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Burden Of Depression Among Individuals With Irritable Bowel Syndrome(IBS) In The Medicaid Population

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BURDEN OF DEPRESSION AMONG INDIVIDUALS WITH IRRITABLE BOWEL

SYNDROME IN THE MEDICAID POPULATION

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ABSTRACT

Objective: To determine the period prevalence of IBS and comorbid depression among individuals with irritable bowel syndrome (IBS) in multi-state Medicaid population, and to assess the impact of comorbid depression on healthcare utilization and costs among individuals with IBS enrolled in Fee-for-Service Medicaid program.

Methods: A retrospective cohort study was conducted using 2006-2008 Medicaid Analytic Extract files for 39 states. Beneficiaries with IBS were identified based on any medical claims for the disease. Beneficiaries with one or more medical claims for depression during the study period were considered to have had comorbid depression. For each beneficiary, the first claim for IBS in 2007 was considered as the index date. 12-month post index date all-cause and IBS-related healthcare utilization and costs were computed for each of the four medical service components – inpatient, outpatient, emergency room, and prescription drug. Generalized linear models were used to assess the impact of comorbid depression on healthcare utilization and costs.

Results: The period prevalence of IBS in the population was 4.4 per 1,000 Medicaid beneficiaries. The period prevalence of comorbid depression among beneficiaries with IBS was 26.88%. Beneficiaries with IBS and depression had significantly greater all-cause and IBS-related inpatient, IBS-related outpatient, all-cause emergency room, all-cause and IBS-related prescription drug utilization, and IBS-related outpatient, all-cause and IBS-related emergency

room, and all-cause and IBS-related prescription drug costs as compared to those without depression.

Conclusion: Given the impact on healthcare use and costs, there is a need for better screening and management of depression in this population.

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CHAPTER I

BACKGROUND

INTRODUCTION

Irritable bowel syndrome (IBS) is a functional gastrointestinal disorder that is characterized by abdominal pain, bloating, and alternating bowel habits. Over the past few decades, the criteria for IBS diagnosis has changed from being exclusion based to symptom based. The various symptom based models that are in place for IBS diagnosis are Manning, Rome I, Rome II, and Rome III criteria. Based on the symptoms of the disease, IBS can be divided into three subtypes – IBS constipation-dominant (IBS-C), IBS diarrhea-dominant (IBS-D), and IBS alternating between constipation and diarrhea or mixed IBS (IBS-M).

Among all gastrointestinal diseases, IBS has a very high frequency. At least one in ten primary care visits and approximately one-fourth to one-half of gastroenterology referral visits can be attributed to IBS (Talley, Zinsmeister, Van Dyke, C. A. R. O. L., & Melton, 1991). In the United States (US), IBS prevalence varies based on the criteria used for determining disease and the study population. Prevalence for IBS has been estimated to be as high as 20%, with the general range of prevalence report to be 10-15% (Saito, Schoenfeld, & Locke III, 2002). Irrespective of the criteria used, the prevalence for IBS also varies by its subtypes (Hungin, Whorwell, Tack, & Mearin, 2003; Guilera, Balboa, & Mearin, 2005). The prevalence of IBS-M has been reported to be four times that of IBS-C, and three times that of IBS-D (Hungin et al., 2003). Prevalence is said to vary by demographic factors including age and gender. In a study conducted by Drossman et al. (1993), IBS prevalence was observed to be higher among

individuals aged less than 45 years as compared to those aged 45 years and above. As per gender, the prevalence of IBS has been reported to be 2-3 times as high among females as compared to males (Drossman et al., 1993; Hahn, Saunders, & Maier, 1997; Thompson, Heaton, Smyth, & Smyth, 2000).

IBS has a marked impact on healthcare use and costs, driven by the variability of disease symptoms and uncertain nature of its diagnosis and treatment. In their study of healthcare burden, Talley et al. (1995) found the healthcare costs among individuals with IBS to be 1.6 times higher than those without IBS. Similar results were observed by Levy et al. (2001), who also found higher healthcare costs associated with IBS diagnosis. A systematic review of cost-of-illness for IBS in the US reported that direct medical cost for each individual with the disease ranged from $1,500 to $7,500 approximately with outpatient, inpatient, and pharmacy expenditures being the predominant drivers of cost (Nellesen, Yee, Chawla, Lewis, & Carson, 2013). Another systematic literature search of studies on the cost of IBS in the UK and US that were published between 1991 and 2003 found the cost of disease to vary from around $350 to approximately $9,000 annually for each individual afflicted with the disease (Maxion-Bergemann, Thielecke, Abel, & Bergemann, 2006). Besides causing considerable health and economic burden, IBS also adversely impacts work productivity and increase in work absenteeism (Leong et al., 2003).

LITERATURE REVIEW

According to the American Gastroenterological Association, irritable bowel syndrome (IBS) is defined as "*a combination of chronic or recurrent GI symptoms not explained by structural or biochemical abnormalities, which is attributed to the intestines and associated with symptoms of pain and disturbed defecation and/or symptoms of bloatedness and distention*" (American Gastroenterological Association, 1997). IBS is associated with chronic, recurring abdominal pain or unease due to alteration in bowel habit, or both, without any trace of structural anomalies to explain these symptoms.

IBS Diagnosis and Subtypes

The diagnostic criteria for IBS has changed over the past few decades, from a system which used various exclusion criteria to the use of symptom-based models such as Manning criteria, Rome I, Rome II, and Rome III. The Manning criteria, developed in the 1970s, includes questions about pain, and whether it is relieved by defecation, increase in frequency of stool at pain initiation, looser stools at the origin of pain, explicit abdominal swelling, feeling of unfinished emptying, and flow of mucus through rectum (Manning, Thompson, Heaton, & Morris, 1978). The Rome I criteria, incorporated in 1990, embraced the majority of the Manning criteria. However, ensuing factor analysis on the criteria revealed that the first three symptoms, namely relief of pain on defecation, incidence of looser stools and increase in frequency of stools with pain, clustered well together while the remaining symptoms did not (Heller, & Schuster, 1990; Talley, Boyce, & Jones, 1998). These considerations were taken into account while framing the Rome II criteria,

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established in 1999, along with recognition that the resultant pain may stem from hard stool as well as loose stool (Thompson et al., 1999). The Rome III criteria framed in 2006, modified the Rome II criteria by taking into account the fact that for a person to be identified with IBS, he or she must have had feelings of abdominal pain at least 3 days per month in the preceding 3 months along with two of the three symptoms listed under Rome II (Longstreth et al., 2006).

Based on the symptoms of the disease, IBS can be divided into three subtypes – IBS constipation-dominant (IBS-C), IBS diarrhea-dominant (IBS-D), and IBS alternating between constipation and diarrhea (IBS-M). The Rome III criteria, which is reliant majorly on the consistency of stool, identifies IBS-C as cases where patients have hard stools more than 25% of the time and loose stools less than 25% of time. When patients experience loose stools more than 25% and hard stools less than 25% of the time then they are classified as IBS-D. Patients that experience both hard and loose stool more than 25% of the time are said to be afflicted with IBS-M (Tillisch et al., 2005).

Prevalence and Incidence of IBS

Among all the diseases affecting the gastrointestinal tract, IBS is the most frequent. Approximately one in ten primary care visits and up to one-half of gastroenterology referral visits can be attributed to IBS (Talley et al., 1991). In the United States (US), IBS prevalence varies based on the determination criteria and the study population amongst other factors. Prevalence rates for IBS have been reported to vary between 3% and 20%, with most estimates reported to be between 10% and 15% (Saito et al., 2002). This variation in prevalence rates can be partly attributed to differences in the threshold criteria for the diagnosis of IBS. In a population-based mail survey conducted by Saito et al. (2000), variation in threshold criteria for

IBS diagnosis such as presence of two, three, and four or more Manning symptoms and recurring abdominal pain yielded prevalence rates of 17.0, 12.8 and 8.7 per 100, respectively.

Variation in prevalence of IBS subtypes has been noted based on determination criteria (Hungin et al., 2003; Guilera et al., 2005). When using the Rome criteria for IBS diagnosis among individuals residing across eight countries in Europe, Hungin and colleagues (2003) found the prevalence of IBS-A to be four times higher than IBS-C and three times higher than IBS-D. In contrast, Talley and colleagues (1995) found similar prevalence of IBS-C, IBS-D, and IBS-A (~5%) when using Manning criteria for case ascertainment in a US-based sample.

Studies have revealed difference in prevalence of IBS among males and females, with prevalence reported to be roughly 2-3 times as high in the latter group as compared to the former (Drossman et al., 1993; Hahn et al., 1997; Thompson et al., 2000). Variation in IBS prevalence has also been reported. As per age, studies have found inconsistent results. Some have reported higher prevalence of IBS among adolescents and young adults as compared to older age groups (Drossman et al., 1993; Thompson et al., 2000). Others have noted the prevalence of IBS to increase with age, with prevalence being 8% for those aged between 65 to 74 years and 12% for those older having age greater than 85 years (Talley, O'Keefe, Zinsmeister, & Melton, 1992).

