Epidemiological study of sepsis in Mexican intensive care units

Raúl Carrillo-Esper,* Jorge Raúl Carrillo-Córdova,** and Luis Daniel Carrillo-Córdova**

Abstract

Background: Consistent data about sepsis in Mexico are lacking. The objective of this epidemiological study is to better define the incidence, characteristics and outcome of sepsis in Mexican intensive care units (ICUs).

Methods: This is a multicenter, transverse study performed in both private and public ICUs. Demographic data, comorbid diseases and clinical and laboratory data were collected prospectively.

Results: A total of 135 ICUs from 24 states of Mexico were studied. From 40,957 annual hospitalizations 11,183 were due to sepsis, which represented 27.3% of admissions to ICU. From 11,183 patients with sepsis, 3402 died, representing a mortality rate of 30.4%. The most frequent sepsis trigger was abdominal infection (47%) followed by pulmonary infection (33%), soft tissue infection (8%) and kidney infection (7%). 5% were from other sources (neurological, osteoarticular). From the isolated bacteria, 52% were gram negative, 38% gram positive and 10% fungal infection; 60% of the private hospital ICUs and 40% of public hospital ICUs applied the Surviving Sepsis Campaign (p<0.05). In 50% of each of the ICUs, they adhere to the campaign recommendations. Costs in septic patients are high.

Conclusions: This study documents the high incidence of sepsis in Mexican ICUs, with high mortality rate and low adherence to Surviving Sepsis Campaign. Our data suggest that sepsis is a public health problem in Mexico.

Key words: sepsis, intensive care unit.

Introduction

Sepsis is a systemic, secondary inflammatory response to infections and represents a challenge in diagnosis and patient management. When it evolves to septic shock and multiple organ failure, its mortality rate reaches 27%-59% with long hospital stays and high management costs.1

Several epidemiological studies have demonstrated that sepsis is one of the chief reasons for admission to the intensive care unit (ICU) and represents a public health problem. Angus et al. analyzed 6 million hospital admissions in the U.S. and found 751,000 sepsis cases per year, representing a mortality rate of 26.6% and an average cost of $22,100 USD per patient ($16.7 billion USD annually). Martin’s epidemiological study, which analyzed U.S. hospitalizations occurring over 22 years, reported that of 750 million admissions, 10,319,418 were related to sepsis, describing an increased sepsis proportion from 82.7 cases/100,000 inhabitants in 1979 to 240.4 cases/100,000 inhabitants in 2000. Alberti et al. analyzed sepsis tendency in a study involving European and Canadian ICUs reporting that of 14,364 admissions, 4500 were related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%. The SOAP study (Sepsis Occurrence in Acutely Ill Patients) reported that 30% of ICU admissions in European hospitals are related to sepsis, with a mortality rate of 53%.
management, mortality rate and associated care costs through an instrument called the National Sepsis Survey (NSS).

**Materials and Methods**

We carried out a multicenter, descriptive, transverse study by creating a measurement instrument named NSS to evaluate epidemiology and behavior of sepsis in Mexican ICUs. The instrument was certified by the Mexican Association of Critical Medicine and Intensive Care (AMMCTI). Public and private hospitals were invited, especially ICU chiefs of service/managers. The instrument was validated and fine-tuned by a professional survey agency (MCC & Warren, Contact Marketing Agency) based on a pilot group to fine-tune questions regarding their clarity and ease of understanding. Surveyors were trained to avoid confusion and bias while collecting data as part of a quality control process. NSS was conducted in 1 day in selected ICUs according to their representativeness in some Mexican states, selected by the number of beds, number of reference institutional centers and number of patients. Selected ICU operations were not modified, the identity of ICUs was kept confidential and no conflicts of interest were reported. The following states were included: Aguascalientes, Baja California Norte, Chihuahua, Coahuila, Distrito Federal, Estado de México, Guerrero, Hidalgo, Jalisco, Guanajuato, Morelos, Nuevo León, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz, Yucatán, Zacatecas.

