Sepsis: A Call for Incorporation of Regional Data and Improved Education Programs

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Abstract

The incidence and impact of sepsis is rising in spite of efforts to increase recognition and enhance treatment. While international and national efforts to address this serious disease continue to develop, there are limited data describing the impact of sepsis at a regional level or the availability of interventions to improve patient outcomes. For example, in 2012, one of every five deaths that occurred in Nevada hospitals was attributed to sepsis. Here we aim to review the epidemiologic data on sepsis at national and regional levels and highlight the importance of professional nurses as a pool of front-line practitioners that can be empowered to improve sepsis outcomes. Specifically, simulation based learning programs are a resource, when regionally available, that have the potential to improve practitioner performance and recognition in the treatment of sepsis.

Key Words: Sepsis, hospital acquired infections, simulation based education.

Introductions

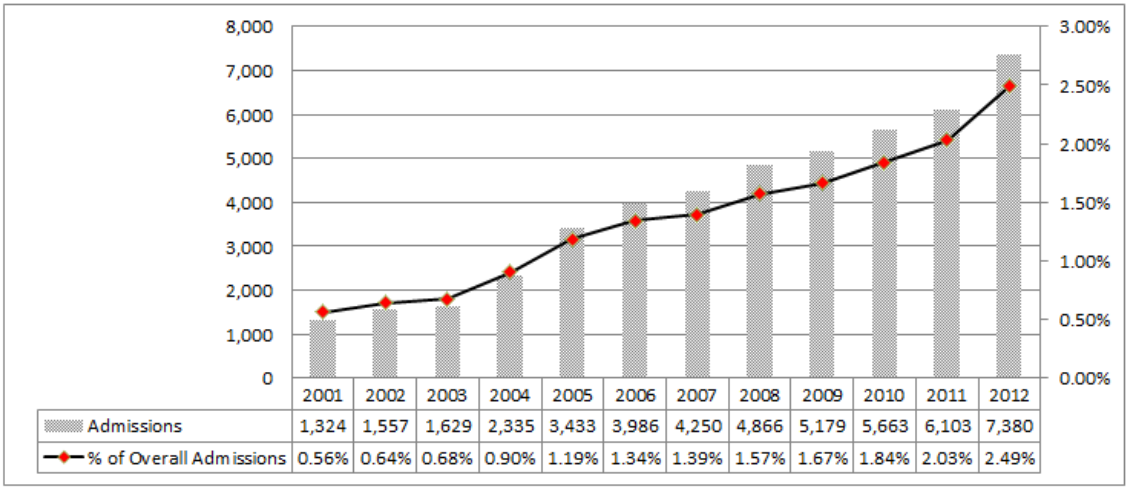
Sepsis is a serious bacterial, viral, fungal or parasitic infection with systemic involvement (Dellinger, Levy, Rhodes, Annane et al., 2013). Sepsis is complex and can be difficult to diagnose and treat because of unspecific temperature, blood pressure and respiratory rate changes that can mimic a variety of disease states (Kent & W, 2012). If unrecognized or left untreated, sepsis and its syndrome of systemic inflammation can progress to end organ failure or septic shock. As infections can develop rapidly, early recognition by health- care professionals is pivotal to the implementation of therapy (Institute for Health Policy, 2012). Recently, sepsis has been shown to result in more than 200,000 deaths annually (Wang, Devereaux, Yealy, Safford et al., 2010) and historic data demonstrate more than one million sepsis-associated deaths between 1999 and 2005 in the U.S. (Melamed & Sorvillo, 2009) despite these alarming figures, hospitalization rates for sepsis have continued to increase 24% to 37.7% (Hall, Williams, DeFrances, & Golosinskiy, 2011). This article is an overview of the incidence and prevalence of sepsis, as well as a discussion on specific efforts to decrease sepsis rates. Because of the specific importance of this subject in professional nursing, we propose the use of simulation-based learning to educate nurses in the recognition and care of patients at risk of sepsis.

