249 (22.6)	< .001	24 (33.8)	.86	114 (28.3)	.07

Data are presented as No. (interquartile range) or No. (%). See Table 1 legend for expansion of abbreviations.

^aFor comparisons, whites are baseline.

^bAlcohol abuse is defined as > 14 drinks/wk.

^cObesity is defined as BMI > 30.

^dHigh-risk surgery is defined as cardiac, aortic, thoracic, spinal, and acute abdominal procedures.

trauma population.³⁰ In the population-based epidemiologic study by Moss et al,⁴ men and blacks had increased ALI mortality. However, because this study focused on decedents with ALI, and details prior to ALI development were unavailable, it is unclear whether the observed disparities were due to a greater incidence of conditions that predispose to ALI, a more severe presentation, higher ALI development in patients at similar risk of ALI, or a similar incidence of ALI but a higher mortality after ALI development. We found that men and blacks are more likely to present to the hospital with conditions (eg, sepsis, shock) associated with the highest risk of ALI development.^{9,10,23,32-35} In addition, we found significant baseline differences in clinical presentation

by sex and race. However, after adjustment and center-level effects, men were no longer at a higher risk of developing ALI, whereas blacks were less likely to develop it.

Contrary to the findings of Moss et al,⁴ we did not find a relationship between ALI-related mortality and sex or race after adjusting for differences in clinical presentation. Our findings support the work of Erickson et al⁵ and Brown et al,³⁶ who found that differences at hospital presentation accounted, in part, for disparities in ALI mortality. We acknowledge that our sample size may have limited our ability to detect whether disparities existed in ALI-related mortality, and our results may have differed had we included patients who presented with ALI or broadened the

Table 3—Patient Demographics and Predisposing Conditions and ALI Development

Characteristics	No ALI (n = 4,894)	ALI (n = 307)	P Value
Demographics			
Age, y	57 (43-71)	56 (43-68)	.17
Male sex	2,687 (54.9)	199 (64.8)	< .001
Hispanic ethnicity	451 (11.0)	27 (9.4)	.43
Race			
White	3,197 (67.4)	222 (73.8)	Ref
Black	1,084 (22.9)	51 (16.9)	< .05
Asian	76 (1.6)	4 (1.3)	.59
Other	385 (8.1)	24 (8.0)	.63
Admission source			
Home	3,894 (80.7)	222 (72.6)	< .001
Outside facility	929 (19.3)	84 (27.4)	< .001
Predisposing conditions for ALI			
Shock	330 (6.7)	69 (22.5)	< .001
Aspiration	171 (3.5)	33 (10.8)	< .001
Sepsis	1,685 (34.4)	118 (38.4)	.15
Pancreatitis	301 (6.2)	9 (2.9)	< .001
Pneumonia	1,102 (22.5)	94 (30.6)	< .001
High-risk surgery ^a	1,214 (24.8)	67 (21.8)	.24
Emergency surgery	265 (5.4)	37 (12.0)	< .001
High-risk trauma surgery	862 (17.6)	72 (23.5)	< .05
ALI risk modifiers			
Alcohol abuse ^b	191 (5.3)	11 (5.5)	.17
Obesity ^c	1,211 (24.7)	100 (32.6)	< .01
Diabetes mellitus	1,135 (23.2)	60 (19.5)	NS
Smoking			
None	2,324 (51.2)	129 (46.4)	.12
Former	1,070 (23.6)	63 (22.7)	.72
Active	1,143 (25.2)	86 (30.9)	< .05
APACHE II	8 (5-13)	13 (9-20)	< .001
LIPS	2.5 (1.5-4)	5 (3.5-7)	< .001
Process of care			
PRBC transfusion	670 (13.7)	101 (32.9)	< .001
Use of noninvasive ventilation	428 (9.2)	91 (33.2)	< .001
Mechanical ventilation	1,243 (26.3)	269 (87.9)	< .001

Data are presented as No. (interquartile range) or No. (%). NS = not significant. See Table 1 legend for expansion of other abbreviations.

^aHigh-risk surgery is defined as cardiac, aortic, thoracic, spinal, and acute abdominal procedures.

^bAlcohol abuse is defined as > 14 drinks/wk.

^cObesity is defined as BMI > 30.

study population to include any patient who developed ALI rather than only at-risk patients, or had we examined long-term outcomes rather than hospital mortality. Given the disparities in discharge practices and posthospitalization care in other populations,^{33-35,37-39} and the greater use of long-term acute-care hospitals among men and blacks, long-term mortality may have differed from hospital mortality.^{34,37,38}

It is not clear why blacks may have a higher incidence of sepsis but lower ALI development than do at-risk whites. One possibility is that chronic conditions that alter immune function and predispose to sepsis, such as diabetes, are more common in black patients,^{20,33} and yet diabetes appears to protect against ALI development.^{19,23,40} In this study, blacks remained significantly less likely to develop ALI when diabetes was included in the model. Another explanation is that sex and racial-based care differences

during the hospitalization might influence development of and outcome in ALI. We found disparities in the rate of RBC transfusions and the use of mechanical ventilation, both of which have been associated with increased development of ALI.^{23,41} Our study suggests the need to focus on both prehospital factors and care provided during the hospitalization to identify and eliminate sex and racial disparities.⁴²