Unlike prevalence, it is difficult to measure the incidence of IBS considering that the symptoms of IBS manifest slowly and that individuals do not always seek care for symptoms associated with IBS. A population-based study in the US, based on data from two surveys conducted on the same sample one-year apart estimated the incidence of IBS to be around 10% (Cremonini, & Talley, 2005). However, when incidence was determined using physician-based diagnosis in the same sample, a substantially lower incidence rate of 196 cases per 100,000

person-years was observed (Locke et al., 2004). In their systematic review of the incidence of post-infectious IBS, Thabane and colleagues (2007) estimated an IBS incidence rate of 10% among individuals with a history of acute gastrointestinal infection.

Healthcare Utilization and Costs of IBS

Driven by the variability of disease symptoms and uncertain nature of its diagnosis and treatment, IBS has a marked impact on healthcare use and costs. When examining the medical costs of IBS through a self-reported questionnaire, Talley and colleagues (1995) found the healthcare costs to be 60% greater for individuals with IBS than a control group of individuals without IBS. A recent study of a commercially insured sample of individuals with IBS-C found the incremental all-cause healthcare spending associated with the disease to be ~$4,000 per member per year, with almost 80% of the incremental spending attributable to medical services (Doshi et al., 2014). Similar results have been observed in other studies, with higher outpatient visits, more frequent inpatient stays, and greater medication prescriptions reported among individuals with IBS as compared to those without IBS (Longstreth et al., 2003). A study conducted on the cost of care for individuals with IBS enrolled in a health maintenance organization found that the cost incurred towards healthcare for those with IBS was 1.5 times the cost incurred for those without IBS. The study noted that barring hospitalization, all other aspects of costs were greater for individuals with IBS as compared to those without the disease. The study further noted that even though individuals with IBS recorded higher costs for lower GI services, only one-third of the total cost difference between those with and without IBS could be attributed to services related to lower GI (Levy et al., 2001). Studies have also revealed that annual healthcare visits made for gastrointestinal and non-gastrointestinal issues to be

significantly greater for individuals with IBS, as compared to those without IBS (Levy, Whitehead, Von Korff, & Feld, 2000; Drossman et al., 1993).

The utilization of healthcare resources among individuals with IBS is chiefly associated with serial diagnostic tests and invasive procedures and operations (American Gastroenterological Association, 2001). In their multivariate analysis on the association between IBS and surgical procedures in physician-diagnosed IBS patients, Longstreth and colleagues (2004) found cholecystectomy rates to be thrice as great for individuals with IBS as compared to those without IBS. Rates for appendectomy and hysterectomy were also twice as high among individuals with IBS as compared to those without IBS. Further, back surgery rate were 50% higher in IBS group as compared to those without IBS. When assessing colonoscopy utilization in different clinical settings, Lieberman and colleagues (2005) found that almost one in every four colonoscopy performed in individuals less than 50 years of age were attributable to IBS.

Healthcare use and spending among individuals with IBS is not only higher than those without the disease, but also comparable or in some cases higher than individuals with other chronic disorders. When examining the charges associated with IBS treatment and comparing them to charges associated with asthma treatment, Ricci and colleagues (2000) found the healthcare charges for the former to be comparable to later ($7,547 vs. $7,170 per patient per year). However, unlike asthma where charges per patient varied based on severity of symptoms, charges for individuals with IBS were uniform throughout the study period with slight increase seen at the time of diagnosis. In their comparison of increase in total all-cause healthcare charges from 12-month pre-to-post diagnosis between individuals with IBS-C and migraine enrolled in managed care plan, Mitra and colleagues (2011) found individuals with IBS-C to have significantly greater increase in total charges than those with migraine.

Though several studies have examined the healthcare utilization and costs associated with IBS among commercial payers, the information on burden of this disease in Medicaid population is limited. Medicaid is a joint federal-state program that provides health insurance to indigent population in the US. In their study of healthcare utilization and cost assessment among individuals with IBS enrolled in California and North Carolina Medicaid programs, Martin and colleagues (2003) found ~50% higher healthcare costs among Medicaid recipients with IBS as compared to a control group of individuals without IBS. Expenses associated with office visits and prescription drugs contributed towards the cost differential between the two groups.

Another study conducted to look into the economic burden of treatment failure to the Missouri Medicaid for individuals with IBS-C found that ineffectiveness of primary therapy for IBS-C led to an additional cost of over $4,000 to Missouri Medicaid compared to patients who responded to the initial therapy. Failure to respond to initial therapy resulted in higher healthcare resource utilization and led to implementation of more cost-intensive therapies (Guerin et al., 2014).

IBS and Comorbidities

Besides the underlying disorder, individuals with IBS seek care for other GI and extra-intestinal complaints. Studies have revealed that IBS and gastroesophageal reflux disease (GERD) have a higher frequency of occurrence in combination than expected. One study found half of all individuals with IBS to have GERD (Kennedy, Jones, Hungin, O'flanagan, & Kelly, 1998). A study conducted using the Nationwide Emergency Department Sample (NEDS) to examine the risk of osteoporosis and osteoporosis-related fractures in individuals with IBS found a

significantly greater risk of osteoporosis or related fractures in this group as compared with the non-IBS control group (Stobaugh, Deepak, & Ehrenpreis, 2013).

Although the underlying etiology is unknown, individuals with IBS have been reported to have a greater likelihood of developing other disorders like depression, fibromyalgia, and migraine. In one study, almost one-third of individuals with IBS were reported to experience symptoms similar to that of fibromyalgia (Sperber et al., 1999). Another study reported that fibromyalgia was prevalent in 20% of individuals with IBS (Lubrano et al., 2001). In a study conducted among individuals with IBS enrolled in a health maintenance organization, prevalence of psychiatric disorders including depression, anxiety and somatoform disorders was reported to be as high as 90% (Whitehead et al., 2007). A population-based study conducted in Sweden also found individuals with IBS to have significantly more psychiatric distress compared to a control population (Österberg et al., 2000). Estimates on the occurrence of comorbid psychiatric disorders among individuals with IBS range between 54% and 94%. (Irwin, Falsetti, Lydiard, & Ballenger, 1996; Lydiard, Fossey, Marsh, & Ballenger, 1993; Walker, Gelfand, Gelfand, & Katon, 1995; Drossman et al., 1988). Studies have observed depression to be the most common psychiatric disorder associated with IBS, followed by anxiety (Whitehead, Palsson, & Jones, 2002). A cohort study conducted in the UK, using data from 123 general practices in the General Practice Research Database (GPRD) reported that patients with IBS have a significantly greater frequency of comorbid anxiety and depression than the control group (Jones, Latinovic, Charlton, & Gulliford, 2006).

Study significance

Though studies have assessed the healthcare utilization and costs associated with IBS, the burden of this disease in Medicaid population is not well understood. To date, only a couple of studies have examined the healthcare use and costs associated with IBS in Medicaid population (Martin et al., 2003; Guerin et al., 2014). In both studies, IBS diagnosis was found to be associated with incremental healthcare burden. These studies provided useful information on the burden of IBS in a vulnerable population; however, certain limitations associated with these studies limit their usefulness. First, these studies used limited state Medicaid data, which restricted the generalizability of their findings. Second, the study by Martin et al. (2003) was based on Medicaid data from more than a decade ago. With the expansion of Medicaid program through passage of the Patient Protection and Affordable Care Act (PPACA) in 2010, several million new enrollees have been added. With increasing enrollment, it is expected that resource utilization associated with chronic diseases including IBS will likely increase over the coming years. As a result, more recent estimates of disease prevalence and healthcare burden would assist policy makers in resource allocation decisions.

As noted in an earlier section, IBS is often accompanied by comorbidities including depression, which can further complicate the disease profile and resource use in this population. To date, no study has assessed the incremental healthcare utilization and cost impact of comorbid depression among individuals with IBS.

Considering these gaps in the literature, the following objectives for the proposed study have been developed:

RESEARCH OBJECTIVES

Objective I – To determine the prevalence of IBS, and comorbid depression among individuals with IBS in multi-state Medicaid population.

Considering that there are no estimates of IBS prevalence in Medicaid population, the proposed study aims to bridge this important gap in the literature. Prevalence of IBS will be calculated using multi-state Medicaid data. Further, prevalence will be calculated and reported by different demographic categories. Moreover, there are no estimates of prevalence of comorbid depression among individuals with IBS in multi-state Medicaid population. An estimate of comorbid depression prevalence in this population will not only add to the body of knowledge about the relationship between IBS and depression but also aid state Medicaid policy makers make health policy decisions in this population of patients.

Research Questions for Objective I –

1. What is the prevalence of IBS in the Medicaid population?
2. What is the prevalence of comorbid depression among adults with IBS in the Medicaid population?

Objective II – To determine the incremental healthcare burden of comorbid depression among individuals with IBS enrolled in Medicaid program.

Depression is one of the most common psychiatric comorbidities in individuals with IBS (Whitehead et al., 2007; Drossman et al., 1988). Studies in other chronic diseases have established the significant economic burden of comorbid depression, in terms of medical costs and healthcare resource utilization. For example, a study using the Medical Expenditure Panel Survey (MEPS) data, revealed that diabetes patients with comorbid depression had greater utilization of ambulatory care services and significantly more prescription medication fills than those without comorbid depression (Egede, Zheng, & Simpson, 2002). Another study that looked into healthcare costs for diabetes and congestive heart failure patients enrolled in the fee-for-service Medicare program, found individuals with comorbid depression to incur greater healthcare costs than individuals without comorbid depression (Unützer et al., 2009).

