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.

Table 1
Demographic, Health Status, and Diagnostic Data on the Study Sample of NH Residents Transferred to an Acute Care Hospital and Subsequently Returned to the NH (n = 236)

Variables	Discharge Diagnosis Includes Sepsis? Mean (SD) or N (%)		*P* Value for Difference[†]
	Yes (n = 59)[*]	No (n = 177)[*]	
Age, y	78.4 (12.2)	79.9 (11.6)	.41
Sex: Male	27 (46)	65 (37)	.23
Prior hospitalization ≤30 d beforehand	19 (32)	74 (42)	.19
Discharge diagnosis: a. pneumonia	21 (36)	46 (26)	.16
b. other respiratory infection	2 (3)	4 (2)	.46
c. Urinary tract infection	30 (51)	44 (25)	<.001
d. skin/soft tissue infection	5 (8)	10 (6)	.31
e. no infection	0 (0)	89 (50)	<.001
Patient returned to NH on antibiotics	44 (75)	81 (46)	<.001
Clinical status documentation 13–72 h before transfer			
Temperature documented	46 (78)	135 (76)	.79
Heart rate documented	44 (75)	134 (76)	.86
Respiratory rate documented	43 (73)	129 (73)	.99
Systolic blood pressure documented	44 (75)	135 (76)	.79
All 4 of the above vital signs documented	43 (73)	123 (69)	.62
Acute mental status change documented	5 (8)	9 (5)	.17
Medical provider saw resident[‡]	11 (19)	31 (18)	.74
Antibiotic prescribed	13 (22)	43 (24)	.77
Clinical status documentation ≤12 h before transfer			
Temperature documented	47 (80)	142 (80)	.93
Heart rate documented	46 (78)	147 (83)	.38
Respiratory rate documented	41 (69)	141 (79)	.11
Systolic blood pressure documented	44 (75)	144 (81)	.26
All 4 of the above vital signs documented	39 (66)	131 (74)	.24
Acute mental status change documented	22 (37)	40 (23)	.08
Medical provider saw resident[‡]	11 (19)	29 (16)	.59
Antibiotic prescribed	18 (31)	39 (22)	.14

[*]Sample sizes for selected variables were slightly reduced because of the lack of documentation.
[†]Determined by χ^2 or *t*-test.
[‡]Medical provider = physician, nurse practitioner, or physician assistant.

Documentation of vital signs and cognitive status, and of medical provider visits to the resident prior to hospitalization is also displayed in Table 1. All 4 vital signs (temperature, pulse, respiratory rate, and blood pressure) were documented during the 12 hours prior to hospitalization in 66% of the sepsis cases and 74% of the nonsepsis cases; for 13–72 hours prior to hospitalization the corresponding numbers were 73% and 69% of cases, respectively. Documentation of a change in cognitive function, a requirement of the qSOFA, was virtually never done using the recommended tool, the GCS.[27] Unstructured documentation of a mental status change was, however, present in 60% of cases, but no entries regarding a preservation of baseline mentation were noted. Documentation of a visit by a medical provider (physician, nurse practitioner, or physician assistant) in the 12 hours prior to hospital transfer was present in only 19% of the sepsis cases and 16% of the nonsepsis cases; during the 13–72 hours prior to transfer the corresponding figures were 19% and 18%, respectively. No significant differences in clinical status documentation were noted between the 2 groups.

To estimate whether sepsis cases had been overdiagnosed in the hospital, we gathered what information on SOFA indicators was available in the hospital discharge summaries and, if available, admission notes, for the 54 study participants with "sepsis" as a discharge diagnosis and with an available discharge summary. Of the SOFA elements, $PaO2/FiO_2$ could be calculated on 56% of records, bilirubin was available in 44%, mean arterial pressure in 80%, platelet count in 96%, and creatinine in 96%. Three had documentation of having been treated with intravenous epinephrine or dopamine. GCS was only available in 1 chart (2%); so, we allowed a statement of mental status impairment (60% of cases) to substitute in estimating the SOFA. Despite the incompleteness of the data, 35 (65%) of the 54 cases had a SOFA score ≥2, which is the threshold for organ dysfunction required for a diagnosis of sepsis; 21 of these 30 (56% of the sample) would have met SOFA criteria if "mental status impairment" was not allowed as a substitute for GCS. The appendix displays a table of the SOFA data from hospital records present in the study participants.