Background

Despite advances in medicine (i.e. vaccinations, antibiotics, acute care hospitals, and evidence- based guidelines), sepsis remains the primary cause of death from infection and is one of the most expensive ailments to treat (Francis, Rich, Williamson, & Peterson, 2010; Kissoon & Carcillo, 2013). Worldwide, the incidence of sepsis is nearly 18 million cases with a mortality of nearly 25% and increasing direct healthcare costs (Calle, Cerro, Valencia, & Jaimes, 2012; Kissoon & Carcillo, 2013). In the United States, hospitalizations due to sepsis more than doubled from 2000 to 2008, with patient treatment costs estimated at $14.6 billion in 2008 alone (Melamed & Sorvillo, 2009). Every year, 750,000 people become septic, making sepsis among the most common causes of hospitalization, and it has become the number one cause of death in U.S. hospitals (Institute for Health Policy, 2012; Lopez-Bushneil, Demaray, & Jaco, 2014). Sepsis cases are expected to rise 1.5% annually and result in over 1 million cases by 2020 (Namas, Zamora, Namas, An et al., 2012). Sepsis in the United States has been associated with hospital mortality rates of 30%, with escalations to 60% seen when the condition progresses to septic shock (American Association of Critical-Care Nurses, 2010; Murphy, Xu, & Kochanek, 2013; Powell, Khare, Courtney, & Feinglass, 2010; Tromp, Hulscher, Bleeker-Rovers, Peters et al., 2010). With delays in recognition and treatment sepsis can progress to septic shock and death 36 hours (Francis et al., 2010; Kissoon & Carcillo, 2013; Melamed & Sorvillo, 2009). Patients with sepsis have higher hospital bills and longer lengths of stay compared to patients with other illnesses. In addition, sepsis survivors, after accounting for co-morbidities, have an increased risk of death for up to 5 years (Wang et al., 2010). Furthermore, the aftercare for sepsis patients is a serious public health concern. Cognitive impairments and physical disabilities (Melamed & Sorvillo, 2009) have been shown to increase significantly (6.1 to 16.7 %) after a diagnosis of sepsis (Dumont & Harding,

2013; Iwashyna, Ely, Smith, & Langa, 2010; Melamed & Sorvillo, 2009). Considering the impact of sepsis, it is important to recognize at-risk populations. Two thirds of the patients hospitalized for sepsis in the U.S. in 2008 were over 65 years of age and among those 85 years and older, progression to sepsis from an initial infection is 30 times more likely (Latto, 2008; Melamed & Sorvillo, 2009).Additionally, from 2001 through 2005, patients over age 46 accounted for 92.8 % of all sepsis related deaths (Dumont & Harding, 2013).

Regional data on sepsis can illustrate important needs within a community. For example, while mortality data in Nevada have been consistent with national and international trends, (21% of hospital deaths being due to sepsis), it is only after careful examination of these data that key trends arise among hospital deaths from sepsis, 41% occurred outside of Clark County, which represent only 28% of the state population (Greenway, 2014). Additionally, recent hospitalizations in Nevada have increased more than 500% (1,324 to 7,380) despite only a 36% rise in Nevada's population (Greenway, 2014). Furthermore, assessment of regional data demonstrates an increasing burden on the regional healthcare system, with sepsis accounting for a progressively larger proportion of hospital admissions over time (Figure 1).



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Admissions	1,324	1,557	1,629	2,335	3,433	3,986	4,250	4,866	5,179	5,663	6,103	7,380
% of Overall Admissions	0.56%	0.64%	0.68%	0.90%	1.19%	1.34%	1.39%	1.57%	1.67%	1.84%	2.03%	2.49%

Figure 1. Twelve years of Nevada hospital admissions with a principal diagnosis of sepsis and the percentage these cases represent to overall hospital admissions (Center for Health Information Analysis hospital claims data).

Analysis of admission data for sepsis also highlights important healthcare systems issues at the state level. Nevada data demonstrate 83.2% of referrals for sepsis hospitalizations were from physician referrals. Further analysis provides insight into differences in severity among sepsis cases from different sources, as hospital mortality ranged from 15.2% to 32.9% depending on the source of the referral. Patients transferred from skilled nursing facilities represented the highest rates of death overall, with rates even exceeding those of patients requiring transfer between acute care hospitals (32.9 vs. 28.1%). (Table 1)

Table 1. Calendar 2012 Nevada hospital admissions with a principal diagnosis of septicemia, by referral source (Center for Health Information Analysis hospital claims data).