Research Questions for Objective II –

1. To determine the healthcare resource utilization of individuals with IBS with versus without comorbid depression
2. *To determine the healthcare costs for individuals with IBS with versus without comorbid depression*

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CHAPTER II

METHODOLOGY

METHODS

For the purpose of this study, a retrospective, longitudinal, cohort study of the 2006-2008 Medicaid fee-for-service (FFS) claims database for 39 states was conducted. Approval was taken from the University of Mississippi Institutional Review Board, following which a data use agreement (DUA) was made with Center for Medicare and Medicaid Services (CMS) through Research Data Assistance Center (ResDAC).

Data Source

Established in 1965, Medicaid is a joint federal-state funded healthcare program that provides medical care insurance coverage to indigent people in the United States (US). Though Medicaid benefits vary among states, these benefits typically cover costs associated with physician and hospital visits, emergency room visits, and prescription drugs. The Center for Pharmaceutical Marketing and Management (CPMM) at the University of Mississippi houses the Medicaid data for 39 states. The 2006-2008 Medicaid Analytic Extract (MAX) files for 39 states (all states except Alaska, Hawaii, Maine, Missouri, Montana, North Dakota, Pennsylvania, South Dakota, Utah, Wisconsin, Wyoming, and District of Columbia) was used for the purpose of the study. The MAX data comprises of -

1) The Personal Summary (PS) file, which contains demographic variables (e.g. date of birth, gender, race), monthly enrollment status, utilization summary, and eligibility information for each of the beneficiaries.

2) The inpatient (IP) discharge level file contains detailed information about the enrollees' utilization of inpatient services including International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) diagnosis codes (a maximum of 10 fields of diagnosis codes), current procedural terminology fourth edition (CPT-4) or healthcare common procedure coding system (HCPCS) procedure codes (a maximum of 7 fields of procedure codes), discharge status, length of stay, and amount paid.

3) The prescription drug (PD) claims file has information regarding utilization of prescription drugs including the date of prescription fill, national drug classification (NDC) codes, days of supply, quantity supplied, and amount paid.

4) The other therapy (OT) claims file contains records for physician services, lab and clinic services, home health, hospice and premium payments. The outpatient hospital institutional claims are also captured in this file. The claims comprise of information about diagnosis codes, procedure codes, and date of service. The MAX OT file contains two fields for diagnosis codes and one field for procedure codes.

To ensure privacy, de-identified data is made available to study researchers. A unique common identifier will be used to link data files for study purposes.

Objective I

Study Sample

The target population for this objective included recipients who were continuously enrolled in Medicaid FFS program for a period of three years from 2006 to 2008, and were greater than or equal to 18 years of age as of January 1, 2006 and less than 65 years of age as of December 31, 2008. Recipients with one or more claims for long-term care were excluded from study analyses. Recipients aged 65 years and above were also excluded considering that Medicaid is not the primary payer for these individuals. Recipients with irritable bowel syndrome (IBS) were identified using the ICD-9-CM code 564.1. Identification of depression among recipients with IBS was based on presence of one or more medical claims for depression (having ICD-9-CM codes of 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.50, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, or 311) in the period between 2006 - 2008.

Moreover, the study also excluded recipients who might have had any claims, either primary or secondary, for malignant neoplasm of digestive organs and peritoneum (having ICD-9-CM codes of 150.0 – 150.5, 150.8 – 150.9, 151.0 – 151.6, 151.8 – 151.9, 152.0 – 152.3, 152.8 -152.9, 153.0 – 153.9, 154.0 – 154.3, 154.8, 155.0 – 155.2, 156.0 – 156.2, 156.8 – 156.9, 157.0 – 157.4, 157.8 – 157.9, 158.0, 158.8-158.9, 159.0 – 159.1, 159.8 – 159.9), inflammatory bowel disease that comprises of Crohn's disease, ulcerative colitis, intestinal vascular insufficiency, or non-infectious enteritis and colitis (having ICD-9-CM codes of 555.xx to 558.xx), or diverticulosis (having ICD-9-CM codes of 562.01 – 562.03, 562.11 – 562.13) since they can confound diagnosis of IBS.

Objective II

Study Sample

The target population for this objective included recipients who were continuously enrolled in Medicaid FFS program for a period of three years from 2006 to 2008, and were greater than or equal to 18 years of age as of January 1, 2006 and less than 65 years of age as of December 31, 2008. Recipients with one or more claims for long-term care were excluded from study analyses. Recipients aged 65 years and above were also be excluded considering that Medicaid is not the primary payer for these individuals. The study excluded recipients who might have had any claims (between 2006-2008), either primary or secondary, for malignant neoplasm of digestive organs and peritoneum (having ICD-9-CM codes of 150.0 – 150.5, 150.8 – 150.9, 151.0 – 151.6, 151.8 – 151.9, 152.0 – 152.3, 152.8 -152.9, 153.0 – 153.9, 154.0 – 154.3, 154.8, 155.0 – 155.2, 156.0 – 156.2, 156.8 – 156.9, 157.0 – 157.4, 157.8 – 157.9, 158.0, 158.8-158.9, 159.0 – 159.1, 159.8 – 159.9), inflammatory bowel disease that comprises of Crohn's disease, ulcerative colitis, intestinal vascular insufficiency, or non-infectious enteritis and colitis (having ICD-9-CM codes of 555.xx to 558.xx), or diverticulosis (having ICD-9-CM codes of 562.01 – 562.03, 562.11 – 562.13) since they can confound diagnosis of IBS.

Recipients with irritable bowel syndrome (IBS) were identified using the ICD-9-CM code 564.1 if they had at least one primary or secondary diagnosis claim for IBS in 2007, and the first observed IBS claim was considered as the "*index date*". Recipients with claims for IBS were divided into two groups based on the presence of one or more medical claims for depression (having ICD-9-CM codes of 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.50, 296.51, 296.52, 296.53, 296.54,

296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, or 311) in the period between 2006 - 2008. Based on this inclusion and exclusion criteria, individuals with IBS were classified into two mutually exclusive groups of individuals with IBS with comorbid depression (IBS with depression) and individuals with IBS without comorbid depression (IBS without depression).

Study Measures

Healthcare Utilization and Costs

The 12-month post-index date all-cause healthcare resource utilization was gauged for the major medical service components – inpatient hospital, emergency room (ER), hospital outpatient, outpatient physician office, and prescription medications.

Similarly, IBS-related healthcare costs were also computed, with costs being divided into four main categories - inpatient, outpatient, emergency room, and prescription drug. IBS-related medical (inpatient, ER, and outpatient) costs were calculated based on the presence of any primary medical claim for irritable colon. IBS-related prescription drug costs were computed based on prescription claims for drugs that are typically used for symptoms of IBS. These include antispasmodics, anxiolytics, bile sequestrants, diphenoxylate, laxatives, loperamide, non-steroidal anti-inflammatory drugs, opioids, pro-motility agents, selective serotonin-reuptake inhibitors, and tricyclic agents. The medical procedures that are usually employed for diagnosis of IBS were considered while calculating the IBS-related healthcare costs. These procedures include flexible sigmoidoscopy, colonoscopy, X-ray – radiography, computerized tomography scan, lower-GI series – barium tests, EMA blood tests, lactose breath hydrogen tests, complete blood counts, stool tests, and abdominal ultrasound.

Other Variables

Age was determined as of December 31 of each year (2006-2008) in order to ascertain eligibility

for inclusion each year. While assessing healthcare costs, charlson comorbidity index (CCI) was

included as a measure of case mix variation between recipients with IBS with depression and

IBS without depression. The D'Hoore adaptation of CCI was used in the study. CCI scores for

the two groups will be calculated for the 12-month pre-index period.

DATA ANALYSIS

Objective I

Period prevalence rate among adults with IBS was calculated by dividing the number of unique recipients with primary or secondary diagnosis of IBS to the number of eligible Medicaid recipients for the period of 2006-2008, after imposing the inclusion and exclusion criteria. Rates were stratified by demographic variables (age, race, state, and region of the country). Prevalence has been reported as cases per 1,000 Medicaid recipients.

Period prevalence of comorbid depression among adults with IBS was determined by dividing the number of unique recipients with claims for both IBS and depression to the total number of unique recipients with claims for IBS in the multi-state Medicaid population. Prevalence rates were stratified by demographic variables (age, race, state, and region of the country). Prevalence has been reported in percentage.

Objective II

Means and standard deviation or frequency and percentages were used to depict the characteristics of the recipients. All analyses were conducted using the Statistical Analysis Software (SAS®) version 9.4 (SAS Institute, Cary, NC). P values < 0.05 will be considered for statistical significance.

For each of the medical service components – inpatient, outpatient, emergency room, and prescription drugs, a generalized linear model (GLM) with an appropriate distribution and link was used to determine the impact of comorbid depression on all-cause and IBS-specific healthcare utilization among adults with IBS. Appropriate distribution (Gaussian, Poisson, Gamma, Inverse Gaussian or Wald) of the dependent variable, number of health services used, was determined with the help of a Modified Park test (Manning and Mullahy, 2001). The link function of the model was determined using the Pregibon Link test (Pregibon, 1980). Based on the results of these tests, poisson distribution and log link was chosen for the generalized linear models. Since, there was a substantial proportion of zero values for the inpatient and emergency room count variables, Vuong test (Vuong, 1989) was used to assess whether the zero inflated poisson or the zero inflated negative binomial distributions should be used instead of the standard poisson to account for zero-inflation or over dispersion. Based on the results of the Vuong test, zero inflated negative binomial was chosen as the appropriate distribution for all-cause inpatient, IBS-related inpatient, and all-cause emergency room utilization variables, and zero-inflated poisson was chosen as the appropriate distribution for the IBS-related emergency room utilization variable.