Table 2 describes the performance of the various screening tools in differentiating patients with impeding sepsis from those who would subsequently be hospitalized with a nonsepsis diagnosis, with analyses restricted to study participants for whom vital sign data were complete during 72 hours prior to hospitalization (n = 182; 73% of the sample). In the 13–72 hours prior to hospitalization, no tool had a

Table 2
Performance of Screening Tools in Distinguishing Patients Transferred From a NH to a Hospital With Early Sepsis From Patients Without Sepsis[*]

Sepsis Screening Tool	Variables	13–72 h Prior to Hospitalization		≤12 h Prior to Hospitalization	
		Nonsepsis	Sepsis	Nonsepsis	Sepsis
SIRS	Met screening criteria	6%	10%	12%	36%
	Sensitivity for sepsis		10%		36%
	Specificity for sepsis		94%		86%
qSOFA	Met screening criteria	4%	7%	13%	27%
	Sensitivity for sepsis		7%		27%
	Specificity for sepsis		96%		88%
100-100-100	Met screening criteria	16%	28%	31%	79%
	Sensitivity for sepsis		28%		79%
	Specificity for sepsis		84%		69%
Temperature ≥99.0° F	Met screening criteria	14%	22%	15%	51%
	Sensitivity for sepsis		22%		51%
	Specificity for sepsis		86%		85%
Temperature ≥100.2° F	Met screening criteria	3%	9%	7%	20%
	Sensitivity for sepsis		9%		40%
	Specificity for sepsis		97%		93%

[*]Analysis limited to study participants with complete vital sign data; n = 47 patients with a hospital discharge diagnosis of sepsis and 135 who were hospitalized without sepsis.

sensitivity above 28%, but all had high specificity (84%–97%). In the 12 hours prior to hospitalization, the sensitivity of each improved, with the most sensitive tools being 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 qSOFA (88%), the SIRS criteria (86%), and a temperature ≥99.0°F (85%).

Discussion

Sepsis is a frequent cause of morbidity and mortality among NH residents. This study from a sample of 31 NHs with characteristics similar to NHs nationally identified several issues around documentation of active surveillance and medical oversight that may have hindered early detection of sepsis. Particularly noteworthy was the absence of documentation of key status indicators, such as vital signs and cognitive status, in a substantial minority of cases, and the observation that few NH residents received a medical provider visit prior to hospital transfer. Also noteworthy was the observation that screening criteria for sepsis commonly used in hospital settings appear to perform poorly in the identification of evolving sepsis in this sample.

Our study evaluated 5 potential methods of early screening for sepsis: the SIRS criteria, the qSOFA, the 100-100-100 Early Detection Tool, and temperature thresholds of 99°F and 100.2°F. All had fair to good specificity; however, sensitivity levels were generally low. The relative importance of sensitivity vs specificity of a screening test for sepsis depends on the setting. In the hospital, where suspected sepsis leads to a large number of potentially hazardous responses, such as additional testing, invasive monitoring, and initiation of antibiotics and fluid resuscitation,[28,29] the specificity of a screening test is especially important. In the NH setting, however, where the goal should be identification of risk and initiation of intensive surveillance, high sensitivity should be preeminent in a screening tool. Here the 100-100-100 Early Detection Tool and the threshold of a temperature ≥99.0°F, performed better than the other criteria and screening tools studied. If further research confirms our results, these simple tools might be useful in identifying patients who need intensive monitoring, rapid laboratory studies, and/or an evaluation by a healthcare provider.[30,31]

