



## Lack of insurance as a barrier to care in sepsis: A retrospective cohort study☆

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### ABSTRACT

Nationally-representative data suggest an association between lack of insurance and in-hospital death from sepsis (Kumar et al., 2014). It remains to be determined whether this association is attributable to differences in baseline health, care-seeking behaviors, hospital care, or other factors.

**Purpose:** To determine whether organ dysfunction present on admission for community-onset sepsis mediates the association between lack of insurance and mortality in sepsis.

**Materials and methods:** Retrospective cohort study using public discharge data from the California Office of Statewide Health Planning and Development. Inpatients age 18–64 with community-onset sepsis at California hospitals in 2010 were identified by diagnosis codes.

**Results:** Controlling for demographics, comorbidities, infection source, and hospital characteristics, lack of insurance was associated with an adjusted odds ratio (OR) of 1.26 (absolute risk difference 4.75%,  $p < 0.001$ ) for organ dysfunction present on admission for community-onset sepsis. Lack of insurance predicted in-hospital mortality (adjusted OR 1.15,  $p < 0.001$ ). Organ dysfunction present on admission was the only significant mediator, explaining 22.3% ( $p < 0.001$ ) of the effect of lack of insurance.

**Conclusions:** The association between lack of insurance and organ dysfunction on admission in community-onset sepsis suggests that lack of insurance may impede timely care for patients with community-onset infections.

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### 1. Introduction

Sepsis, defined as a dysregulated host response to infection, is among the most common reasons for hospitalization in the US and is the leading cause of death in non-cardiac intensive care units [1–3]. Though nationally-representative data suggest that lack of insurance is associated with increased risk of in-hospital death from sepsis with organ dysfunction [4], it is unclear whether this disparity in mortality is attributable to differences in baseline health, care-seeking behaviors, in-hospital care, or other as-yet unidentified factors.

Health insurance has been linked to multiple health-related outcomes, including improved self-reported health status and reduced

mortality [5–7]. One of the mechanisms by which insurance improves health is by facilitating earlier presentation and recognition of illness. For instance, in patients with cancer, lack of insurance has been associated with advanced stage at time of diagnosis and a corresponding reduction in survival [8,9]. In the setting of acute illness, uninsured individuals may face both financial and nonfinancial barriers to care, such as lack of transportation [10]. In sepsis, every hour of delay between diagnosis and initiation of treatment increases the risk of death [11]. We hypothesized that lack of insurance increases risk of death from sepsis by acting as a barrier to timely care.

The definition of sepsis has recently changed, such that it is no longer possible to have sepsis without organ dysfunction [1]. However, when the patients from our retrospective cohort received their treatment, it was possible to be coded as having sepsis prior to the onset of organ dysfunction. Sepsis progressed to “severe sepsis” if organ dysfunction developed. Patients who were coded as having sepsis that was “present on admission,” but whose organ dysfunction developed after admission, are ascertained to have been admitted to the hospital earlier in the course of their illness than individuals who had both sepsis and organ dysfunction present on admission. The purpose of this study was to exploit these distinctions to test our hypothesis.

**Abbreviations:** OSHPD, Office of Statewide Health Planning and Development; MIRCal, Medical Information Reporting for California; ICD-9 CM, International Classification of Diseases, Ninth Revision, Clinical Modification; OR, odds ratio.

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## 2. Materials and methods

### 2.1. Data source

The primary source of patient-level information was the California Office of Statewide Health Planning and Development (OSHPD) Patient Discharge Data public use file. OSHPD compiles comprehensive data on inpatient admissions to licensed hospitals in California with one record for each discharge. The OSHPD data is collected via the Medical Information Reporting for California (MIRCal) System. For hospital-level data, the OSHPD patient discharge data file was linked to OSHPD financial disclosure reports.

### 2.2. Study design

The design was an observational, retrospective cohort study evaluating whether lack of insurance predicts organ dysfunction at time of admission to hospital with community-onset sepsis.

### 2.3. Inclusion and exclusion criteria

We included patients age 18–64 who were admitted from home to a nonfederal hospital in California for acute care in 2010 and assigned International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9 CM) diagnosis codes consistent with sepsis, septic shock, or disseminated infection (see Supplementary Table 1) [12–15]. To meet the inclusion criteria, diagnosis codes needed to indicate “severe sepsis”, “septic shock”, or both sepsis and organ dysfunction. The subcategories of organ dysfunction were respiratory, cardiovascular, renal, hepatic, hematologic, or neurologic.

