Epidemiology of De Novo Acute Renal Failure in Hospitalized African Americans

Comparing Community-Acquired vs Hospital-Acquired Disease

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Background: The high incidence and prevalence of end-stage kidney disease among African Americans is well known, but the epidemiology of acute renal failure (ARF) among African Americans is unknown. This study was designed to determine the incidence, associated risk factors, and prognosis of ARF in hospitalized African Americans and to compare these variables in hospital-acquired ARF (HA-ARF) against community-acquired ARF (CA-ARF).

Methods: A 3-year (1994-1996), computer-assisted retrospective analysis of hospital discharges with confirmed diagnoses of ARF. One hundred of 240 cases met the inclusion criteria for de novo ARF. Demographic, laboratory, and clinical profiles of all patients were retrieved and subdivided into CA-ARF and HA-ARF. Both analysis of variance and $\chi^2$ tests were used for analysis. Survival regression used both the Cox proportional hazards and Kaplan-Meier models.

Results: The incidence of CA-ARF was 3.5 times greater than that of HA-ARF (0.55% vs 0.15%). The mean age of all patients was 54 years with a 67% male predominance. There were no significant differences in age, sex, peak serum creatinine levels, or underlying medical history. Prerenal causes of ARF were more common among CA-ARF than HA-ARF (35% vs 19%; $P = .07$), but intra-renal causes were more common among HA-ARF (81% vs 55%; $P = .07$). All cases of obstruction occurred in CA-ARF. Mortality was higher in HA-ARF (59% vs 33%; $P = .03$), and the incidence of recognized predictors of mortality was higher in patients with HA-ARF than in those with CA-ARF: oliguria (59% vs 35%; $P = .04$); sepsis (73% vs 35%; $P = .004$); stay in the intensive care unit (ICU) or mechanical ventilation (55% vs 6%; $P <.001$); and multiorgan failure (59% vs 24%; $P = .002$). Those with HA-ARF were twice as likely to require dialysis as those with CA-ARF. The mortality was high in younger patients with CA-ARF and in older patients with HA-ARF, but the dialysis-related mortality rate was 3-fold higher among patients with HA-ARF. While mean ± SD length of hospital stay was more prolonged in HA-ARF than CA-ARF (26 ± 28 days vs 12 ± 11 days; $P <.001$), the 120-day survival rate was lower in HA-ARF than CA-ARF (43% vs 66%; $P = .05$). The HA-ARF status was associated with a relative risk of 2.5 (confidence interval, 1.1-5.5; $P = .03$) for shortened survival.

Conclusions: The overall epidemiologic characteristics of ARF among hospitalized African Americans seem to be comparable to those in whites, but the difference in incidence between CA-ARF and HA-ARF was much higher in African Americans. In view of the high mortality and morbidity rates associated with ARF and the fact that younger African American patients with CA-ARF were more likely to die than their older counterparts, we recommend that renal failure awareness be incorporated into community-based health educational programs in African American populations.

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Despite substantial advances in renal replacement therapy and health care delivery, morbidity and mortality rates associated with acute renal failure (ARF) have remained high. Hence, most recent publications on ARF have concentrated on outcome and related predictors of mortality.\(^1,2\) Epidemiologic studies on ARF are few and most often have been compartmentalized into 2 entities: hospital-acquired ARF (HA-ARF)\(^3,5\) and community-acquired ARF (CA-ARF).\(^6,8\) There is a dearth of literature providing a comprehensive, direct, head-to-head comparison between HA-ARF and CA-ARF. A subtle comparison was made by one study when ARF cases were classified into “initial and delayed” ARF.\(^3\) However, that study was primarily concerned with HA-ARF. Indeed, some have claimed that ARF is predominantly a hospital-acquired disorder.\(^9\)
PATIENTS AND METHODS

This is a 3-year (1994-1996), computer-assisted retrospective review of all cases classified as ARF, acute tubular necrosis (ATN), or acute tubulointerstitial nephritis at the time of hospital discharge or death. The location was a 900-bed urban medical center that serves as a secondary and tertiary care facility. The average annual admission to the adult medical/surgical services during the study period was 15,000 (96% African Americans). Two hundred forty cases of ARF were initially identified; however, only 100 of these satisfied the inclusion criteria: African American ethnic origin; no prior history of renal disease; age 18 years or older; a rise in serum creatinine level of at least 44.2 µmol/L (0.5 mg/dL) and 176.8 µmol/L (2.0 mg/dL) or greater during hospitalization; and admission creatinine level of 176.8 µmol/L (2.0 mg/dL) or greater when no prior history of renal disease was available. All cases of glomerulonephritis, obstetric-related renal failure and acute-on-chronic renal failure were excluded. Patients with incomplete medical records, those who left the hospital prematurely without follow-up arrangements, and those whose elevation in serum creatinine levels resolved within 48 hours were excluded.