A prerequisite for effective screening for sepsis in the NH is documentation of vital signs and cognitive changes that indicate incipient delirium. Table 1 demonstrates that current NH surveillance and documentation of these basic parameters is far from perfect. Indeed, over a quarter of NH residents lacked documentation of vital signs in the 72 hours prior to hospital transfer. Better surveillance of persons who undergo changes in status is, therefore, an important element of improved detection of early sepsis. How to improve cognitive status documentation, a key element of the qSOFA, is more challenging. The GCS, which the qSOFA recommends, is not appropriate for the NH setting, both because of its complexity and because it presumes a premorbid normal cognitive status.[26] Change from baseline is more relevant; however, this too is challenging to measure, because fluctuations in cognitive function are common enough in dementia to not be associated overall with acute events,[32] and because subsyndromic delirium may be more relevant in screening for sepsis risk but is quite common and heterogeneous in older persons.[33]

Particularly noteworthy was the infrequency in which we found documentation of a visit from a physician, nurse practitioner, or physician assistant during the 72 hours prior to hospital transfer. During the 12 hours prior to transfer, only 19% of the sepsis admissions and 16% of the nonsepsis admissions had a medical note or other indication of a provider examination. While it is unrealistic to expect NH medical staff to have the same on-site presence as their hospital counterparts,[34] from the standpoint of effective early diagnosis of sepsis, this may be a situation where healthcare providers are indeed "missing in action" and care, therefore, suffers.[35] A possible solution is telemedicine, if the resources were put in place to make on-call physicians able to have a robust virtual visit to patients with changes in medical status, and if reimbursement were provided at an appropriate level for such services.[36]

An effective NH sepsis prevention and early detection program will, therefore, require several changes to current care practices. One approach would be to obtain ongoing vital signs on all residents for whom staff notice a status change that could constitute an early sign of infection, and to use the vital signs to screen for sepsis risk employing the 100-100-100 Early Detection Tool and/or a temperature threshold of 99.0°F or greater (or 2 standard deviations above that resident's normal temperature).[25] NH residents who screen positive would then have an in-person or virtual visit with a medical provider, and would begin scheduled vital sign recordings every 4 hours. Ideally, rapid diagnostic testing and result availability for such markers as the white blood count, serum lactate level, and possibly serum calcitonin would also be put in place, as has been done for portable radiographic testing. A protocol incorporating all of these elements could be expected to reduce hospitalizations for sepsis while improving diagnostic and treatment time for patients with true sepsis. Consequently, further research into practice changes that would make this capacity possible should be considered a priority.

Our study has several limitations. Because the research was conducted using an institutional review board approved waiver of informed consent, our study staff did not review all hospital records but rather depended on what hospital records were returned to the NH. As a result, we excluded from our study the 20% of NH residents who were hospitalized and failed to return to the NH, either because of death or discharge to a different setting. Furthermore, our ability to determine whether study participants met SOFA criteria was limited to discharge summaries and, if available, admission records. So, while only two-thirds of study participants met SOFA criteria based on our data collection, more might have met SOFA criteria if complete records had been reviewed, and, as in many hospital settings, our diagnostic standard for sepsis (the hospital discharge summary) may have lacked diagnostic specificity.[37]

Conclusions

This study found that a substantial minority of NH residents who were subsequently hospitalized for sepsis did not have vital signs documented prior to hospital transfer, and that the majority were not seen by a physician, nurse practitioner, or physician assistant prior to transfer. It also found that no tool adequately screens for early sepsis in the NH population but that several show some promise. Most importantly, it demonstrated that 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. Finally, the poor performance of all screening tests means that medical and nursing staff must not overinterpret or overreact. As a result, NH medical staff will have to continue using clinical judgment and what tools are available in an attempt to negotiate between the Scylla of underdiagnosis and the Charybdis of overtreatment.

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Appendix

Spreadsheet of Data for Calculating SOFA Score Among Sepsis Participants With Hospital Discharge Summaries (n = 54)

