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thesis entitled

MODEL PREDICTING SOMATIZATION STATUS OF HIGH-UTILIZING PATIENTS IN A MANAGED CARE SYSTEM

presented by

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has been accepted towards fulfillment
of the requirements for

M.S. degree in **Epidemiology**

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Date 4-2-2000

MODEL PREDICTING SOMATIZATION STATUS OF HIGH-UTILIZING PATIENTS IN A MANAGED CARE SYSTEM

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Epidemiology

2000

ABSTRACT

MODEL PREDICTING SOMATIZATION STATUS OF HIGH-UTILIZING PATIENTS IN A MANAGED CARE SYSTEM

By

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Somatizers are disproportionately high utilizers of medical services, surgical and laboratory procedures. Somatizers have drawn the attention of Health Maintenance Organizations (HMOs) in recent years because of their expensive health seeking behaviors. The aim of this thesis is to develop an effective screening algorithm for somatizing patients within an HMO setting. A logistic regression model was formulated to predict the somatization status in high-utilizing patients using demographic and clinical information abstracted from the patients' medical record.

The data sample was obtained from computerized patient files from all three sites of the Blue Care Network of Mid Michigan. In order to calculate and test the logistic model, separate derivation and validation sets were created. Of the 883 total data subjects, 13.82% were somatizers and 86.18% were nonsomatizers. A priori discrete variables to be used in the model included gender, the number of total visits, and percent of visits indicative of "somatic potential". The sensitivity and specificity in the derivation set was 96.20% and 51.47%, respectively; in the validation set, 79.07% and 44.84%. The positive predictive value in the derivation set was 23.53%, and 19.65% in the validation set. The negative predictive value in the derivation set was 98.87%, and 96.62% in the validation set. The results from this research are not necessarily generalizable to other HMOs.

To my wonderful son.

ACKNOWLEGDEMENTS

I would like to acknowledge the excellent instruction, guidance, and support I received from the faculty and staff of the Department of Epidemiology. My advisor, Dr. Joseph Gardiner, has been an exceptional and dedicated mentor. I would also like to express my heartfelt gratitude to Dr. Robert Smith and Dr. Dorothy Pathak for not only taking the time to be members of my thesis committee, but for their wisdom which has provided me with invaluable training beyond what I learned in the classroom.

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INTRODUCTION

Somatizers are disproportionately high utilizers of medical services, surgical and laboratory procedures. Kellner (1990) estimates that one fifth of the medical budget is spent on treating somatizers. Somatization has been identified as a mechanism to mask and alleviate stressful emotions, and to prevent being diagnosed with a mental illness. The somatizer usually presents with multiple symptoms in any body part or organ system, which may imitate organic disease. The most common symptoms are pain, diffuse muscle aches, fatigue, dizziness, shortness of breath and palpitations (Lipowski, 1988). Typically, there exists no real underlying organic disease and the somatizer often submits to numerous laboratory tests, possible surgery, drug treatments, and sessions with specialists in an attempt to treat their symptoms. These may harm the patient in the process or may help to intensify a patient's preoccupation with their health.

Somatizers have drawn the attention of Health Maintenance Organizations (HMOs) in recent years because of their expensive health seeking behaviors. Barsky and Borus (1995) note an increase in health seeking for self-limited infirmities such as upper respiratory tract infections and digestive complaints; isolated, benign symptoms such as insomnia, motion sickness and fatigue; and physical characteristics, such as baldness and myopia. Public health educational campaigns concerning serious diseases such as cancer and heart disease may prompt some people to place emphasis on and seek medical attention for benign symptoms (Barsky and Borus, 1995). Clearly, somatizers present a problem to managed care plans.

Despite the financial pressures faced by managed care plans in treating somatization, they present an opportunity to devise cost-effective and efficient strategies for care of somatizers. Managed health care plans should attempt to educate primary physicians and nurses in the identification and management somatizers. The primary physician can be trained to effectively treat most somatizing patients. In their study, Smith *et al.* (1998) concluded that residents participating in a one-month intensive training rotation had better knowledge, attitudes, somatization management and interviewing than residents without the training rotation. Patient satisfaction and well being were also higher under the trained residents (Smith *et al.*, 1998). Somatizing patients require a supportive and therapeutic relationship with their physician (Smith, 1991). Through proper identification and treatment, physicians can avoid the many medical, surgical and drug treatments somatizers undergo to treat organic disease where none exists.

The goal of this thesis is to compute a mathematical model to aid physicians within an HMO in identifying somatizers among their high-utilizing patients for cost containment and proper medical treatment.

The data sample was obtained from computerized patient files from Health Central of the Blue Care Network of Mid Michigan (BCNMM). BCNMM is a nonacademic, for-profit HMO with a staff model of care. It serves over 20,000 adult primary care patients through three local clinics. The sample consists of a random selection of patients between 20 and 55 years of age during the 1995 calendar year who had at least six distinct medical and/or hospital visits. A resident physician reviewed medical charts for each patient in the sample and classified the patient as possessing true organic disease or somatization. It

was determined that out of the 883 total data subjects, 122 patients were somatizers (13.82%) and 761 were nonsomatizers (86.18%).

