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Hospital Resource Utilization among Patients with Chronic Obstructive Pulmonary Disease - An Analysis of 2002 - 2005 Healthcare Cost and Utilization Project Data

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HOSPITAL RESOURCE UTILIZATION AMONG PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE – AN ANALYSIS OF 2002 – 2005 HEALTHCARE COST AND UTILIZATION PROJECT DATA

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By

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ABSTRACT

HOSPITAL RESOURCE UTILIZATION AMONG PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE – AN ANALYSIS OF 2002 – 2005 HEALTHCARE COST AND UTILIZATION PROJECT DATA

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Objective: The objective of this study is to develop a national assessment of the length of stay (LOS), total costs, and in-hospital mortality among patients with chronic obstructive pulmonary disease (COPD), using retrospective data derived from Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP).

Methods: COPD- related hospitalizations using inpatient discharge-level data derived from 2005 NIS was utilized. Records with principal diagnosis of COPD were extracted using ICD-9 codes 490.xx-492.xx and 496.xx. Patient- (age, race, gender, payer, patient location, and median household income) and hospital-related (region, location, hospital bed size, type of admission type, and number of procedures on record) variables were considered in the analysis. Descriptive analysis was conducted to examine the differences in COPD-related hospital LOS, total hospital costs, and in-hospital mortality.

Multiple regression was conducted to identify predictors of LOS, costs, and in-hospital mortality among patients with COPD.

Results: An estimated total of 616,818 hospitalized cases for COPD as primary diagnosis, and 1,426,723 cases for COPD as secondary diagnosis were identified. The study showed that the burden of disease associated with COPD is substantially underestimated, and that it usually affects females, Caucasians, people aged 65 and above, and people from lower income level groups. It was also seen that COPD most commonly affected people located in the metropolitan areas, and also those from the southern region of the US. The mean LOS was found to be 4.69 and mean total costs were found to be $6,939. An estimated 12,054 in-hospital deaths were observed with COPD listed as the primary diagnosis. The study clearly demonstrated that disparities do exist in occurrence of COPD, and the outcomes related to the disease. Number of procedures and number of diagnoses listed on the record; were seen to be important predictors for hospital LOS, total hospital costs as well as in-hospital mortality. Hospital region, gender, and payer were among other important predictors for hospital LOS; whereas for total hospital costs, important predictors included hospital region, race, and patient location. Age and gender were seen to be important predictors of in-hospital mortality. For the years 2002-2005, a decreasing trend in hospital LOS was observed, while an increasing trend was observed for total hospital costs.

Conclusion: Hospital resource utilization is high in patients with COPD. Appropriate disease management, and application of preventative care such as early disease management for COPD, and the related co-morbidities in identified population, can help in lowering hospital admission rates and costs associated with it.

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CHAPTER ONE

INTRODUCTION

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, formed by the United States (US) National Heart, Lung, and Blood Institute (NHLBI) and the World Health Organization (WHO), define Chronic Obstructive Pulmonary Disease (COPD) as a preventable and treatable disease with some significant extrapulmonary effects that may contribute to the disease severity in individual patients. COPD is an incessant disease characterized by decline in lung function and obstruction to air flow that is not fully reversible.[1, 2]

The obstruction in the air flow is caused by a combination of obstructive bronchitis and emphysema.[1, 2] In obstructive bronchitis, the chronic inflammation of the small airways leads to structural changes resulting in airflow limitation. In emphysema, the inflammation causes destruction of the lung parenchyma. The parenchymal destruction leads to loss of alveolar attachments to the small airways and decreases lung elastic recoil, which impairs the ability of the airways during expiration. The relative contribution of obstructive bronchitis and/or emphysema, to the disease severity may vary from person to person.[1]

An exacerbation of COPD is defined as an event in the natural course of the disease characterized by a change in the patient's baseline dyspnea, cough, and/or sputum that is beyond normal day-to-day variations. An exacerbation is acute in onset, and may warrant a change in regular medication in a patient with underlying COPD.[1] Patients with COPD on an average, have two exacerbations per year.[3] Exacerbations are the main cause of medical visits and hospitalizations, and they are associated with a high health-care expenditure.[4, 5] Exacerbations in COPD also have serious negative impact on patient's quality of life, lung function , and socioeconomic costs.[1]

Pathology, Pathogenesis, and Pathophysiology

Typical characteristics of pathological changes in COPD include chronic inflammation with increased number of specific inflammatory cell types, and structural changes resulting from repeated injury and repair. These changes occur in the proximal airways, peripheral airways, lung parenchyma, and pulmonary vasculature. In patients with COPD, the inflammation appears to be an amplification of the normal response of the respiratory tract to chronic irritants such as cigarette smoke. COPD involves a specific pattern of inflammation involving inflammatory cells like neutrophiles, macrophages and lymphocytes. The inflammatory cells release inflammatory mediators like chemotactic factors, proinflammatory cytokinines, and growth factors; which interact with structural cells in the airways and lung parenchyma. Lung inflammation is further amplified by oxidative stress or a protease-antiprotease imbalance.

Physiological changes in COPD include mucus hypersecretion, airflow limitation and air trapping, gas exchange abnormalities, and cor pulmonale. The several systemic features, especially in patients with severe COPD include cachexia, skeletal muscle wasting, increased risk of cardiovascular disease, anemia, osteoporosis, and depression. Exacerbations are a further amplification of the inflammatory responses in COPD, and may be triggered by infection with bacteria or viruses or by environmental pollutants.[1]

Epidemiology

COPD is considered to be a major cause of morbidity and mortality across the world, and its prevalence continues to increase.[6] Currently 12.1 million US adults (aged ≥ 18 years) are estimated to have been diagnosed with COPD and as many as 24 million US adults have evidence of impaired lung function; indicating an under-diagnosis of COPD.[7] COPD can be described as an ill-defined mixture of overlapping manifestations of chronic bronchitis, emphysema, and asthma. And because of the overlapping symptoms associated with these conditions, COPD is often misdiagnosed or under diagnosed.[8] Additionally, variable definitions, and different diagnostic criteria of COPD have significantly lead to the underestimation of COPD. Study results have shown that the burden of disease associated with COPD is largely underestimated, as COPD is usually listed as a secondary diagnosis.[9] It has been found that morbidity due to COPD increases with age and is greater in men than women. The prevalence of COPD has also been found to be considerably higher in smokers and ex-smokers, and in individuals over 40 years of age.[1, 10]

COPD is the fourth leading cause of death in the US accounting for nearly 1.3 million lives in 2003, and it has been predicted to become the third most common cause of mortality by 2020.[7, 11] Trends in death rate in the US from 1970 through 2002 for the six leading causes of death indicate; that while mortality from several of these chronic conditions declined, mortality due to COPD increased during that period.[2] The increase in mortality rate in females due to COPD is also alarming. Between 1971 and 2000, a five-fold increase in mortality rate was observed among females.[12] In 2003 alone, 63,000 females died due to COPD as compared to 59,000 males.[7] The increased and changing

COPD mortality trend could be due to the expanding epidemic of smoking and the changing demographics.[11]

Economic and Social Burden

The economic and social burden associated with COPD is enormous.[1, 4] COPD is a costly disease in terms of both direct and indirect costs.[1] According to the NHLBI, annual cost of COPD (2007 value) in the US was around $42.6 billion. This included $26.7 billion in direct health care expenditures, $8 billion in indirect morbidity costs, and $7.9 billion in indirect mortality costs.[7] Hospitalization accounted for a major portion ($11.3 billion) of the direct health care expenditure. The total cost of care for patients is significantly increased due to presence of COPD, especially in terms of inpatient costs. The per capita expenditures for hospitalizations of COPD patients were found to be 2.7 times the expenditures for patients without COPD.[13] Also, a direct relationship exists between the severity of COPD and the cost of care. It has been reported that hospitalization and ambulatory oxygen costs increase as the disease progresses.[14]

The social burden of COPD is also increasing and in terms of Disability-Adjusted Life Years (DALYs) lost worldwide, COPD is expected to become the fifth leading cause in 2020; from being the twelfth leading cause among all chronic diseases in 1990.[15]

Risk Factors

A number of risk factors have been attributed to the development of COPD. Cigarette smoking is a major risk factor for COPD.[1] It is widely believed that 15% of smokers develop COPD, however according to the recent US National Health and Nutrition study (NHANES), sooner or later as many as 50% of the smokers may develop COPD.[16] Environmental or occupational exposure to lung irritants due to air pollution from chemical fumes, vapors, and dusts; exposure to biomass smoke; early-life infections and malnutrition have also been identified as a COPD risk factors.[1, 9] COPD is a progressive disease, particularly if the patient's exposure to such noxious agents continue.[1] The hereditary deficiency of alpha-1 antitrypsin, a rare recessive genetic trait most commonly seen in individuals of Northern European origin; is also reported as a risk factor for COPD.[2]

COPD and Co-morbidities

COPD generally develops in middle aged population, with a long smoking history. And co-morbid conditions related to either smoking or aging, either already exist in this population; or they are at an increased risk to develop such co-morbidities.[17] The extrapulmonary effects related to COPD itself can lead to other co-morbid conditions. Some of the most common co-morbid conditions that have been described in association with COPD include pneumonia, hypertension, diabetes, coronary artery disease, heart failure, pulmonary infections, cancer, and pulmonary vascular disease. Studies have also shown that co-morbidities in patients with COPD, especially cardiovascular diseases and lung cancer play an important role in increasing the hospitalizations and risk of mortality among patients with COPD.[17]

Disease Management

The GOLD guidelines suggest that an effective COPD management plan includes four components - assess and monitor disease, reduce risk factors, manage stable COPD, and manage exacerbations.[1]

Assessment and classification of COPD disease severity

The impact of COPD on patients depends not only on the degree of airflow limitation but also on any existing co-morbidities, and the severity of disease symptoms.[1] The symptoms of COPD include chronic and progressive dyspnea, breathlessness, and decreased exercise capacity, cough, and sputum production.[2] The diagnosis of COPD, and determination of disease severity in COPD is usually done by the spirometry test.[1] Spirometry measures the volume of air forcibly exhaled from the point of maximal inspiration (forced vital capacity, FVC) and the volume of air exhaled during the first second of this maneuver (forced expiratory volume in one second, FEV_1). The ratio of these two measurements (FEV_1/FVC) is calculated, and the presence of airflow limitation is defined by a post-bronchodilator $FEV_1/FVC < 0.70$. The GOLD guidelines use patient's pulmonary function parameter such as post-bronchodilator FEV_1, to classify patients into different disease severity group (see Table1).[2]

Table 1: Different stages of disease severity based on FEV_1 value

Stage	Severity	FEV_1 /FVC
I	Mild COPD	FEV_1 /FVC < 0.70 $FEV_1 \geq 80\%$ predicted
II	Moderate COPD	FEV_1 /FVC < 0.70 $50\% \leq FEV_1 < 80\%$ predicted
III	Severe COPD	FEV_1 /FVC < 0.70 $30\% \leq FEV_1 < 50\%$ predicted
IV	Very Severe COPD	FEV_1 /FVC < 0.70 $FEV_1 < 30\ \%$ predicted

Adapted from Global strategy for the diagnosis, management, and prevention of Chronic Obstructive Pulmonary Disease. Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines 2007.

The different stages of COPD disease severity, based on GOLD guidelines are[1]

Stage I, Mild COPD: Characterized by mild airflow limitation, with or without chronic cough and sputum production. At this stage, the individual is usually unaware that his or her lung function is abnormal.

Stage II, Moderate COPD: Characterized by worsening airflow limitation, with shortness of breath typically developing on exertion, cough and sputum production may be present sometimes. At this stage, patients typically seek medical attention because of chronic respiratory symptoms or an exacerbation of their disease.

Stage III, Severe COPD: Characterized by further worsening of airflow limitation, greater shortness of breath, reduced exercise capacity, fatigue, and repeated exacerbations that almost always have an impact on patient's quality of life (QoL).

Stage IV, Very Severe COPD: Characterized by severe airflow limitation and presence of respiratory failure. This may also lead to effects on the heart such as cor pulmonale (right heart failure). At this stage, QoL is very appreciably impaired and exacerbations may be life threatening.

Health-care interventions to reduce risk factors

Reduction of exposure to tobacco smoke, occupational dusts and chemicals, and indoor and outdoor air pollutants; is essential for preventing the onset and progression of COPD. This can be achieved with the help of public health initiatives including smoking cessation, and protective steps taken by individual patients. It is suggested that interventions that improve COPD outcomes by decreasing symptoms and preventing acute exacerbations could substantially decrease the costs associated with COPD.[18]

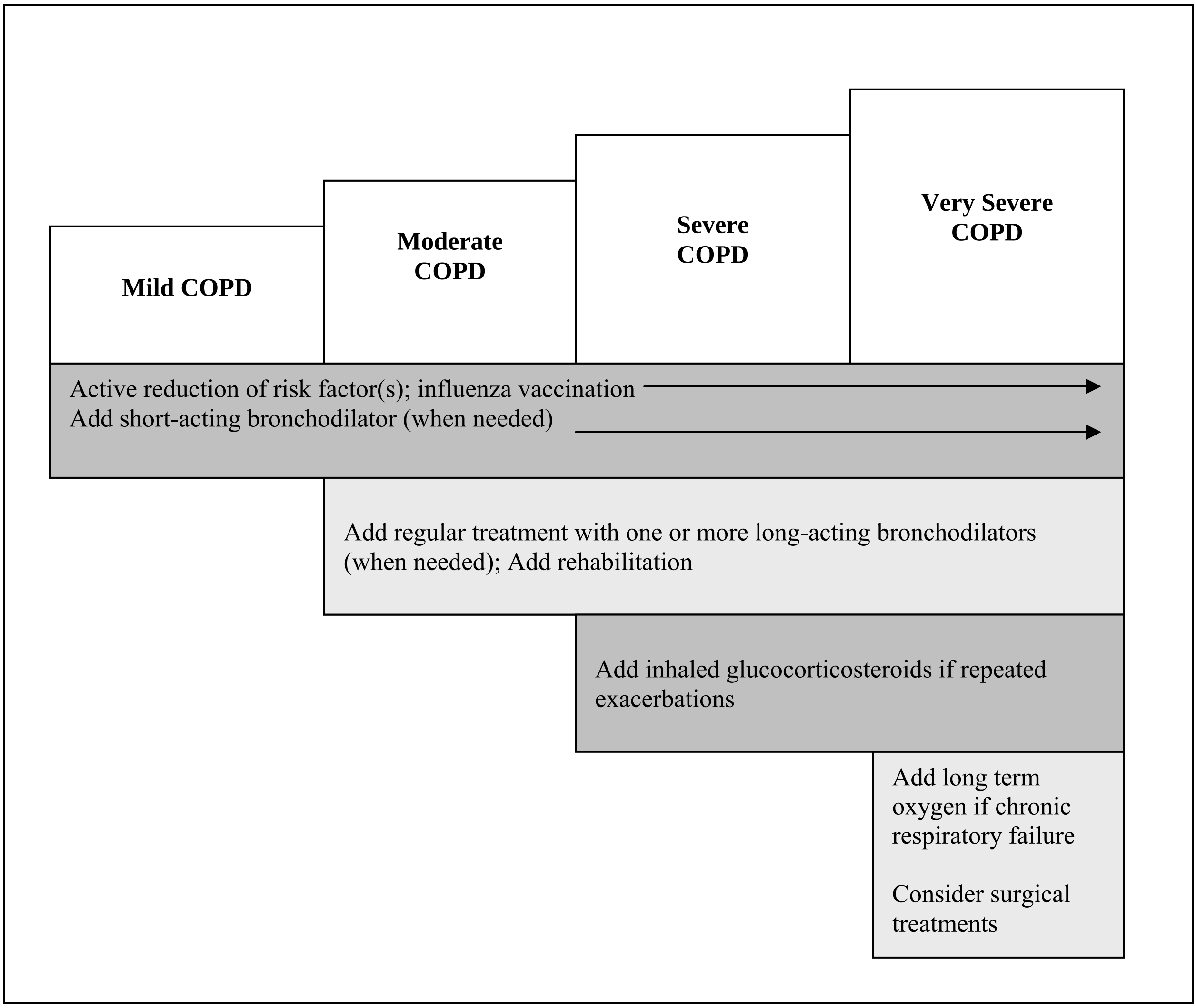
The GOLD guidelines recognize smoking cessation as the single most effective and cost-effective intervention in most people, to reduce the risk of developing COPD and stop its progression. A review of data from several countries estimated the median societal cost of various smoking cessation interventions at $990 to $13,000 per life year gained.[19]

In the US, it is estimated that up to 19% of COPD in smokers and up to 31% of COPD in nonsmokers may be attributable to occupational dust and fume exposure.[1] Many occupationally induced respiratory disorders can be reduced or controlled through strategies such as controlled airborne exposure at workplace and other strategies aimed at reducing the burden of inhaled particles and gases.[1]

Management of stable COPD

GOLD has outlined guidelines for management of COPD. Pharmacotherapy is used in COPD for preventing and controlling symptoms, reducing the frequency and severity of exacerbations, improving health status, and improving exercise tolerance.[1] A step-wise treatment strategy is used in management of COPD, according to which the medications are presented in an order, based on the level of disease severity and clinical symptoms.[1] (Figure 1) The selection within each class of medication depends upon individualized assessment of disease severity and the patient's response.

Figure 1: Therapy at different stages of COPD.



Adapted from Global strategy for the diagnosis, management, and prevention of Chronic Obstructive Pulmonary Disease. Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines 2007.

Pharmacologic treatments

The classes of medications commonly used in treating COPD are

- Bronchodilators (short and long acting)

  β_2 agonists: Albuterol (short acting), Salmeterol (long acting)

  Anticholinergics: Ipratropium (short acting), Tiotropium (long acting)

  Methylxanthines: Theophyline, Aminophylline

- Inhaled glucocorticosteroids: Beclomethasone, Fluticasone.

Bronchodilators

Bronchodilators are central to the symptomatic management of COPD. They are prescribed on an as-needed basis or on a regular basis to prevent or reduce symptoms and exacerbations. The choice between β_2 agonists, anticholinergics, and methylxanthines, or combination therapy depends on the availability and the individual's response in terms of symptom relief and side effects. Combining bronchodilators may improve efficacy and decrease the risk of side effects compared to increasing the dose of a single bronchodilator. Regular treatment with long-acting bronchodilators is more effective and convenient than treatment with short-acting bronchodilators.[1]

Glucocorticoids

Long term treatment with systemic glucocorticoids may cause side-effects such as steroid myopathy in patients with advanced COPD. Thus chronic treatment with systemic glucocorticoids should be avoided because of the unfavorable benefit-to-risk ratio. However, the addition of regular treatment with inhaled glucocorticoids to bronchodilator treatment is appropriate for symptomatic COPD patients with severe COPD, very severe COPD, and those with repeated exacerbations.