ID	PaO_2/FiO_2	Respir-ation Score	Highest Bilirubin	Liver Score	Mean Arterial Pres-sure	Cardio-vascular Score	Lowest Platelet Count	Coagulation score	GCS	MSI	CNS Score Using GCS Only	Adjusted CNS Score with MSI	Creatinine	Renal Score	Rough SOFA Score with MSI	Rough SOFA Score without MSI[‡]
12221			0.54	0			116000	1					0.6	0	1	1
14208	214	2	1	0			179000	0		Yes		1	1.98	2	5	4
14216			0.3	0			185000	0		Yes		1	0.77	0	1	0
15221	329	1			66	1	288000	0					0.6	0	2	2
15222	329	1	0.19	0	87	0	475000	0					0.6	0	1	1
16137							432000	0		Yes		1	0.56	0	1	0
20127							262000	0		Yes		1	0.9	0	1	0
20221	410	0			105	0	168000	0		Yes		1	1.4	1	2	1
20226	410	0					256000	0		Yes		1	2.2	2	3	2
20229	329	1	0.6	0			183000	0		Yes		1	1.4	1	3	2
21207	290	2					217000	0					2.82	2	4	4
21208[*]			0.9	0	67	2	205000	0		Yes		1	4.51	3	6	5
21211					86	0	453000	0					2.8	2	2	2
21215					76	0	151000	0					1.02	0	0	0
22222	282	2	0.5	0	110	0	145000	1		Yes		1	0.93	0	4	3
22223															0	0
22228	192	3			117	0	127000	1		No		0	0.65	0	4	4
24201	690	0			76	0	623000	0		Yes		1	2.9	2	3	2
24204	138	3			76	0	161000	0		Yes		1	1.4	1	5	4
24206			0.3	0			170000	0		Yes		1	1.4	1	2	1
25227	533	0	0.84	0	77	0	144000	1		Yes		1	1.73	1	3	2
27207			0.4	0	88	0	206000	0	14	Yes	1	1	0.59	0	1	1
28021					65	1	384000	0		Yes		1	0.8	0	2	1
28022							232000	0					2.4	2	2	2
28024					72	0	316000	0					1.5	1	1	1
28234	690	0			66	1	401000	0		Yes		1	1.8	1	3	2
28237			0.8	0			377000	0		Yes		1	1.5	1	2	1
30202	348	1	0.7	0	86	0	218000	0		Yes		1	1.5	1	3	2
30207			0.2	0	97	0	246000	0		Yes		1	2.6	2	3	2
32102					75	0	109000	1							1	1
32227	203	2	0.6	0	68	1	332000	0					1.27	1	4	4
33227	261	2			93	0	361000	0		Yes		1	1.03	0	3	2
33229	282	2	0.7	0	87	0	118000	1		Yes		1	0.41	0	4	3
33231	307	1	0.9	0	71	0	181000	0					0.59	0	1	1
33235					68	1	155000	0		Yes		1	1.14	0	2	1
34005			0.6	0	75	0	299000	0		Yes		1	1.04	0	1	0
35114[†]			0.8	0	71	0	245000	0		Yes		1	2.7	2	3	2
35207	690	0			109	0	712000	0					0.88	0	0	0
36205	269	2			79	0	296000	0					1.23	1	3	3
36220	533	0			66	1	82000	2		No		0	1.25	1	4	4
38118							284000	0		Yes		1	0.72	0	1	0
39107			1.1	0	60	1	174000	0		Yes		1	1.4	1	3	2
39215[†]	210	2			58	1				Yes		1	0.8	0	4	3
39219	376	1	0.5	0	66	1	535000	0		Yes		1	1.3	1	4	3
39221	392	1			57	1	453000	0		No		0	1	0	2	2
40207			0.28	0	97	0	278000	0		Yes		1	1.1	0	1	0
44015[†]	232	2			64	1	325000	0		Yes		1	0.69	0	4	3
44202					115	0	194000	0		No		0	1.32	1	1	1
44204	376	1	0.4	0	104	0	295000	0					0.46	0	1	1
44209	690	0	0.4	0	100	0	248000	0		Yes		1	1.1	0	1	0
47005	329	1			90	0	124000	1		Yes		1	2.9	2	5	4
47008	376	1			108	0	349000	0					1.4	1	2	2
47237							273000	0		No		0	0.6	0	0	0
49011	247	2	0.5	0	89	0	171000	0		No		0	0.82	0	2	2

CNS, central nervous system; ID, identification; MSI, mental status impairment.

[*]Received dopamine.

[†]Received norepinephrine.

[‡]In spite of considerable data being missing, 35 (65%) of the 55 patients met SOFA criteria for organ dysfunction when MSI was included as a substitute for the GCS, and 30 (56%) met SOFA criteria for organ dysfunction.