To assess the impact of comorbid depression on all-cause and IBS-related healthcare costs among adults with IBS, a GLM with an appropriate distribution and link function were employed. To ascertain appropriate distribution of the dependent variable, healthcare cost in this case, a Modified Park test was conducted (Manning and Mullahy, 2001). The link function was determined using Pregibon Link test (Pregibon, 1980). Based on the results of these tests, gamma distribution and log link were chosen for each of the eight GLM models for healthcare costs. Due to presence of zero values for costs for some recipients for inpatient and emergency

room expenditures, these particular cost measures were estimated using the two-part model. The first part of the model comprised of a logistic regression model to predict the probability of observing non-zero costs and the second part of the model was a GLM with gamma distribution and log link for recipients with non-zero costs. Multiplying the probability of non-zero cost from the first part with the estimated costs from the second part gave us the final cost estimates. The two part model is usually used when there are many zero values in the data, which is very common in healthcare data. The model adjusts for the zero costs as well as the skewness resulting from large cost values to give a reliable estimate of medical costs (Blough et al, 1999).

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CHAPTER III

ECONOMIC BURDEN OF COMORBID DEPRESSION AMONG INDIVIDUALS WITH

IRRITABLE BOWEL SYNDROME ENROLLED IN FEE-FOR-SERVICE MEDICAID

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Economic Burden of comorbid depression among individuals with Irritable Bowel Syndrome enrolled in Fee-for-Service Medicaid

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ABSTRACT

Objective: To determine the period prevalence of IBS and comorbid depression among

individuals with irritable bowel syndrome (IBS) in multi-state Medicaid population, and to

assess the impact of comorbid depression on healthcare utilization and costs among individuals

with IBS enrolled in Fee-for-Service Medicaid program.

Methods: A retrospective cohort study was conducted using 2006-2008 Medicaid Analytic

Extract files for 39 states. Beneficiaries with IBS were identified based on any medical claims

for the disease. Beneficiaries with one or more medical claims for depression during the study

period were considered to have had comorbid depression. For each beneficiary, the first claim

for IBS in 2007 was considered as the index date. 12-month post index date all-cause and IBS-

related healthcare utilization and costs were computed for each of the four medical service

components – inpatient, outpatient, emergency room, and prescription drug. Generalized linear

models were used to assess the impact of comorbid depression on healthcare utilization and

costs.

Results: The period prevalence of IBS in the population was 4.4 per 1,000 Medicaid

beneficiaries. The period prevalence of comorbid depression among beneficiaries with IBS was

26.88%. Beneficiaries with IBS and depression had significantly greater all-cause and IBS-

related inpatient, IBS-related outpatient, all-cause emergency room, all-cause and IBS-related prescription drug utilization, and IBS-related outpatient, all-cause and IBS-related emergency room, and all-cause and IBS-related prescription drug costs as compared to those without depression.

Conclusion: Given the impact on healthcare use and costs, there is a need for better screening and management of depression in this population.

ECONOMIC BURDEN OF COMORBID DEPRESSION AMONG INDIVIDUALS WITH

IRRITABLE BOWEL SYNDROME ENROLLED IN FEE-FOR-SERVICE MEDICAID

Introduction

Irritable bowel syndrome (IBS) is a functional gastrointestinal disorder that is characterized by abdominal pain, bloating, and alternating bowel habits. Based on the symptoms of the disease, IBS can be divided into three subtypes – IBS constipation-dominant (IBS-C), IBS diarrhea-dominant (IBS-D), and IBS alternating between constipation and diarrhea (IBS-M). Among all gastrointestinal diseases, IBS has a very high frequency. At least one in ten primary care visits and approximately one-fourth to one-half of gastroenterology referral visits can be attributed to IBS.[1]

In the United States (US), IBS prevalence varies based on the criteria used for determining disease and the study population. Prevalence for IBS has been estimated to be as high as 20%.[2] Irrespective of the criteria used, the prevalence for IBS also varies by its subtypes.[3,4] The prevalence of IBS-M has been reported to be four times that of IBS-C, and three times that of IBS-D.[3] Prevalence is said to vary by demographic factors including age and gender. In a study conducted by Drossman and colleagues (1993), IBS prevalence was observed to be higher among individuals aged less than 45 years as compared to those aged 45 years and above.[5] As per gender, the prevalence of IBS has been reported to be 2-3 times as high among females as compared to males.[5, 6, 7]

IBS has a marked impact on healthcare use and costs, driven by the variability of disease symptoms and uncertain nature of its diagnosis and treatment. In their study of healthcare burden, Talley et al. found the healthcare costs among individuals with IBS to be 1.6 times higher than those without IBS.[8] Similar results were observed by Levy et al. (2001), who also found higher healthcare costs associated with IBS diagnosis.[9] Besides causing considerable health and economic burden, IBS also adversely impacts work productivity and increase in work absenteeism.[10]

Though studies have assessed the healthcare utilization and costs associated with IBS, the burden of this disease in Medicaid population is not well understood. To date, only a couple of studies have examined the healthcare use and costs associated with IBS in Medicaid population.[11, 12] In both studies, IBS diagnosis was found to be associated with incremental healthcare burden. These studies provided useful information on the burden of IBS in a vulnerable population; however, certain limitations associated with these studies limit their usefulness. First, these studies used limited state Medicaid data, which restricted the generalizability of their findings. Second, the study by Martin et al. was based on Medicaid data from more than a decade ago. With the expansion of Medicaid program through passage of the Patient Protection and Affordable Care Act (PPACA) in 2010, several million new enrollees have been added. With increasing enrollment, it is expected that resource utilization associated with chronic diseases including IBS will likely increase over the coming years. As a result, more recent estimates of disease prevalence and healthcare burden would assist policy makers in resource allocation decisions. Estimates on the occurrence of comorbid psychiatric disorders among individuals with IBS range between 54% and 94%.[13, 14, 15] Studies have observed depression to be the most common psychiatric disorder associated with IBS, followed by

anxiety.[16] IBS is often accompanied by comorbidities including depression, which can further complicate the disease profile and resource use in this population.

Studies in other chronic diseases have established the significant economic burden of comorbid depression, in terms of medical costs and healthcare resource utilization. For example, a study using the Medical Expenditure Panel Survey (MEPS) data, revealed that diabetes patients with comorbid depression had greater utilization of ambulatory care services and significantly more prescription medication fills than those without comorbid depression.[17] Another study that looked into healthcare costs for diabetes and congestive heart failure patients enrolled in the fee-for-service Medicare program, found individuals with comorbid depression to incur greater healthcare costs than individuals without comorbid depression.[18]

Study significance

Considering that there are no estimates of IBS prevalence in multi-state Medicaid population, one of the objectives of the study was to estimate the prevalence of IBS in multi-state Medicaid population. Moreover, given that there are no estimates of prevalence of comorbid depression among individuals with IBS in multi-state Medicaid population, the study aimed to determine the prevalence of comorbid depression among recipients with IBS in the multi-state Medicaid population. Additionally, no previous study has assessed the incremental healthcare utilization and cost impact of comorbid depression among individuals with IBS in this population. This study aimed to estimate the impact of comorbid depression on healthcare utilization and expenditures among individuals with IBS in the multi-state Medicaid population.

Study Methodology

For the purpose of this study, a retrospective, longitudinal, cohort study of the 2006-2008 Medicaid fee-for-service (FFS) claims database for 39 states (Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, Washington, and West Virginia) was conducted. Approval was taken from the University of Mississippi Institutional Review Board, following which a data use agreement (DUA) was made with Center for Medicare and Medicaid Services (CMS) through Research Data Assistance Center (ResDAC).

Data Source

Established in 1965, Medicaid is a joint federal-state funded healthcare program that provides medical care insurance coverage to indigent people in the United States (US). Though Medicaid benefits vary among states, these benefits typically cover costs associated with physician and hospital visits, emergency room visits, and prescription drugs. The 2006-2008 Medicaid Analytic Extract (MAX) files for 39 states was used for the purpose of the study. The MAX data comprises of -

1) The Personal Summary (PS) file, which contains demographic variables (e.g. date of birth, gender, race), monthly enrollment status, utilization summary, and eligibility information for each of the beneficiaries.

2) The inpatient (IP) discharge level file contains detailed information about the enrollees' utilization of inpatient services including International Classification of Diseases, ninth revision, clinical modification (ICD-9-CM) diagnosis codes (a maximum of 10 fields of diagnosis codes), current procedural terminology fourth edition (CPT-4) or healthcare common procedure coding system (HCPCS) procedure codes (a maximum of 7 fields of procedure codes), discharge status, length of stay, and amount paid.

3) The prescription drug (PD) claims file has information regarding utilization of prescription drugs including the date of prescription fill, national drug classification (NDC) codes, days of supply, quantity supplied, and amount paid.