Other pharmacologic treatments

Other pharmacologic treatments used in the management of COPD include use of vaccines, immunoregulators, antitussives, vasodilators and several other medications which help in relieving symptoms and reducing the severity of exacerbations. Influenza vaccines can reduce serious illness and death in COPD patients by about 50%.[1] Influenza vaccination has also been shown to reduce the risk of hospital admission and death in elderly subjects with chronic lung disease.[20]

Non pharmacologic treatments

Non pharmacologic treatments include pulmonary rehabilitation, oxygen therapy, ventilatory support, and surgical interventions.[1]

Pulmonary rehabilitation

A pulmonary rehabilitation program includes exercise training, nutrition counseling and education. Pulmonary rehabilitation covers a range of non-pulmonary problems (exercise de-conditioning, depression, muscle wasting, and weight loss) that may not be adequately addressed by medical therapy for COPD. Pulmonary rehabilitation has shown to reduce symptoms, anxiety and depression associated with COPD. It has also reduced the number of hospitalizations, hospital length of stay, and improved quality of life, and increased physical and emotional participation in everyday activities.[1]

Oxygen therapy

It is one of the principal nonpharmacologic treatments for patients with very severe COPD. It can be administered in three ways: long-tem continuous therapy, during exercise, and to relieve acute dyspnea. In patients with chronic respiratory failure, the long-term administration of oxygen (> 15 hours per day) has shown to increase survival.[21]

Ventilatory support

Noninvasive ventilation is now widely used to treat acute exacerbations of COPD.

Surgical treatments

Surgical treatments used in patients with COPD include bullectomy, lung volume reduction surgery (LVRS), and lung transplantation.

Bullectomy

Bullectomy is used for bolus emphysema, and can be performed thoracoscopically. It is effective in reducing dyspnea and improving lung function in carefully selected patients.

Lung volume reduction surgery (LVRS)

In LVRS, parts of the lung are resected to reduce hyperinflation, making respiratory muscles more effective pressure generators by improving their mechanical efficiency. LVRS also increases the elastic recoil pressure of the lung and improves expiratory flow rates. It is an expensive palliative surgical procedure and can be recommended only in carefully selected patients.

Lung transplantation

Lung transplantation has been shown to improve quality of life and functional capacity in appropriately selected patients.

Management of Exacerbations

The impact of exacerbations is significant, and inhaled bronchodilators and oral glucocorticosteroids are effective treatments for exacerbations of COPD. During exacerbations, noninvasive mechanical ventilation has shown to improve respiratory acidosis, decrease respiratory rate, severity of breathlessness, and decrease length of hospital stay.[1]

PROBLEM STATEMENT

In 2000, COPD was responsible for eight million physician office and hospital outpatient visits, 1.5 million emergency department visits, and 726,000 hospitalizations, and 119,000 deaths in the US.[7, 9] It is a leading cause of hospitalization in the older population.[18] Hospital admissions for COPD are mainly due to disease exacerbations and respiratory failure.[22] The rate of hospital readmissions is also particularly high for exacerbations of COPD, with over half of the patients who are hospitalized for exacerbations of COPD, being readmitted at least once in the following 6 months and a majority of readmissions occurring within the first 3 months after hospital discharge.[23] The frequency of readmission varies from 11.6% (48 hours after discharge from the emergency room) to 63% (one year after admission to a general hospital).[24] Because hospitalization in patients with COPD usually occur in the later stages of the disease, it is associated with a greater risk of mortality in the subsequent years.[25] Mortality was found to be 60% one year after hospitalization in patients 65 years and older, who were hospitalized for exacerbation of COPD.[25]

As discussed earlier, hospitalizations account for a major portion of the total cost of care in patients with COPD.[1, 4] Some studies show that the cost of hospital stay represents 40-57% of the total direct costs generated by patients with COPD, reaching up to 63% in severe patients.[26, 27] During an exacerbation, health-care utilization is usually significantly increased, and thus, exacerbations are the key drivers of the costs of COPD.[16]

The disparities in hospital resource utilization and factors associated with hospitalization in COPD are poorly understood.[24, 29-35] The influence of gender on the susceptibility to and mortality from COPD is controversial. Some studies show an increased risk of death in men with COPD, while other studies suggest that men are less likely to die from COPD than women.[29, 31, 32] There is a dearth of studies which have done stratified analyses in the US population, to determine the effect of COPD according to race, type of hospital, insurance, and socioeconomic status on the resulting differences in health-care access, and on the risk of hospitalization and death .

There is also a lack of information about differences between hospital types with respect to length of stay (LOS) and mortality in a national sample in the US. Hence, in this study, we will look at the characteristics of the patient population with COPD utilizing hospital resources and evaluate the factors responsible for hospital resource utilization, in-hospital mortality, and total hospitalization costs due to COPD. A study of the rates of hospitalizations and duration of such hospital stays, due to COPD, can help us understand the characteristics of the patient population and their level of resource utilization.

Hospitalization for COPD could be avoided with appropriate management, use of preventative care and early disease management.[24] The study findings can help us identify a subset of patients with COPD that could benefit best from an active interventional program or a therapeutic strategy, which may help lowering hospital readmission rates and costs, thereby reducing the economic burden of the disease.

CONCEPTUAL FRAMEWORK

The objective of this study is to develop a national assessment of hospital resource usage in patients with COPD, using retrospective data derived from Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP). The study will determine COPD- related hospitalizations using inpatient discharge-level data for 100% of the discharges from a sample of hospitals in participating states, in terms of patient and hospital characteristics. Temporal patterns (for years 2002-2005) of hospital LOS, mortality during hospitalization, and total hospital costs due to COPD- related hospitalizations will be identified.

The HCUP database was established by the Agency for Healthcare Research and Quality (AHRQ) to provide multi-state, administrative, population-based data. It contains set of information found in a typical discharge abstract including all listed diagnosis and procedures, discharge status, patient demographics, and charges for all patients- insured and uninsured in a uniform format.

HCUP provides five types of databases:

The State Inpatient Database (SID): It contains the universe of inpatient discharge abstracts from community hospitals of the participating states.

The State Ambulatory Surgery Database (SASD): It contains data from ambulatory care encounters in hospital-affiliated and sometimes freestanding ambulatory sites.

The State Emergency Department Database (SEDD): It contains data from hospital affiliated emergency department abstracts for visits that do not result in a hospitalization.

The Kid's Inpatient Database (KID): It contains a nationwide sample of inpatient discharges of patients 18 years and younger.

The Nationwide Inpatient Sample (NIS): It is the largest all-payer inpatient care database containing data from 5 to 8 million hospital stays from about 1000 hospitals sampled to approximate a 20% stratified sample of US community hospitals.

We would be using the NIS database for our study.

The NIS is available from 1988 to 2005. It is the only national hospital database with charge information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance and the insured. Researchers and policymakers use the NIS to identify, track, and analyze national trends in healthcare utilization, access, charges, quality and outcomes.

The NIS contains patient-level clinical and resource use information included in a typical discharge abstract. The NIS includes specialty hospitals such as obstetrics-gynecology, ear-nose-throat, short term rehabilitation, orthopedic, pediatric, public hospitals and academic medical centers. Excluded are long term hospitals, psychiatric hospitals, alcoholism/chemical dependency treatment and short term rehabilitation (beginning with 1998 data). The community hospitals are divided into strata using five hospital characteristics: ownership/control, bed size, teaching status, urban/rural location and US region.

OVERALL HYPOTHESIS

The overall hypothesis of this study is that disparities exist in hospital resource utilization and mortality among patients with COPD.

STUDY OBJECTIVES

The specific objectives of this study would be:

1. To calculate and compare weighed averages for hospital length of stay (LOS), total hospital costs, and in-hospital deaths; related to COPD as a primary and secondary diagnosis using the 2005 NIS database.
2. To study the COPD-related hospitalizations in terms of patient and hospital characteristics using the 2005 NIS database.

3. To study the differences in the COPD-related hospital length of stay (LOS) by patient and hospital characteristics using the 2005 NIS database.
4. To study the differences in the COPD-related hospital costs by patient and hospital characteristics using the 2005 NIS database.
5. To study the differences in the COPD-related in-hospital mortality by patient and hospital characteristics using the 2005 NIS database.
6. To identify predictors of COPD-related length of stay (LOS), in terms of patient and hospital characteristics using the 2005 NIS database.
7. To identify predictors of COPD-related total hospital costs, in terms of patient and hospital characteristics using the 2005 NIS database.
8. To identify predictors of in-hospital mortality in patients with COPD, in terms of patient and hospital characteristics using the 2005 NIS database.
9. To study the temporal pattern of COPD-related hospital length of stay (LOS), total hospital costs, and in-hospital deaths; between years 2002-2005, using the NIS database.

SIGNIFICANCE OF THE STUDY

This study can help us identify the characteristics of patients with COPD , who would benefit most from the interventional programs or preventive disease management strategies. Also the study results can help us understand if there are disparities in access to care in patients with COPD. This can help health care professionals in designing health care policies and interventions targeting these high risk populations. This may eventually help in delaying the progression of disease, preventing exacerbations and the subsequent hospitalizations, reducing mortality in such population, and thus, alleviating the economic burden associated with COPD.

Assessing patient- and hospital-related characteristics in COPD will help understand the factors that influence the rate of hospital admissions, and the total cost of hospitalization. This will further help assist health care professionals in making important decisions regarding the management COPD, and eliminating COPD disparities.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews the literature found on COPD-related hospitalizations and important outcomes such as hospital LOS, total hospital charges, and in-hospital mortality due to COPD-related hospitalizations. Information on trends in COPD-related hospitalizations and predictors of such outcomes, have also been included in this chapter. In addition, studies which have looked at cost of care in patients with COPD and exacerbations of COPD were also reviewed here.

The studies found in the literature review were categorized as:

1. Trends in COPD-related hospitalizations and mortality.
2. Factors responsible for or predictors of COPD-related hospitalizations and mortality.
3. Costs of managing exacerbations and COPD-related hospitalizations

Trends in COPD-related hospitalizations and mortality

Mannino and colleagues (2002) used data from national health surveys conducted by National Center for Health Statistics (NCHS) to report trends in different measures of COPD during 1971-2000. The results in the COPD surveillance summary report showed that during 2000, COPD was responsible for 726,000 hospitalizations and 119,000 deaths. The most substantial change was an increase in the mortality rate due to COPD in women; from 20.1/100,000 in 1980 to 56.7/100,000 in 2000. There was a more modest increase in the mortality rate for men; from 73.0/100,000 in 1980 to 82.6/100,000 in 2000. Also in 2000, the number of women dying from COPD exceeded the number of men for the first time. During the study period, the overall death rate for COPD increased 67%. The results also showed that the hospitalization rates for COPD among Caucasians were greater than those among African Americans during 1980-1987, after which rates have been similar. Hospitalization rates for men were greater than females through 1980s; however, since 1995, these rates have been similar. Since 1990, hospitalization for COPD have increased among all age groups, with the largest increase observed for those aged 65-74 years (62%) and those ≥75 years (52%).[28]

Saynajakangas and colleagues (2004) conducted a retrospective study to assess the trends in the duration of inpatient episodes following emergency admissions for COPD. The hospital discharge register maintained by the Finnish National Research and Development Center for Welfare was investigated. Records of emergency admissions of patients aged over 44 years (n = 72,672) that ended during 1993-2001 and had COPD as the principal diagnosis were included in the analysis. The results showed that the mean age on admission was 72.1 years (SD 8.7) in 2001. The average hospital LOS was 7.8 days (SD 7.6), being 8.5 days (SD 8.2) in 1993 and 6.8 days (SD 6.6) in 2001, indicating a decrease in LOS for COPD exacerbations. Elderly women (aged 64 years and older) had the longest inpatient episodes (LOS = 8.8 days). A total of 12.1% of the patients had 10 or more inpatient episodes. It was also reported that a 1-week stay in hospital resulted in the longest interval to readmission.[29]

Predictors of COPD-related hospitalizations

McGhan and colleagues (2007) used the Veteran's Affair health-care system to determine the predictors of rehospitalization and mortality rates in patients with COPD. They used data for inpatient stays; and a sample of 51,353 patients was included in the study. Only those, who were hospitalized for COPD and discharged between years 1999-2003, were included in the study. The two primary outcomes that were studied were time to death and time to death in the time frame of six years. The study results showed that the majority of patients (63%) had a history of prior hospitalization, and a history of non-COPD hospitalization was more common than a history of hospitalization for COPD. Many patients had multiple subsequent stays for COPD, with a mean LOS of 6.5 days. The risk of rehospitalization for COPD was 25% at 1 year, and 44% at 5 years. The risk of mortality was found to be considerable in the cohort, with the risk of death 21% at 1 year, and 55% at 5 years. Increasing age, being male, number of prior hospitalizations, and certain comorbidities including asthma and pulmonary hypertension were found to be risk factors for death and rehospitalization in patients discharged after a severe exacerbation. Noncaucasian race and other comorbidities were associated with a decreased risk.[30]

Chen and colleagues (2005) used the Person Orientated Information Database, which contains the hospital discharge data from all Canadian provinces in a retrospective cohort study. Participants included 257,604 COPD patients in the 3-year study period (1994-1997). The results showed 142,770 hospitalizations due to COPD as primary diagnosis, and 463,089 hospitalizations for COPD listed as one of the five underlying diagnosis. Overall, men were more likely to have hospitalizations for COPD and had a higher proportion of death at hospital than women. The relative risk for women versus men gradually increased with decreasing age, and was significantly greater in the 55-59 year group for hospitalizations due to COPD as a primary diagnosis. The researchers also believed that there was a growing body of evidence for a possibility of increased susceptibility to COPD in response to tobacco smoke in women.[31]

Prescott and colleagues (1997) examined data from the Copenhagen City Heart Study (CCHS). The subjects were administered a questionnaire assessing their level of education, household income, tobacco consumption, pulmonary symptoms, and measurement of lung function by spirometry. The results indicated that socio-economic status, measured by income and educational level, is significantly associated with admission to hospital for COPD. The age adjusted relative risks of admission to hospital for COPD, in the lowest socioeconomic group was approximately three-fold higher than in the highest group, and was similar in females and males. The study results indicated that socioeconomic factors affected the adult risk of developing COPD, independently of smoking status in both females and males.[32]

Holguin and colleagues (2005) used the National Hospital Discharge Survey data (1979 to 2001); to study the prevalence of co-morbidities and in-hospital mortality of patients with COPD. During the study period, there were an estimated 47,404,700 hospital discharges; of which 20.8% had COPD as the primary diagnosis, and 79.2 % had COPD as a secondary diagnosis. It was concluded that any mention of COPD in the discharge diagnosis is associated with higher hospitalization prevalence and in-hospital mortalities.[17]

Ansari and colleagues (2007) computed age- and gender-standardized hospital admission rates of COPD for years 2003-2004 in Australia, using the Victorian Admitted Episodes Dataset. Hospital admission rates for COPD were found to be higher in rural areas of Victoria than in metropolitan areas. Multiple regression analysis showed significant association between COPD admission rates and socio-economic status, smoking rates, and remoteness of area.[33]

An audit study of acute hospital care of COPD was conducted in the UK by Hosker and colleagues (2007). The audit was run jointly by the Clinical Effectiveness and Evaluation unit of the Royal College of Physicians and the British Thoracic Society. The audit showed that, despite the publication of standards and guidelines for the management of COPD, there remained marked between-hospital variability in all aspects of acute inpatient COPD care. The type and severity of patients admitted to large, medium, and small units were similar, but the organization and facilities available for those patients were not. In addition, the process of care and outcomes appeared worse in smaller hospitals.[34]

The results of another pilot study conducted by Roberts et al (2003) in England and Wales also showed that better survival was seen in teaching and larger hospitals; suggesting that significant differences in mortality in acute COPD may exist between hospital types. Thirty hospitals were randomly selected by geographical region and hospital types (teaching, large and small district general hospital [DGH]). Data on process and outcomes of care including death and LOS was collected, both retrospectively and prospectively. Small DGHs were seen to have a higher mortality (17.5%) than teaching hospitals (11.9%) and large DGHs (11.2%).[35]

Cost of exacerbations and hospitalizations

Some studies show that the cost of hospital stay represents 40-57% of the total direct costs generated by patients with COPD, reaching as high as 63% in severe patients.[28, 29] Miravitlles and colleagues (2003) conducted a prospective one-year follow-up study on a large cohort of patients (n = 1,510) with chronic bronchitis and COPD, recruited from general practices located throughout Spain. All direct medical costs incurred by the cohort and related to their respiratory disease were reviewed. They reported that the mean direct annual cost of chronic bronchitis and COPD was $1,876, and hospitalization costs represented 43.8% of these costs. The cost of severe COPD ($2,911) was almost double that of mild COPD ($1,484). Hospitalization accounted for 41.2% and 46.8% of the total costs for mild COPD and severe COPD respectively. They also reported that the cost of chronic bronchitis and COPD were almost twofold of those reported for asthma.[27]

Hilleman and colleagues (2000) used a retrospective study design in a university teaching hospital setting. A cost of illness analysis was conducted using health-care resource utilization data and costs identified through chart review. Severity of COPD was stratified using the American Thoracic Society stages I, II, and III. The study demonstrated a strong correlation between disease severity and total treatment cost in COPD, with stage I having the lowest cost. The study also demonstrated that the type of bronchodilator therapy also impacts total cost in COPD. Hospitalization was the most important cost variable for all three stages of COPD severity. The study results supported the notion that adherence to published treatment guidelines in COPD resulted in lower health-care costs.[14] The annual median treatment costs per patient per year across different stages of COPD were as follows: (See Table 2)

Wilson and colleagues (2000) used a prevalence approach and a societal perspective to estimate the annual direct medical costs of COPD (specifically chronic bronchitis and emphysema) in 1996, in the US. The authors used multiple national, state, and local data sources to estimate the health-care utilization and costs. The annual direct medical costs of COPD were $14.5 billion in 1996 dollars. Total inpatient costs were $8.3 billion (57% of total costs) while outpatient and emergency care were $5.8 billion (40% of total costs), and home and institutional care was only $0.34 billion. The largest costs were for inpatient hospital stays ($7.8 billion, 54% of total costs).[36] Hospital inpatient utilization and costs by disease (chronic bronchitis and emphysema) in 1996, are indicated in Table 3.

Table 2: Annual median treatment costs incurred over the entire duration of follow-up and stratified by severity of COPD.

Severity of COPD	Hospitalization cost*	Total cost
Stage I	$680 (40%)	$1,681
Stage II	$2,658 (53%)	$5,037
Stage III	$6,770 (63%)	$10,812

Hilleman and colleagues (2000)

*Costs presented as per patient per year (percentage of total costs)

Table 3: Hospital utilization and related costs, by disease.

Disease	No. of discharge (in thousands)	Length of stay (in days)	Hospitalization rate (%)	Total costs (in billions)
COPD	1,465	7.06	8.93%	8.3
CB	1,168	6.97	8.15%	6.3
Emphysema	296	7.92	14.3%	2.0

Wilson and colleagues (2000)

COPD= Chronic Obstructive Pulmonary Disease.