The following variables were collected:

- Hospital characteristics: hospital type (public or private), ICU type (open or closed), number of beds, healthcare personnel characteristics (intensive care medicine specialization and certification), equipment characteristics, number of admissions and 10 top admission diagnoses; degree of knowledge and implementation of Surviving Sepsis Campaign (SSC)

- Patient characteristics: age, sex, comorbidities, clinical and infectious agent information, administered antibiotics and antifungals, SSC7 adherence and follow-up, hospitalization costs, outcome (survival or death)

Disease seriousness was evaluated through APACHE score and the number of organ failures using SOFA scale.

Patients included in the study were >18 years of age, and had been diagnosed with sepsis on the day the survey was conducted. In order to unify criteria we used definitions from ACCP/SCCM Consensus Conference Committee (American College of Chest Physicians/Society of Critical Care Medicine). Infection

Infection is defined as the presence of a pathogenic microorganism in a usually sterile environment (blood, cerebrospinal fluid, ascitic fluid) or as clinically suspicious infection plus antibiotic administration.

**Sepsis**

Sepsis is defined as infection associated with two or more systemic inflammatory criteria.

**Diagnostic criteria of systemic inflammatory response**

These include body temperature <36°C or >38°C; heart rate <90 beats/min; respiration rate >20 breaths/min or PaCO2 £32 mmHg, mechanical ventilation; leukocytosis >12,000/mm³ or leukopenia <4000 mm³.

**Severe sepsis**

Sever sepsis is defined as sepsis associated organ dysfunction

- **Multiple organ dysfunction**
  - **cardiovascular failure**—patient requires vasopressor/inotropic drugs and/or SAP <90 mmHg or SAP >40 mmHg from base
  - **renal failure**—urine volume <700 ml/day or progression in RIFLE score
  - **respiratory failure**—PaO₂ <70 mmHg or PaO₂/FiO₂ ratio <250 in mechanical ventilation
  - **hematologic failure**—platelet count <80,000

**Infection acquired in ICU**

These are defined as infections occurring >48 h from the time of ICU admission.

**Fungemia**

Fungemia is defined as a positive fungal blood culture associated with signs, symptoms and organ involvement.

**Antibiotics**

Use of antibiotics is defined as daily administration of at least one of the following antibiotics: penicillin, cephalosporin, carbapenem, macrolide, glycopeptide, aminoglycoside, quinolone, sulfates, among others.

The work load for treating a patient with sepsis was evaluated using TISS-28 (Therapeutic Intervention Scoring System). Each TISS point is equivalent to 10.6 min of nursing work during an 8 h shift and indicates the patient’s condition and number of interventions implemented for his care.
We classified ICUs according to their operation characteristics: **polyvalent**: a non-specialized ICU admitting any seriously ill patient; **monovalent**: a specialized ICU admitting patients from certain specialties (cardiology, neurology, trauma, etc.); **open**: patients are managed by healthcare personnel who are not yet intensive care specialists; **closed**: patients are managed only by intensive care specialists.

We evaluated sepsis development as a whole and, afterwards, we compared its evolution (survival or death), treatment resources and costs among public and private institutions.

Data were gathered prospectively by completing the NSS printed form. All subjects interviewed were informed personally and in detail how to complete the form, research purposes and, if necessary, a glossary to avoid conceptual bias and therefore an erroneous form completion. A web link was opened at AMMCTI site to improve communication with surveyed personnel and guarantee proper form completion (www.ammcti.org.mx). This web site contained details on the survey, procedure and definitions.

**Statistical Analysis**

All results were expressed as trends and standard deviations. The difference between incidence and mortality in groups was evaluated using $\chi^2$. The difference between costs was evaluated using Student’s t-test. The effect of hospital sepsis mortality was considered statistically significant if regression coefficient was $p < 0.05$.