4) The other therapy (OT) claims file contains records for physician services, lab and clinic services, home health, hospice and premium payments. The outpatient hospital institutional claims are also captured in this file. The claims comprise of information about diagnosis codes, procedure codes, and date of service. The MAX OT file contains two fields for diagnosis codes and one field for procedure codes.

Study Sample

Determination of prevalence of IBS and comorbid depression among adults with IBS

The target population for this objective included recipients who were continuously enrolled in Medicaid FFS program for a period of three years from 2006 to 2008, and were greater than or

equal to 18 years of age as of January 1, 2006 and less than 65 years of age as of December 31, 2008. Recipients with one or more claims for long-term care were excluded from study analyses. Recipients aged 65 years and above were also excluded considering that Medicaid is not the primary payer for these individuals. Recipients with irritable bowel syndrome (IBS) were identified using the ICD-9-CM code 564.1. Identification of depression among recipients with IBS was based on presence of one or more medical claims for depression (having ICD-9-CM codes of 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.50, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, or 311) in the period between 2006 - 2008.

Moreover, the study also excluded recipients who might have had any claims, either primary or secondary, for malignant neoplasm of digestive organs and peritoneum (having ICD-9-CM codes of 150.0 – 150.5, 150.8 – 150.9, 151.0 – 151.6, 151.8 – 151.9, 152.0 – 152.3, 152.8 -152.9, 153.0 – 153.9, 154.0 – 154.3, 154.8, 155.0 – 155.2, 156.0 – 156.2, 156.8 – 156.9, 157.0 – 157.4, 157.8 – 157.9, 158.0, 158.8-158.9, 159.0 – 159.1, 159.8 – 159.9), inflammatory bowel disease that comprises of Crohn's disease, ulcerative colitis, intestinal vascular insufficiency, or non-infectious enteritis and colitis (having ICD-9-CM codes of 555.xx to 558.xx), or diverticulosis (having ICD-9-CM codes of 562.01 – 562.03, 562.11 – 562.13) since they can confound diagnosis of IBS.

Impact of comorbid depression on healthcare utilization and costs

The target population for this objective included recipients who were continuously enrolled in Medicaid FFS program for a period of three years from 2006 to 2008, and were greater than or

equal to 18 years of age as of January 1, 2006 and less than 65 years of age as of December 31, 2008. Recipients with one or more claims for long-term care were excluded from study analyses. Recipients aged 65 years and above were also be excluded considering that Medicaid is not the primary payer for these individuals. The study excluded recipients who might have had any claims (between 2006-2008), either primary or secondary, for malignant neoplasm of digestive organs and peritoneum (having ICD-9-CM codes of 150.0 – 150.5, 150.8 – 150.9, 151.0 – 151.6, 151.8 – 151.9, 152.0 – 152.3, 152.8 -152.9, 153.0 – 153.9, 154.0 – 154.3, 154.8, 155.0 – 155.2, 156.0 – 156.2, 156.8 – 156.9, 157.0 – 157.4, 157.8 – 157.9, 158.0, 158.8-158.9, 159.0 – 159.1, 159.8 – 159.9), inflammatory bowel disease that comprises of Crohn's disease, ulcerative colitis, intestinal vascular insufficiency, or non-infectious enteritis and colitis (having ICD-9-CM codes of 555.xx to 558.xx), or diverticulosis (having ICD-9-CM codes of 562.01 – 562.03, 562.11 – 562.13) since they can confound diagnosis of IBS.

Recipients with irritable bowel syndrome (IBS) were identified using the ICD-9-CM code 564.1 if they had at least one primary or secondary diagnosis claim for IBS in 2007, and the first observed IBS claim was considered as the "*index date*". Recipients with claims for IBS were divided into two groups based on the presence of one or more medical claims for depression (having ICD-9-CM codes of 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 296.50, 296.51, 296.52, 296.53, 296.54, 296.55, 296.56, 296.60, 296.61, 296.62, 296.63, 296.64, 296.65, 296.66, 296.89, 298.0, 300.4, 309.1, or 311) in the period between 2006 - 2008. Based on this inclusion and exclusion criteria, individuals with IBS were classified into two mutually exclusive groups of individuals with IBS with comorbid depression (IBS with depression) and individuals with IBS without comorbid depression (IBS without depression).

Study Measures

The 12-month post-index date all-cause healthcare resource utilization was gauged for the major medical service components – inpatient hospital, emergency room (ER), hospital outpatient, outpatient physician office, and prescription medications.

Similarly, IBS-related healthcare costs were also computed, with costs being divided into four main categories - inpatient, outpatient, emergency room, and prescription drug. IBS-related medical (inpatient, ER, and outpatient) utilization and costs were calculated based on the presence of any primary medical claim for irritable colon. IBS-related prescription drug utilization and costs were computed based on prescription claims for drugs that are typically used for symptoms of IBS. These include antispasmodics, anxiolytics, bile sequestrants, diphenoxylate, laxatives, loperamide, non-steroidal anti-inflammatory drugs, opioids, pro-motility agents, selective serotonin-reuptake inhibitors, and tricyclic agents. The medical procedures that are usually employed for diagnosis of IBS were considered while calculating the IBS-related healthcare utilization and costs. These procedures include flexible sigmoidoscopy, colonoscopy, X-ray – radiography, computerized tomography scan, lower-GI series – barium tests, EMA blood tests, lactose breath hydrogen tests, complete blood counts, stool tests, and abdominal ultrasound.

Age was determined as of December 31 of each year (2006-2008) in order to ascertain eligibility for inclusion each year. While assessing healthcare costs, charlson comorbidity index (CCI) was included as a measure of case mix variation between recipients with IBS with depression and IBS without depression. The D'Hoore adaptation of CCI was used in the study. CCI scores for the two groups will be calculated for the 12-month pre-index period.

Statistical Analysis

Period prevalence rate among adults with IBS was calculated by dividing the number of unique recipients with primary or secondary diagnosis of IBS to the number of eligible Medicaid recipients for the period of 2006-2008, after imposing the inclusion and exclusion criteria. Rates were stratified by demographic variables (age, race, state, and region of the country). Prevalence has been reported as cases per 1,000 Medicaid recipients.

Period prevalence of comorbid depression among adults with IBS was determined by dividing the number of unique recipients with claims for both IBS and depression to the total number of unique recipients with claims for IBS in the multi-state Medicaid population. Prevalence rates were stratified by demographic variables (age, race, state, and region of the country). Prevalence has been reported in percentage.

Means and standard deviation or frequency and percentages were used to depict the characteristics of the recipients. All analyses were conducted using the Statistical Analysis Software (SAS®) version 9.4 (SAS Institute, Cary, NC). *P* values < 0.05 will be considered for statistical significance.

For each of the medical service components – inpatient, outpatient, emergency room, and prescription drugs, a generalized linear model (GLM) with an appropriate distribution and link was used to determine the impact of comorbid depression on all-cause and IBS-specific healthcare utilization among adults with IBS. Appropriate distribution (Gaussian, Poisson, Gamma, Inverse Gaussian or Wald) of the dependent variable, number of health services used, was determined with the help of a Modified Park test.[19] The link function of the model was determined using the Pregibon Link test.[20] Based on the results of these tests, poisson

distribution and log link was chosen for the generalized linear models. Since, there was a substantial proportion of zero values for the inpatient and emergency room count variables, Vuong test[21] was used to assess whether the zero inflated poisson or the zero inflated negative binomial distributions should be used instead of the standard poisson to account for zero-inflation or over dispersion. Based on the results of the Vuong test, zero inflated negative binomial was chosen as the appropriate distribution for all-cause inpatient, IBS-related inpatient, and all-cause emergency room utilization variables, and zero-inflated poisson was chosen as the appropriate distribution for the IBS-related emergency room utilization variable.

To assess the impact of comorbid depression on all-cause and IBS-related healthcare costs among adults with IBS, a GLM with an appropriate distribution and link function were employed. To ascertain appropriate distribution of the dependent variable, healthcare cost in this case, a Modified Park test was conducted.[19] The link function was determined using Pregibon Link test.[20] Based on the results of these tests, gamma distribution and log link were chosen for each of the eight GLM models for healthcare costs. Due to presence of zero values for costs for some recipients for inpatient and emergency room expenditures, these particular cost measures were estimated using the two-part model. The first part of the model comprised of a logistic regression model to predict the probability of observing non-zero costs and the second part of the model was a GLM with gamma distribution and log link for recipients with non-zero costs. Multiplying the probability of non-zero cost from the first part with the estimated costs from the second part gave us the final cost estimates. The two part model is usually used when there are many zero values in the data, which is very common in healthcare data. The model adjusts for the zero costs as well as the skewness resulting from large cost values to give a reliable estimate of medical costs.[22]