CB= Chronic Bronchitis

In another study of COPD-related costs, Sullivan and colleagues (2000) studied the National Medical Expenditure Survey and indicated that inpatient hospitalization and emergency department care formed the largest proportion (72.8%) of total expenditure. Only 10% of persons with COPD accounted for more than 70% of all medical care costs. The study also reported that international studies of trends in COPD-related hospitalization indicated that although the average LOS had decreased since 1972, admissions per 1,000 persons per year for COPD had increased in all age groups 45 years and older.[37]

Health-care utilization is usually significantly increased during an exacerbation and thus, exacerbations are considered the key drivers of costs in COPD.[38]

Miravitlles and colleagues (2002) conducted pharmacoeconomic evaluation of acute exacerbations of chronic bronchitis and COPD using a prospective study design in an ambulatory setting, in Spain. The study results showed that the total direct mean cost of all exacerbations was $159, and patients who were hospitalized generated 58% of the total cost. Cost per treatment failure, defined as the need of a new medical contact for persistence or aggravation of symptoms during the 30 days after initiating treatment, was $477.50. Thus, 63% of the total costs associated with the management of exacerbation were costs derived from treatment failure. Sensitivity analysis showed that, when treatment failure is reduced to zero, the average cost of treatment of an exacerbation would decrease from $159 to only $58.7.[4]

Although, there is a body of literature which reflect on the differences in outcomes for respiratory diseases, such as asthma and lung cancer; there is very little information about disparities in COPD care.[39] Several patient characteristics like age, gender, race, comorbidities, disease severity, and prior hospitalizations have been identified as predictors of outcomes like LOS, in-hospital mortality, and total costs in hospitalizations due to COPD. Some correlation between the hospital characteristics such as hospital type and location, and the outcomes, was also seen. However, no study has been conducted that gives a detailed overview of disparities among patients with COPD, based on the patient and hospital characteristics; at a national level. Also, it has not been studied whether patient's type of insurance or their socioeconomic status (SES) can be one of the predictors of hospital LOS, mortality, and the total costs of hospitalization in patients with COPD. The present study aims to retrospectively determine hospital LOS, mortality, total hospital charges, and trends in these outcomes; in patients hospitalized with COPD. A descriptive analysis of different patient- and hospital-related characteristics that affect these outcomes using the Nationwide Inpatient Sample (NIS) of the Healthcare Cost and Utilization Project (HCUP) data will be conducted.

CHAPTER THREE

METHODOLOGY

Data Source

Healthcare Cost and Utilization Project (HCUP)

The HCUP is a family of health care databases and related software tools developed through a Federal-State-Industry partnership to build a multi-state health data system for health care research and decision-making. The HCUP sponsored by the Agency for Healthcare Research and Quality (AHRQ), contains a core set of clinical and nonclinical information found in a typical discharge abstract. The information is translated into a uniform format with privacy protections in place. HCUP includes the largest collection of longitudinal hospital care data in the US, with all-payer, encounter-level information beginning in 1988. The HCUP databases enable research in different areas such as health policy issues, including cost and quality of health services, medical practice patterns, access to health care programs, and outcomes of treatments at the national, state, and local market levels.

The Nationwide Inpatient Sample (NIS), one of the datasets of HCUP, was used in this study. The NIS is the largest all-payer inpatient dataset that includes information on all discharge data from a national sample of more than 1,000 hospitals. All discharges from sampled hospitals are included in the NIS database. The NIS is available from 1988 to 2005. It is the only national hospital database with charge information on all patients, regardless of payer, including persons covered by Medicare, Medicaid, private insurance and the uninsured. Inpatient stay records in the NIS include patient-level clinical and resource use information included in a typical discharge abstract. Hospital and discharge weights are provided for producing national estimates. The NIS contains discharge-level records, not patient-level records. Thus, individual patients who are hospitalized multiple times in one year may be present in the NIS multiple times. There is no uniform patient identifier available that allows a patient-level analysis with the NIS.

The NIS is designed to approximate a 20% stratified sample of US community hospitals. The American Hospital Association (AHA) defines community hospital as “all non-federal, short term, general and other specialty hospitals, excluding hospital units of institutions.” The NIS includes specialty hospitals such as obstetrics-gynecology, ear-nose-throat, short term rehabilitation, orthopedic, pediatric, public hospitals and academic medical centers. Excluded are long term hospitals, psychiatric hospitals, alcoholism/chemical dependency treatment and short term rehabilitation (beginning with 1998 data). The community hospitals are divided into strata using five hospital characteristics: ownership/control, bed size, teaching status, urban/rural location and US region. Researchers and policymakers use the NIS to identify, track, and analyze national trends in healthcare utilization, access, charges, quality and outcomes.

From the NIS dataset for each year, the inpatient core data file was utilized. This inpatient discharge-level file contains data for 100% of the discharges from a sample of hospitals in participating states, and the unit of observation is an inpatient stay record. To address some of the objectives, the hospital weights file was also used from the NIS dataset. It contains weights and variance estimation data elements, as well as linkage data elements, and the unit of observation is the hospital. Data elements from both these files were used to create a final dataset, to be used for analysis in this study. The summary for the NIS datasets used in the study are given in Table 4.

Table 4: Summary of NIS datasets

Year	Data from	Number of hospitals	Number of discharges, unweighed	Number of discharges, weighed for national estimates
2002	35 states	995	7,853,982	37,804,021
2003	37 states	994	7,977,728	38,220,659
2004	37 states	1,004	8,004,571	38,661,786
2005	37 states	1,054	7,995,048	39,163,834

Adapted from Introduction to the HCUP NIS, available on the HCUP-US website http://www.hcup-us.ahrq.gov

The NIS contains several clinical and non-clinical data elements for each hospital stay. Data elements in the NIS Inpatient Core file include admission and discharge information, patient demographics (e.g., gender, age, race, median household income for ZIP code, location), diagnoses information, procedure information, expected payment source, total hospital charges, length of stay (LOS), and hospital information (e.g. the HCUP hospital identification number which provides the linkage between the NIS Inpatient Core files and the Hospital Weights file). The NIS Hospital Weights file contains data elements which include discharge weights (which can be used to create national estimates), the HCUP hospital identifiers, and hospital characteristics (bed size, location, teaching status, region.

Patient population

The NIS from HCUP for the years 2002, 2003, 2004 and 2005 were used. The NIS data obtained from HCUP was extracted and the Inpatient Core discharge-level files containing 100% of the discharges from a sample of hospitals in participating states were used. The Hospital Weights file, which helps to account for the complex sampling frame of the NIS dataset, was used. The Cost-charge ratio file, which helps to translate the hospital charges in the dataset into actual costs, was also used. Individuals from this sample having the primary or secondary diagnosis as COPD (as defined by the International Classification of Diseases, 9th Revision ICD-9 code) was then selected. Thus, all hospitalizations with primary or secondary diagnosis (only the first and the second diagnostic listing) with ICD-9 codes 490-492 and 496 were extracted and merged, to form our final dataset that was used for the several objectives of our study.

Data extraction

The NIS data obtained from the HCUP was extracted by decompressing the data and unzipping the required necessary files such as NIS Inpatient Core and Hospital Weights files. These files which were in ASCII format were converted to Statistical Package for Social Sciences (SPSS)(version 16.0) for analytical purposes. The conversion of ASCII to SPSS format was done with the help of SPSS Load Programs obtained in the NIS documentation files available on the HCUP-US website. [40] From this main data, only individuals having COPD were selected. Individuals from this sample having a primary or secondary diagnosis of COPD (as defined by the ICD-9 code) were then selected. This dataset was used as the final dataset for the several objectives of this study. The same extraction procedure was applied to all datasets for each of the four years.

Patient-Level Variables

Patient-level variables that were included in the analysis were age, race, gender, payer information, location of patient, and median household income. These variables were described by the NIS as:

Age at admission

Age at admission, was coded 0-124 years in HCUP. Age at admission was calculated from the date of birth and the admission date. It was considered invalid if it was out of range (0-124 years) or it could not be calculated. For the purpose of our analysis, age was categorized in different age groups: 0-20 years, 21-40 years, 41-64 years, 65-80 years, and 80 years and above. These levels of age were categorized to reflect access to Medicare (starting after age 65).

Race

Both race and ethnicity are included in one data element as 'Race' in HCUP. In HCUP, the variable race is categorized into Caucasian, African American, Hispanic, Asian or Pacific Islander, Native American, and others. For regression analyses in our study, race was categorized into the following four groups: Caucasian, African American, Hispanic and Others.

Gender

The gender variable was used as an indicator of sex of the hospitalized patient.

Payer information

The payer variable indicates the expected primary payer. In HCUP, to ensure the uniformity of coding across data sources, this variable combines detailed categories in the more general groups like Medicare, Medicaid, Private insurance, self pay, no charge and other. For example, Medicare includes both fee-for-service and managed care Medicare patients. Medicaid too includes both fee-for-service and managed care Medicaid patients. Private insurance includes Blue Cross, Commercial carriers, and private health maintenance organizations (HMOs) and preferred provider organization (PPOs). Other includes Worker's compensation, The Civilian Health and Medical Program of the Uniformed Services (CHAMPUS), The Civilian Health and Medical Program of the Department of Veterans Affairs (CHAMPVA), and other government programs.

Patient Location

The patient location variable is a four category urban-rural designation for the patient's county of residence. The 12 categories of the Urban Influence Codes (UIC) are combined into four broader categories: large metropolitan areas with at least 1 million residents, small metropolitan areas with less than 1 million residents, micropolitan areas (non-metro areas either adjacent to large metro or small metro or not adjacent to any metro area), and non-urban areas (non-core areas either adjacent or not adjacent to a metro or a micro).

Median household income

This variable is the median household income for patient's ZIP code (based on current year) and provides a quartile classification of the estimated median household income of residents in the patient's ZIP code. Quartiles are identified by the values of 1 to 4 indicating poorest to the wealthiest population. Since these estimates are updated annually, the value ranges vary by year. Dollar ranges represented by each category are shown in Table 5.

Table 5: Levels of median household income quartiles for patient's ZIP codes. NIS 2002-2005

Year	Quartile 1($)	Quartile 2 ($)	Quartile 3 ($)	Quartile 4 ($)
2002	1-35,999	36,000-45,999	46,000-61,999	≥ 62,000
2003	1-35,999	36,000-45,999	46,000-59,999	≥ 60,000
2004	1-35,999	36,000-45,999	46,000-58,999	≥ 59,000
2005	1-36,999	37,000-45,999	46,000-60,999	≥ 61,000

Adapted from Introduction to the HCUP NIS, available on the HCUP-US website http://www.hcup-us.ahrq.gov

Hospital-Level Variables

Hospital-level variables such as geographic region, location, teaching status, and hospital bed size were utilized for the purpose of the study. These variables were obtained from the NIS Hospital Weights file, and the HCUP hospital identification number was used to provide the linkage between the NIS Inpatient Core files and the Hospital Weights file.

In NIS, the NIS Stratum is a four-digit stratum identifier used to post-stratify hospitals for the calculation of universe and frame weights. The NIS Stratum includes the hospital census region, ownership/control, location/teaching status, and bed-size; all combined into one variable. Information on the hospital variables was obtained from the American Hospital Association (AHA) Annual Survey of Hospitals. For the purpose of analysis in this study, the hospital level variables were looked at separately:

Geographic region

The hospital's geographic region was classified into four categories: Northeast, Midwest, South, and West. This information was obtained from the AHA Annual Survey of Hospitals, and the geographic region was defined by the U.S. Census Bureau. This is an important stratifier because practice patterns have been shown to vary substantially by region. For example, lengths of stay tend to be longer in East Coast hospitals than in West Coast hospitals.[40]

Table 6: All states by Region, NIS 2005

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

Adapted from Introduction to the HCUP NIS, available on the HCUP-US website http://www.hcup-us.ahrq.gov

Location

The hospital location is categorized as rural and urban. Beginning with the 2004 data, the classification of urban or rural hospital location used the newer Core Based Statistical Area (CBSA) codes. CBSA groups were based on 2000 Census data. Hospitals residing in counties with a CBSA type of metropolitan were considered urban, while hospitals with a CBSA type of micropolitan or non-core were classified as rural. Government payment policies often differ according to this designation. Also, rural hospitals are generally smaller and offer fewer services than urban hospitals.

Teaching status

The hospital's teaching status was obtained from the AHA Annual Survey of Hospitals. The missions of teaching hospitals differ from nonteaching hospitals. In addition, financial considerations differ between these two hospital groups. A hospital is considered to be a teaching hospital if it has an AMA-approved residency program, is a member of the Council of Teaching Hospitals (COTH) or has a ratio of full-time equivalent interns and residents to beds of .25 or higher.

Rural hospitals were not split according to teaching status, because rural teaching hospitals were rare.

Bed-size

Bed-size categories are based on hospital beds, and bed-size assesses the number of short-term acute beds in a hospital. Hospitals were classified on the basis of bed size as small, medium and large. Refer Table 7. The hospital's bed-size category is nested within location and teaching status, and is defined using region of the U.S, the urban-rural designation of the hospital, in addition to the teaching status.

Table 7: Hospital bed size categories, by region. NIS 2005

Location & Teaching status	Hospital bed-size		
	Small	Medium	Large
Northeast Region			
Rural	1-49	50-99	100+
Urban, Non-Teaching	1-124	125-199	200+
Teaching	1-249	250-424	425+
Midwest Region			
Rural	1-29	30-49	50+
Urban, Non-Teaching	1-74	75-174	175+
Teaching	1-249	250-374	375+
Southern Region			
Rural	1-39	40-74	75+
Urban, Non-Teaching	1-99	100-199	200+
Teaching	1-249	250-449	450+
Western Region			
Rural	1-24	25-44	45+
Urban, Non-Teaching	1-99	100-174	175+
Teaching	1-199	200-324	325+

Adapted from Introduction to the HCUP NIS, available on the HCUP-US website http://www.hcup-us.ahrq.gov

Other Variables related to Diagnoses, Procedures and Type of admission

Other variables which can affect the patient's hospital resource utilization, such as variables related to the diagnosis reported or procedures conducted were also considered in the analysis.

Number of procedures

The Number of Procedures (NPR) variable indicates the total number of ICD-9-CM procedures coded on the discharge record. A maximum of 15 procedures have been retained on a NIS inpatient record. Some states provided fewer than 15 procedures on the discharge record; for example, if a state supplied 5 procedures, PR6 through PR15 are blank (" ") on all records from that state. Whereas some states provide more than 15 procedures, and these records may have information truncated. If an inpatient record from these states had more than 15 non-missing procedures, procedures in positions 16 and above was not included in the NIS file.

Number of diagnoses on discharge record

The Number of Diagnoses (NDX) variable indicates the total number of diagnoses coded on the discharge record. Similar to NPR, a maximum of 15 diagnoses has been retained on a NIS inpatient record. States that provide more than 15 diagnoses may have information truncated for this variable.

Elective

The ELECTIVE variable indicated, whether the admission to the hospital was elective or non-elective. This information was derived from another variable related to type of admission (ATYPE).

Outcome Variables

The outcome variables that were included in this study were hospital length of stay (LOS), in-hospital deaths, total hospital costs, and principal procedures performed on a patient with COPD. The total hospital charges were obtained from the Inpatient Core files and the Cost-to-Charge Ratio files were used to convert the charge data, and derive cost estimates of in-patient care. Following is the information on these variables as provided by HCUP.

Length of stay (LOS)

LOS is calculated by subtracting admission date from the discharge date. Same day stays are hence coded as 0. The value of LOS ranges from 0-365 days.

In-hospital death

This indicates whether the patient died during hospitalization. It is coded from disposition of the patient, depending on whether the patient was discharged alive or if the patient died in the hospital.

Total hospital charge/costs

The total hospital charge variable provides the value of a total hospital charge for a patient. The total charge is rounded to the nearest possible figure, and the value of this variable ranges from US $25 – $1 million. Generally total charges in HCUP do not include professional fees and non-covered charges. If the source provides total charges with professional fees, then the professional fees are removed from the charge during HCUP processing. But emergency department charges incurred prior to admission to the hospital may have been included in total hospital charges. Then total hospital costs were computed for each discharge record using the Cost-to-charge ratio to convert the charges to costs.

Data Analysis

The data analysis was conducted by using SPSS (version 16.0). The first eight objectives of this study were analyzed using the NIS dataset for the year 2005. For studying trends in LOS, total hospital costs, and the procedures (Objectives 9), datasets for 2002-2005 were utilized.

Objective 1: To calculate weighed averages for COPD-related hospitalizations, annual inpatient deaths and mean total charges for the year 2005.

Hospital and discharge weights were used to generate national level weighed averages for total number of cases with a primary or secondary diagnosis of COPD, and annual inpatient deaths and mean total charges and costs due to COPD-related hospitalizations.

Objective 2: To describe the COPD-related hospitalizations in the core in-patient sample from the NIS from HCUP dataset in terms of patient and hospital characteristics.

A descriptive analysis was conducted where frequencies for each of the patient- and hospital-related and other related variables, were analyzed. Frequencies for LOS, in-hospital deaths and total hospital charges were also analyzed and reported. Only those patients were included in the analysis, who had a primary diagnosis of COPD.

Objective 3: To compare the differences in the COPD-related hospital length of stay (LOS) by patient and hospital characteristics.

Means for LOS were compared across each of the patient- and hospital-related variables. Only those patients were included in the analysis, who had a primary diagnosis of COPD. All patient- and hospital-related variables of interest were taken as independent variables, whereas LOS was taken as a dependent variable. For variables with more than two categories, one-way ANOVA was conducted to check if the different categories of each variable differed significantly among each other. Those variables which were observed to be significant in ANOVA were subjected to Post-hoc Hochberg analysis. The Post-hoc analysis is helpful in isolating exactly where the significant differences among variables lie. For a variable that had two categories (e.g., gender) a t-test was conducted to see if LOS, total hospital charges, and procedures differed between males and females.

Objective 4: To compare the differences in COPD-related total hospital costs by patient and hospital characteristics.

Means for total hospital costs were compared across each patient and hospital variable. Only those patients were included in the analysis, who had a primary diagnosis of COPD. Also here, one-way ANOVA, post-hoc analyses and independent t-test were conducted to look for differences among categories.

Objective 5: To compare the differences in COPD-related in-hospital deaths by patient- and hospital-related characteristics.

Cross tabulations were conducted to compare proportions of in-hospital deaths across the several patient-related and hospital-related variables. Only those patients were included in the analysis, who had a primary diagnosis of COPD.

Objective 6: To identify patient- and hospital-related predictors of COPD-related hospital LOS., total hospital costs and in-hospital deaths.

A multiple linear regression model was utilized to achieve this study objective. Only those patients were included in the analysis, which had a primary diagnosis of COPD. All patient-related and hospital-related variables were used as independent variables to predict LOS. While conducting the analyses, LOS was taken as the dependent variable. Both Enter and Stepwise methods of multiple linear regressions were utilized. Variables having a significant p-value (defined as $p \leq 0.05$) were reported as predictors for LOS. All variables having more than two categories were subject to creation of dummy variables. Hence, dummy variables were created for age, race, location, payer information, median household income, and all hospital-related variables. Dummy variables are needed as they help in indicating the absence or presence of some categorical effect that may shift the outcome of the analyses.

Objective 7: To identify patient- and hospital-related predictors of COPD-related total hospital costs.