Demographic, biochemical, and clinical profiles of all patients were examined by further in-depth hard-copy chart review. Oliguria was considered present when urine output was 400 mL/d or less; CA-ARF was defined as renal failure developing outside the hospital, while HA-ARF was defined as renal failure that developed during hospitalization for non–renal-related problems in patients whose admission serum creatinine level was normal. Preexisting chronic renal insufficiency was defined as a documented serum creatinine level of 150 µmol/L (1.7 mg/dL) or higher in the previous 12 months. Volume depletion was considered present when patients satisfied 1 or more of several previously described criteria. These criteria included orthostatic hypotension, weight loss of more than 5% of baseline body weight, urinary sodium content less than 10 mmol/L, central venous pressure lower than 5 cm H2O, or pulmonary capillary wedge pressure lower than 5 mm Hg.4,8 The length of hospital stay (LOS) for patients with CA-ARF was defined as the number of days between the date of admission and the date of discharge or death; in patients with HA-ARF, it was defined as the number of days between the onset of ARF (as defined in the inclusion criteria) and discharge or death.

Variables are reported as mean ± SD where appropriate. Analysis of variance with factorial analysis was used to compare some characteristics, while nominal variables were evaluated by contingency tables with raw data and χ² analysis. Survival regression analysis employed both the Cox proportional hazards and Kaplan-Meier models to examine the effect of 4 comorbid conditions (sepsis, oliguria, mechanical ventilation or ICU stay, and multiorgan failure) and the origin of the ARF (ie, CA-ARF vs HA-ARF) as a dichotomous variable on survival. Multiorgan failure was defined and scored according to the format suggested by Marshall et al.13 Goodness of fit statistics were provided by the Wald and likelihood ratio tests, both of which yielded P<.001. The estimated experimental coefficients and their 95% confidence intervals (CIs) provided the relative hazard for shortened survival associated with the variables. Censoring occurred at 120 days based on a 90-day maximum hospital stay with 30 days postdischarge follow-up. Statistical software package “Statview” (SAS Institute Inc, Cary, NC, 1998) was used in all analyses.

The racial composition of the patients with ARF has been prominently absent from most studies; hence, the impact of race on the various epidemiologic variables in ARF is unknown. The overwhelming predominance in both the incidence and prevalence of end-stage renal disease in African Americans has been well documented10; however, there is a paucity of similar information on ARF. Based on an annual admission of 15,000 patients (96% African Americans) to the adult medical/surgical services, the incidence of de novo ARF in this study was 0.69%, with an overall mortality rate of 39%. The mean age of all patients was 54 ± 20 years with a male predominance of 67%. Table 1 compares the demographic and clinical characteristics of the patients according to the origin of ARF. A significantly higher incidence of oliguria, sepsis, multiorgan failure, mechanical ventilation or stay in the ICU, and mortality rates characterized the patients with HA-ARF. Dehydration and volume depletion were more prevalent in patients with CA-ARF, though not significantly so.

When the physiologic characteristics of ARF were divided into the categories of prerenal, intrarenal, and postrenal causes, intrarenal causes of ARF accounted for a greater proportion of HA-ARF (81% vs 55% CA-ARF; P = .07), while the prerenal causes were more common among patients with CA-ARF (35% vs 19% for HA-ARF; P = .07). All cases of obstructive uropathy developed prior to hospitalization (10% of CA-ARF vs 0% of HA-ARF; P = .07) (Figure 1). The figure also shows that patients with CA-ARF with prerenal and postrenal causes of ARF were generally older than their HA-ARF counterparts, while intrarenal causes were more frequent in older patients with HA-ARF.