Study results

Table 1. Demographic and baseline characteristics

Variables	IBS only group (n=1450)	IBS + Depression group (n=533)	p-value
Race, n (%)			<0.001
Caucasians	994 (68.55)	444 (83.30)	
African-Americans	142 (9.79)	45 (8.44)	
Others	314 (21.66)	44 (8.26)	
Region, n (%)			<0.001
North-east	701 (48.34)	111 (20.83)	
South	505 (34.83)	258 (48.41)	
Mid-west	225 (15.52)	158 (29.64)	
West	19 (1.31)	6 (1.13)	
Gender, n (%)			<0.001
Female	1179 (81.31)	477 (89.49)	
Male	271 (18.69)	56 (10.51)	
Age, mean (sd)	46.41 (10.82)	46.61 (11.81)	0.734
CCI score, mean (sd)	1.47 (1.95)	1.39 (1.72)	0.412
Healthcare utilization, mean (sd)			
All-cause inpatient	0.75 (1.74)	1.02 (2.21)	0.004
IBS-related inpatient	0.20 (0.57)	0.29 (0.65)	0.002
All-cause outpatient	157.12 (212.77)	174.09 (207.36)	0.113
IBS-related outpatient	6.12 (16.92)	10.78 (65.29)	0.012
All-cause emergency room	2.36 (4.79)	5.63 (8.92)	<0.001
IBS-related emergency room	0.04 (0.25)	0.08 (0.32)	0.026
All-cause prescription drugs	82.74 (66.47)	102.53 (68.36)	<0.001
IBS-related prescription drugs	11.39 (12.11)	13.94 (11.12)	<0.001
Healthcare cost, mean (sd)			
All-cause inpatient	5358.97 (16810.87)	5510.78 (15574.12)	0.856
IBS-related inpatient	1174.70 (4362.96)	1397.35 (3939.12)	0.302
All-cause outpatient	16069.67 (27902.91)	13990.02 (20062.53)	0.115

IBS-related outpatient	370.03 (2297.88)	588.20 (3488.29)	0.107
All-cause emergency room	257.06 (1118.35)	832.23 (2108.03)	<0.001
IBS-related emergency room	6.16 (89.66)	14.08 (155.67)	0.16
All-cause prescription drugs	7146.52 (7652.25)	7835.62 (7863.77)	0.078
IBS-related prescription drugs	477.78 (775.44)	528.80 (836.14)	0.204

A total of 1,983 IBS patients were included in the study (1,450 patients in the IBS only group and 533 patients in the IBS and depression group). The mean age of patients in the IBS group (46 ± 11) was similar to that of the patients in the IBS and depression group (47 ± 12). Patients in the two groups had similar comorbidity scores (CCI score of 1.47 for the IBS only group and 1.39 for the IBS and depression group). Patients in the IBS and depression group had a significantly greater proportion of females as compared to patients in the IBS only group (89.5% vs 81.3%, P<0.001). Moreover, the two groups differed significantly on race and the region of the country that they are from. Additionally, the IBS and depression group had a significantly greater mean utilization of all-cause inpatient admissions, IBS-related inpatient admissions, IBS-related outpatient visits, all-cause and IBS-related emergency room admissions, and all-cause and IBS-related prescription drug fills than the IBS only group. (Table 1)

Prevalence of IBS among Medicaid beneficiaries across the 39 state Medicaid programs

Table 2. Prevalence of IBS in the Medicaid population

	Rate per 1,000 Medicaid beneficiaries
Unadjusted prevalence rate	4.4
Adjusted prevalence rates	
Adjusting for region	
North-east	6.2
South	7.5
Mid-west	7.1

West	0.2
Adjusting for race	
Caucasians	9.0
African Americans	2.8
Others	1.6
Adjusting for gender	
Female	5.1
Male	2.6
Adjusting for age	
18-25	1.6
26-35	2.1
36-45	4.0
46-55	8.1
56-65	9.0

Out of 449,690 beneficiaries that were eligible for the study, 1,983 had a diagnosis of IBS. The unadjusted prevalence rate of IBS in the Medicaid population was 4.4 per 1,000 Medicaid beneficiaries. Adjusting for region, we found the prevalence rate of IBS to vary from 7.5 for beneficiaries from the North-eastern states to 0.2 for beneficiaries from the Western states per 1,000 Medicaid beneficiaries (Table 2). Adjusting for race, we noticed that prevalence rates varied based on race, with Caucasians having the highest prevalence of IBS (9.2 per 1,000 Medicaid beneficiaries). Gender-adjusted estimates of prevalence revealed that IBS prevalence was twice as much in females as in males (5.1 vs 2.6, per 1,000 Medicaid beneficiaries). Adjusting for age, we found that beneficiaries who were 46 years old or older had the greatest prevalence of IBS (8.1 and 9.0 per 1,000 Medicaid beneficiaries for beneficiaries in the age groups 46-55 and 56-65 respectively).

Prevalence of comorbid depression among Medicaid beneficiaries with IBS

Table 3. Prevalence of comorbid depression among beneficiaries with IBS

	Prevalence rate (%)
Unadjusted prevalence	26.88

	Prevalence rate (%)
Adjusted prevalence	
Adjusting for region	
North-east	13.67
South	33.81
Mid-west	41.25
West	24.00
Adjusting for race	
Caucasians	30.88
African Americans	24.06
Others	12.29
Adjusting for gender	
Male	17.13
Female	28.80
Adjusting for age	
18-25	23.08
26-35	24.25
36-45	31.38
46-55	28.55
56-65	23.40

Out of the 1,983 IBS patients that had been included in the study, 533 patients also had a diagnosis of depression. The unadjusted prevalence of comorbid depression among beneficiaries with IBS was 26.9% (Table 3). Adjusting for region, race, gender, and age we found that IBS patients from the Mid-western states had the highest prevalence of comorbid depression (41.3%), Caucasians had a higher prevalence of comorbid depression as compared to beneficiaries from other races (30.9% vs 24.1% and 12.3%), females had a higher prevalence of comorbid depression as compared to males (28.8% vs 17.1%), and beneficiaries in the 36-45 age group had a higher prevalence of comorbid depression (31.4%) than beneficiaries in other age groups (Table 3).

Impact of comorbid depression on healthcare utilization among beneficiaries with IBS

Table 4. Comparison of healthcare utilization among the two groups

Type of utilization	IBS and depression group			IBS only group			P-value
		95% Confidence Interval			95% Confidence Interval		
	Adjusted Mean	Lower 95% CI	Upper 95% CI	Adjusted Mean	Lower 95% CI	Upper 95% CI	
All-cause inpatient	1.058	0.729	1.535	0.689	0.453	1.051	0.001
IBS-specific inpatient	0.251	0.138	0.455	0.133	0.08	0.22	<0.0005
All-cause outpatient	144.071	142.024	146.147	143.193	141.345	145.065	0.134
IBS-specific outpatient	8.045	7.633	8.479	5.411	5.161	5.673	<0.0005
All-cause ER	3.876	3.01	4.989	2.055	1.568	2.693	<0.0005
IBS-specific ER	0.391	0.161	0.948	0.527	0.256	1.085	0.497
All-cause prescription drugs	66.599	65.141	68.091	57.059	55.879	58.262	<0.0005
IBS-specific prescription drugs	9.543	8.999	10.119	7.83	7.409	8.275	<0.0005

A comparison of mean healthcare utilization among beneficiaries with IBS and beneficiaries with IBS and depression is presented in Table 4. After adjusting for age, gender, region, other comorbidities, and race, patients with IBS and depression had more all-cause inpatient visits (1.06 vs 0.69, P = 0.001), IBS-specific inpatient visits (0.25 vs 0.13, P<0.001), IBS-specific outpatient visits (8.04 vs 5.41, P<0.001), and all-cause emergency room admissions (3.88 vs 2.06, P<0.001) than IBS patients without depression. Additionally, beneficiaries with IBS and depression had more all-cause prescription fills (66.6 vs 57.1, P<0.001) and IBS-specific prescription fills (9.54 vs 7.83, P<0.001) than their non-depressed counterparts. We did not find any statistically significant differences between the two groups in the mean number of all-cause outpatient visits and IBS-specific emergency room admissions.

Impact of comorbid depression on healthcare costs among beneficiaries with IBS

Table 5. Comparison of healthcare costs among the two groups

Type of cost	IBS and depression group			IBS only group			P-value
		95% Confidence Interval			95% Confidence Interval		
	Adjusted Mean	Lower 95% CI	Upper 95% CI	Adjusted Mean	Lower 95% CI	Upper 95% CI	
All-cause inpatient (in US $)	4,833	3,776	6,187	3,316	2,602	4,226	0.284
IBS-specific inpatient (in US $)	1,060	771	1,457	685	498	942	0.736
All-cause outpatient (in US $)	14,468	12,322	16,987	16,000	13,900	18,417	0.105
IBS-specific outpatient (in US $)	608	506	730	448	385	521	<0.0005
All-cause ER (in US $)	403	318	511	142	115	175	<0.0005
IBS-specific ER (in US $)	13	7	23	3	2	5	<0.0005
All-cause prescription drug (in US $)	4,738	4,104	5,469	4,168	3,674	4,728	0.011
IBS-specific prescription drug (in US $)	347	282	426	291	242	351	0.016

A comparison of mean healthcare expenditures among individuals with IBS and individuals with IBS and depression is shown in Table 5. After adjusting for covariates, we found that individuals with IBS and depression incurred more expenditures on IBS-related outpatient visits ($608 vs $448, P<0.001), all-cause emergency room admissions ($403 vs $142, P<0.001) and IBS-related emergency room admissions ($13 vs $3, P<0.001) than those with IBS but without depression. Moreover, individuals with IBS and depression had significantly higher all-cause prescription drug cost ($4,738 vs $4,168, P=0.011) and IBS-related prescription drug cost ($347 vs $291, P = 0.016) than their non-depressed counterparts with IBS. We did not find statistically significant differences in any other expenditure category.

