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Hospital costs in the US for pulmonary mycobacterial diseases

Mehdi Mirsaeidi ^{a,*}, Mary Beth Allen ^b, Golnaz Ebrahimi ^a, Dean Schraufnagel ^a

^a Section of Pulmonary, Critical Care, Sleep and Allergy, Department of Medicine, University of Illinois at Chicago, IL, USA

^b Department of Public Health Management and Information Sciences, University of Louisville, Louisville, KY, USA

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Preliminary data generated from this study will be presented in the first Asian-African Mycobacteriology Society meeting, 2015.

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ABSTRACT

Background: Pulmonary mycobacterial diseases describe both tuberculosis (TB) and nontuberculous mycobacteria (NTM). Few data are available measuring the cost burden of mycobacterial diseases at the national level. The purpose of this study is to evaluate the cost burden and measure emerging trends in hospitalization of pulmonary TB and NTM cases in the United States from 2001 through 2012.

Methods: This study is a retrospective, community-based cost analysis of hospitalized patients with a principal diagnosis of pulmonary mycobacterial diseases from 2001 through 2012. Data for pulmonary TB and NTM were retrieved from the Healthcare Cost and Utilization Project (HCUP), US Department of Health and Human Services. The statistical significance of observed trends of NTM and TB national hospital costs was calculated using Poisson log-linear regression.

Results: 20,049 hospital discharges were reported for pulmonary NTM and 69,257 for pulmonary TB in the US from 2001 through 2012. The total associated cost of these discharges was \$903,767,292 for pulmonary NTM and \$2,078,113,317 for pulmonary TB. During the study period, the national hospital costs of pulmonary NTM increased at a statistically significant rate in the US over each year ($P = 0.001$). However, no such increase was found for national hospital costs of pulmonary TB.

Conclusions: The national hospital cost of NTM management is increasing. These results emphasize the importance of continued research in pulmonary NTM in order to improve current guidelines in prevention and treatment strategies.

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Introduction

Pulmonary mycobacterial diseases describe both tuberculosis (TB) and nontuberculous mycobacteria (NTM). Pulmonary

mycobacterial disease has been a long-term public health problem in the US and all over the world. TB incidence peaked in the early twentieth century in the US, when it became a major cause of mortality [1].

* Corresponding author at: Section of Pulmonary, Critical Care, Sleep and Allergy, Department of Medicine M/C 719, University of Illinois at Chicago, 840 S. Wood St., Chicago, IL 60612-7323, USA. Tel.: +1 240 383 7539.

E-mail addresses: mmirsae@uic.edu, golmeh@yahoo.com (M. Mirsaeidi).

Abbreviations: TB, tuberculosis; NTM, nontuberculous mycobacteria; HCUP, Healthcare Cost and Utilization Project; NIS, National Inpatient Sample; US, The United States; OR, Odds ratio; ICD-9, International Classification of Diseases, 9th Revision, Clinical Modification; HMO, Health Maintenance Organization; PPO, Preferred Provider Organization

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While efforts in treatment and surveillance of TB have resulted in a decrease in its incidence in recent years [2], the incidence of NTM is increasing and has been classified as an emerging public health problem in the US [3] and the world [4,5]. The incidence of NTM has even surpassed that of TB in several States of the US [6,7].

NTM are organisms that are found ubiquitously in the environment. In the 1950s, NTM was first recognized as human pathogens when 1–2% of various sanitarium's patients did not respond to routine anti-TB regimens [5,8]. Currently, over 150 NTM species are known, and many new species with clinical relevance have recently been reported [9].

Unlike TB, diseases caused by NTM generally have prolonged treatment for complete cure. Therefore, the prevalence is far greater than the incidence, and cost of treatment is more dependent on prevalence than incidence.

Healthcare costs have been key factors in national economies, and controlling healthcare costs has become a priority for essentially all countries in the world and is an important area of research. Healthcare costs associated with mycobacterial disease lie more heavily on public healthcare systems because of the communicable nature of TB. The healthcare costs of tuberculosis have been reported several times; the average cost for hospitalization of non-drug-resistant TB was estimated to be \$28,000 per patient in 2005–2007 [10]. The hospital costs of managing patients with NTM disease are less clear. A limited amount of data are available measuring the healthcare costs of NTM at the national level. Previously published studies have attempted to measure various aspects of cost, but have done so using small sample sizes or with a limited study period [10–12]. The purpose of this study is to offer a comprehensive evaluation of the in-hospital costs of care for pulmonary TB and NTM using national data during a long study period beginning in 2001 up through 2012.

Methods

Study design and patient data

This is a retrospective, population-based comparative study using data obtained from the National Inpatient Sample (NIS) within the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP). NIS is the largest inpatient healthcare dataset in the US providing national estimates of hospital costs stratified by disease State. NIS collects data from every State participating in HCUP,

which represents more than 95% of the US population [13]. All patients with a principal diagnosis of pulmonary NTM and TB who were discharged from the hospital during the period 2001 through 2012 were included in this study.

Study definitions

Pulmonary NTM was defined by any hospital discharge associated with a principal diagnosis of the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9) code 031.0. This code includes pulmonary infection by *mycobacterium avium*, *mycobacterium intracellulare* and *mycobacterium kansasii*. Pulmonary TB was defined by any discharge associated with ICD-9 codes 011.90–011.96. The principal diagnosis was defined as the main reason for discharge. The regions of the US were classified into four zones recognized by the Bureau of the Census as Northeast, Midwest, South and West (Table 1). Length of stay was defined as the number of nights the patient remained in the hospital. Payer was defined by the type of insurance coverage carried by the patient or lack thereof, which included Medicare, Medicaid, private insurance (Blue Cross, commercial carriers, and private HMOs and PPOs), uninsured (which includes an insurance status of “self-pay” and “no charge”), and other (which includes Worker's Compensation and other government payers). Median income was defined as the median household income of the patient's zip code of residence and compared with the national median income for the same year. HCUPnet used value ranges of the median household income itemized by year (Table 2) [14].

Study variables

Variables included in this study were age group, sex, region, payer, median zip code, hospital length of stay in days, mean hospital charge per discharge, mean aggregated charge, total aggregated charge, and in-hospital deaths.

Statistical analysis

The statistical significance of observed trends of NTM and TB national hospital costs were calculated using Poisson log-linear regression. National hospital costs for NTM and TB were projected in relation to healthcare inflation for each year. Expected mean aggregated charge (EaC) was calculated based on healthcare inflation using the equation: $(EaC = Hci \times OaC)$, in which EaC is the expected aggregated hospital charge, Hci is healthcare inflation percent for each

Table 1 – The regions of the US were classified into four zones recognized by the Bureau of the Census.

Northeast	Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont
Midwest	Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Michigan, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin
South	Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Maryland, Mississippi, Louisiana, Tennessee, North Carolina, Oklahoma, South Carolina, Texas, Virginia, and West Virginia
West	Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

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