Similar analysis, as described for objective 6 was conducted, and the dependent variable here was total hospital costs.

Objective 8: To identify patient- and hospital-related predictors of COPD-related in-hospital deaths

Similar analysis, as described for objective 6 was conducted; however Binary logistic regression was used instead of multiple linear regression. The dependent variable here was in-hospital mortality.

Objective 9: To describe the temporal pattern of COPD-related hospitalization LOS, total hospital costs and in-hospital deaths for 2002, 2003, 2004, and 2005 using the core in-patient sample from the NIS from HCUP dataset.

Descriptive statistics were conducted to check for the frequencies of LOS, total hospital costs and the number of in-hospital deaths for the years 2002, 2003, 2004, and 2005. Only those patients were included in the analysis, who had a primary diagnosis of COPD. Means for LOS were reported, and a temporal pattern (trend) if observed, was also reported. Hospital costs were adjusted to the year 2005 (last quarter) levels, using the consumer price index for inpatient hospital services that were provided by the Bureau of Labor Statistics.

CHAPTER FOUR

RESULTS

In this chapter, results for the study objectives will be presented.

From the NIS dataset for each year, the inpatient discharge-level data representing 100% of the discharges from a sample of hospitals in participating states was utilized. From this main data, only individuals having COPD as primary or secondary diagnosis, based on the ICD-9 codes (490.xx-492.xx and 496.xx) were then selected. For study objectives 1 through 8, NIS dataset for year 2005 was utilized, while for study objective 9 which described the trends, NIS datasets for years 2002-2005 were utilized. For all the analysis, hospitalizations due to COPD as primary diagnosis only were considered; except for study objective 1, where hospitalizations due to COPD as secondary diagnosis were also considered. There were 126,504; 127,393; 112,983 and 126,130 hospitalizations identified with COPD as the primary diagnosis in the datasets for years 2002, 2003, 2004, and 2005 respectively.

Objective 1: National estimates for hospital LOS, mean total charges, and in-hospital mortality for hospitalizations due to COPD for the year 2005

Using the 2005 data, descriptive analysis were conducted to determine the frequencies of total hospitalizations, mean LOS, mean total charges, in-hospital deaths with COPD as both a primary and secondary diagnosis. Discharge weights were applied to derive weighed averages or national estimates. There were 616,818 estimated hospitalizations in the year 2005 with COPD as the primary diagnosis. Additionally an estimated 1,426,723 hospitalizations were identified, with COPD as the secondary diagnosis on record. Both the mean LOS and the mean total charges and costs were higher for records with COPD listed as a secondary diagnosis. After applying weights, the mean LOS and mean total costs for hospitalizations with COPD as primary diagnosis were found to be 4.86 and $6,938.55; whereas for hospitalizations with COPD as secondary diagnosis, they were 5.03 and $7,636.73, respectively. There were an estimated 12,054 in-hospital deaths due to COPD as primary diagnosis and an estimated 40,738 in-hospital deaths due to COPD as secondary diagnosis in the year 2005.

Table 8. National estimates (Weighed data) of COPD - related hospitalizations: NIS 2005

Variable	Diagnosis of COPD	
	Primary	Secondary
Hospitalizations	616,818#	1,426,723#
Deaths	12,054#	40,738#
LOS	4.68 ± 3.62*	5.03 ± 4.24*
Total hospital charges ($)	17,259.84 ± 21,660.84*	23,450.62 ± 27,784.86*
Estimated Costs ($)	6,938.55 ± 7,776.81*	7,636.73 ± 8,250.43*

*Mean ± S.D
#Total Number
LOS = Length of stay

Objective 2: Frequency of patient, hospital, and outcome variables

Using descriptive analysis, frequencies of patient-related, hospital-related, and outcome variables for the year 2005 were determined. Patient variables included age, race, gender, payer information, location and median household income. Hospital variables included geographic region, location, and hospital bed-size. Other variables included type of admission (elective vs. non-elective), total number of diagnoses on record, total number of procedures on record while outcome variables included length of stay, total hospital charges, and in-hospital mortality.

Patient variables

A descriptive analysis indicated that the study sample consisted predominantly females (55.9%), and that the mean age of patients hospitalized with COPD in this sample was 68.83 years (S.D. = 13.34). Caucasians (85.5%) formed a predominant section of the patient population, followed by African Americans (7.4%) and Hispanics (4.7%). Other races including Asians or Pacific Islanders and Native Americans, together accounted for the least number of hospitalizations due to COPD (2.5%). The patients were mainly located in the large metropolitan areas (44.0%), while only a small section (13.1%) located in the non-core areas. A majority of the patients (33.9%) were in the income level group of $1- $36,999 followed by the group with income level $37,000-$45,999 (28.3%). The primary expected payer for most of the patient population was Medicare (71.9%) followed by private payers (13.9%) and Medicaid (9.3%). (Refer Table 9)

Table 9. Patient characteristics of COPD - related hospitalizations: NIS 2005 (N = 125,584)

Patient variables	Level of patient variables	N (%)
Age (years)	0-20	796 (0.6)
(68.83 ± 13.31)*	21-40	1,851 (1.5)
	41-64	39,895 (31.8)
	65-80	59,133 (47.1)
	81 and above	23,885 (19.0)
	Total	125,560 (100.0)
Race	Caucasian	76,123 (85.5)
	African American	6,573 (7.4)
	Hispanic	4,156 (4.7)
	Asian	741 (0.8)
	Native American	257 (0.3)
	Other	1,214 (1.4)
	Total	89,064 (100.0)
Gender	Male	55,381 (44.1)
	Female	70,140 (55.9)
	Total	125,521 (100.0)
`		
Payer	Medicare	90,248 (71.9)
	Medicaid	11,653 (9.3)
	Private	17,497 (13.9)
	Self Pay	3,300 (2.6)
	No charge	410 (0.3)
	Other	2,386 (1.9)
	Total	125,494 (100.0)

Patient variables	Level of patient variables	N (%)
Patient Location	Large Metropolitan	55,109 (44.0)
	Small Metropolitan	34,865 (27.8)
	Micropolitan	18,901 (15.1)
	Non-urban	16,440 (13.1)
	Total	125,315 (100.0)
Income	$1-$36,999	41,500 (33.9)
	$37,000 – $45,999	34,705 (28.3)
	$46,000 – $60,999	27,167 (22.2)
	$61,000 +	19,116 (15.6)
	Total	122,488 (100.0)

*Mean ± S.D.

N = Number of hospitalizations at each level

Hospital variables

The hospital located in the Southern region (45.9%) of the U.S., and urban non-teaching setting (50.9%) accounted for a majority of the hospitalizations. Very few (13.0%) hospitalizations were seen in the Western regions of the U.S. Also, a majority of hospitalizations were observed in hospitals with a large bed size (56.1%), with the least number (16.9%) of hospitalizations occurring in hospitals with a small bed size(Refer Table 10).

Table 10. Hospital characteristics of COPD - related hospitalizations: NIS 2005 (N= 125,584)

Hospital variables	Level of hospital variables	N (%)
Geographic Region	Northeast	22,411 (17.8)
	Midwest	29,184 (23.2)
	South	57,697 (45.9)
	West	16,292 (13.0)
	Total	125,584 (100.0)
Location	Rural	31,654 (25.2)
	Urban non-teaching	63,979 (50.9)
	Urban teaching	29,951 (23.8)
	Total	125,584 (100.0)
Bed-Size	Small	21,246 (16.9)
	Medium	33,898 (27.0)
	Large	70,440 (56.1)
	Total	125,584 (100.0)

N = Number of hospitalizations at each level

Other procedure and diagnoses-related variables

Most (21.8%) hospitalization records had at least 9 diagnoses listed on them, while very few (1.3%) had only one diagnoses listed. The mean number of diagnoses listed on record were 7.29 (S.D = 3.14). In terms of number of procedures on record, majority of the records (78%) had no procedures listed, whereas only 11.4% records showed at least one procedure to be listed on the record. Most (89.2%) of the hospitalizations were due to non-elective admissions (Refer Table 11).

Table 11. Other characteristics of COPD - related hospitalizations: NIS 2005 (N= 125,584)

Variables	Level of variables	N (%)
Number of diagnoses on the record (7.29 ± 3.14)*	1	1,589 (1.3)
	2	4,428 (3.5)
	3	8,010 (6.4)
	4	10,971 (8.7)
	5	13,287 (10.6)
	6	13,697 (10.9)
	7	2,772 (10.2)
	8	2,493 (9.9)
	9	27,391 (21.8)
	10 and above	20,926 (16.3)
	Total	125,584 (100.0)
Number of procedures on the record (0.45 ± 1.14)*	0	97,910 (78.0)
	1	14,307 (11.4)
	2	6,212 (4.9)
	3	3,319 (2.6)
	4	1,622 (1.3)
	5	884 (0.7)
	6	755 (0.6)
	7	213 (0.2)
	8	135 (0.1)
	9	100 (0.1)
	10 and above	127 (0.1)
	Total	125,584 (100.0)

Variables	Level of variables	N (%)
Type of hospital admission	Elective	13,271 (10.6)
	Non-elective	111,995 (89.2)
	Total	125,266 (100.0)

* Mean ± S.D.
N = Number of hospitalizations at each level

Table 12. Top five Secondary Diagnoses listed on records of patient with a Primary diagnosis of COPD: NIS 2005 (N= 125,584)

ICD-9 Code	Disease/ Illness	N (%)
428.0	Congestive heart failure, unspecified	15,735 (12.5)
401.9	Essential hypertension, unspecified	7,863 (6.3)
427.31	Atrial fibrillation	6,971 (5.6)
486.0	Pneumonia	4,611 (3.7)
305.1	Tobacco use disorder	3,626 (2.9)

Table 13. Top five Primary Diagnoses listed on records of patient with a Secondary diagnosis of COPD: NIS 2005 (N= 288,992)

ICD-9 Code	Disease/ Illness	N (%)
486.0	Pneumonia	210,669 (14.8)
428.0	Congestive heart failure, unspecified	119,560 (8.4)
518.81	Acute respiratory failure	62,264 (4.4)
786.59	Chest pain	29,843 (2.1)
414.01	Coronary arthrosclerosis	29,690 (2.1)

Outcome variables

It was seen that LOS for patients hospitalized with COPD ranged from 0-102 days. However, to exclude extreme outliers, only those records with LOS ≤ 30 days were considered for analysis, and the mean LOS was found to be 4.69 days (S.D. = 3.63) (Refer Table 14). The majority of hospitalizations (52.1%) were for 2-4 days, while only 8% patients had mean LOS of 10 or more days.

The total costs for hospitalization for COPD ranged from $29 - $311,599 with a mean total charge of $6,939.94 (S.D=7,759.51) for the year 2005. Around 74.8% of all hospitalizations had total charges in the range of $1,000 - $9,999; another 11.3% hospitalizations had hospital charges in the range of $10,000 -$19,999, while only 0.5% hospitalizations had hospital charges of more than $50,000.

A total of 2,451 in-hospital deaths due to COPD as primary diagnosis were reported in the year 2005 (Refer Table 15).

Table 14. Hospital length of stay (LOS), total hospital charges and costs for COPD-related hospitalizations: NIS 2005 (N= 125,584)

Outcome variables	Level of outcome variables	N (%)
LOS (days)	0	1,193 (0.9)
(4.69 ± 3.63)*	1	10,344 (8.2)
	2	22,189 (17.7)
	3	23,974 (19.1)
	4	19,265 (15.3)
	5	13,758 (11.0)
	6	9,699 (7.7)
	7	7,046 (5.6)
	8	4,733 (3.8)
	9	3,280 (2.6)
	10 & above	10,103 (8.0)
	Total	125,584 (100.0)
Total hospital charges	0-999	207 (0.2)
(dollars)	1,000-9,999	53,453 (42.9)
(17,383.78 ± 21,719.35)*	10,000-19,999	40,448 (32.5)
	20,000-29,999	14,445 (11.6)
	30,000-39,999	6,395 (5.1)
	40,000-49,999	3,409 (2.7)
	50,000-59,999	1,915 (1.5)
	60,000-69,999	1,197 (1.0)
	70,000-79,999	792 (0.6)
	80,000-89,999	534 (0.4)
	90,000-99,999	388 (0.3)
	100,000 & above	1,323 (1.1)
	Total	125,584 (100)

Outcome variables	Level of outcome variables	N (%)
Total hospital costs	0-999	1,019 (0.8)
(dollars)	1,000-9,999	93,897 (74.8)
(6,939.94 ± 7,759.51)*	10,000-19,999	14,149 (11.3)
	20,000-29,999	2,876 (2.3)
	30,000-39,999	936 (0.7)
	40,000-49,999	419 (0.3)
	50,000-59,999	195 (0.2)
	60,000-69,999	126 (0.1)
	70,000-79,999	84 (0.1)
	80,000-89,999	40 (0.0)
	90,000-99,999	21 (0.0)
	100,000 & above	87 (0.1)
	Total	113,849 (100)

* Mean ± S.D.
N = Number of hospitalizations at each level

Table 15. Deaths during hospitalization in of COPD - related hospitalizations: NIS 2005 (N = 125,584)

Levels of variable 'Died'	N (%)
Died during hospitalization	2,451 (2.0)
Did not die during hospitalization	123,092 (98.0)
Total	125,543 (100.0)

N = Total Number

Objective 3: Differences in length of stay (LOS) by patient-related and hospital-related variables

For the year 2005, the differences in LOS were observed for patients with COPD, by patients and hospital variables. Means for LOS were compared across all levels of patient- and hospital- related variables.

LOS by patient-related variables

The mean LOS was highest for the age group 81 years and above (5.03 days, S.D. = 3.70), and lowest for age group 0-20 years (3.04 days, S.D. = 3.08). African Americans and Hispanics had lower LOS (4.77 days, S.D. = 3.88 and 4.73 days, S.D = 3.75) as compared to Caucasians (4.81 days, S.D. = 3.79). Females were observed to have a longer LOS (4.84 days, S.D. = 3.64) than males (4.51 days, S.D. = 3.60). The patients with Medicare as their primary expected payer had a longer mean LOS (4.89 days, S.D. = 3.71), followed by those with private payers (4.21 days, S.D. = 3.44), while those with no insurance had the lowest mean LOS (3.52 days, S.D. = 3.52 days, S.D. = 2.72). Patients living in the large metropolitan had a longer LOS (4.90 days, S.D. = 3.88), whereas those who lived in the non-core areas had the lowest LOS (4.16 days, S.D. = 3.02). The mean LOS increased with the increasing levels of patient income groups. Patients in the income group of $1- $36,999 had a shorter mean LOS (4.53 days, S.D. = 3.49) than those in the $61,000+ group (5.07 days, S.D. = 3.94).

A one-way ANOVA was conducted for all the patient variables, except gender. All patient variables, except Race were found to be significant ($p < 0.050$) (Table 16). To further tease out the differences among the levels of the significant patient variables, Post-hoc Hochberg analyses were conducted. The Post Hoc tables lists the different levels of the variables in the first column, and then compares each level to every other level to see if they are significantly different.

The different categories of age were compared, and significant differences were seen among all the categories of age (Refer Tables 17, 18). However, the difference between the groups 81+ years and 0-20 years was highest (the LOS was 1.9 days longer in the age category 81+ years as compared to those in the group 0-20 years) and the difference was least in the groups 81+ years and 65-80 years (the LOS was only 0.16 days longer in the age category 81+ as compared to those in the group 65-80 years). There were significant differences between patients with different Payers, in almost all the categories of Payers (Refer Table 19). The difference was highest between those with Medicare and those patients with no insurance, with patients under Medicare observed to have longer LOS (1.4 days more than patients with no insurance). Significant differences were also seen among all the categories of patient location, the difference being largest between the patient living in the large metropolitan areas and those living in the non-urban areas (Refer Table 20). The patients in the large metropolitan areas had a relatively longer LOS (0.73 days). Inpatient median income groups, significant differences in LOS were seen across all the levels. The most difference was seen in patients with income $61,000 and above as compared to those with in the income group $1- $36,999, with the former having a longer LOS (0.53 days) than the latter.

A difference in LOS between males and females was tested using Independent t-test; and the differences between males and females were found to be found to be statistically significant ($p<0.05$).

Table 16. Differences in hospital length of stay (LOS) by patient variables: NIS 2005 (N= 125,584)

Patient variables	Level of patient variables	Mean LOS (days)	S.D.
Age (years)	0- 20	3.04	3.08
(68.83 ± 13.31)*	21- 40	3.36	2.88
	41- 64	4.31	3.04
	65- 80	4.87	3.72
	81+	5.03	3.74
	Total	4.69	3.62
Race	Caucasian	4.81	3.79
	African American	4.77	3.88
	Hispanic	4.73	3.75
	Other	4.95	4.42
	Total	4.81	3.75
Gender	Male	4.51	3.60
	Female	4.84	3.64
Payer	Medicare	4.89	3.71
	Medicaid	4.21	3.43
	Private	4.27	3.44
	Self Pay	3.52	2.72
	No charge	3.67	3.00
	Other	4.19	3.21
	Total	4.69	3.63

Patient variables	Level of patient variables	Mean LOS (days)	S.D.
Patient Location	Large Metropolitan	4.90	3.88
	Small Metropolitan	4.71	3.61
	Micropolitan	4.49	3.29
	Non-urban	4.16	3.02
	Total	4.69	3.63
Income ($)	1-36,999	4.53	3.49
	37,000 – 45,999	4.62	3.53
	46,000 – 60,999	4.77	3.71
	61,000 +	5.07	3.94
	Total	4.69	3.63

* Mean ± S.D.
LOS = Length of stay
S.D. = Standard deviation

Table 17. Differences between patient variables for length of stay (LOS): NIS 2005 (N= 125,584)

Patient variables	Test statistics	Sig. (*p*)
Age	F = 302.426[a]	0.000*
Race	F = 1.991[a]	0.113
Payer	F = 228.440[a]	0.000*
Patient Location	F = 198.243[a]	0.000*
Income	F = 103.753[a]	0.000*
Gender	T-test = -16.005[b]	0.000*

[a] One-way ANOVA
[b] Independent t-test.
Dependent variable: LOS
*Significance is at 0.05 level

Table 18. Differences within significant patient variable (age) for length of stay (LOS): NIS 2005 (N= 125,584)

Age (I)	Age (J)	Mean Difference	Std. Error	Sig. (*p*)
0-20 years	21-40 years	-0.319	0.153	0.235
	41-64 years	-1.274	0.129	0.042*
	65-80 years	-1.830	0.129	0.000*
	81+ years	-1.992	0.130	0.000*
21-40 years	0-20 years	0.319	0.153	0.253
	41-64 years	-0.955	0.086	0.000*
	65-80 years	-1.511	0.085	0.000*
	81+ years	-1.673	0.087	0.000*
41-64 years	0-20 years	1.274	0.129	0.000*
	21-40 years	0.955	0.086	0.000*
	65-80 years	-0.556	0.023	0.000*
	81+ years	-0.718	0.030	0.000*
65-80 years	0-20 years	1.830	0.129	0.000*
	21-40 years	1.511	0.085	0.000*
	41-64 years	0.556	0.023	0.000*
	81+ years	-0.162	0.028	0.000*
81+ years	0-20 years	1.992	0.130	0.000*
	21-40 years	1.673	0.087	0.000*
	41-64 years	0.718	0.030	0.000*
	65-80 years	0.162	0.028	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Age
*Significance is at the 0.05 level
Mean Difference = I – J