Discussion

To the best of our knowledge, this is the first study to report prevalence rates, prevalence of comorbid depression, and the impact of depression on all-cause and IBS-specific inpatient, outpatient, emergency room, and prescription drug utilization and costs among adults with IBS using multi-state Medicaid claims data.

A total of 1,983 Medicaid beneficiaries had a diagnosis of IBS across the 39 state Medicaid programs in the period between 2006 and 2008. The period prevalence rate of IBS was 4.4 per 1,000 Medicaid beneficiaries. Our IBS prevalence estimates are lower than the treated prevalence rates seen in published literature.[11] This can be due to several reasons. One, study only included beneficiaries that were continuously enrolled in the Medicaid Fee-for-Service program for the entire study period (2006-2008). Two, the study excluded Medicaid beneficiaries that were enrolled in long term care or had dual eligibility in Medicaid and Medicare. Our prevalence estimates are also much lower than the 10-15% estimated by population-based surveys. This can be attributed to various methodological factors. It is not possible to detect IBS cases that are not diagnosed, or are misdiagnosed or miscoded from a claims-based analysis. Additionally, the study excluded beneficiaries with any claim for malignant neoplasm of digestive organs and peritoneum, inflammatory bowel disease, or diverticulosis. Moreover, it has been reported that majority of the patients with IBS do not seek healthcare.[23] These factors may have led to an underestimation of IBS prevalence rates in the study.

The prevalence of comorbid depression among beneficiaries with IBS across the 39 state Medicaid programs between 2006 and 2008 was 26.9%. The prevalence of comorbid depression was similar to those found in previous studies. A study by Thijssen et al.[24] reported presence of comorbid depression in 22% of IBS patients. Another study by Whitehead et al.[25] found a 30.5% prevalence of comorbid depression among IBS patients. Martin et al.[11] noted a prevalence of 12% and 19.3% of comorbid depression in California and North Carolina state Medicaids. Among each gender females with IBS had a greater prevalence of comorbid depression than males with IBS. This finding is similar to that of the study by Thijssen et al.[24] who reported a higher prevalence of depressive symptoms among males with IBS than females with IBS.

No study has previously examined the impact of comorbid depression on healthcare utilization and expenditures among individuals with IBS. This study assessed the impact of comorbid depression on healthcare utilization and costs on each of the four major healthcare service components – inpatient, outpatient, emergency room, and prescription drugs, in order to help identify drivers of healthcare utilization and costs in this patient population. Beneficiaries with depression had more all-cause and IBS-specific inpatient, IBS-specific outpatient, all-cause emergency room, all-cause and IBS-specific prescription drug utilization than their non-depressed counterparts. This is similar to the results of previous studies that have looked at the impact of comorbid depression on the general population and other chronic diseases. A study by Egede et al.[17] reported significantly greater office visits and prescription drug use for individuals with depression as compared to those without depression in a cohort of diabetes patients. Another study by Himmelhoch et al.[26] that looked at the impact of comorbid depression on emergency department and inpatient hospitalization utilization among Medicare beneficiaries with chronic medical conditions noted that patients with depression were more than two times as

likely to use emergency department and inpatient hospital services as compared to those without depression.

Moreover, we found that beneficiaries with depression had more IBS-specific outpatient, all-cause and IBS-specific emergency room, all-cause and IBS-specific prescription drug expenditures than those without depression. This is similar to that found in previous studies with comorbid depression. Egede et al.[17] observed that diabetes patients with depression had significantly more total healthcare and prescription drug expenditures than those without depression. A study that examined healthcare costs associated with anxiety and depressive disorders in primary care reported that primary care patients with anxiety or depressive disorders had significantly greater healthcare costs than those without.[27] Another study that compared healthcare costs among depressed and non-depressed patients with either diabetes, congestive heart failure or both in Fee-for-Service Medicare found significantly greater healthcare costs associated with the depressed group as compared with the non-depressed group.[18]

The findings of this study not only supports previous studies with respect to the economic burden of comorbid depression but also significantly adds to the knowledge base about the relationship between IBS and comorbid depression. Based on the result of this study, it seems that there is a need for better depression screening and management among adults with IBS. This is of great importance considering the high prevalence of comorbid depression in this population and the markedly greater healthcare utilization and expenditure associated with depression. A study that assessed the efficacy of an intervention program geared towards improving depression outcomes among patients with diabetes and comorbid depression found that compared to the control group, the patients in the intervention group had significantly lower healthcare costs and showed improvement in depression outcomes.[28]

Limitations

This study has a few limitations. The identification of IBS and depression was based on ICD-9-CM diagnostic codes, and incorrect coding of the codes may lead to biased study results. It has been seen that only a small proportion of the individuals with IBS seek medical care. The fact that only the more severe individuals with disease seek medical care, may have overestimated the healthcare resource use and cost estimates borne out of the analysis. Moreover, inherent limitations of studies using administrative claims databases apply to this study as well. Also, as in all observational studies, claims regarding causation cannot be made. We cannot infer that the increased healthcare utilization and expenditures among the depressed group was solely due to depression. Additionally, Medicaid coverage differs from one state to another and disparities in different state Medicaid coverage may have affected the results of this study. Finally, the results of this study cannot be generalized beyond the Medicaid Fee-for-Service population.

Conclusion

This is the first study to have assessed the prevalence of IBS, prevalence of comorbid depression, and the impact of comorbid depression on healthcare utilization and costs among adults with IBS, enrolled across several state Medicaid programs. This is also the first study to look into the economic burden of comorbid depression among adults with IBS. The results of this study show that comorbid depression has a significant impact on healthcare utilization and costs among individuals with IBS. Given the high prevalence of comorbid depression among individuals with IBS and the significantly greater healthcare utilization and costs incurred by those with comorbid depression as compared to the non-depressed group, there is an immediate need for improvement in depression screening and management in this population.

Transparency

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CHAPTER IV

CONCLUSIONS

SUMMARY & CONCLUSIONS

To the best of our knowledge, this is the first study to report prevalence rates, prevalence of comorbid depression, and the impact of depression on all-cause and Irritable Bowel Syndrome-specific (IBS-specific) inpatient, outpatient, emergency room, and prescription drug utilization and costs among adults with IBS using multi-state Medicaid claims data. This study showed that not only did the beneficiaries with IBS in the multi state Medicaid population have a very high prevalence of comorbid depression but also that beneficiaries with depression had more all-cause and IBS-specific inpatient, IBS-specific outpatient, all-cause emergency room, all-cause and IBS-specific prescription drug utilization than their non-depressed counterparts. Additionally, the study found that beneficiaries with depression had more IBS-specific outpatient, all-cause and IBS-specific emergency room, all-cause and IBS-specific prescription drug expenditures than those without depression. This study significantly adds to the knowledge base about the relationship between IBS and comorbid depression. Based on the result of this study, it seems that there is a need for better depression screening and management among adults with IBS. This is of great importance considering the high prevalence of comorbid depression in this population and the markedly greater healthcare utilization and expenditure associated with depression.

The results of this study show that comorbid depression has a significant impact on healthcare utilization and costs among individuals with IBS. Given the high prevalence of comorbid depression among individuals with IBS and the significantly greater healthcare utilization and

costs incurred by those with comorbid depression as compared to the non-depressed group, there is an immediate need for improvement in depression screening and management in this population. Future studies should examine the association between comorbid depression and healthcare utilization and costs among individuals with IBS in other populations to gain a better understanding of the economic burden of comorbid depression among individuals with IBS.

LIST OF APPENDICES

APPENDIX A: TABLES

Table 1. Demographic and baseline characteristics

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South	7.5
Mid-west	7.1
West	0.2
Adjusting for race	
Caucasians	9.0
African Americans	2.8
Others	1.6
Adjusting for gender	
Female	5.1
Male	2.6
Adjusting for age	
18-25	1.6
26-35	2.1
36-45	4.0
46-55	8.1
56-65	9.0

Table 3. Prevalence of comorbid depression among beneficiaries with IBS

	Prevalence rate (%)
Unadjusted prevalence	26.88
Adjusted prevalence	
Adjusting for region	
North-east	13.67
South	33.81
Mid-west	41.25
West	24.00
Adjusting for race	
Caucasians	30.88
African Americans	24.06
Others	12.29
Adjusting for gender	
Male	17.13
Female	28.80
Adjusting for age	
18-25	23.08
26-35	24.25
36-45	31.38
46-55	28.55
56-65	23.40

Table 4. Comparison of healthcare utilization among the two groups

Type of utilization	IBS and depression group			IBS only group			P-value
		95% Confidence Interval			95% Confidence Interval		
	Adjusted Mean	Lower 95% CI	Upper 95% CI	Adjusted Mean	Lower 95% CI	Upper 95% CI	
All-cause inpatient	1.058	0.729	1.535	0.689	0.453	1.051	0.001
IBS-specific inpatient	0.251	0.138	0.455	0.133	0.08	0.22	<0.0005
All-cause outpatient	144.071	142.024	146.147	143.193	141.345	145.065	0.134
IBS-specific outpatient	8.045	7.633	8.479	5.411	5.161	5.673	<0.0005
All-cause ER	3.876	3.01	4.989	2.055	1.568	2.693	<0.0005
IBS-specific ER	0.391	0.161	0.948	0.527	0.256	1.085	0.497
All-cause prescription drugs	66.599	65.141	68.091	57.059	55.879	58.262	<0.0005
IBS-specific prescription drugs	9.543	8.999	10.119	7.83	7.409	8.275	<0.0005

