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Georeferencing of deaths from sepsis in the city of São Paulo

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ABSTRACT

Objective: The aim of the present study was to obtain information about deaths due to sepsis in São Paulo from 2004 to 2009 and their relationship with geographical distribution.
Methods: Causes of death, both main and secondary, were defined according to the codes of the International Classification of Disease version 10 (ICD-10) contained in the database. Sepsis, septic shock, multiple organ failure, pneumonia, urinary tract infection, peritonitis and other intraabdominal infections, skin and soft tissue infections (including surgical wound infection) and meningitis were considered as immediate cause of death or as the condition leading to the immediate cause of death related or associated to sepsis.
Results: In the analyzed period, there was a 15.3% increase in the absolute number of deaths from sepsis in São Paulo. The mean number of deaths during this period was 28,472 ± 1566. Most deaths due to sepsis and sepsis-related diseases over the studied period occurred in a hospital or health care facility, showing that most of the patients received medical care during the event that led to death. We observed a significant concentration of deaths in the most populous regions, tending more toward the center of the city.
Conclusions: Georeferencing data from death certificates or other sources can be a powerful tool to uncover regional epidemiological differences between populations. Our study revealed an even distribution of sepsis all over the inhabited areas of São Paulo.

Introduction

Sepsis is a syndrome resulting from systemic manifestations of infection associated with high incidence and mortality rate. Also, care of patients with sepsis costs as much as $50,000 per patient, resulting in an economic impact for society of nearly $17 billion annually in the United States alone.[1,2] Demographic and socioeconomic variables, pre-existing diseases, and access to health care are factors that affect the incidence and mortality of patients with severe sepsis and septic shock.[2–6] For instance, an American retrospective study

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showed a higher incidence of sepsis among blacks, men, and people from abject poverty and urbanization. The same groups also had higher rates of mortality.[3]

Disparities also occur as the source of infection. Men have more respiratory infections, while women have more genitourinary infections. Regardless of the infection site in men, infections with Gram-positive bacteria are more prevalent.[5] The same is true for black Americans, who have more comorbidities and longer hospitalization. The reasons for these disparities are not well understood. In Brazil, studies on the epidemiology of sepsis are limited to intensive care units from some public and private hospitals. Those studies have showed that the mortality rate is higher in Brazil compared to other countries.[2,7]

Georeferencing, which relates information to the geographic location, is an important and innovative tool in epidemiological studies[8,9] that has been used in various scenarios,[10–12] aiming to clarify aspects of geographic distribution. The application of the methodology of georeferencing assists in studies of population mobility correlating with socioeconomic and geographic segmentation of a given area. In fact, the Brazilian population has important socioeconomic disparities in access to health care, which could impact sepsis outcomes. Hence, georeferencing may be used for understanding the relationship between socioeconomic attributes and the outcomes of septic patients.

The aim of the present study was to obtain information about deaths due to sepsis in São Paulo from 2004 to 2009 and their relationship with geographical distribution.

Materials and methods

Deaths database was extracted from "Programa de Aprimoramento das Informações de Mortalidade" (PRO-AIM; "Mortality Information Improvement Program"), coordinated by the São Paulo County Health Authority and Data Processing Company (PRODAM). Death certificate information was collected for residents who died within the county boundaries. Addresses were standardized and cross-match coded with a street database using fuzzy techniques aiming to clean strange characters or errors. Death certificates from 2004 to 2009 were analyzed for age, sex, primary and secondary cause of death, patients' address, and place of death.

Causes of death, both main and secondary, were defined according to the codes of the International Classification of Disease version 10 (ICD-10) contained in the database. Sepsis, septic shock, multiple organ failure, pneumonia, urinary tract infection, peritonitis and other intra-abdominal infections, skin and soft tissue infections (including surgical wound infection), and meningitis were considered as immediate cause of death or as the condition leading to the immediate cause of death related or associated to sepsis.

When death occurred in hospitals or health institutions, these establishments were identified by the National Health Establishments Registry (Cadastro Nacional de Estabelecimentos de Saúde (CNES)) or Health System Ambulatory Information (Sistema de Informações Ambulatoriais do SUS (SIASUS)) databases. Correspondence of health institutions' addresses between the two databases was made to obtain code uniformity in order to avoid duplicate or missing information. The spatial distribution of deaths was performed using patients' residence address and place of death.

Human development index (HDI; United Nations Development Program) was used to grade the socioeconomic status of São Paulo County districts. Differences between districts were compared for number of deaths, their causes, and their relation to the HDI and mortality coefficients. Data from the Brazilian 2000 Census (Instituto Brasileiro de Geografia e Estatística (IBGE)) was used to generate mortality coefficients for every district in São Paulo County, according to population estimates for that year.

Comparison of two proportions was done using Z statistics with normal distribution and 95% confidence intervals or Chi-square tests when appropriate. Spearman linear regression was used for correlation between the HDI and mortality rates. Maps were generated using the MAPINFO Professional 9.0, using data from the year 2009 as an example. All statistical analyses were performed with Excel 2010 (Microsoft, USA) and SPSS v.13.0 (IBM Corporation, New York, USA). For all analyses, two-sided p-values <0.05 were considered significant. The study was approved by the Ethics Committee in Research of the Secretaria Municipal de Saúde (CEP-SMS). All patient records and information were anonymized and de-identified prior to analysis.

Results

Total deaths due to sepsis

In the analyzed period, there was a 15.3% increase in the absolute number of deaths from sepsis in São Paulo, rising from 27,135 in 2004 to 31,286 in 2009. The mean number of death during this period was $28{,}472 \pm 1566$. For an estimated mean population of 10,965,000 inhabitants during this period, the mortality coefficient was 259.55/100,000 inhabitants.

Distribution of deaths according to gender, age, and age group

The number of deaths from sepsis in São Paulo increased with age of the patients, being 8905 (5.2%) up to 18 years, 51,166 (29.9%) from 19 to 64 years, and 110,080 (64.4%) for 65 years or older. Age information was not available for 680 patients (0.4%). The distribution of deaths according to gender was nearly equal for both sexes: 51% in males and 49% in females. This distribution remained stable during all periods from 2004 to 2009. However, when we analyzed deaths by sex, stratifying them by age groups, there were more deaths among males in the age group up to 18 years (53.9% vs. 46.1%) and 19–64 years (61% vs. 39%). In the age group above 65 years, the proportion reversed to 46.3% for males and 53.7% for females. These differences were statistically significant (Table 1).

Distribution of deaths according to regions and the human development index

We choose the year 2009 to calculate the mortality rate per 100,000 inhabitants in different regions of São Paulo. The