Only patients whose diagnosis of sepsis, severe sepsis, or septic shock was present on admission, indicating community-onset sepsis, were included in the sample. Patients age 65 or older were excluded based on Medicare eligibility. We chose 2010 as the most recent year of publicly available data from OSHPD in which key covariates, including age, gender, race and ethnicity were included. After applying our inclusion and exclusion criteria, patients from 313 California hospitals were identified.

### 2.4. Variables

The proximate outcome was a binary variable indicating that at least one diagnosis code consistent with organ dysfunction was marked as present on admission. The set of diagnoses used (see Appendix 1) was based on methodology first employed by Martin et al. [14] that has since been validated and replicated in the sepsis literature [12,13,16]. These diagnoses were chosen to represent acute illness, rather than chronic comorbidity or baseline health. Organ dysfunction present on admission was also calculated as a count outcome based on the number of subcategories of organ dysfunction (i.e., respiratory, cardiovascular) identified as present on admission. The distal outcome was in-hospital mortality.

Patient-level covariates included age, race, Hispanic ethnicity, baseline health, code status, and source of infection, including pneumonia, skin and/or soft tissue infection, or urinary tract infection. Baseline health was represented using a count variable indicating the sum of medical diagnoses present from the Elixhauser comorbidity index, a set of clinical conditions representing chronic illness that are known to influence in-hospital mortality [17,18]. Categories for source of infection were defined by ICD-9 codes using the Healthcare Cost and Utilization Project’s Clinical Classification Software (<https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>). Hospital-level covariates included type of ownership, bed count, percentage of admissions by acute care transfer, percentage of indigent patients, and number of major surgeries performed annually. Percentage of patients classified as indigent was determined based on the proportion of patients listed as self-pay, indigent, or “other,” indicating absence of either public or private insurance.

### 2.5. Statistical analysis

Multivariable logistic regression was used to assess the relationship between predictor and outcomes after controlling for covariates. During the process of model specification, fixed effects and random effects models were fit to account for clustering by hospitals. Models were compared based on likelihood ratio tests, AIC values and Hausman-Wu test as appropriate. Absolute risk difference and relative risk were calculated based on predictive margins from multivariate logistic regression with fixed effects. To further disentangle the effect of lack of insurance on organ dysfunction, negative binomial regression was performed using number of dysfunctional organ systems present on admission as a count outcome. Standard errors in the negative binomial model were inflated to account for clustering by hospital.

Within-level and cross-level moderation effects were evaluated using interaction terms in multilevel models with random effects. Mediation analysis was performed by decomposing the total effects of lack of insurance on mortality from logistic regression into direct effects and indirect effects attributable to a mediator (using the user-written *khb* command) [19,20]. STATA/IC version 14.1 was used for all analyses.

### 2.6. Missing data

Six hospitals (1.08% of the total sample) did not provide financial data and were excluded from the reported analysis. In one case, the patient’s disposition was marked as “invalid/blank”; this case was excluded from mediation analysis. Of the remaining cases, 29.2% contained missing values in one or more demographic categories. Multiple imputation by chained equations was used to address missing values for covariates. Model specification was performed using 5 imputations. Final analysis used 30 imputations to approximate the percentage of incomplete cases [21]. The study was conducted using publicly available de-identified data and therefore is exempt from requirements for IRB approval or consent from individuals.

## 3. Results

32,561 patients from 312 medical facilities across the state of California were included in the analysis (Fig. 1). Characteristics of the patients and facilities are presented in Tables 1 and 2, respectively. All patients included in the sample developed organ dysfunction; 26,604 (81.7%) had organ dysfunction coded as “present on admission.” Significant differences between those who presented with organ dysfunction at time of admission and those who did not were identified. Specifically, patients without organ dysfunction at admission tended to be younger, to be female, to have racial categories other than non-Hispanic White or African-American, to be “full code” status, and to have fewer Elixhauser comorbidities. Pneumonia was more common among individuals with organ dysfunction present on admission, while skin and soft tissue infection was less common in this group.

### 3.1. Relationship between lack of insurance and organ dysfunction at admission

On multivariable analysis, lack of insurance was associated with organ dysfunction present on admission with an adjusted odds ratio (OR) of 1.26 ( $p < 0.001$ ) and predicted an increase in absolute risk of organ dysfunction present on admission of 4.75% (relative risk 1.07). Among the other covariates, Elixhauser comorbidity index, “do not resuscitate” status, pneumonia, and urinary tract infection were all associated with increased likelihood of organ dysfunction at admission, while African American race, Hispanic ethnicity, female gender, and skin and soft tissue infections were associated with decreased likelihood of organ dysfunction (see Supplementary Table 2 for full set of coefficients and adjusted ORs). The strongest predictors of organ dysfunction at admission were “do not resuscitate” status (adjusted OR 1.70,  $p < 0.001$ ),

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