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Original Study

Can Sepsis Be Detected in the Nursing Home Prior to the Need for Hospital Transfer?

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A B S T R A C T

Objectives: To determine whether and to what extent simple screening tools might identify nursing home (NH) residents who are at high risk of becoming septic.
Design: Retrospective chart audit of all residents who had been hospitalized and returned to participating NHs during the study period.
Setting and Participants: A total of 236 NH residents, 59 of whom returned from hospitals with a diagnosis of sepsis and 177 who had nonsepsis discharge diagnoses, from 31 community NHs that are typical of US nursing homes overall.
Measures: NH documentation of vital signs, mental status change, and medical provider visits 0–12 and 13–72 hours prior to the hospitalization. The specificity and sensitivity of 5 screening tools were evaluated for their ability to detect residents with incipient sepsis during 0–12 and 13–72 hours prior to hospitalization: The Systemic Inflammatory Response Syndrome criteria, the quick Sequential Organ Failure Assessment (SOFA), the 100-100-100 Early Detection Tool, and temperature thresholds of 99.0°F and 100.2°F. In addition, to validate the hospital diagnosis of sepsis, hospital discharge records in the NHs were audited to calculate SOFA scores.
Results: Documentation of 1 or more vital signs was absent in 26%–34% of cases. Among persons with complete vital sign documentation, during the 12 hours prior to hospitalization, the most sensitive screening tools were the 100-100-100 Criteria (79%) and an oral temperature >99.0°F (51%); and the most specific tools being a temperature >100.2°F (93%), the quick SOFA (88%), the Systemic Inflammatory Response Syndrome criteria (86%), and a temperature >99.0°F (85%). Many SOFA data points were missing from the record; in spite of this, 65% of cases met criteria for sepsis.
Conclusions: NHs need better systems to monitor NH residents whose status is changing, and to present that information to medical providers in real time, either through rapid medical response programs or telemetry.

Sepsis is a major source of morbidity and mortality among the nation's estimated 1.4 million nursing home (NH) residents.[1] In the emergency department, NH residents are 17 times more likely to be diagnosed with sepsis than non-NH residents, such that nearly 4% of emergency department visits among NH residents include a diagnosis of sepsis.[2] Furthermore, when sepsis occurs, it is more likely to be severe if the patient is a NH resident, leading to higher rates of intensive care unit admission, longer hospital stays, and higher mortality rates when compared to non-NH residents.[3–5] Moreover, older adults who survive sepsis are at increased risk of new or worsening cognitive impairment and functional decline when compared with nonsepsis admissions.[6] The prominence of sepsis in this setting highlights the importance of early identification and

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effective management of NH residents who are at high risk of becoming septic.

Because early diagnosis and treatment can reduce morbidity, several screening tools for early sepsis have been developed. A long-established tool is the Systemic Inflammatory Response Syndrome (SIRS) criteria. In the setting of suspected infection, SIRS criteria are met if 2 or more of the following are present: body temperature >38°C or <36°C, heart rate >90 bpm, respiratory rate >20 breaths/min or $PaCO_2$ <32 mm Hg, or white blood cell count >12,000 or <4000 cells/microliter.[7] Despite the fact that studies indicated that the SIRS criteria had only moderate sensitivity and low specificity,[8] they were incorporated directly into "sepsis initiation bundles" of many hospitals participating in the international Surviving Sepsis campaign.[9] Concomitant with the focus on early detection and treatment of sepsis was a nearly 300% rise in hospital sepsis diagnoses between 2003 and 2011, leading to concern that sepsis was being overdiagnosed in emergency departments and hospitals.[10]

To address this issue, a combined task force of the Society of Critical Care Medicine and the European Society of Intensive Care Medicine convened in 2014 to evaluate and update the definitions of sepsis and septic shock. This effort led to the development of the Sequential Organ Failure Assessment (SOFA) score as a diagnostic criterion for sepsis,[11,12] and the quick SOFA, or qSOFA, as a sepsis screening tool that requires no laboratory tests. In the setting of suspected infection, qSOFA criteria are met if the patient has 2 or more of the following: respiratory rate ≥22/min, altered mentation [Glasgow Coma Scale (GCS) < 15], or systolic blood pressure ≤100 mm Hg.[11] A third tool, the 100-100-100 Early Detection Tool, has been recommended by the Minnesota Hospital Association as a screening triage tool for sepsis in long-term care.[13,14] In patients with suspected infection, the 100-100-100 criteria are met if 2 or more of the following are present: temperature >100°F, heart rate >100 bpm, and systolic blood pressure <100 mm Hg.[13,14]

Unfortunately, little is known about the prehospital course of NH residents and the performance of the above screening tools. Indeed, published studies of NH sepsis have exclusively relied on emergency department and hospital data, and none have reviewed NH records.[2–5,15–21] Thus, there is a dearth of published studies that have investigated the pre-admission status of NH residents who were subsequently hospitalized with a diagnosis of sepsis. As a result, it is unclear whether and to what extent signs are present in the days prior to hospitalization that could have allowed NH staff to identify and treat early sepsis, thereby improving overall morbidity and mortality.