Table 19. Differences within significant patient variable (payer) for length of stay (LOS): NIS 2005 (N= 125,584)

Payer (I)	Payer (J)	Mean Difference	Std. Error	Sig. (*p*)
Medicare	Medicaid	0.680	0.036	0.000*
	Private	0.618	0.030	0.000*
	Self Pay	1.372	0.064	0.000*
	No charge	1.221	0.179	0.000*
	Other	0.705	0.075	0.000*
Medicaid	Medicare	-0.680	0.036	0.000*
	Private	-0.061	0.043	0.912
	Self Pay	0.693	0.071	0.000*
	No Charge	0.542	0.182	0.000*
	Other	0.025	0.081	1.000
Private	Medicare	-0.618	0.030	0.000*
	Medicaid	0.061	0.043	0.912
	Self Pay	0.754	0.069	0.000*
	No Charge	0.603	0.181	0.000*
	Other	0.087	0.079	0.990
Self Pay	Medicare	-1.372	0.064	0.000*
	Medicaid	-0.693	0.071	0.000*
	Private	-0.754	0.069	0.000*
	No Charge	-0.151	0.189	1.000
	Other	-0.667	0.097	0.000*

Payer (I)	Payer (J)	Mean Difference	Std. Error	Sig. (*p*)
No Charge	Medicare	-1.221	0.179	0.000*
	Medicaid	-0.542	0.182	0.000*
	Private	-0.603	0.181	0.000*
	Self	0.151	0.189	1.000
	Other	-0.517	0.193	0.021*
Other	Medicare	-0.705	0.075	0.000*
	Medicaid	-0.025	0.081	1.000
	Private	-0.087	0.079	0.990
	Self Pay	0.667	0.097	0.000*
	No charge	0.517	0.193	0.021*

Post-hoc Hochberg Analysis
Significant patient variable – Payer
*Significance is at the 0.05 level
Mean Difference = I – J

Table 20. Differences within significant patient variable (patient location) for length of stay (LOS): NIS 2005 (N= 125,584)

Patient location (I)	Patient location (J)	Mean Difference	Std. Error	Sig. (*p*)
Large metropolitan	Small metropolitan	0.187	0.025	0.000*
	Micropolitan	0.413	0.031	0.000*
	Non-urban	0.737	0.032	0.000*
Small metropolitan	Large metropolitan	-0.187	0.025	0.000*
	Micropolitan	0.227	0.033	0.000*
	Non-urban	0.551	0.034	0.000*
Micropolitan	Large metropolitan	-0.413	0.031	0.000*
	Small metropolitan	-0.227	0.033	0.000*
	Non-urban	0.324	0.039	0.000*
Non-urban	Large metropolitan	-0.737	0.032	0.000*
	Small metropolitan	-0.551	0.034	0.000*
	Micropolitan	-0.324	0.039	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Patient location
*Significance is at the 0.05 level
Mean Difference = I – J

Table 21. Differences within significant patient variable (median income) for length of stay (LOS): NIS 2005 (N= 125,584)

Income (I)	Income (J)	Mean Difference	Std. Error	Sig. (*p*)
$1- $36,999	$37,000- $45,999	-0.089	0.026	0.000*
	$46,000- $60,999	-0.241	0.028	0.000*
	$61,000 or more	-0.535	0.032	0.000*
$37,000- $45,999	$1- $36,999	0.089	0.026	0.000*
	$46,000- $60,999	-0.151	0.029	0.000*
	$61,000 or more	-0.446	0.033	0.000*
$46,000- $60,999	$1- $36,999	0.241	0.028	0.000*
	$37,000- $45,999	0.151	0.029	0.000*
	$61,000 or more	-0.294	0.034	0.000*
$1- $36,999	$1- $36,999	0.535	0.032	0.000*
	$37,000- $45,999	0.446	0.033	0.000*
	$46,000- $60,999	0.294	0.034	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Patient location
*Significance is at the 0.05 level
Mean Difference = I – J

LOS by hospital-related variables

The results indicated that LOS was highest in hospitals in the Northeastern region (5.42 days, S.D. = 3.98) and lowest in the Western region (4.36 days, S.D. = 3.61) (Refer Table 19). With respect to hospital's location and teaching status, LOS was high in urban areas (4.85 days, S.D. = 3.76 in urban non-teaching and 4.80 days, S.D. = 3.84 in urban teaching), as compared to the hospitals in rural areas (4.25 days, S.D. = 3.06). LOS was lowest in hospitals with small bed-size (4.39 days, S.D. = 3.68).

A one-way ANOVA was conducted to detect differences in LOS across different levels of hospital-related variables (Refer Table 23). All of the hospital-related variables were found to be significant ($p < 0.050$). Post-hoc Hochberg analyses were further conducted, to tease out the differences among the levels of the significant hospital variables.

On comparing the different region categories of hospital, significant differences were seen among almost all of the regions (Refer Table 24). The highest difference was seen between the LOS in hospitals in the Western region and hospitals in the Northeastern region, and the difference was lowest between the hospital in the Western region and those in the Southern region. Patients from hospitals in the Western region had smaller LOS as compared to patients from hospitals in the Northeastern region as well as from those in the Southern region (1.06 days shorter, and 0.30 days respectively). There were significant differences between patients from hospitals with small, medium, and large bed-sizes (Refer Table 25). The difference was highest between those in hospitals with larger bed-size and those patients in hospitals with smaller bed-size. Patients from hospitals with larger bed-size had a longer LOS (0.44 days). In terms of

LOS, significant differences were seen across all the three categories of hospital location-teaching status, the highest difference being between patients from hospitals in the urban non-teaching setting and those from hospitals in rural setting (Refer Table 26). Patients from hospitals in the urban settings had a relatively longer LOS than the patients from hospitals in the rural setting (0.60 days longer in urban non-teaching and 0.55 days longer in urban teaching setting).

Table 22. Differences in length of stay (LOS) by hospital variables: NIS 2005 (N= 125,845)

Hospital variables	Level of hospital variables	Mean LOS (days)	S.D.
Geographic Region	Northeast	5.42	3.98
	Midwest	4.38	3.28
	South	4.66	3.62
	West	4.36	3.61
	Total	4.69	3.63
Location	Rural	4.25	3.06
	Urban non-teaching	4.85	3.76
	Urban teaching	4.80	3.84
	Total	4.69	3.63
Bed Size	Small	4.39	3.68
	Medium	4.58	3.52
	Large	4.83	3.67
	Total	4.69	3.63

LOS = Length of stay
S.D. = Standard deviation

Table 23. Differences between hospital variables for length of stay (LOS): NIS 2005 (N =125,845)

Hospital variables	Test statistics	Sig. (*p*)
Geographic Region	F = 426.15[a]	0.000*
Location	F = 311.69[a]	0.000*
Bed-Size	F = 138.10[a]	0.000*

[a] One-way ANOVA
[b] Independent t-test
Dependent variable: LOS
*Significance is at the 0.05 level

Table 24. Differences within significant hospital variable (region) for length of stay (LOS): NIS 2005 (N =125,845)

Region (I)	Region (J)	Mean Difference	Std. Error	Sig. (*p*)
Northeast	Midwest	1.042	0.032	0.000*
	South	0.764	0.028	0.000*
	West	1.065	0.037	0.000*
Midwest	Northeast	-1.042	0.032	0.000*
	South	-0.278	0.026	0.000*
	West	0.023	0.035	0.986
South	Northeast	-0.764	0.028	0.000*
	Midwest	0.278	0.026	0.000*
	West	0.301	0.032	0.000*
West	Northeast	-1.065	0.037	0.000*
	Midwest	-0.023	0.035	0.986
	South	-0.301	0.032	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Geographic location of hospital
*Significance is at the 0.05 level
Mean Difference = I – J

Table 25. Differences within significant hospital variable (hospital bed size) for length of stay (LOS): NIS 2005 (N =125,584)

Hospital bed size (I)	Hospital bed size (J)	Mean Difference	Std. Error	Sig. (*p*)
Small	Medium	-0.189	0.032	0.000*
	Large	-0.436	0.028	0.000*
Medium	Small	0.189	0.032	0.000*
	Large	-0.247	0.024	0.000*
Large	Small	0.436	0.028	0.000*
	Medium	0.247	0.024	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Hospital bedsize
*Significance is at the 0.05 level
Mean Difference = I – J

Table 26. Differences within significant hospital variable (location/teaching status) for length of stay (LOS): NIS 2005 (N= 125,584)

Hospital loc-teach (I)	Hospital loc-teach (J)	Mean Difference	Std. Error	Sig. (*p*)
Rural	Urban non-teaching	-0.603	0.025	0.000*
	Urban teaching	-0.550	0.029	0.000*
Urban non-teaching	Rural	0.603	0.025	0.000*
	Urban teaching	0.053	0.025	0.019*
Urban teaching	Rural	0.550	0.029	0.000*
	Urban non-teaching	-0.053	0.025	0.019*

Post-hoc Hochberg Analysis
Significant patient variable – Hospital bedsize
*Significance is at the 0.05 level
Mean Difference = I – J

Objective 4: Differences in total hospital costs by patient-related and hospital-related variables

The overall differences in total hospital costs by patient and hospital variables were observed for the year 2005. This analysis involved comparing mean total hospital costs within categories of different patient- and hospital-related variables. The mean total hospital costs were found to be approximately $7,383.66 (S.D. = 8,819.07) per hospitalization related to COPD.

Total hospital costs by patient-related variables

The results indicated that mean costs per hospitalization increased with age, and the hospital costs were highest on an average, for patients in the age group 81+ years ($7,162.73, S.D. = 7,094.52). It was observed that Hispanics had the highest per hospitalization ($8,600.73, S.D. =9,976.90), followed by African Americans ($7,872.68 , S.D. = 8,819). Caucasians had the least costs per hospitalization ($7,173.65 S.D. = 8,070.61). Females ($6,986.66, S.D. =7,651.29) had slightly higher mean costs per hospitalization as compared to males ($6,880, S.D. = 7,893.91). Mean costs per hospitalization were found to be the lowest for patients who had no insurance ($4,953.75, S.D. = 5,067.98). The mean costs per hospitalization were higher for patients with Medicare and for patients with private insurance ($7,130.74, S.D = 7,772.85 for Medicare and $6,710.62, S.D = 8,618.62 for private insurance). Also, patients who were located in non-urban areas had the lowest mean costs compared to patients living in other locations. Mean costs per hospitalization were also found to increase, with increasing income levels of the patients.

A one-way ANOVA was conducted for all the patient variables, except gender. All patient level variables were found to be significant ($p < 0.050$) (Refer Table 28). Post-hoc Hochberg analyses were then conducted, to further tease out the differences among the levels of the significant patient variables.

The different categories of age were compared, and significant differences were seen among all the categories of age. Refer Table 29. However, the difference between the groups 81+ years and 0-20 years was highest (the mean costs were $2,245 higher for patients, 81+ years of age). In terms of mean costs, significant differences were seen amongst patients of all races (Refer Table 30). Caucasians had lower mean costs per hospitalization as compared to both Hispanics ($1,427 less), as well as African Americans ($699 less). There were significant ($p < 0.001$) differences between patients with different Payers, in almost all categories of Payers (Refer Table 31). The difference was highest between those with Medicare and those patients with no insurance. Patients under Medicare were observed to have higher mean costs per hospitalization ($2,176 more than patients with no insurance). Least difference was seen between mean costs of patients with Medicare and patients with private insurance (mean costs only $420 higher for patients with Medicare). Significant differences ($p < 0.001$) were also seen among all the categories of patient location, the difference being largest between the patient living in the large metropolitan areas and those living in the non-urban areas (Refer Table 32). The patients in the large metropolitan areas had relatively higher mean costs per hospitalization ($10,486.94). Among the patient median income groups, significant differences ($p < 0.001$) in mean costs were seen across all the levels. The least difference in mean costs was seen in patients in the income group $37,000 - $45,999 and those in the income group $1- $36,999, with the patients in the $37,000 - $45,999 group having higher mean costs ($473 more).

A difference in total mean costs between males and females was tested using Independent t-test; and the differences between males and females were not found to be statistically significant ($p < 0.05$).

Table 27. Differences in total hospital costs by patient variables: NIS 2005 (N= 125,584)

Patient variables	Level of patient variables	Mean total costs ($) per hospitalization	S.D.
Age (years)	0-20	4,917.09	9,775.36
(68.83 ± 13.31)*	21-40	5,378.72	6,424.86
	41-64	6,617.11	8,141.72
	65-80	7,142.21	7,743.18
	81+	7,162.73	7,094.52
	Total	6,939.61	7,758.61
Race	Caucasian	7,173.65	8,070.61
	African American	7,872.68	8,819.07
	Hispanic	8,600.73	9,976.90
	Others	8,767.56	10,601.16
	Total	7,309.23	8,273.49
Gender	Male	6,880.97	7,893.91
	Female	6,986.66	7,651.29
Payer	Medicare	7,130.74	7,772.85
	Medicaid	6,484.98	7,162.72
	Private	6,710.62	8,618.62
	Self Pay	5,325.03	5,416.04
	No charge	4,953.75	5,067.98
	Others	6,039.56	5,685.31
	Total	6,940.47	7,759.67

Patient variables	Level of patient variables	Mean total costs ($) per hospitalization	S.D.
Patient Location	Large Metropolitan	8,035.24	8,983.93
	Small Metropolitan	6,442.47	7,212.26
	Micropolitan	5,950.47	5,824.48
	Non-urban	5,590.29	5,356.69
	Total	6,936.58	7,707.89
Income	$1- $36,999	6,121.03	6,687.12
	$37,000 – $45,999	6,594.85	7,121.59
	$46,000 – $60,999	7,447.29	8,229.27
	$61,000 +	8,649.13	9,597.80
	Total	6,951.39	7,733.41

* Mean ± S.D.
S.D. = Standard deviation

Table 28. Differences between patient variables for total hospital costs: NIS 2005 (N= 125,584)

Patient variables	Test Statistics	Sig. (p)
Age	F = 57.10[a]	0.000*
Race	F = 55.00[a]	0.000*
Payer	F = 54.24[a]	0.000*
Patient Location	F = 633.88[a]	0.000*
Income	F = 483.82[a]	0.000*
Gender	T-test = -1.468[b]	1.43

[a] One-way ANOVA
[b] Independent t-test.
Dependent variable: Total hospital charges
*Significance is at 0.05 level

Table 29. Differences within significant patient variable (age) for total hospital costs: NIS 2005 (N =125,584)

Age (I)	Age (J)	Mean Difference	Std. Error	Sig. (*p*)
0-20 years	21-40 years	-461.63	365.84	0.895
	41-64 years	-1,700.02	316.95	0.000*
	65-80 years	-2,225.12	316.12	0.000*
	81+ years	-2,245.64	318.76	0.000*
21-40 years	0-20 years	461.63	365.84	0.895
	41-64 years	-1,238.38	191.52	0.000*
	65-80 years	-1,763.48	190.13	0.000*
	81+ years	-1,784.01	194.50	0.000*
41-64 years	0-20 years	1,700.02	316.95	0.000*
	21-40 years	1,238.38	191.52	0.000*
	65-80 years	-525.09	52.62	0.000*
	81+ years	-545.62	62.61	0.000*
65-80 years	0-20 years	2,225.12	316.12	0.000*
	21-40 years	1,763.48	190.13	0.000*
	41-64 years	525.09	52.62	0.000*
	81+ years	-20.52	62.61	1.000
81+ years	0-20 years	2,245.64	318.76	0.000*
	21-40 years	1,784.01	194.50	0.000*
	41-64 years	545.62	66.70	0.000*
	65-80 years	20.52	62.61	1.000

Post-hoc Hochberg Analysis
Significant patient variable – Age
*Significance is at the 0.05 level
Mean Difference = I – J

Table 30. Differences within significant patient variable (race) for total hospital costs: NIS 2005 (N =125,584)

Race (I)	Race (J)	Mean Difference	Std. Error	Sig. (*p*)
Caucasian	African American	-699.03	116.83	0.010*
	Hispanic	-1,427.07	160.61	0.010*
	Others	-1,593.90	200.22	0.010*
African American	Caucasian	699.03	116.83	0.010*
	Hispanic	-728.04	193.45	0.011*
	Others	-894.87	227.41	0.011*
Hispanic	Caucasian	1,427.07	160.61	0.010*
	African American	728.04	193.45	0.011*
	Others	-166.83	252.71	0.986
Others	Caucasian	1,593.90	200.22	0.010*
	African American	894.87	227.41	0.011*
	Hispanic	166.83	252.71	0.986

Post-hoc Hochberg Analysis
Significant patient variable – Race
*Significance is at the 0.05 level
Mean Difference = I – J

Table 31. Differences within significant patient variable (payer) for total hospital costs: NIS 2005 (N= 125,584)

Payer (I)	Payer (J)	Mean Difference	Std. Error	Sig. (*p*)
Medicare	Medicaid	645.76	79.27	0.000*
	Private	420.12	67.52	0.000*
	Self Pay	1,805.71	150.38	0.000*
	No charge	2,176.99	426.87	0.000*
	Other	1,091.18	67.70	0.000*
Medicaid	Medicare	-645.76	79.27	0.000*
	Private	-225.63	96.84	0.207
	Self Pay	1,159.94	165.64	0.000*
	No Charge	1,531.23	432.47	0.000*
	Other	445.42	181.50	0.135
Private	Medicare	-420.12	67.52	0.000*
	Medicaid	225.63	96.84	0.207
	Self Pay	1,385.58	160.34	0.000*
	No Charge	1,756.87	430.47	0.000*
	Other	671.05	176.68	0.000*
Self Pay	Medicare	-1,805.71	150.38	0.000*
	Medicaid	-1,159.94	165.64	0.000*
	Private	-1,385.58	160.34	0.000*
	No Charge	371.28	450.96	1.000
	Other	-714.52	221.98	0.000*

Payer (I)	Payer (J)	Mean Difference	Std. Error	Sig. (*p*)
No Charge	Medicare	-2,176.99	426.87	0.000*
	Medicaid	-1,531.23	432.47	0.000*
	Private	-1,756.87	430.47	0.000*
	Self	-371.28	450.96	1.000
	Other	-1,085.81	457.03	0.179
Other	Medicare	-1,091.18	67.70	0.000*
	Medicaid	-445.42	181.50	0.135
	Private	-671.05	176.68	0.000*
	Self Pay	714.52	221.98	0.000*
	No charge	1,085.81	457.03	0.179

Post-hoc Hochberg Analysis
Significant patient variable – Payer
*Significance is at the 0.05 level
Mean Difference = I – J

Table 32. Differences within significant patient variable (patient location) for total hospital costs: NIS 2005 (N= 125,584)

Patient location (I)	Patient location (J)	Mean Difference	Std. Error	Sig. (*p*)
Large metropolitan	Small metropolitan	1,592.77	54.87	0.000*
	Micropolitan	2,084.77	67.31	0.000*
	Non-urban	2,444.95	71.19	0.000*
Small metropolitan	Large metropolitan	-1,592.77	54.87	0.000*
	Micropolitan	492.00	71.73	0.000*
	Non-urban	852.18	75.37	0.000*
Micropolitan	Large metropolitan	-2,084.77	67.31	0.000*
	Small metropolitan	-492.00	71.73	0.000*
	Non-urban	360.18	84.86	0.000*
Non-urban	Large metropolitan	-2,444.95	71.19	0.000*
	Small metropolitan	-852.18	75.37	0.000*
	Micropolitan	-360.18	84.86	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Patient location
*Significance is at the 0.05 level
Mean Difference = I – J

Table 33. Differences within significant patient variable (median income) for total hospital costs: NIS 2005 (N= 125,584)

Income (I)	Income (J)	Mean Difference	Std. Error	Sig. (*p*)
$1- $36,999	$37,000- $45,999	-473.81	58.74	0.000*
	$46,000- $60,999	-1,326.25	62.98	0.000*
	$61,000+	-2,528.09	70.71	0.000*
$37,000- $45,999	$1- $36,999	473.81	58.74	0.000*
	$46,000- $60,999	-852.43	64.84	0.000*
	$61,000+	-2,054.28	72.37	0.000*
$46,000- $60,999	$1- $36,999	1,326.25	62.98	0.000*
	$37,000- $45,999	852.43	64.84	0.000*
	$61,000+	-1,201.84	75.86	0.000*
$61,000+	$1- $36,999	2,528.09*	70.71	0.000*
	$37,000- $45,999	2,054.28*	72.37	0.000*
	$46,000- $60,999	1,201.84*	75.86	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Patient location
*Significance is at the 0.05 level
Mean Difference = I – J

Total hospital costs by hospital-related variables

The mean costs per hospitalization were found to be the highest for hospitals located in the Western region ($9,378.43, S.D. = 12,461.73) and lowest for those located in the Southern region ($5,747.31, S.D. = 5,516.07). Hospitals with teaching status in urban areas had higher mean costs per hospitalization ($7,908.41, S.D. =10,355) compared to rural hospitals ($5,645.29, S.D. = 5,072.56). Hospitals with large bed sizes had the highest mean costs per hospitalization ($7,272.00, S.D. =8,337.15) than hospitals with small or medium bed sizes (Refer Table 34).