	Admissions		Expirations	
ReferralSource	Frequency	Percent	Frequency	Percent
Physician Referral	6,143	83.2%	1,049	17.1%
Transfer from a Hospital	589	7.6%	122	20.7%
Transfer from a Skilled Nursing Facility	252	3.3%	83	32.9%
Clinic Referral	130	1.7%	21	16.2%
Transfer from Another Health Care Facility	121	1.6%	34	28.1%
Other	145	1.9%	22	15.2%
Total	7,380	100.0%	1,331	18.0%

It is also important to consider the economic impact of sepsis at a regional level. Nevada remains among the highest states(inclusive of the District of Columbia) in the U.S. for unemployment (51st as of 2/2014 United States Department of Labor, Bureau of Labor Statistics (**http://www.bls.gov/lau/lastrk13.htm)** and 48th for geographically adjusted poverty level (**http://scorecard.assetsandopportunity.org/2014/state/nv)**. Contrasting these regional financial limitations are the aforementioned increasing healthcare burdens of sepsis. In 2012, for patients with a principal diagnosis of septicemia, compared to all inpatient hospital claims, average hospital charges increased ($128,404 vs. $54,687) as well as length of stay (9.7 vs. 5.3 days) and of adults admissions with a principal diagnosis of septicemia, 8.5% were readmitted to a hospital during the following year (Greenway, 2014).

A finer resolution of state data, such as county level, can be used to identify anomalies in patient outcomes. For example, at less than 1% of the state population, Churchill County is among the least inhabited areas in Nevada. However, proportionately Churchill County had the highest number of sepsis cases (497 per 100,000 residents). Comparatively, Lincoln County contains less than one quarter the population of Churchill County yet had the lowest number of sepsis cases (75 per 100,000 residents) in the state. Regional analysis of data such as these can help identify areas requiring focused attention within a state's healthcare system. It is possible that the disproportionate mortality rate in the medically underserved Churchill County could be mitigated with improved healthcare delivery, as this death rate was considerably higher than that for the most populated areas of Clark and Washoe Counties (23.9 and 55.3% lower sepsis mortality, respectively) (Greenway, 2014). (Table 2)

Table 2. Calendar 2012 cases per 100,000 population, Nevada hospital admissions and expirations of patients with a principal diagnosis of septicemia, by patient county (Center for Health Information Analysis hospital claims data).

	Cases per	Admissions		Expirations	
Patient County	100K population	Frequency	Percent	Frequency	Percent
Clark	216	4,206	54.4%	791	18.8%
Washoe	380	1,609	20.8%	242	15.0%
Carson City	352	200	2.6%	19	9.5%
Lyon	338	178	2.3%	23	12.9%
Churchill	497	123	1.6%	22	17.9%
Nye	270	118	1.5%	28	23.7%
Douglas	220	100	1.3%	17	17.0%
Elko	134	66	0.9%	12	18.2%
Mineral	821	39	0.5%	9	23.1%
Humboldt	157	28	0.4%	6	21.4%
White Pine	148	15	0.2%	0	0.0%
Lander	186	11	0.1%	3	27.3%
Pershing	163	9	0.1%	1	11.1%
Lincoln	75	4	0.1%	0	0.0%
Storey	422	4	0.1%	0	0.0%
Eureka	106	2	0.0%	0	0.0%
Esmeralda	124	1	0.0%	0	0.0%
Out of State	NA	651	8.4%	152	23.3%
Unknown	NA	16	0.2%	6	37.5%
Total		7,380	100.0%	1,331	18.0%

Additional regional disparities can be seen in specific age and racial groups. In Nevada, Caucasians are overly represented in sepsis admissions and deaths when compared to Hispanics and blacks (Greenway, 2014). Blacks are 7% of Nevada's population and make up 7.3% of sepsis admissions and 8.3% of sepsis deaths. Hispanics are 20% of the population and make up 8.6% of sepsis admissions and 8.6% of sepsis deaths. Whites are 53% of Nevada's population and make up 74.3% of sepsis admissions and 71.6% of sepsis deaths. Furthermore, age is an important risk factor for sepsis mortality in Nevada, as a patient aged 65 and older is three times more likely to die than patients between the ages of 18 and 35 (Greenway, 2014).

Sepsis Initiatives

There are several organized efforts to reduce the impact of sepsis. The *Surviving Sepsis Campaign*, the *Survive Sepsis* initiative, the *Institute for Healthcare Improvement*, and the *German Sepsis Society* are examples of collaborative efforts in the international healthcare arena to improve patient outcomes with sepsis. Specifically, The *Surviving Sepsis Campaign* (SSC) is an ongoing collaborative initiative formed in 2002 with members from the *European Society of Critical Care Medicine*, the *International Sepsis Forum* and the *Society of Critical Care Medicine* that develops and updates guidelines emphasizing research findings that early identification and treatment for sepsis increases patients' chances of survival (Hitti, Lewin, Lopez, Hansen et al., 2012; Melamed & Sorvillo, 2009; Nguyen, Corbett, Steele, Banta et al., 2007; Nguyen, Oh, Otero, Burroughs et al., 2010; Tromp et al., 2010). These evidence based interventions provide healthcare professionals with clinical guidelines for the early identification of patients at high risk for sepsis, and reduce the morbidity and mortality associated with a diagnosis of sepsis. Work remains to be done, as several studies illustrate a lack of recognition by healthcare professionals of patients at high risk for sepsis or who have a diagnosis of septicemia. In addition, funding for sepsis research remains less than that for stroke, cancer, heart disease, and human immunodeficiency disease combined (De Miguel-Yanes, Andueza-Lillo, González-Ramallo, Pastor et al., 2006; Institute for Health Policy, 2012; Jones, Focht, M, & Kline, 2007; Kissoon & Carcillo, 2013).