**Results**

The survey was applied in 135 ICUs from 24 Mexican states. Of these, 64 (48%) were private institutions and 71 (52%) were public institutions. The following public institutions were included: IMSS (Mexican Social Security Institute), ISSSTE (Institute for Social Security and Services for State Workers), SS (Secretary of Health), Red Cross and PEMEX hospitals. Total annual admissions to surveyed ICUs was 40,957 patients. Of these, 29,181 admissions were to public hospitals and 11,776 admissions were to private services (statistical difference, $p < 0.01$). The annual average admissions per public ICU is 411 patients and 184 admissions per private ICU ($p < 0.01$). Of surveyed ICUs, 54% were polyvalent, 23% open, 15% closed and 8% monovalent, with an average of 13 beds in public ICUs and 9 beds in private ICUs ($p < 0.05$).

**Personnel**

Regarding nurses, only 6.4% working at public ICUs are specialized and certified in seriously ill patients care. Only 5% of nurses working at private facilities are certified. Most nurses working at ICUs are general nurses or have taken short updated courses to deal with seriously ill patients. TISS was high and related to patient severity and the number of support measures required for treatment. As for physicians, all ICUs have intensive care specialists; however, the number is not high enough to provide service 24 h/day, 365 days/year. The average numbers of specialists per unit are 3.7 in public ICUs and 3.6 in private ICUs. Units or shifts that do not have an intensive care specialist are managed by internal medicine physicians in 70% of cases.

**Equipment**

Equipment available in surveyed ICUs is shown in Figure 1. A large number of ICUs, either public or private, lack specialized equipment such as mechanical ventilation, hemodynamic monitoring, hemodialysis, neurological monitoring with bispectral analysis (BIS) and intracranial pressure (ICP), and echocardiograph ($p < 0.05$). Private ICUs have more equipment for hemodialysis, neurological monitoring with BIS and ICP, as well as echocardiograph ($p < 0.05$). On the other hand, we found no significant difference regarding the availability of equipment for mechanical ventilation, hemodynamic monitoring and specialized beds among both ICU types.
Sepsis and Surviving Sepsis Campaign (SSC)

Of 40,957 annual admissions to ICUs, 11,183 presented sepsis (27.3%). Public ICUs received 9230 cases with an annual average of 130 cases per unit. Private ICUs received 1953 cases with an annual average of 31 cases per unit. The difference was significant between the number of cases assisted in public and private ICUs ($p < 0.01$).

Of 11,183 patients with sepsis, 3402 died (30.4%). Of fatal cases, 2953 (87%) occurred in public ICUs and 449 (13%) in private ICUs, which is statistically significant ($p < 0.01$). Of 40,957 annual admissions to ICUs, deaths related to sepsis represented a mortality rate of 8.3% (3402 cases). APACHE II and SOFA scores were 24 ± 3 and 7 ± 2 in public ICUs and 18 ± 3 and 4 ± 1 in private ICUs, respectively, which represented a statistically significant difference ($p < 0.01$).

The most frequent sepsis triggers were abdominal infection (47%), pulmonary infection (33%), soft tissue infection (8%), renal infection (7%) and others (5%) (neurological and osteoarticular). Microorganisms responsible for infection were gram-negative bacteria (52%), gram-positive bacteria (38%) and fungi (10%). Distribution of gram-negative bacteria was Pseudomonas (50%), E. coli (30%), Proteus (10%), Acinetobacter (7%), and Klebsiella (3%). Distribution of gram-positive bacteria was Staphylococcus aureus (60%), Enterococcus (20%), Pneumococcus (10%), and S. epidermidis (10%). Fungi were distributed as follows: Candida albicans (76%), and non-albicans Candida (24%).