One-way ANOVA were then conducted for all hospital-related variables, which indicated that the differences for geographic region, hospital bed size and location /teaching status were all statistically significant (Refer Table 35). A post-hoc Hochberg test was conducted to see the differences among these variables.

On comparing the different region categories of hospital, significant differences were seen among almost all four regions (Refer Table 36). The highest difference was seen between the mean costs in hospitals in the Western region and hospitals in the Southern region, and the difference was lowest between the hospitals in the Midwestern region and those in the Southern region. The post-hoc tests also showed significance difference between hospitals located in urban areas with teaching facilities compared to hospitals located in rural areas ($p<0.001$). The results showed that teaching hospitals in urban areas had higher mean costs per hospitalization ($2,263.11) than hospitals in rural areas (Refer Table 37). There were also significant ($p < 0.001$) differences in costs for patients from hospitals with small, medium, and large bed-sizes (Refer Table 38). The difference was highest between those in hospitals with larger bed-size and those patients in hospitals with smaller bed-size. Patients from hospitals with larger bed-size had higher mean costs ($1,088.37 more).

Table 34. Differences in total hospital costs by hospital variables: NIS 2005 (N= 125,845)

Hospital variables	Level of hospital variables	Mean total costs ($) per hospitalization	S.D
Geographic Region	Northeast	8,649.14	8,690.17
	Midwest	6,270.35	6,201.74
	South	5,747.31	5,516.07
	West	9,378.43	12,461.73
	Total	6,939.94	7,759.51
Location	Rural	5,645.29	5,072.56
	Urban non-teaching	7,152.18	7,394.35
	Urban teaching	7,908.41	10,355.40
	Total	6,939.94	7,759.51
Bed-size	Small	6,183.63	6,560.40
	Medium	6,716.97	7,126.57
	Large	7,272.00	8,337.15
	Total	6,939.94	7,759.51

S.D. = Standard deviation

Table 35. Differences between significant hospital variables for total hospital costs: NIS 2005 (N= 125,845)

Hospital variables	Test Statistics	Sig. (*p*)
Geographic Region	F = 1355.46[a]	0.000*
Location / Teaching status	F = 647.23[a]	0.000*
Bed-size	F = 163.22[a]	0.000*

[a] One-way ANOVA
Dependent variable: Total hospital charges
*Significance is at the 0.05 level

Table 36. Differences within significant hospital variable (region) for total hospital costs: NIS 2005 (N= 125,845)

Region (I)	Region (J)	Mean Difference	Std. Error	Sig. (*p*)
Northeast	Midwest	2,378.79	67.76	0.000*
	South	2,901.83	61.89	0.000*
	West	-729.28	79.96	0.000*
Midwest	Northeast	-2,378.79	67.76	0.000*
	South	523.04	56.85	0.000*
	West	-3,108.07	76.12	0.000*
South	Northeast	-2,901.83	61.89	0.000*
	Midwest	-523.04	56.85	0.000*
	West	-3,631.11	70.96	0.000*
West	Northeast	729.28	79.96	0.000*
	Midwest	3,108.07	76.12	0.000*
	South	3,631.11	70.95	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Geographic location of hospital
*Significance is at the 0.05 level
Mean Difference = I – J

Table 37. Differences within significant hospital variable (hospital location-teaching) for total hospital costs: NIS 2005 (N= 125,845)

Hospital loc-teach (I)	Hospital loc-teach (J)	Mean Difference	Std. Error	Sig. (*p*)
Rural	Urban non-teaching	-1,506.88	55.25	0.000*
	Urban teaching	-2,263.11	65.16	0.000*
Urban non-teaching	Rural	1,506.88	55.25	0.000*
	Urban teaching	-756.23	57.08	0.000*
Urban teaching	Rural	2,263.11	65.16	0.000*
	Urban non-teaching	756.23	57.08	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Hospital bed size
*Significance is at the 0.05 level
Mean Difference = I – J

Table 38. Differences within significant hospital variable (hospital bed-size) for total hospital costs: NIS 2005 (N= 125,845)

Hospital bed size (I)	Hospital bed size (J)	Mean Difference	Std. Error	Sig. (*p*)
Small	Medium	-533.33	71.38	0.000*
	Large	-1,088.37	63.67	0.000*
Medium	Small	533.33	71.38	0.000*
	Large	-555.03	53.95	0.000*
Large	Small	1088.37	63.67	0.000*
	Medium	555.03	53.95	0.000*

Post-hoc Hochberg Analysis
Significant patient variable – Hospital bedsize
*Significance is at the 0.05 level
Mean Difference = I – J

Objective 5: Differences in in-hospital mortality by patient-related and hospital-related variables

The overall differences in in-hospital mortality by patient and hospital variables were observed for the year 2005 using Cross tabulations. A total of 2,451 (2.0%) in-hospital deaths were observed in the sample for the year 2005, with COPD as a primary diagnosis on record.

In-hospital deaths by patient-related variables

The proportion of in-hospital deaths as a hospitalization outcome increased with increasing age, and was higher for males (2.2%) as compared to females (1.8%). Results indicated that proportion of in-hospital deaths was highest (3.2%) for patients in the age group 81+ years, and lowest (0.1%) for patients in the age group 21-40 years. Caucasians (2.2%) were seen to have a higher proportion of in-hospital deaths as compared to African Americans (1.3%) and Hispanics (1.7%). Higher proportion of in-hospital mortality was observed in patients with Medicare (2.1%) and those with private insurance (2%). Patients who were located in non-urban areas reported lower (1.7%) proportions of in-hospital mortality, as compared to patients living in other locations (Table 39).

In-hospital deaths by hospital-related variables

The proportion of in-hospital deaths was observed to be relatively higher (2.6%) in the hospitals from Northeastern part of the US. More in-hospital deaths were reported in the hospitals in the urban setting, and also in hospitals with large bed-sizes (Table 40).

Table 39. Differences in in-hospital mortality by patient variables: NIS 2005 (N =125,845)

Patient variables	Level of patient variables	Did not die	Died	Total
Age (years)	0-20	794 (99.7)	2 (0.3)	796
	21-40	1,849 (99.9)	2 (0.1)	1,851
	41-64	39,559 (99.2)	327 (0.8)	39,886
	65-80	57,754 (97.7)	1,359 (2.3)	59,113
	81+	23,112 (96.8)	761 (3.2)	23,873
	Total	123,068 (98.0)	2451 (2.0)	125,519
Race	Caucasian	74,448 (97.8)	1,642 (2.2)	76,090
	African American	6,487 (98.7)	85 (1.3)	6,572
	Hispanic	4,086 (98.3)	69 (1.7)	4,155
	Others	2,169 (98.1)	42 (1.9)	2,211
	Total	87,190 (97.9)	1,838 (2.1)	89,028
Gender	Male	54,143 (97.8)	1,217 (2.2)	55,360
	Female	68,886 (98.2)	1,234 (1.8)	70,120
	Total	123,029 (98.0)	2,451 (2.0)	125,480

Patient variables	Level of variable	Did not die	Died	Total
Payer	Medicare	88,282 (97.9)	1,934 (2.1)	90,216
	Medicaid	11,570 (99.3)	82 (0.7)	11,652
	Private	17,140 (98.0)	352 (2.0)	17,492
	Self Pay	3,277 (99.3)	23 (0.7)	3,300
	No charge	407 (99.3)	3 (0.7)	410
	Others	2,330 (97.7)	55 (2.3)	2,385
	Total	123,006 (98.0)	2,449 (2.0)	125,455
Patient Location	Large Metropolitan	53,988 (98.0)	1,097 (2.0)	55,085
	Small Metropolitan	34,136 (97.9)	719 (2.1)	34,855
	Micropolitan	18,545 (98.1)	354 (1.9)	18,899
	Non-urban	16,161 (98.3)	279 (1.7)	16,440
	Total	122,830 (98.0)	2,449 (2.0)	125,279
Income	$1- $36,999	40,793 (98.3)	699 (1.7)	41,492
	$37,000 – $45,999	34,033 (98.1)	667 (1.9)	34,700
	$46,000 – $60,999	26,555 (97.8)	597 (2.2)	27,152
	$61,000 +	18,663 (97.7)	446 (2.3)	19,109
	Total	120,044 (98.0)	2,409 (2.0)	122,453

Table 40. Differences in in-hospital mortality by hospital variables: NIS 2005 (N= 125,845)

Patient variables	Level of patient variables	Did not die	Died	Total
Geographic Region	Northeast	21,805 (97.4)	590 (2.6)	22,395
	Midwest	28,617 (98.1)	553 (1.9)	29,170
	South	56,738 (98.3)	958 (1.7)	57,696
	West	15,932 (97.9)	350 (2.1)	16,282
	Total	123,092 (98.0)	2,451 (2.0)	125,543
Location	Rural	31,096 (98.2)	557 (1.8)	31,653
	Urban non-teaching	62,688 (98.0)	1,262 (2.0)	63,950
	Urban teaching	29,308 (97.9)	632 (2.1)	29,940
	Total	123,092 (98.0)	2,451 (2.0)	125,543
Bed-size	Small	20,830 (98.1)	404 (1.9)	21,234
	Medium	33,294 (98.2)	599 (1.8)	33,893
	Large	68,968 (97.9)	1,448 (2.1)	70,416
	Total	123,092 (98.0)	2,451 (2.0)	125,543

Objective 6: Patient- and hospital-related predictors of hospital LOS .

To assess the predictors of LOS, multiple regression analyses were conducted, and dummy variables were used for variables with more than two levels.

Predictors of length of stay (LOS)

A multiple linear regression was conducted to find the variables that predicted LOS in hospitalized patients with COPD. An 'Enter' regression was conducted to determine significant predictors and further a 'Stepwise' regression was conducted to find out the predictors, which contributed most to the variance in LOS (Refer Tables 41, 42).

The regression analysis conducted by the Enter method found most variables to be significant predictors for LOS (i.e. had a p-value of ≤ 0.05). The variables not found to be significant were the race African American, the 'other' category of health insurance, the micropolitan patient location, the $61,000+ income group, and the urban-teaching hospital setting.

Males had a smaller (0.3 days less) LOS as compared to females. Both patients with no health insurance (0.5 days less), patients with private insurance had a smaller LOS (0.5 days, and 0.2 days less) as compared to those with Medicare in the regression model. Also patients from the Western and Midwestern region had LOS smaller than those from the Southern region (0.7days less and 0.5 days less respectively). Patients from small bed size hospitals had 0.3 days smaller LOS than from large bed size hospitals. Patients who had Elective type of hospital admission had a shorter LOS stay (0.5 days less) in the regression model.

The results for Stepwise method of multiple linear regression analysis for hospital LOS of COPD patients are shown in Table 41. Only significant variables ($p < 0.001$) entered the model, and the final model (Step 3) accounted for 19.3% of the variance in hospital LOS, where Number of procedures accounted for most of the variance (13.5%). The other significant predictors (sequentially in the order of inclusion in the model) that entered in this model were Number of diagnoses, Midwestern region, Western region, Gender (female), Elective type of hospital admission, Urban non-teaching hospital setting, patients with no insurance or private insurance, patients with Medicaid, North eastern region, small and medium bed size hospital setting, and small metropolitan area.

Table 41. Factors associated with length of stay (LOS) for COPD – related hospitalizations: NIS 2005(N= 125,845) {Enter Method}

Variables	Model Levels	B	SE	t	Sig.
Age	-	0.015	0.001	18.01	0.000*
Race	Caucasian†				
	African American	0.020	0.042	0.462	0.644
	Hispanic	0.149	0.052	2.844	0.004*
	Others	0.369	0.070	5.252	0.000*
Gender	Female†				
	Male	-0.328	0.19	-0.045	0.000*
Payer	Medicare†				
	Medicaid	-0.151	0.036	-4.148	0.000*
	Pvt. Insurance	-0.209	0.030	-7.069	0.000*
	Self-pay	-0.564	0.060	-9.390	0.000*
	Other	-0.126	0.069	-1.841	0.066
Location	Large Metro†				
	Small Metro	-0.149	0.023	-6.353	0.000*
	Micropolitan	-0.085	0.047	-1.796	0.073
	Non-Core	-0.174	0.048	-3.623	0.000*
Income	$1,000 - $36,999†				
	$37,000 – $45,999	-0.075	0.025	-0.009	0.002*
	$45,000 – $60,999	-0.077	0.028	-0.009	0.006*
	$61,000 +	0.002	0.033	0.065	0.948

Model Variables	Levels	B	SE	t	Sig.
Geog. Region	South†				
	Northeast	0.192	0.028	6.984	0.000*
	Midwest	-0.490	0.024	-20.220	0.000*
	West	-0.743	0.030	-24.972	0.000*
Location/ Teaching	Rural†				
	Urban non-teaching	0.220	0.044	5.012	0.000*
	Urban teaching	-0.041	0.046	-0.895	0.371
Bed-size	Large†				
	Small	-0.293	0.026	-11.132	0.000*
	Medium	-0.222	0.022	-10.140	0.000*
Admission Type	Non-elective†				
	Elective	-0.548	0.030	-18.120	0.000*
Number of diagnoses	-	0.220	0.003	71.149	0.000*
Number of procedures	-	1.041	0.008	124.649	0.000*

Multiple Linear Regression Analysis – Enter Method, all variables entered.
Dependent variable: LOS
*Significance is at 0.05 level
†Reference category
B = Regression Coefficient; SE = Standard Error of the regression coefficients; t = t-test (ratio of the sample regression coefficient B to its standard error)

Table 42. Factors associated with length of stay (LOS) for COPD – related hospitalizations: NIS 2005 (N= 125,845) {Stepwise Method}

	B	SE	β	R^2
Step 1				
Constant	4.159	0.010		**0.135**
Number of procedures	1.168	0.008	0.367	
Step 2				
Constant	2.494	0.024		**0.178**
Number of procedures	1.031	0.008	0.325	
Number of diagnoses	0.237	0.003	0.205	
Step 3				
Constant	3.517	0.041		**0.193**
Number of procedures	1.035	0.008	0.326	
Number of diagnoses	0.226	0.003	0.195	
Midwest region	-0.499	0.024	-0.058	
West region	-0.715	0.029	-0.066	
Gender (Female)	-0.333	0.019	-0.046	
Elective admission	-0.534	0.030	-0.046	
Urban non-teaching setting	0.272	0.020	0.037	
Payer- Self pay	-0.836	0.058	-0.037	
Payer- Private and HMO	-0.420	0.027	-0.040	
Payer-Medicaid	-0.442	0.032	-0.035	
Northeast region	0.231	0.027	0.024	
Small bed-size	-0.289	0.026	-0.030	
Medium bed-size	-0.221	0.022	-0.027	
Small metropolitan areas	-0.163	0.022	-0.020	

Multiple Linear Regression Analysis – Stepwise Method, only significant variables entered.
Dependent variable: LOS
Significance is at 0.05 level

B = Regression Coefficient; SE = Standard Error of the regression coefficients; β = Standardised regression coefficient; R^2 = Adjusted R^2
Reference category = Race (Caucasians). Gender (Female), Payer (Medicare), Location (Large metro), Income ($1-$35,999), Geographic region (South), Location/Teaching Status (Urban Teaching), Bed-size (Large)
ΔR^2 Step 1= 0.135
ΔR^2 Step 2= 0.043
ΔR^2 Step 3= 0.015

Objective 7: Patient- and hospital-related predictors of total hospital costs.

To assess the predictors of total hospital costs, multiple regression analyses were conducted, and dummy variables were used for variables with more than two levels.

Predictors of total hospital costs

A multiple linear regression was conducted to test the variables that predict total hospital charges. Just like for LOS, an 'Enter' regression to determine significant predictors and further a 'Stepwise' regression was conducted to find out the predictors, which contributed most to the variance in total hospital charges. Refer tables 43, 44.

By using Enter method in multiple linear regression analysis, it was found that most patient-related and all hospital- related variables were significant predictors for total hospital costs (i.e. had a p-value of ≤ 0.05). The variables not found to be significant were no health insurance and patient income groups $37,000 - $45,999, and age at admission

Hispanics had a total of $910 higher charges per hospitalization than Caucasians (reference group in dummy variables). Males had $170.89 lesser costs per hospitalization than females (reference group in dummy variables). Those with no insurance had $617.57 lesser costs per hospitalization than those with Medicare (reference group in dummy variables), also patients who lived in the non-urban areas had costs per hospitalization $623.68 than those who lived in the large metropolitan areas (reference group in dummy variables). Hospitals in the Western region had a total of $2,426 higher charges per hospitalization than hospitals in the Southern region (reference group in dummy variables), and hospitals in the urban non-teaching setting had $455.06 higher charges than hospitals in rural setting. Patients who had elective type of hospital admission had \$394.74 lesser charges per hospitalization than those who had a non-elective type of hospital admission (reference group in dummy variables).