Patients with HA-ARF had a more prolonged LOS. The average LOS for CA-ARF was 12 ± 11 days, while that of HA-ARF was 26 ± 28 days (P<.001). The mean LOS for all intrarenal cases was significantly longer than both prerenal and postrenal cases: 17 ± 19 days vs 11 ± 12 and 13 ± 12 days, respectively (P = .05). Further subanalysis of the identifiable causes of ARF revealed that ATN and postoperative ARF were associated with pro-
Table 1. Demography and Clinical Profiles of the Patients

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>HA-ARF</th>
<th>CA-ARF</th>
<th>P</th>
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<tbody>
<tr>
<td>No. of patients</td>
<td>21</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD age, y</td>
<td>58.3 ± 20.4</td>
<td>53.1 ± 9.8</td>
<td>.40</td>
</tr>
<tr>
<td>Men</td>
<td>13 (59)</td>
<td>54 (69)</td>
<td>.30</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>60.9 ± 11.1</td>
<td>66.6 ± 17.0</td>
<td>.15</td>
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<tr>
<td>MAP, mm Hg</td>
<td>80.8 ± 17.6</td>
<td>89.2 ± 19.9</td>
<td>.09</td>
</tr>
<tr>
<td>Incidence, %</td>
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<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD peak serum creatinine, µmol/L</td>
<td>415.5 ± 221.0</td>
<td>521.6 ± 371.3</td>
<td>.10</td>
</tr>
<tr>
<td>Dialysis</td>
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<td>7</td>
<td>.30</td>
</tr>
<tr>
<td>Dehydration</td>
<td>36</td>
<td>53</td>
<td>.20</td>
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<td>MODS</td>
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</tr>
<tr>
<td>Mortality</td>
<td>59</td>
<td>33</td>
<td>.03</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated, data are number (percentage) of patients. HA-ARF indicates hospital-acquired acute renal failure; CA-ARF, community-acquired acute renal failure; MAP, mean arterial pressure; ICU, intensive care unit; and MODS, multisystem organ dysfunctional state.

The relationship between age, mortality, and origin of ARF is shown in Figure 3. Mortality was equally likely in both younger patients with CA-ARF and elderly patients with HA-ARF. Of the patients who died, the mean difference in age between CA-ARF and HA-ARF was 8 years (P = .09), but among survivors the mean difference in age was 2 years (P = .70). Mortality was higher among patients with intrarenal causes of ARF (54%) than those with either prerenal (16%) or postrenal causes (12.5%) (P < .001). The mortality rate of intrarenal ARF was higher among patients with HA-ARF (66.6%) than patients with CA-ARF (48.8%) (P = .05). The mortality rate in postoperative ARF was 75%. With censoring at 120 days, the better survival among patients with CA-ARF over HA-ARF was distinct (66% vs 43%; P = .05) (Figure 4). In the presence of several comorbid conditions, patients with HA-ARF were more likely to have significantly increased risk of shortened survival (Table 2). This risk was reduced when comorbid factors were eliminated from analysis (data not shown).

There was a broad spectrum of underlying chronic medical conditions present in the patients (Table 3). Differences between the ARF settings were not statistically significant. Most of the unknown cases were young adults with no underlying medical illness. They were admitted with volume depletion, dehydration, or pigment-induced ARF. The patients with acquired immunodeficiency syndrome (AIDS) were most often young men, aged 40 years or younger. Although the underlying medical
conditions did not significantly alter mortality rates, some medical conditions were associated with high mortality rates. These include congestive heart failure, 86%; chronic obstructive pulmonary disease, 67%; and AIDS, 44%.

According to several published reports, the overall incidence of HA-ARF ranges from 2% to 4.9% of admissions, while that of CA-ARF ranges from 0.37% to 1% of admissions. It has also been noted that CA-ARF is 1.5 to 2 times more common than HA-ARF. In this study we observed that CA-ARF was 3.5 times more common than HA-ARF among hospitalized African American patients. The relatively low incidence of both HA-ARF and CA-ARF in this study was probably related to our patient selection criteria. Patients with acute-on-chronic ARF were eliminated from the study because of the unpublished observation that African Americans had a higher incidence (>60%) at this study facility than the 12.7% reported in whites. Additionally, the overwhelmingly high prevalence of both diabetic and hypertensive nephropathy in African Americans has been well documented. Most patients in this study had underlying hypertension and/or diabetes, and inclusion of patients with acute-on-chronic renal failure would have biased this study and not provided a true incidence of de novo ARF in African Americans.

In agreement with other published reports, we also observed a male sex predominance in both HA-ARF and CA-ARF. The presence of prostatic hypertrophy and subsequent obstructive uropathy undoubtedly contributed to the overrepresentation of men. Not surprisingly, all but 1 of the 26 patients with AIDS were men.