Our study has several limitations. First, self-reported race is a poor surrogate for individual ancestry and genetic background; however, it has been important in defining different groups in society that experience health disparities. We acknowledge that such health disparities are multifactorial and can stem from genetic, socioeconomic, religious, cultural, and educational differences between groups. Unfortunately, such data were not available for analysis in this study. Second, our parent study excluded 166 patients

Table 4—Association Between Sex and Race and ALI Development and In-Hospital Mortality in Those Who Develop ALI

Outcomes	Whole Cohort (N = 5,201)	Male (n = 2,886)	Female (n = 2,315)	P Value	White (n = 3,419)	Black (n = 1,135)	P Value ^a	Asian (n = 80)	P Value ^a	Other Race (n = 409)	P Value ^a
ALI/ARDS	307 (5.90)	199 (6.9)	108 (4.7)	<.001	222 (6.5)	51 (4.5)	.01	4 (5)	.59	24 (5.9)	.63
ALI/ARDS mortality	75 (24.4)	55 (27.6)	20 (18.5)	.08	55 (24.8)	11 (21.6)	.63	2 (50.0)	.25	4 (16.7)	.38
Death, all cause	259 (4.98)	144 (4.99)	115 (4.97)	.97	178 (5.2)	56 (4.9)	.72	5 (6.3)	.68	13 (3.2)	.08
ICU length of stay	2 (1-5)	2 (1-5)	2 (0-5)	.002	2 (1-5)	3 (1-5)	.10	3 (0-4)	.98	2 (0-4)	.02
Hospital length of stay	6 (3-10)	6 (3-10)	6 (3-9)	.10	6 (3-9)	6 (4-10)	.04	4.5 (3-9)	.36	6 (4-10)	.11

Data are presented as No. (interquartile range) or No. (%). See Table 1 legend for expansion of abbreviations.

^aFor comparisons, whites are baseline.

Table 5—Multivariable Logistic Regression Model Demonstrating Association Between Sex and Race and ALI Development (n = 5,043)

Variable ^a	Adjusted OR	95% CI	P Value
Male sex	1.24	(0.96-1.63)	.10
Race			
White	Ref	Ref	
Black ^b	0.69	(0.49-0.98)	.04
Asian	0.79	(0.28-2.28)	.67
Other	1.08	(0.67-1.74)	.75

See Table 1 legend for expansion of abbreviations.

^aAdjusted for age, BMI, comorbid conditions (diabetes mellitus, end-stage renal disease, class 4 CHF), aspirin use, APACHE II score, RBC transfusion, and LIPS. Alcohol abuse and tobacco use, when available, were included in the LIPS.

^bThe association between black race and ALI development remained significant after adjusting for initial tidal volume per kilogram of predicted body weight in ventilated patients (n = 1,148; OR, 0.57; 95% CI, 0.36-0.90; P = .02).

presenting with ALI, and data regarding their sex and race are not available. Third, racial and ethnic determination depended on medical records, rather than an interview with the patient. Further, ethnic determination was missing in 15% of the patients and “other” race constituted 409 patients (8% of the study population), which may have biased our results in this subgroup in unforeseen ways. Fourth, given the observational study design, a potential for uncontrolled confounding exists. Although we adjusted for transfusion, other process-of-care measures, such as early goal-directed therapy and timely antibiotics for severe sepsis, known to differ by sex and race,⁴³⁻⁴⁵ were not available. Fifth, we did not ascertain longer-term outcomes and transitions of care to long-term facilities, and further studies are required to assess this relationship.

CONCLUSIONS

We found that sex- and race-based differences exist at presentation in patients at high risk of ALI. These

Table 6—Multivariable Logistic Regression Model Demonstrating Association Between Sex and Race and In-Hospital Mortality in Patients With ALI (n = 301)

Variable ^a	Adjusted OR	95% CI	P Value
Male sex ^b	1.54	(0.81-2.92)	.19
Race			
White	Ref	Ref	
Black	0.87	(0.39-1.93)	.73
Asian	3.48	(0.35-34.98)	.29
Other	0.70	(0.21-2.33)	.56

See Table 1 legend for expansion of abbreviation.

^aAdjusted for age, sepsis, shock, aspiration, and APACHE II.

^bThe association between sex and in-hospital mortality remained nonsignificant after adjusting for initial tidal volume per kilogram of predicted body weight in ventilated patients (n = 224; OR, 2.08; 95% CI, 0.88-4.90; P = .10).

differences accounted for the sex-based difference in the rate of development of ALI and ALI-related mortality. These differences did not account fully for the association between race and ALI development, because black patients remained less likely to develop ALI. Finally, although we did not find disparities in short-term outcomes, future studies are required to study whether long-term outcomes differ as a result of differences in posthospitalization care.

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Dr Gong: contributed to the development of the research plan, the conduct of the study, the supervision and guidance of the statistical analysis, the review of the results, and the manuscript writing and review.

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Additional information: The e-Appendix can be found in the "Supplemental Materials" area of the online article.

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