Table 43 shows the Stepwise method of multiple linear regression analysis for total hospital costs of patients with COPD. Only significant variables ($p < 0.001$) entered the model, and the final model (Step 3) accounted for 29.8% of the variance in total hospital costs, with Number of procedures and Number of diagnosis again accounting for most of the variance (27.2%). The other significant predictors (sequentially in the order of inclusion in the model) that entered in this model were Western region, Northeastern region, patients in the income group \$61,000+, Micropolitan areas of patient location, small and medium hospital bed size, the Hispanic race/ethnicity category, African American race/ethnicity category, Elective type of hospital admission, and urban hospital setting.

Table 43. Factors associated with total hospital costs for COPD – related hospitalizations: NIS 2005(N= 125,845) {Enter Method}

Model Variables	Levels	B	SE	t	Sig.
Age	-	-1.455	1.805	-0.806	0.420
Race	Caucasian†				
	African American	691.915	93.078	7.434	0.000*
	Hispanic	910.106	101.658	-1.885	0.059
	Others	934.764	112.981	-1.114	0.034*
Gender	Female†				
	Male	170.890	39.023	4.379	0.000*
Payer	Medicare†				
	Medicaid	-246.709	75.745	-3.257	0.001*
	Pvt. Insurance	-188.896	62.556	-3.020	0.003*
	Self-pay	-602.529	131.655	-4.577	0.000*
	No charge	-617.577	360.965	-1.711	0.087
	Other	-269.582	143.007	-1.885	0.059
Location	Large Metro†				
	Small Metro	-1,151.927	49.247	-23.391	0.000*
	Micropolitan	-1,147.991	99.398	-11.549	0.000*
	Non-Core	-623.686	101.726	-6.131	0.000*
Income	$1,000 - $36,999†				
	$37,000 – $45,999	85.006	51.670	1.645	0.080
	$46,000 – $60,999	361.578	58.543	6.176	0.000*
	$61,000 +	950.646	69.266	13.724	0.000*

Model Variables	Levels	B	SE	t	Sig.
Geog. Region	South†				
	Northeast	971.118	57.433	16.935	0.001*
	Midwest	-237.744	50.360	-4.721	0.000*
	West	2426.448	63.035	38.494	0.000*
Location/	Rural†				
Teaching	Urban teaching	-276.762	97.307	-2.844	0.004*
	Urban non-teaching	-455.067	92.592	-4.915	0.000*
Bed-size	Large†				
	Small	-643.122	55.191	-11.653	0.000*
	Medium	-523.436	46.145	-11.343	0.000*
Admission	Elective				
Type	Non-elective	-394.740	65.222	6.052	0.000*
Number of diagnoses	-	432.029	6.585	65.606	0.000*
Number of procedures	-	2,974.112	17.403	170.895	0.000*

Multiple Linear Regression Analysis – Enter Method, all variables entered.
Dependent variable: Total hospital costs
*Significance is at 0.05 level
†Reference category
B = Regression Coefficient; SE = Standard Error of the regression coefficients; t = t-test (ratio of the sample regression coefficient B to its standard error)

Table 44. Factors associated with total hospital costs for COPD – related hospitalizations: NIS 2005 (N= 125,845) {Stepwise Method}

	B	SE	β	R^2
Step 1				
Constant	5,429.07	21.62		**0.240**
Number of procedures	3,295.91	17.40	0.490	
Step 2				
Constant	2,238.64	50.11		**0.272**
Number of procedures	3,040.04	17.42	0.452	
Number of diagnoses	454.61	6.437	0.182	
Step 3				
Constant	2,3298.42	77.43		**0.298**
Number of procedures	2968.30	17.32	0.400	
Number of diagnoses	437.22	6.45	0.146	
West region	2434.68	62.84	0.116	
Northeast region	984.76	56.88	-0.067	
Small metropolitan areas	-1137.81	49.16		
$61,000 +	914.66	62.38	0.029	
Micropolitan	-928.43	68.16	-0.070	
Small bed-size	-633.80	49.29	-0.064	
Race- Hispanic	876.26	98.56	0.044	
Medium bed-size	-530.24	24.40	-0.037	
Race- African American	653.91	41.35	0.030	
$46,000- $60,999	318.21	40.94	0.022	
Non-elective admission	-411.06	71.44	-0.021	
Male sex	174.12	24.29	0.067	
Non core areas	-426.60	61.60	0.045	
Midwest region	-229.00	18.01	-0.013	
Urban non teaching setting	-212.36	-14.03	-4.573	

Multiple Linear Regression Analysis – Stepwise Method, only significant variables entered.
Dependent variable: Total hospital costs

Significance is at 0.05 level

B = Regression Coefficient; SE = Standard Error of the regression coefficients; β = Standardised regression coefficient; R^2 = Adjusted R^2
Reference category = Race (Caucasians). Gender (Female), Payer (Medicare), Location (Large metro), Income ($1-$35,999), Geographic region (South), Location/Teaching Status (Urban Teaching), Bed-size (Large)
ΔR^2 Step 1= 0.240
ΔR^2 Step 2= 0.272
ΔR^2 Step 3= 0.298

Objective 8: Patient- and hospital-related predictors of in-hospital mortality.

To assess the predictors of in-hospital mortality, binary logistic regression analyses were conducted, and dummy variables were used for variables with more than two levels.

Predictors of length of in-hospital mortality

The Forward Wald method was used, and only significant predictors entered the model, and the final model (Step 3) accounted for 22% of the variance in in-hospital mortality, with Number of procedures alone accounting for most of the variance (14%). The other significant predictors (sequentially in the order of inclusion in the model) that entered in this model were Age, Number of diagnoses, Private payer, non-elective type of hospital admission, gender, the race African American, and Medium bed-size hospital setting.

Table 45. Factors associated with in-hospital mortality for COPD – related hospitalizations: NIS 2005 (N= 125,845) {Forward Wald Method}

	B	SE	Wald	R^2
Step 1				
Constant	-4.301	0.025	30340.15	
Number of procedures	0.423	0.009	2307.32	**0.014**
Step 2				
Constant	-8.527	0.177	2311.37	
Number of procedures	0.403	0.010	1750.80	**0.022**
Age	0.054	0.002	651.85	
Number of diagnoses	0.068	0.006	124.93	
Payer- Private and HMO	0.631	0.064	96.70	
Non elective admission	-0.423	0.061	47.90	
Payer-Other	0.745	0.143	27.14	
Gender (Male)	0.229	0.042	29.49	
Race- African American	-0.286	0.114	6.277	
Medium bed-size	-0.121	0.049	6.090	

Logistic Regression Analysis – Forward Wald Method, only significant variables entered.
Dependent variable: In-hospital mortality
Significance is at 0.05 level

B = Regression Coefficient; SE = Standard Error of the regression coefficients; β = Standardised regression coefficient; R^2 = Adjusted R^2
Reference category = Race (Caucasians). Gender (Female), Payer (Medicare), Location (Large metro), Income ($1-$35,999), Geographic region (South), Location/Teaching Status (Urban Teaching), Bed-size (Large)

Objective 9: Trends in hospital LOS, total hospital charges, and in-hospital deaths for years 2002-2005

Descriptive analysis was conducted using NIS datasets for the years 2002-2005 to determine trends in hospital LOS, total hospital charges and number of in-hospital deaths. The number of hospitalized cases with COPD listed as the primary diagnosis was 126,504 cases, 127,393 cases, 112,983 cases, and 126,130 cases in the year 2005 in the year 2002, 2003, 2004 and 2005 respectively.

The results also showed a decreasing trend in the hospital LOS, it being highest for the year 2002 (4.88 days, S.D = 3.76). Refer Table 46, and highest for the year 2005 (4.69 days, S.D = 3.63). The charges however showed an increasing trend. The total hospital charges per hospitalization were highest for the year 2005 . In terms of in-hospital mortality, there was a decreasing trend, which appeared to level off towards the end.

Table 46. Trends in hospital length of stay (LOS) and total hospital costs (THC): NIS, 2002-2005

Variables	Years			
	2002	2003	2004	2005
N	126,504	127,393	112,983	126,130
Mean LOS (days)	4.88	4.76	4.71	4.69
Mean THC ($)*	6,958	7,206	7,293	7,383
Deaths	3,355	3,052	2,570	2,587

N = Number of hospitalizations in each year
THC= Total hospital costs
* Inflated costs (2005 values)

Figure 2: Trends in hospital LOS, NIS 2002-2005.

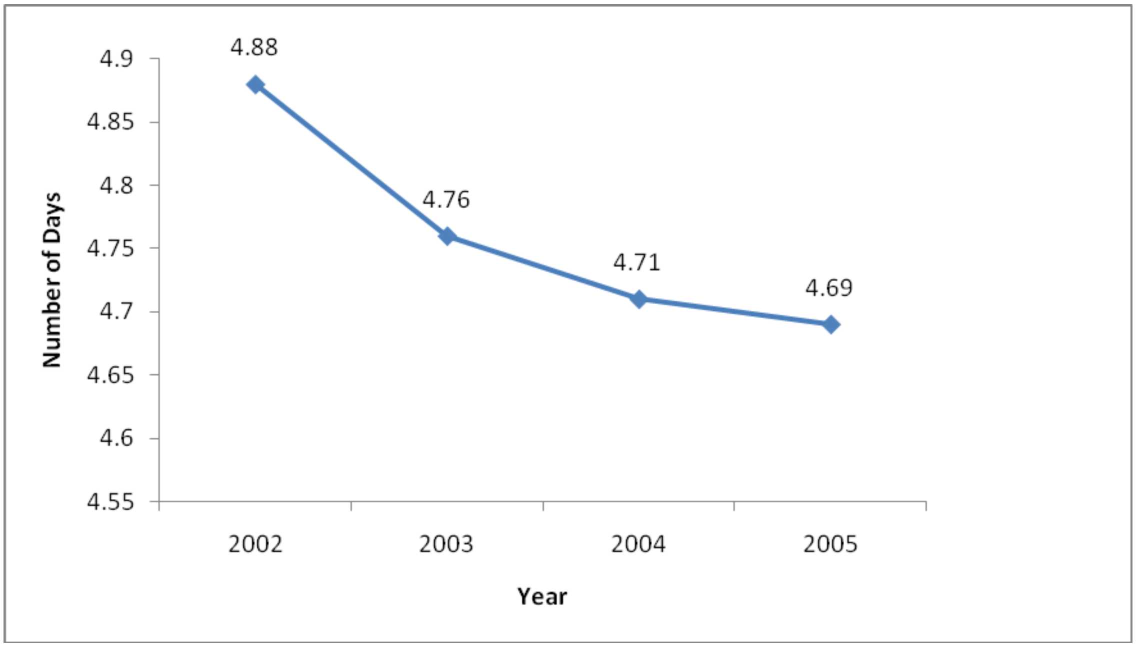


Figure 3: Trends in mean total hospital costs (Inflated, 2005 values), NIS 2002-2005.

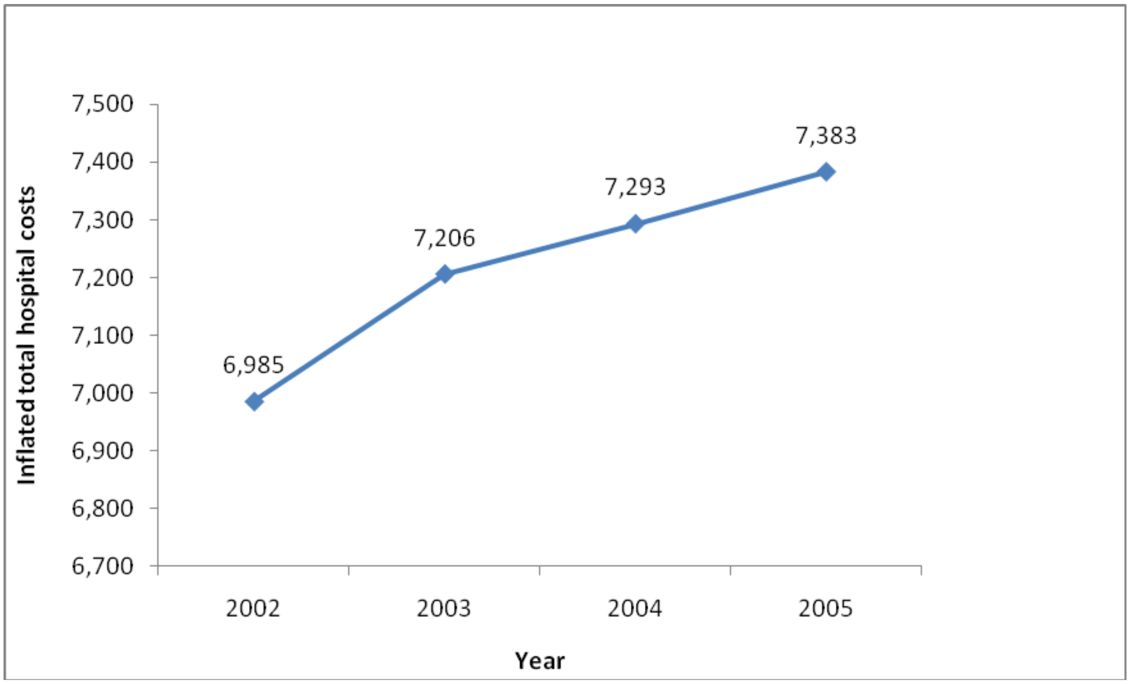
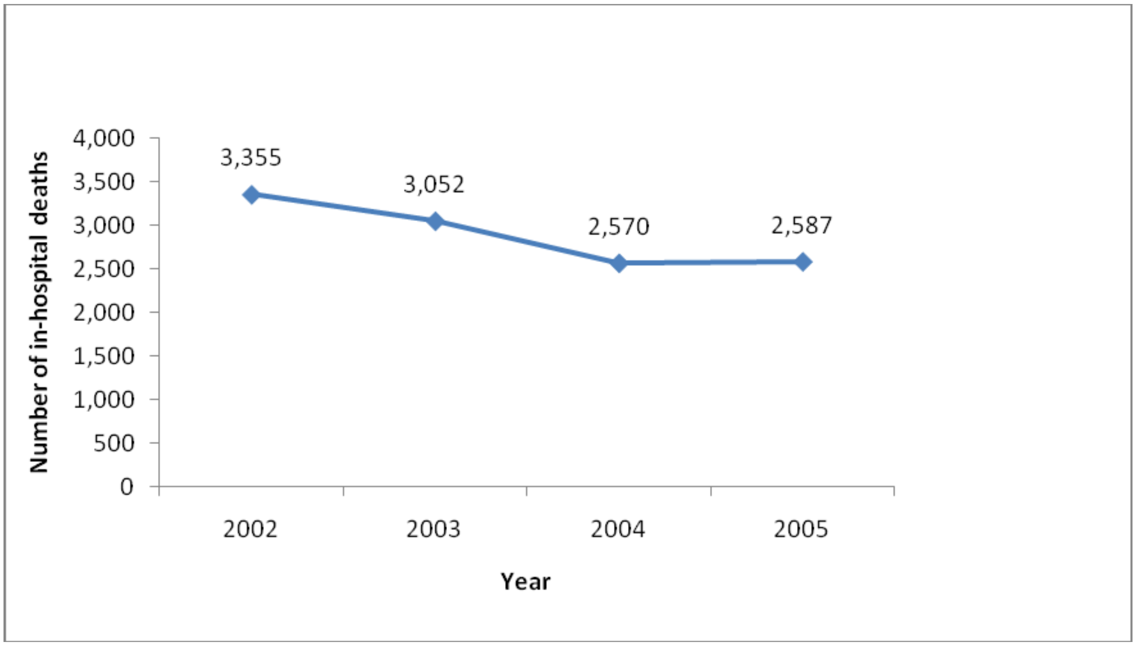


Figure 4: Trends in in-hospital mortality, NIS 2002-2005.



CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

In this chapter, implications and study limitations will be presented.

Chronic Obstructive Pulmonary Disease (COPD) affects nearly 12 million individuals in the United States. In this study, the Nationwide Inpatient Sample (NIS) dataset from the Healthcare Cost Utilization Project (HCUP) database was used to study the various patient- and hospital-related characteristics of patients hospitalized with COPD, for the years 2002, 2003, 2004, and 2005. Important outcome variables such as hospital length of stay, total hospital costs, and in-hospital mortality; and the factors associated with these outcomes were studied in hospitalized cases with a primary or secondary (listed second on the discharge records) diagnosis of COPD

For the year 2005, the number of hospitalized cases with COPD listed as the secondary cause of diagnosis (national estimate 1,426,723) were found to be more than twice the number of hospitalized cases with COPD listed as the primary diagnoses (national estimate 616,818). In another study, McGhan et al. (2007) found that patients were more than four times likely to have a prior "non-COPD" hospitalization than a prior COPD hospitalization; which highlights the high prevalence of co-morbid conditions in patients with COPD.[30] It has been reported that even in patients with severe COPD, a large proportion of patients are admitted to the hospital for other comorbidities. Thus, COPD is seldom labeled as a secondary diagnosis, and non-respiratory diseases account for > 50% of the underlying causes of death in COPD.[17, 41, 42] Consistent with other studies, the most prevalent co morbid conditions in patients with COPD were pneumonia, hypertension, congestive heart failure, cardiac arrhythmia, and peripheral vascular disease.[17, 41] In our study, the number of in-hospital deaths was more than three times in cases with COPD listed as the secondary diagnosis, as compared to the number of deaths in cases with COPD listed as the primary diagnosis. Thus, it is likely that the burden of disease associated with COPD is substantially underestimated. Some of the other factors accounting for such an underestimation include reduction in the incidence of COPD exacerbations requiring hospitalization (which would otherwise be labeled as primary discharge diagnosis), due to outpatient treatment.[43]

Our findings from the 2005 NIS data showed that patients with COPD in the age group 65-80 years had the highest number of hospitalizations (47.1%), with the mean age being 68.83 years. This finding is similar to the results of a study by McGhan and colleagues (2007), where the mean age of patients with COPD was found to be 68.81 years.[30] Also, the proportion of in-hospital deaths was highest in the age group 65 and above. These findings are in support of the natural history of COPD among smokers, which describes that smoking behaviors start during youth, lung function decline becomes apparent when smokers reach age 40-50 years, hospitalizations begin when smokers reach age 50-69, and deaths occur when they reach age 60-79.[44] It was seen that patients with COPD, 65 years and older accounted for 66.1% of the hospitalizations. This is in accordance with the fact that patients under Medicare accounted for 71.9% of hospitalizations.