Table 5. Comparison of healthcare costs among the two groups

Type of cost	IBS and depression group			IBS only group			P-value
		95% Confidence Interval			95% Confidence Interval		
	Adjusted Mean	Lower 95% CI	Upper 95% CI	Adjusted Mean	Lower 95% CI	Upper 95% CI	
All-cause inpatient (in US $)	4,833	3,776	6,187	3,316	2,602	4,226	0.284
IBS-specific inpatient (in US $)	1,060	771	1,457	685	498	942	0.736
All-cause outpatient (in US $)	14,468	12,322	16,987	16,000	13,900	18,417	0.105
IBS-specific outpatient (in US $)	608	506	730	448	385	521	<0.0005
All-cause ER (in US $)	403	318	511	142	115	175	<0.0005
IBS-specific ER (in US $)	13	7	23	3	2	5	<0.0005
All-cause prescription drug (in US $)	4,738	4,104	5,469	4,168	3,674	4,728	0.011
IBS-specific prescription drug (in US $)	347	282	426	291	242	351	0.016

CURRICULUM VITAE

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CURRICULUM VITAE

KAUSTUV BHATTACHARYA

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EDUCATIONAL BACKGROUND

University of Mississippi, University, MS

MS in Health Economics and Outcomes Research, Aug 2014 - May 2017

PhD in Health Economics and Outcomes Research, Aug 2014 – May 2019 (Expected)

Relevant Coursework: Secondary Data Analysis, Pharmacoepidemiology, Pharmacoeconomics, Health Economics, Drug Development and Marketing, Primary Data Techniques, Basic Multivariate Statistics, Longitudinal Data Analysis, Health Policy, Advanced Drug Marketing

Jadavpur University, Kolkata, India   **Jul 2008-Jun 2012**

Bachelors in Pharmaceutical Sciences

RESEARCH EXPERIENCE

PROJECTS

MS Thesis

- ➤ Burden of Depression Among Individuals with Irritable Bowel Syndrome in the National Medicaid Population

Impact of Depression on Health-Related Quality of Life among Survivors of Skin Cancer

- ➤ Analyzed BRFSS data with complex survey design using SAS 9.4; developed manuscript as first author

Medication Adherence as a Predictor of Switching Oral Antipsychotic Users to Long-term Injectables

➢ Analyzed MS Medicaid Administrative Claims Data using SAS 9.4

Cost-effectiveness Analysis of Palbociclib and other Aromatase Inhibitors for the Treatment of Advanced Breast Cancer

➢ Developed a Markov disease-state transition model to compare the cost-effectiveness of Palbociclib with that of other aromatase inhibitors using TreeAge Pro 2015

Impact of a Coordinated Care Program on Costs and Outcomes of Children with Mental Illnesses in Mississippi Medicaid

➢ Analyzed MS Medicaid data 2014-2016; used propensity-score matching technique to match cases and controls; used generalized linear models to assess study outcomes

Factors associated with student pharmacists opting to pursue professional education at the University of Mississippi

➢ Conducted semi-structured qualitative interviews of student pharmacists at the University of Mississippi; Used qualitative content analysis to analyze the interviews

RESEARCH IN PROGRESS

Independent Research Projects

➢ Incremental Impact of Depression on Health-Related Quality of Life among patients with Irritable Bowel Syndrome

➢ Quality of life and health utility among children and adolescents with hemophilia and its impact on care-givers

➢ Quality of care among patients with hemophilia enrolled in Mississippi Medicaid

WORK EXPERIENCE

Bristol-Myers Squibb, Plainsboro, NJ   **June 2016 – August 2016**

Summer Intern, Access MI and Health Outcomes

➢ Responsible for writing AMCP dossier and updating the PVP document
➢ Involved in identifying studies for Medicaid summaries and incorporating them
➢ Reviewed ICER RA scoping document and reviewed the Budget Impact Analysis protocol for the product in Psoriatic Arthritis

- ➢ Devised a systematic search algorithm to generate the full body of clinical and economic evidence for the product

University of Mississippi, University, MS **July 2015-Present**

Graduate Research Assistant, Center for Pharmaceutical Marketing and Management,

Department of Pharmacy Administration

Advisor: Dr. Benjamin F. Banahan

- ➢ Systems analyst, responsible for designing SAS programs for creation of weekly research files, monthly resource utilization reports, annual drug exceptions monitoring reports
- ➢ Research analyst, MS-DUR; responsible for study design and analysis of various research projects under MS-Evidence based Drug Utilization Review

University of Mississippi, University, MS **June 2015**

Graduate Research Assistant, Department of Pharmacy Administration

Advisor: Dr. Rahul Khanna, Dr. John P. Bentley

- ➢ Assisted in submitting a grant proposal, titled "Health utility and its determinants among children with hemophilia", to the Bayer Hemophilia Awards Program

University of Mississippi, University, MS **Aug 2014 – May 2015**

Graduate Teaching Assistant, Department of Pharmacy Administration

Course: Social and Behavioral Aspects of Pharmacy Practice; Introduction to Pharmacy and U.S. Health Care System

- ➢ Responsibilities involved organizing and updating online educational portal, developing quizzes and grading exams, facilitating student projects.

PEER-REVIEWED CONFERENCE PRESENTATIONS

Bhattacharya K, Banahan BF. "Medication Adherence as a Predictor of Switching Oral Antipsychotic Users to Long-term injectables"

Academy of Managed Care Pharmacy (AMCP) Spring Meeting, April 19-22, 2016, San Francisco, CA

Bhattacharya K, Noori W, Khanna R. "Impact of Depression on Health-Related Quality of Life among Survivors of Skin Cancer"

International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 21st Annual International Meeting, May 21-25, 2016, Washington, DC

Bhattacharya K, Yang Y. "A Cost-effectiveness analysis of Palbociclib and other Aromatase Inhibitors for Treatment of Advanced Breast Cancer."
International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 21st Annual International Meeting, May 21-25, 2016, Washington, DC

Bhattacharya K, Banahan BF III. Comparison of the CMS Chronic Conditions Data Warehouse (CCW)Algorithms and the Condition-Based and Prescription-Based Comorbidity Scores as Predictors of Ambulatory Healthcare Utilization Using Mississippi Division of Medicaid (DOM) Claims Data.
International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 22nd Annual International Meeting, May 20-24, 2017, Boston, MA

Bhattacharya K, Ramachandran S, Young J, Elkin D. Impact of a Coordinated Care Program on Costs and Outcomes of Children with Mental Illnesses in Mississippi Medicaid
Submitted to the Academy of Managed Care Pharmacy (AMCP) Nexus 2017 Meeting, October 16-19, 2017, Dallas, TX

CONFERENCES ATTENDED

International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 20th Annual International Meeting, May 16-20, 2015, Philadelphia, PA

Pharmaceutical Marketing Research Group (PMRG) 9th Annual PMRG Institute, October 4-6, 2015, Philadelphia, PA

International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 21st Annual International Meeting, May 21-25, 2016, Washington, DC

International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 22nd Annual International Meeting, May 20-24, 2017, Boston, MA

DATABASES HANDLED

- ➢ Behavioral Risk Factor Surveillance System (BRFSS)
- ➢ National Medicaid Administrative claims data
- ➢ Mississippi Medicaid Administrative claims data

CERTIFICATIONS

➢ SAS® certified Base Programmer for SAS® 9
➢ SAS® certified Advanced Programmer for SAS® 9

KEY SKILLS

➢ Proficiency in retrospective analysis of complex survey databases (BRFSS) and administrative claims data (Mississippi Medicaid, National Medicaid)
➢ Proficiency in various primary data collection and analysis techniques, and economic analysis and decision analysis modeling
➢ Well versed with various statistical analysis software (SAS, SPSS), economic modeling software (TreeAge Pro 2015), and survey design software (Qualtrics)
➢ Expertise in using various Microsoft office softwares like MS Excel, MS Word, MS PowerPoint
➢ Knowledge of US Managed Care system

LEADERSHIP EXPERIENCES AND PROFESSIONAL MEMBERSHIPS

➢ Secretary and Treasurer of the ISPOR Student Chapter at the University of Mississippi (2015-present)
➢ Vice-President of the ISPOR Student Chapter at the University of Mississippi (2016-2017)
➢ President of the ISPOR Student Chapter at the University of Mississippi (2017-present)
➢ Member of the University of Mississippi (UM) ISPOR Student Chapter (2014 – present)
➢ Member of the UM PMRG Student Chapter (2014 – present)
➢ Member, Rho Chi Pharmaceutical Honor Society (2016 – present)
➢ Secretary, Rho Chi Pharmaceutical Honor Society (2016 – present)
➢ Member, The Honor Society of Phi Kappa Phi (2016 – present)

AWARDS

➢ Travel grant recipient -UM ISPOR Student Chapter for attending the 20th Annual International ISPOR meeting, May 16-20, 2015, Philadelphia, PA
➢ Winner of the PMRG case study competition and was awarded a travel grant by the PMRG Institute to attend the 9th Annual PMRG Institute meeting, October 4-6, Philadelphia, PA
➢ Winner of the UM ISPOR Chapter Research Grant, 2015.