Even with this limitation, there are national initiatives to decrease the impact of sepsis cases in hospitals and reduce mortality. Examples of this are the use of protocoled early goal directed therapy and incorporation of SSC guideline recommendations to train healthcare professionals on early recognition and treatment of sepsis (Turi & Von Ah, 2013). Additionally, initiatives, such as the Center for Medicare and Medicaid's program Partnership for Patients, employs elements, such as hospital engagement networks, that seek to make hospitals safer by reducing preventable injuries and complications in hospital patient care including nosocomial sepsis. This partnership has over 8,000 members from federal agencies, offices, and other interested stakeholders across the nation committed to providing safe and effective patient care (Center for Medicare and Medicaid Services). Another effort is the *Kaiser Permanente Sepsis Care Performance Initiative* (Institute for Health Policy, 2012) that has developed and implemented guidelines for patients with an infection and abnormal vital signs in an effort to provide early recognition and receive prompt and aggressive treatment to patients with sepsis. Furthermore, the Kaiser Initiative utilizes simulation to train physician's techniques to avoid preventable infections and safe treatment. These efforts have demonstrated a threefold increase in the rate of sepsis detection and a 60% reduction in mortality for septic patients (Institute for Health Policy, 2012).

Existing programs in Nevada do include efforts to reduce the incidence of infections that can develop into sepsis. Hospital Engagement Networks (HENs) have been developed to identify solutions to reduce hospital acquired conditions and decrease readmission rates for these hospital acquired conditions. The HENs system also works to disseminate these solutions to other hospitals and healthcare providers (HEN, 2013). There are five HENs servicing Nevada: 1) Dignity Health, 2) Nevada Hospital Association, 3) Premier, 4) University Health System Consortium and, 5) Lifepoint Hospitals, Inc. that include 39 of the 63 licensed hospitals in the state (Center for Medicare and Medicaid Services). The Nevada HENs are comprised of 24 Partnership for Patient (PfP) eligible facilities, and 15 non-PfP eligible facilities. HENs across the country are responsible for encouraging incorporation of patient safety programs, such as the Leading Edge Advance Practice Topics (LEAPT) program, that focuses on 10 areas of patient safety, such as reducing sepsis acquired within hospitals (Center for Medicare and Medicaid Services).

Other examples of regional projects that may improve sepsis outcomes in Nevada include The Nevada Hospital Association, partnered with HealthInsight, that funded efforts to assist in the implementation of the Comprehensive Unit based Safety Program which targets Catheter Associated Urinary Tract Infections (CUSP CAUTI) (Center for Medicare and Medicaid Services). While efforts like this are admirable, only through dissemination of regional data and sharing successful strategies can

progress be made on improving patient outcomes. Unfortunately, in the current absence of such a dissemination program in Nevada, CAUTI and CLABSI rates continue to rise with significant risk of contributing to the burden of sepsis.

Simulation Based Hospital Education

While the aforementioned worldwide initiatives to decrease sepsis rates continue to focus on quality improvement programs and implementation of evidence based strategies (i.e. the SCC guidelines), these guidelines are unable to curb the rise in sepsis rates alone. The Institute of Medicine's report *The Future of Nursing: Leading Change, Advancing Health* recommends incorporating high-fidelity simulation (HFS) into education programs on patient safety and could provide real benefit to sepsis education programs (Horst, White, & Lowe, 2012). HFS is an active-learning strategy that facilitates higher order thinking and provides hands-on experience, reflection on action, abstract conceptualization, and experimentation with elements that assist learning in adults (Arwood, 2009; Kolb, 1984). HFS has been effective throughout the spectrum of professional education with benefit demonstrated in the education of clinically practicing professional nurses, as well as smoothing the transfer transition of new graduate nurses into practice (Arwood, 2009; Horst et al., 2012; Liaw, Chan, Scherpbier, Rethans et al., 2012; Nagle BM, 2009). The principles and practices of HFS lend themselves well as a means by which healthcare educators could instruct early recognition and treatment of sepsis in a simulated patient with high risk for sepsis.