SSC was acknowledged in 60% of private ICUs and 40% of public ICUs ($p < 0.05$) and 50% of both institutions adhered to sepsis management protocol with packaged guidelines including goal-oriented early resuscitation (volume, vasopressors, inotropics), pulmonary ventilation with alveolar protection, low steroid dosages, strict glucose control, thrombus prevention, digestive hemorrhage prophylaxis, sedation and analgesia, nutrition and early use of antibiotics. The use of recombinant activated protein C was limited because of its high cost in both types of ICUs; however, it was used more frequently in private ICUs than in public ICUs (9 cases vs. 6 cases per year, respectively).

The most common vasopressor combination was norepinephrine with dopamine, followed by norepinephrine with vasopressin. The most frequently used inotrope was dobutamine (74% of cases) followed by levosimendan (26% of cases). We found no significant difference between public and private ICUs regarding their selection and use criteria for vasopressors and inotropics. Routine serum lactate was determined in 67% of private ICUs and 59% of public ICUs with purposes of management follow-up.

Antibiotics were administered in common combinations as follows: carbapenems (imipenem/cilastatin, meropenem, aminoglycosides (amikacin), glycopeptides (vancomycin), third-generation cephalosporins and piperacillin/tazobactam. Antifungal drug usage distribution was fluconazole (60%), amphotericin B (30%), voriconazole (5%), and caspofungin (5%).

Sedation was achieved with midazolam, propofol and dexmedetomidine. Delirium was managed with haloperidol (96% of cases) and olanzapine (4% of cases). In 60% of private ICUs and 40% of public ICUs, a daily sedative window was practiced ($p < 0.05$).

All patients received nutritional support; 66% received enteral nutrition and 34% received parenteral nutrition. Of patients receiving enteral nutrition, 52% were polymeric, 30% elementary and 18% semi-elementary. Antioxidants were used in 44% of cases and, of these cases, 80% received vitamin C; selenium was used only in 5% of cases.

Costs

Costs associated with care of sepsis patients are high. In public ICUs, it represents 600,000 MXN per patient and in private ICUs it can reach 1,870,000 MXN, which represents an investment >$9769 million MXN per year ($835 million USD) and an average cost per patient of $73,000 USD.

Discussion

This is the first epidemiological study carried out in Mexico that includes analysis of incidence, costs and mortality rate associated with sepsis as well as resources and equipment of ICUs and the knowledge and adherence to Surviving Sepsis Campaign (SSC). According to the results of the National Sepsis Survey (NSS), this entity represents 27.3% of all admissions to ICUs in Mexico, which agrees with results from the SOAP5 and Padkin12 studies where sepsis represented 30% and 27.1% of admissions, respectively. However, we must take into consideration that other epidemiological studies report that sepsis is the cause of admission in between 6% and 14% of cases. Sepsis prevalence according to adjusted population in surveyed states is 40/100,000 inhabitants, which is less than reported at an international level (54-97/100,000 inhabitants). This is because not all ICUs were surveyed and not all Mexican states were included.13-15

Associated mortality rate was 30%, which agrees with other epidemiological studies,16 although there is a large variability in mortality rate (40%-80%).17 The great difficulty to interpret these results is because of the heterogeneity of the studied groups, resources used for treatment and adherence to the clinical guidelines.18 It is worth noting the higher mortality rate secondary to sepsis in public hospitals, which is related to the higher number of patients cared for, illness severity (evaluated through APACHE II and SOFA scores), immunocompromise, risk factors, technological deficiencies, lack of specialized personnel and restricted access to high-cost medications. Our results agree with the Brazilian Sepsis Epidemiological Study (BASES), in relation to prevalence, incidence and higher mortality rate from sepsis in public hospitals. Contrary to our results, the mortality rate
associated with serious sepsis in Brazil was 47.3%. This demonstrates there are similar conditions in developing countries such as Brazil and Mexico, closely related to lack of infrastructure for the implementation of care strategies and policies such as access to specialized medical care, technological deficits and limited access to specialized medications, with the subsequent delay in effective diagnosis, treatment and access to information and resources.\textsuperscript{18-20}

Abdominal infection was the most common sepsis etiology, followed by pulmonary infection. This is important because most sepsis cases cared for in ICUs are secondary to abdominal pathology and surgery complications. This alerts us towards a change of epidemiological profile because large sepsis studies show that its main trigger is pneumonia.\textsuperscript{21,22} This finding may be related to pneumonia underreporting as sepsis cause or reflect the seriousness of surgical problems or their delayed treatment, which would be beneficial to analyze in another study.