To better understand the potential for earlier diagnosis of sepsis in the NH setting, we audited the records of 236 NH residents who had been hospitalized and returned to the NH, 59 whose hospital discharge diagnoses included sepsis and 177 whose discharge diagnoses did not. Data collection included demographic elements, vital signs, treatment data from ≤12 hours and 13–72 hours prior to hospitalization, and SOFA elements from the hospital discharge summaries. Our goal was to determine whether and to what extent the qSOFA, the SIRS criteria, the 100-100-100 Early Detection Tool, and the presence or absence of fever might have differentiated early sepsis from other evolving acute conditions.

Methods

Setting and Study Population

We recruited 31 community NHs in North Carolina to participate in a study of infection management. To help obtain NH buy-in, potential sites were identified through either a for-profit regional NH chain or a long-term care medical practice. A total of 35 NHs were approached for participation; 4 refused and 31 (86%) agreed to participate. The mean NH bed size was 113; 81% were for-profit; the mean occupancy rate was 87%; licensed nurses and certified nursing assistants were staffed at an average rate of 1.5 and 2.2 hours, respectively, per resident; and the mean quality rating on Nursing Home Compare was 3.3. None of these mean characteristics differ statistically from all NHs nationally.[22]

Measures and Data Collection

Within each NH, 2 data collection site visits were conducted. The first data visits were between November 2014 and March 2015 and included all 31 homes; the second visits were between December 2015 and April 2016 and included 27 homes (the others had withdrawn from the study by that time). At each visit, trained research assistants identified and audited all cases in which patients had been hospitalized and returned to the NH in the month prior to that data collection visit. Cases that did not return to the NH (20% of admissions) were excluded from the study because hospital discharge summaries were unavailable.

Each individual case's medical and nursing records were systematically audited to record signs and symptoms during 2 time periods: 0–12 and 13–72 hours prior to hospitalization. Data recorded included vital signs, visits by medical providers, and actions taken. Data were also recorded on each patient's age and sex, and whether they had been hospitalized in the 30 days prior to this hospitalization.

To help identify whether and to what extent sepsis may have been overdiagnosed, hospital discharge records available in the NH were audited to identify or calculate the following SOFA indicators: PaO_2/FiO_2, platelet count, bilirubin, mean arterial pressure, mental status impairment, and serum creatinine.[11] We did not expect many, if any, NH staff to record the GCS, as recommended in determining the qSOFA, so we also audited for any indication of alteration in mental status from baseline. Urine output, an additional measure of kidney dysfunction (beyond serum creatinine) in the SOFA scale, was not collected, as it was rarely if ever included in hospital discharge summaries.

Study methods and measures were approved by the Institutional Review Board of the University of North Carolina at Chapel Hill.

Statistical Analysis

Analyses included descriptive statistics. The 2 study samples (admissions with a sepsis diagnosis and those without) were compared using 2-tailed χ^2 statistic or the Student *t*-test, as appropriate, and calculated using SAS v 9.4 (SAS Institute, Cary, NC).[23] Data available from the NH record were used to estimate the proportion of cases with a sepsis diagnosis who met SOFA criteria for sepsis. To adjust for difference in the method of measuring temperature, we subtracted 0.75°F from rectal and tympanic readings and added 0.75°F to axillary readings to estimate an oral temperature equivalent.[24]

The sensitivity and specificity of the SIRS, qSOFA, and 100-100-100 criteria were calculated by comparing positive rates in the sepsis sample with the rates for the nonsepsis sample. Using the same method, we also calculated the sensitivity and specificity of a temperature ≥99.0°F and a temperature ≥100.2°F.[25,26]

Results

Table 1 displays demographic data, infection diagnoses in the hospital, and the clinical status in the 72 hours prior to hospitalization for the 59 sepsis and 177 nonsepsis cases. No significant difference was noted between age, sex, or prior hospitalization status of the 2 groups. One-half of the nonsepsis sample had a discharge diagnosis that included 1 or more infections, and 46% were returned to the NH on antibiotics, compared with 75% of the sepsis group.