Physiologic classification of ARF into prerenal, intrarenal, and postrenal cases revealed that although pre-renal causes were more prevalent in CA-ARF, intrarenal causes of ARF were responsible for most cases of ARF both within the hospital and in the community. According to a recent community-based ARF study, the incidence of ATN was 49%, prerenal ARF was 21%, while obstruction was 10% among their patients. The low incidence of obstruction in patients with HA-ARF was once again demonstrated in this study. Although we observed no cases of postrenal ARF in our patients with HA-ARF, another study reported an incidence of 4%.

We observed that patients with HA-ARF were more likely to have significantly prolonged LOS than those with CA-ARF. This should not come as a surprise, since patients with HA-ARF were more likely to have more severe illness, and the HA-ARF group included postoperative ARF cases, which accounted for most of the prolonged LOSs. The reported median LOS for CA-ARF according to one report was about 10 days, while that of HA-ARF was 23 days. Our study is consistent with these reports.

All notable adverse outcomes in ARF such as dialysis and mortality occurred more frequently in HA-ARF. It has been previously noted that mortality in CA-ARF may be up to 20% lower than that of HA-ARF. The mortality rate in CA-ARF ranged from 15% to 26% according to some recent reports, while that in HA-ARF has ranged from 25% to 70%. Although our observed mortality rates appeared to be high (59% for HA-ARF and 33% for CA-ARF), Brivet et al observed a rate of 71% vs 50% when their patients with delayed ARF were compared with those with initial ARF. Hence, the mortality rates observed in our study were consistent with these published reports. Documented predictors of mortality such as oliguria, sepsis, multiorgan failure, and ICU stay or mechanical ventilation occurred more frequently in our patients with HA-ARF. We have reported that these predictors and other factors not previously identified were
associated with a significantly high relative risk of death in ARF. The nature of the underlying medical illness did not contribute significantly to mortality, although high mortality rates were observed in patients with congestive heart failure, chronic obstructive pulmonary disease, and AIDS. Mortality was mostly attributable to cases of ARF that resulted from intrarenal factors.

The need for acute dialysis in patients with ARF ranges from 36% to 86%, depending on the origin of the ARF and the hospital setting. A rate of 36% was reported in one community-based study, while the rate was 46% to 86% in a hospital-based ICU study. Ten percent of our patients required dialysis, but more alarming is the fact that patients with HA-ARF were twice as likely to require dialysis as those with CA-ARF and had a 3-fold higher mortality rate.

Unlike in other studies, age and sex did not affect survival in our patient population. This may be related to the fact that our patients younger than 40 years had the highest incidence of ATN, which was associated with the highest mortality rate. Not surprisingly, the mortality rate was higher in younger patients with CA-ARF, who were more likely to present with ATN, than in elderly patients with CA-ARF, who presented mostly with obstruction and volume depletion. The overall survival was significantly better in CA-ARF than HA-ARF. This disparity was most likely related to the higher prevalence of intrarenal causes of ARF and adverse outcome factors in patients with HA-ARF. The importance of these comorbid factors was clearly shown when the hazard risk for shortened survival in patients with HA-ARF was reduced when these factors were eliminated from analysis.

There is a lack of consensus on the definition of ARF. This disparity in criteria has caused some to question the validity of comparative studies in ARF. Chertow et al used a rise in creatinine level of 88 µmol/L or greater (≥1.0 mg/dL) and excluded patients with both underlying chronic renal insufficiency and those whose elevation in creatinine levels stabilized or resolved within 24 to 48 hours. In keeping with other authors, we defined ARF as an elevation in creatinine level of 170.8 µmol/L (2.0 mg/dL). Finally, recent publications have generally excluded obstetric-related ARF. In view of the similarities in criteria definition for ARF between these studies and ours, and the ethnic uniqueness of our patient population, we believe that our comparisons and inferences are in order.

While the overrepresentation of African Americans among patients with end-stage renal disease is well established, our study reveals that the same is not true for ARF. In fact, the epidemiology, etiology, and prognosis of ARF in hospitalized African Americans in this study were comparable to those in whites. However, compared with whites, CA-ARF seemed to occur relatively more frequently than HA-ARF in hospitalized African Americans. Because younger African American patients with CA-ARF have a higher risk of death than older patients, concerted efforts should be directed at improving the African American population’s awareness of the causes, associated risks, and prognosis of ARF.

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REFERENCES