Infectious agents are primarily gram-negative bacteria (\textit{Pseudomonas, S. aureus}), but it is interesting that the third place is occupied by fungal infections (\textit{C. albicans}), which agrees with international epidemiological data.\textsuperscript{23,24} It is very likely this does not show the reality in our country because not all ICUs look for a sepsis fungal etiology or have laboratory infrastructure for its identification. Bacterial epidemiological behavior and prevalence of different microorganisms agree with EPIC I and II studies that emphasize the importance of \textit{Pseudomonas, Acinetobacter, S. aureus} and \textit{Candida} as the organisms with higher prevalence, pathogenicity and mortality associated with seriously ill patients, mainly in those with multiple disabilities or with major surgery or immunocompromise.\textsuperscript{25} It is important to highlight that the epidemiological profile of ICUs infections has recently changed, with changes in patient characteristics and associated risk factors that tend to increase the seriousness of infections by opportunistic, multi-resistant germs. This reflects the use and pattern of administered antibiotics in intensive care therapies (carbapenems, aminoglycosides, glycopeptides) and antifungal drugs (azoles, echinocandins), which have collateral effects and high costs. \textit{Candida} infections were present in 1183 patients, despite having a low prevalence.

Unfortunately, we did not analyze mortality by infection group to evaluate mortality attributable to each microorganism and determine mortality rate associated with fungi, but we suppose it is high because raw mortality and attributable mortality from \textit{Candida} is 50% and 20%, respectively.\textsuperscript{26}

Costs associated with sepsis patients are high and changes from one country to the next. It represents $22,100 USD in the U.S., $11,300 USD in China and $73,000 USD in Mexico (considering public and private ICUs). These results may show an overestimation in costs from surveyed parties or include only the cost of the most seriously ill patients. These results may represent a delayed diagnosis and treatment of sepsis with the subsequent increase in hospital stay and resources or because of the lack of policies and administrative procedures guided towards improved efficiency and regulation of resources assigned to treatment for sepsis patients. To solve this problem it is necessary to develop and implement (with a group of financial experts), a pharmaco-economic and administrative study that evaluates actual sepsis costs in public institutions and, if possible, in private institutions to define clearly the economic impact of this entity in Mexico and the cost-effectiveness of sepsis patient management.

Despite significant efforts from AMMCTI for national communication of SSC, this campaign is unknown by 100% of physicians who attend sepsis patients at ICUs in Mexico, which according to our study is secondary to the fact that a large number of ICUs are managed by non-intensive care specialists. This impacts management and lack of adherence to the campaign and underlies the need to have more intensive care specialists and or implement specialized courses to communicate sepsis knowledge and SSC among non-intensive care physicians. This could be carried out through AMMCTI and other association web sites, changing physicians’ perception about sepsis and significantly improving patient evolution and the more efficient use of financial resources.\textsuperscript{27,28} Support from public institutions in Mexico (IMSS, ISSSTE, SS, etc.) is essential because efforts by medical associations are limited due to lack of resources, logistic, personnel and scarce institutional impact, which would weaken the proposal and shortly run its course.

An important aspect from this study is that high sepsis incidence in Mexican ICUs and associated mortality is not shown in the official health statistics. Mortality rate charts published by the offices of the Secretary of Health and INEGI do not show sepsis as one of the primary mortality causes, and it is inappropriately classified because it is included in CIE-10,\textsuperscript{31} a Mexican disease classification as Streptococcus sepsis (A40), meningococcus (A39.2), other sepsis (A41), “other sepsis” (A41.8) and “unspecified sepsis” (A41.9). This creates an ambiguous and difficult to interpret classification because it does not follow international sepsis definitions diagnosis. The term is misinterpreted as infection, which is evident by some names used in the classification. On the other hand, section A41.8 includes the term “other sepsis,” which is incorrect because sepsis is one entity. It is defined as a systemic inflammatory response secondary to a suspected or confirmed infection without considering its origin.