The results showed that the number of hospitalized cases for COPD were higher in females, as compared to males. This is consistent with results from the study using the 2003 National Health Interview Survey (NHIS), which indicated higher rates of combined chronic bronchitis and emphysema in females than males.[12] Han MK and colleagues (2007) suggest that COPD prevalence in women is likely to increase now, as women are living longer, there is increased tobacco use in women and they are exposed to the same workplace risks as men.[12] Also, some studies hypothesize that females may be at greater risk of smoking induced lung function impairment for the same level of tobacco exposure.[12] Studies have demonstrated that in terms of impact on secondary care COPD is a disease of the elderly and is becoming more common in women.[31]

COPD is considered to be disease of the “Caucasians”, and studies show that the prevalence of COPD remains higher in Caucasians than in African Americans.[45] Our study results too showed the same pattern with Caucasians being most commonly affected (85.5%) followed by African americans (7.4%) and Hispanics (4.7%).

Patients with the lowest median household income had more than twice the number of hospitalizations as compared with those with highest income (33.9% vs 15.6%). Buist et al. (2007) reported that COPD is causally associated with cigarette smoking and with adverse working conditions, both of which, in turn manifest a strong socio-economic status (SES) gradients.[46] Blanc et al. (2008) also observed that lower SES was strongly linked to decreased odds of using tiotropium, a COPD medication introduced in recent years; and suggested that health care access and such SES gradients in medication use represent a potential source of health disparities.[47]

Our study results showed that almost 46% of all the hospitalizations due to COPD were reported in hospitals in the Southern region. This is in accordance with the report on COPD mortality rates (1990-1997), funded by the Appalachian region commission; which showed that distinct geographic patterns are evident in the distribution of COPD death rates.[48] The authors reported that high death rates from COPD are predominant in the regions of Kentucky, West Virginia, Georgia, and Alabama; and all these states were categorized as Southern region in the NIS dataset used in our study.

Our study results also showed that patients with COPD were more likely to be admitted to large and urban setting hospitals. Increased hospitalizations of patients in large urban areas may be explained in part by the larger proportion of hospitals in the urban areas (urban hospitals: 2,926, rural hospitals: 2,001).[49] Other possible explanations may include larger hospitals having more respiratory consultants, more non-physician specialist support, and greater availability of wider range of services.[34]

The mean hospital LOS per patient with COPD was found to be 4.69 days in 2005. Using hospital data from Spain, Iglesia et al. (2002) also reported the mean LOS to be 4.6 days in 2001.[50] However, the mean LOS reported by this study is significantly lower than that reported by some other studies. Saynajakangas et al. (2004) reported the mean LOS to be 6.8 days in 2001, while Kong and Bellmen (1997) found the mean LOS to be 6.5 days.[29, 51] A possible explanation for the significant decrease in mean LOS in the past few years may be due to the increasing costs of hospitalizations.[52] Because of the increasing charges, there is a possibility that many health plans may have begun to use clinical practice guidelines regarding LOS to limit use of inpatient services.[52] Kong and Bellmen (1997) also found that the necessary LOS for patients with COPD may be significantly less than actual LOS. After reviewing the practice guidelines and conducting a retrospective study, the authors demonstrated that when patients are classified as low risk according to the practice guideline, the hospital LOS could potentially be shortened to 3.2 days, with probably little effect on quality of care.[51]

In our study, the LOS was observed to be higher in older people (age > 64 years) and in females as compared to males. These results are in accordance with the findings of the study by Saynajakangas et al. (2004), where it was seen that the LOS was longer for older people and females, and the elderly females had the longest inpatient stays.[29]

Mawajdeh et al. (1997) conducted a retrospective review of medical records of public and private hospitals and after controlling for all types of illness category, found that insured patients exhibited statistically longer hospital LOS compared to uninsured patients, possibly to avoid high hospital charges.[53] Our study findings are consistent with these findings, and the LOS was observed to be shortest for uninsured patients compared to those with insurance coverage.

The LOS was found to be longer in hospitals in urban areas as compared to rural areas, and was longest in hospitals with large bed-sizes. In our study, the LOS was found to be longest in the Northeast region and, it was shortest in the Western region. The post-hoc analysis showed a significant difference of 1.065 days in LOS between the Northeast and the Western region. This is consistent with the results of a case study by Chassin (1983), where a similar geographic variation was reported, LOS being longest in the Northeast and shortest in the West.[54]

Similar to hospital LOS, total hospital costs were found to be higher in older people (age > 64 years), and in females as compared to males. The possible reason for higher costs could be the longer LOS. Patients with no insurance were found to have the least hospital costs, and this is also in accordance with results of the study by Mawajdeh, et al. (1997); where patients with no health insurance had substantially lower hospital charges than those patients with insurance.[53]

The total hospital costs were higher for both Hispanics and African Americans, in comparison to Caucasians. Most Hispanics and African Americans in our study sample were found to be covered by Medicare and Medicaid. On conducting further analysis, it was found that, of the sample population that lacked health insurance; Hispanics accounted for 6%, African Americans accounted for 12%, while Caucasians accounted for 78%. Further analysis also showed that African Americans had a higher average number of procedures listed on the discharge records, as compared to Caucasians; which could be suggestive of more disease severity among African Americans. Also cross tabulations showed that 52% of African Americans and 48% of Hispanics belonged to lowest category of the median household income groups. Studies show that African Americans have lower lung function than Caucasian.[39] And Dransfield (2006) suggested that racial differences in SES may explain this difference; as poverty, a known predictor of lower lung function, is more common among African Americans.[39]

Another factor, which could explain the difference in disease severity could be hazardous occupational exposure. The estimated fraction of COPD cases caused by occupational exposure ranges from 15% to 31% among never-smokers.[55] Minority groups have historically been overexposed to hazardous industries, and a study based on analysis of the National Health and Nutrition Examination Survey (NHANES) data showed that the fraction of airflow obstruction attributable to workplace exposure was lowest among Caucasians (21.5%), intermediate among African Americans (25.4%), and highest among Hispanics (55.7%).[55] Studies have been published that address racial disparities in the application of smoking cessation programs, and influenza vaccination; both of which are interventions known to alter COPD severity. One study reported that smoking cessation counseling was offered less often to African Americans than Caucasians (30% versus 42%), and another study showed that African American COPD patients were less likely than their Caucasian counterparts to receive influenza vaccination.[39]

The total hospital costs in urban areas were almost twice than those for rural areas, and our results are in accordance with other studies which report that urban location of hospitals are associated with higher hospital charges and costs.[56] On conducting cross-tabulations, it was seen that most of the medium and the large bed-size hospitals were located in the urban locations. This explains the total hospital costs being higher for hospitals with medium or large-bed sizes.

The proportion of in-hospital deaths was substantially higher for those who were 65 years and older. The proportion of in-hospital deaths were also seen to be higher in Caucasians, as compared to other races. Chatila et al. (2004) examined the smoking habits in a group of patients with COPD and reported that for COPD- related surgeries, African Americans presented at an earlier age and with fewer pack-years of smoking.[45] Even in our study populations, most of the COPD patients aged 65 and above were Caucasian. This can explain the higher in-hospital mortality among Caucasians. However higher proportion of Caucasians in our study population could be a reason for these findings.

Although males had a shorter hospital LOS, and lesser total hospital costs than females; the proportion of males having an in-hospital death was higher as compared to the proportion of females. Further analysis showed that males had a relatively higher average number of procedures listed on their discharge records, as compared to females; indicative of disease being more severe among males. Another possible explanation could be that men seek medical care, only in the later stages of the disease; usually when the disease is more severe, and the level of pain or discomfort is extremely high.

Most of the COPD related deaths were observed in those aged 65 and above, and this can also explain Medicare beneficiaries having substantially higher proportion of in-hospital deaths.

CONCLUSIONS OF THE STUDY

In this study, patient- and hospital-related characteristics of COPD-related hospitalizations were assessed. The study clearly demonstrated that disparities do exist in COPD occurrence, and the outcomes related to the disease. The study showed that the burden of disease associated with COPD is substantially underestimated, and that it usually affects females, Caucasians, people aged 65 and above, and people from lower income level groups. It was also seen that COPD most commonly affected people located in the metropolitan areas, and also those from the southern region of the US.

Predictors for hospital LOS, total hospital costs, and in-hospital mortality for hospitalizations due to COPD were also studied. Number of procedures and number of diagnoses listed on the record; were seen to be important predictors for hospital LOS, total hospital charges as well as in-hospital mortality. Hospital region, gender, and payer were among other important predictors for hospital LOS; whereas for total hospital costs, important predictors included hospital region, race, and patient location. Age and gender were seen to be important predictors of in-hospital mortality.

IMPLICATIONS OF THE STUDY

The findings of this study are important: they show that hospital resource utilization is high in patients with COPD, and that there are disparities in hospital resource utilization. The identification of the predictors of hospital LOS, total hospital costs, and in-hospital mortality can be used to help the healthcare professionals in identifying at-risk population who would benefit most from effective management of the disease. The results can also be used by policy makers to make optimal resource allocation decisions, such that there is equal access to care to the population at risk. Appropriate disease management, and application of preventative care such as early disease management and smoking cessation in identified population, can help in delaying the progression of disease, preventing exacerbations, reducing mortality; and thus help in lowering hospital admission rates and alleviating the economic burden of COPD.

LIMITATIONS OF THE STUDY

The present study has some limitations: the inherent limitations of a retrospective database are applicable to this study as well. Some of these limitations include dependency on previously recorded data in the chart, whose quality may be limited by systematic or recorder bias, data coding-recoding errors, incomplete data, data quality, and confounding factors. However, selection bias, inherent to large databases; can be considered negligible here due to the complex sampling frame used in designing the NIS database.

Because the NIS contains hospitals discharge records from only 20% of all hospitals in the US, our projection of the number of COPD-related hospitalizations could have been underestimated. The NIS database did not provide any information about disease severity, medication use or information on other potential confounding factors which could affect the COPD-related outcomes such as smoking behavior, environmental and occupational exposure. And the failure of considering these important confounding factors, in our study; is a limitation.

NIS provides only discharge-level data, and not patient-level data. Therefore hospital re-admissions rates could not be determined. Because of lack of patient identifiers, patients who may have been hospitalized several times for the same condition; could have been counted as separate individual records for analysis. As a result, the total cost of hospitalization for each individual patient with COPD could not be determined. And cost estimates for each hospitalization, as a separate event only; could be determined in the study. The nature of the data also led to inability to determine any prevalence or incidence rates related to COPD or the other associated co morbidities.

In NIS, the financial charge information provided is based on hospital charges and not on actual costs or the amounts reimbursed by the payer. Also, several charges such as emergency transportation costs and physician professional fees are not included as a part of the hospital charges. Thus, our estimation may not completely or accurately reflect the actual economic burden of COPD-related hospitalizations.

Only 29% of the discharge records had a race/ethnicity category listed on them, and this could affect our results related to the racial-disparities.

OPPURTUNITIES FOR FUTURE RESEARCH

Based on our study results, it is evident that disparities do exist among patients with COPD. Further research needs to be conducted to better understand these differences, and the related factors.

Because co-morbidities are an important aspect of COPD, further studies should be conducted to determine the prevalence of the important co-morbid conditions in patients with COPD. Also the differences in health outcomes and resource utilization should be studied across the different cohorts of patients (patient with COPD and different co-morbid conditions). Results from such a study, would help develop treatment guidelines which would focus on early disease prevention and management of co-morbid conditions in patients with COPD. Thus, providing an opportunity to avert additional healthcare expenditure afflicted due to the co-morbid conditions in patients with COPD. COPD is now being as a systemic disorder leading to development of co-morbid conditions. Time-to-event or survival analysis studies could also provide an insight about the hazard risk ratio of developing the co-morbid conditions after being diagnosed with COPD.

Patient-level data, in the form of patient registry data or health care claims data with patient identifiers can be used to determine the rate of rehospitalizations and the identify the population at risk of rehospitalization among patients with COPD.

Health outcomes may vary across the different therapeutic drug classes which are in prescribed in patients with COPD. Recent studies have shown that the beta-agonists prescribed in patients with COPD have been associated with an increased risk for cardiovascular diseases. Health care claims data with prescription drug information, could be used to study the healthcare expenditure on prescription medications, and the differences which may exist in treatment outcomes; across the different treatment groups.

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Research Interests

Secondary Database Analysis, Patient Reported Outcomes, Health Related Quality of Life, Pharmacoeconomics and Decision Analysis.

Academic Credentials

August 2008 – Current
Graduate Student
Major Area: Health Outcomes Research
Department of Pharmaceutical Systems and Policy, West Virginia University, Morgantown, WV.

August 2006 – July 2008
Master of Science (MS)
Major Area: Pharmacy Administration
Division of Clinical, Social and Administrative Sciences, Duquesne University, Pittsburgh, PA.

August 2001 - May 2005
Bachelor of Pharmaceutical Sciences (BS)
Major Area: Pharmaceutical Sciences
M.E.T Institute of Pharmacy, Mumbai University, Mumbai, India.

Research/Work Experiences

January 2010 - Current
Establishing Appropriate Activity Expectations After Total Joint Replacement.
Research Assistant on a study funded by the Agency for Healthcare Research and Quality to develop and pilot test a pre-operative intervention for establishing appropriate activity expectations among patients undergoing total joint replacement surgery.

September 2009 - Current
Utilization and cost of hospitalization and drug use among patients with Chronic Obstructive Pulmonary Disease With versus Without Comorbid Cardiovascular Disease and Comorbid Lung Cancer.
Developed a research study, Cleaned data from the Medical Expenditure Panel Survey Data and National In- patient Sample data, conducting recoding and analysis.

June 2009 – September 2009
Summer intern, Xcenda, FL

June 2009 – September 2009
Cost of HealthCare Admissions related to Chronic Obstructive Pulmonary Disease: An analysis of the PREMIER Perspective Dataset (2005-2008).
Helped in developing the study proposal and analysis plan; cleaned data from the Premier in-patient medical, pharmacy and billing data; conducted the analysis, and prepared the final report.

August 2009 – September 2009
Global Value Dossier for SYCREST® (Asenapine) for Schizophrenia and Bipolar I (Disorder).
Performed an extensive literature search on disease state description, epidemiology and pathophysiology, health related quality of life, and social and economic burden to patients and payors. Helped in drafting the global value dossier.

October 2007- July 2008
Thesis tittle. Assessing trends in hospital resource utilization in patients with Chronic Obstructive Pulmonary Disease in United States, using the National Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP) data years 2002-2005.

December 2006 - June 2007
Research Assistant. Content analysis of FDA warning letters to manufacturers of pharmaceuticals and biologics. (Study funded by **Novartis Inc.**)
Developed a data collection sheet, and framed supporting operational definitions. Performed data coding, collection and analysis.

December 2006 - June 2007
Research Assistant. Consequences of Pharmacy Benefits Design: An examination of clinical, economic, ethical and humanistic considerations. (Study funded by **Novartis Inc**.)
Performed an extensive literature search and compiled a review report, on the aforementioned topics.

February 2006 - June 2006
Cognizant Technology Solutions, Mumbai, India.
Position: Safety Data Manger.
Worked in the Pharmacovigilance department for **Pfizer Inc**., where the post marketing safety surveillance of Pfizer medications in the US were monitored and the related adverse events were reported to the US FDA.

Teaching Experiences

August 2008 – Current
Graduate Teaching Assistant to the instructor in Pharmacoeconomic Evaluations and Patient Reported Outcomes course at WVU

August 2006 – July 2008
Graduate Teaching Assistant to the instructor in Center for Pharmacy Practice virtual pharmacy practice lab and lectured in Pharmacy Practice-I recitation course at Duquesne

University. Other responsibilities involved grading professional pharmacy student's papers and proctoring.

Publications

Kamal Khalid, **Pallavi Rane,** Parekh Rachi, Desselle Shane, Christopher Zacker. Analysis of FDA warning letters to manufacturers of pharmaceuticals and therapeutic biologicals for promotional violations. *Drug Information Journal* 2009; 43:385-393

Parekh R**, Rane P,** Kamal KM. Enhancing Pharmacist-Physician Communication: A step towards reducing medication errors. *Bulletin of the Allegheny County Medical Society* 2007; 96(11):508-12.

Rane P, Kamal KM. Hospital resource utilization and predictors of hospitalization among patients with Chronic Obstructive Pulmonary Disease. *(At preparation stage, Ready for submission by April 2010)*

Scientific Presentations

Rane PB, Kamal KM, Keys PA, Giannetti VJ. Disparities in Hospital Resource Utilization in Patients with Chronic Obstructive Pulmonary Disease: An Analysis of the National Inpatient Sample Data. Poster presented at the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 14th annual international meeting, May 16-20, 2009 Orlando, FL .

Kamal M. Kamal, **Pallavi Rane**, Rachi Parekh, Shane P. Desselle, Christopher Zacker. Analysis of FDA Warning Letters and Notices to Manufacturers of Pharmaceuticals Concerning Health Outcomes-Related Promotional Claims Violations. Poster presented at the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 13th annual international meeting, May 3-7, 2008 Toronto, Canada.

Parekh R, **Rane PB***, Kamal KM, Desselle S. Content analysis of FDA warning letters to manufacturers concerning promotional violations. Poster presented at the annual meeting of American Managed Care Pharmacy (AMCP), October 2007 Boston, MA. *Presenting Author.

Rane PB, Kamal KM. A review of health related quality of life instruments used in children and adolescents with epilepsy. Poster presented at the annual meeting of the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 12th annual international meeting, May 19-23, 2007 Arlington, VA.

Parekh H, Parekh R, **Rane P**, Desselle S. A content analysis of advertisements for pharmacist's positions: employers' use of intrinsic and extrinsic motivational appeals. The annual meeting of the American Pharmacists Association (APhA), March 2007 Atlanta, GA.

Grants and Contracts (Funded)

Title: Consequences of pharmacy benefits design: An examination of clinical, economic, ethical, and humanistic considerations.
Amount: $22,696.33
Agency: Novartis
Role/Date: Research Assistant, December 1, 2006 to June 1, 2007.

Title: Content analysis of FDA warning letters to manufacturers of pharmaceuticals and biologics.
Amount: $7,389.37
Agency: Novartis
Role/Date: Research Assistant, December 1, 2006 to June 1, 2007.

Participation in Research/ Practice Workshops

Microsoft Excel: Skills for Modeling and Efficiency. The annual meeting of Society for Medical Decision Making, Pittsburgh, PA (October 21, 2007).

Utility Measures. The annual meeting of the International Society for Pharmacoeconomics and Outcomes Research (ISPOR), Washington, (May 2007).

Relevant Courses

Statistic courses

- Statistical analysis using SPSS: ANOVA, Multivariate analysis, Regression techniques.
- Statistics: Linear models & Experimental designs.
- Data analysis using Statistical Analysis Systems (SAS)

Outcomes Research courses

- Pharmacoeconomic Evaluations.
- Patient-Reported Health Outcomes.
- Health Disparities and Social Determinants
- Principles of Epidemiology.
- Pharmacoepidemiology.
- Large Database Analysis

Other courses

- Research Methods in Pharmacy Administration.
- Managed care principles and policies.
- Health Systems.
- Intermediate Microeconomics.
- Consumer Behavior.

Computer Skills:

Statistical packages:	SAS/Base/Stat, SQL, SPSS.
Decision analysis software:	DATA TreeAge
Other:	MS Word/Excel/PowerPoint

Affiliations

Member of International Society for Pharmacoeconomics & Outcomes Research (ISPOR)
Member of the American Pharmacists Association (APhA)