Currently, there are little published data on the use of HFS for sepsis education programs. However, hospital educators consider HFS an effective learning strategy for several important clinical scenarios for registered nurses (Askew, Trotter, Vacchiano, Garvey et al., 2012). For example, HFS training has been used to identify and improve "failure to rescue" situations in cardiac and respiratory arrests, resulting in a clinically meaningful performance improvement of 300% with improved situational awareness and disease recognition where nurses called the emergency response team 60% more often and recognized clinical deterioration early (Askew et al., 2012). Additionally, HFS for team training for medical surgical nurses is an effective learning strategy with demonstrated improvement in recognition of clinical deterioration, improved knowledge, confidence, teamwork, and clinical performance outcomes (Cooper, Kinsman, Buykx, McConnell-Henry et al., 2010; Harvey, Echols, Clark, & Lee, 2014). Simulation based learning in combination with HFS augments these outcomes with positive results in both clinical nurses and nursing students to detect deteriorating health in patients at a high risk for sepsis (Fisher & Lindy, 2013).

The implementation of sepsis bundles and evidence based guidelines can be effectively taught with HFS (Ross, 2012). Some hospitals currently use HFS with sepsis scenarios as part of critical care orientation, obstetric emergencies, and for failure to rescue events for practicing nurses (Aebersold & Tschannen, 2013; Askew et al., 2012; Ottestad, Boulet, & Lighthall, 2007). Ottestead, Boulet and Lighthall developed a scoring system to evaluate sepsis management by residents engaged in HFS with sepsis scenarios (Ottestad et al., 2007). Despite standardized sepsis education on evidence-based sepsis bundles and on crisis resource management delivered on rounds, in classroom lecture, and in printed form, there were significant differences in the management of the simulated septic shock patient. These data were valuable and used to implement educational interventions to improve the care of patients with sepsis. We recommend that hospital educators incorporate HFS into sepsis education programs. This strategy could provide healthcare professionals time to rehearse or practice caring for a simulated patient at high risk for sepsis in a safe, controlled environment without the repercussions of making clinical mistakes or sub-optimal decisions on living patients (Aebersold & Tschannen, 2013).

While the financial burden of individual hospitals instituting their own HFS program with site-specific equipment and instructors is impractical, Nevada is uniquely positioned to impact the majority of healthcare providers through integration of existing facilities. Currently, the Nevada System of Higher Education maintains the Clinical Simulation Center of Southern Nevada (CSCSN) and the Nevada Clinical Simulation Lab with both located in proximity to more than 85% of the Nevada state population (University of Nevada Las Vegas and University of Nevada respectively). Current precedent exists for utilization of these facilities for the education of clinical staff as the CSCSN hosts regular TeamSTEPPS education courses for critical care nurses and has several simulation programs (including sepsis education) for physicians in training at the University Medical Center of Southern Nevada. Through utilization of existing simulation facilities staff the financial impact of HFS incorporation could be minimized if hospital systems would negotiate for integration with those resources and adopt such programs as a priority in their own continuing education efforts.

Conclusions and Recommendations

There is a growing concern over the individual and societal burden caused by a diagnosis of sepsis. Currently in the U.S., there is wide variation in state sepsis outcome rates (41 to 80.1 deaths per 1,000,000 persons) (Wang et al., 2010). It is important for nurses to be knowledgeable on the most current research on evidence based sepsis practice and on the incidence and prevalence of sepsis. We have illustrated that data from different geographical regions can provide important guidance for directors of education in hospitals and professional nurses on the early identification, diagnosis, treatment and prevention of sepsis. Additionally, we have presented evidence in the literature as to the effectiveness of utilizing HFS as a learning strategy on sepsis.

We Recommend:

- Nurse educators in hospitals should be encouraged to implement sepsis educational programs that include sepsis guidelines, bundles, and the latest research on the pathophysiology of sepsis.
- Hospital education programs incorporate high fidelity simulation scenarios on sepsis as part of a comprehensive program on early recognition of a patient at high risk for sepsis.
- Hospital education departments without simulation technology could benefit from partnerships with nurse educators in academia who have expertise in education and in HFS.

  These efforts may have a positive impact on early identification of a patient at high risk for sepsis and may improve patient outcome

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