Current official statistics lead us to believe sepsis is almost nonexistent in Mexico; however, developed countries regard it as a health problem and invest a large amount of resources for research, update and treatment programs. This is a consequence of several critical situations that have favored and perpetuated the ignorance of sepsis among physicians, institutions and health authorities. It is frequent that physicians do not report sepsis as a cause of death listed on death certificates. If a patient with cancer, diabetes, trauma or pneumonia dies from sepsis (which is very frequent), the death certificate names only the primary disease as the direct cause of death. This has led to the underestimation
and misdiagnosing of sepsis as a cause of death and favors that its etiology or comorbidity is regarded as the cause of death. In addition to being erroneous, this has placed sepsis as a practically nonexistent entity in Mexico, omitting it from priority programs from the Secretary of Health and other institutions. Also, this complex phenomenon of sepsis misdiagnosis is related to an educational process that omits its teachings in medicine schools or in several medical specialization programs. As a consequence, serious conceptual errors are perpetuated, such as considering sepsis as a synonym of infection and therefore evaluate it and treat it as such. This contributes to misdiagnosis, inadequate treatment and late and erroneous epidemiological reporting.

We consider that our study could be improved by the inclusion of homogeneous ICUs from all states throughout Mexico. All ICUs with sepsis patients should be included, considering that many patients are misdiagnosed and most are cared for outside the ICU. Improvements could be made in regard to the design and survey procedures through a second national survey with support from the federal government through the development of a Sepsis Surveillance Epidemiological Network (SSEN).

Despite the above, the strong areas in this study are as follows:

- The first Mexican study of its kind that provides a sepsis panorama in Mexico
- Provides a measurement of human and finance resources available for sepsis management
- Includes an evaluation of adherence to Surviving Sepsis Campaign that adds Mexico to countries that have developed a similar study to understand sepsis epidemiology.

Results from the present study provide arguments to propose the national implementation of SSEN as well as a program to increase the knowledge of this disease in order to have a more efficient diagnosis and treatment. On the other hand, it would be convenient to include sepsis treatment in a general assistance program (Seguro Popular) because it is a costly and catastrophic disease. This would provide resources for its proper management and therefore ensure that no Mexican dies from sepsis because of lack of financial, human and technical resources. The Mexican Academy of Surgery and the Mexican National Academy of Medicine, advisors from the federal government with AMMCTI (which groups Mexican intensive care specialists), would be responsible for the formal proposal to address administrative and political issues that would name sepsis as a serious public healthcare problem in Mexico such as trauma, ischemic cardiopathy, cancer and diabetes.

In conclusion, based on the results of the present study, sepsis is a highly prevalent disease in Mexican ICUs that is associated with high costs and is underestimated by physicians, healthcare institutions and health authorities. Despite methodological limitations and lack of inclusion of every ICU and all sepsis patients in Mexico, survey results show that, each day, ICUs admitted 30 new sepsis cases. Of these cases, nine patients die, which represents that every 2.6 h a Mexican person dies from this terrible disease. This figure could offer a worse scenario if we carried out a study to include the entire Mexican healthcare system. It is urgent that Mexican Academies and AMMCTI present a project to the authorities of the office of the Secretary of Health to create a Sepsis Surveillance Epidemiological System (SSES) to begin an actual impact over this disease and develop strategies for diffusion, diagnosis, classification, epidemiological reporting and treatment.

Acknowledgments

The Mexican Association of Critical Medicine and Intensive Therapy and the authors are grateful to all the participating Intensive Care Units for their enthusiastic and generous collaboration.

References

Epidemiological study of sepsis