A logistic model for predicting somatization was constructed from approximately two-thirds of the sample (n = 588), and validated using the remaining 295 in the sample. The final model consists of information regarding gender, the percent of total visits involving a varied group of diagnoses believed to be indicative of somatization, and the total number of visits. The percent of patients classified correctly, sensitivity and specificity in relation to probability cutoff values was computed. From this information, a receiver operating characteristic (ROC) curve was constructed. This curve was used to determine the best decision rule to predict the somatizing status of a given patient. According to the best decision rule, a patient is predicted to be a nonsomatizer if their predicted probability is less than 0.03206, or a somatizer when the predicted probability is 0.03206 or larger. The sensitivity and specificity in the derivation set was 96.20% and 51.47%, respectively; in the validation set, 79.07% and 44.84%. The overall correct classification in the derivation set was 66.40% and for the validation set 49.83%. The positive predictive value in the derivation set was 23.53%, and 19.65% in the validation set. The negative predictive value in the derivation set was 98.87%, and 96.62% in the validation set. This model and its decision rule are not necessarily generalizable to other HMOs but might serve as an aid to any primary physician who suspects somatization.

Chapter 1

THE PROBLEM AND EPIDEMIOLOGY OF SOMATIZATION

Costs of Somatization

The psychosomatic process currently labeled somatization has been recognized throughout history. Most doctors are aware that many of their high-utilizers could be somatizers, yet they lack the necessary combination of diagnostic and psychological skills to distinguish and treat these patients. Somatization has many negative aspects for patients and their families, friends and primary care physicians. It can lead to inappropriate care that is both frustrating to the patient and provider because the patient feels that his or her ailments have not been sufficiently alleviated, while physicians have to contend with a dissatisfied patient for whom their care has not been effective. Moreover, the cost of treatment in terms of time and resource use can be enormous. There are great personal costs to the somatizer in terms of physical and emotional suffering. These personal costs include time off from work, cost of medication, deductibles and copayment charges, which are also calculable expenses. The reduction in the somatizer's quality of life caused by this condition cannot be quantified.

In recent years, the growth of managed and capitated plans as a means for delivering health care has brought into focus the costs of somatization. To be competitive, these organizations are under pressure to contain costs (Bruns, 1997). HMOs place emphasis on health promotion and disease prevention (Barsky and Borus, 1995). High-utilizers, especially somatizers are viewed as economic liabilities for these organizations. In a university family practice center, deGruy *et al.* (1987) discovered that somatizers had higher rates of office visits and charges incurred when compared to

matched controls. Somatizers had an average of 0.58 visits and $23.28 in charges incurred per month and as opposed to 0.41 visits and $14.44 in high-utilizing controls. Using the same BCNMM data that was used in this thesis, investigators Dr. John Goddeeris and Sharon Roble calculated medical charges for each case and found that charges were higher for somatizers than nonsomatizers. The average total charges for 1995 for all services combined were $5474 for somatizers and $4410 for nonsomatizers. Median charges were $3454 for somatizers and $1472 for nonsomatizers. Average and median charges for outpatient care exclusively were computed to be $3479 and $2426 for somatizers, and only $2580 and $1019 for nonsomatizers. Office visits, diagnostic tests, laboratory work, specialist consultation, and drug prescriptions comprise most of the costs incurred by the patient. Effective identification and management could indeed save thousands of dollars treating each high-utilizing patient.

Under managed care, Cantor (1996) believes that physicians may be forced to single out somatizers and limit their access to office visits, second opinions, specialists and procedures. Physicians would be encouraged to practice more efficiently and effectively primarily to contain costs. They would have greater incentive to do less for the somatizing patient, as opposed to too much (Barsky and Borus, 1995). The quality of medical care for any patient classified as a somatizer who in fact has an organic disease, would be greatly reduced. Somatizers would be cut off from the medical services that they rely upon for care (Barsky and Borus, 1995). On the other hand, somatizers would be at a reduced risk for unnecessary surgeries, medications, other iatrogenic procedures, and fragmented care ("doctor shopping") which is favorable (Barsky and Borus, 1995).

As managed care attempts to contain costs, it may inadvertently increase the cost of treating somatizing patients. By restricting access to medical care, somatizers might be compelled to invent and amplify their complaints to be allowed a visit. This may raise an individual to a higher degree of somatization. Patients will also somatize when their personal health expenses are affected. Many managed care providers will pay for treatment if the patient's diagnosis is a medical one, but if the same condition is given a psychological diagnosis, sometimes the amount of benefits is considerably less (Bruns, 1997). Patients will choose to seek care through medical symptoms and complaints, even if the problem is psychological.

Barsky and Borus (1995) note that most cost-containment efforts have concentrated on limiting access to care and restricting its supply. The authors believe that by studying somatization, the demand for care can be regulated. Various researchers have found that the physician can effectively manage the somatizing patient once he or she has been identified. Although guidelines are available to physicians, there is further research to be done.

Means of identifying potential somatizers will be important in the managed care setting, and for deploying cost-effective interventions to address the needs of these patients. A study conducted by Smith *et al* (1995) demonstrated an average decrease in 1990 of $289.11 in medical costs and $51.93 in psychiatric costs for somatizers who were assigned to an intervention. This intervention advised physicians to space visits, perform less diagnostic tests and provide more positive diagnoses to their somatizing patients. It appears that it would be advantageous for physicians to be educated about the somatization process. Many traditional medical schools now include communication and

listening skills in their curricula. Medical schools based on osteopathic teaching methods are becoming more common. Nevertheless, the additional training of primary-care physicians to detect and manage somatizers might not always be sufficiently cost-effective. Physicians may not have the desire or disposition to become cross-trained in psychiatry. The predictive model presented in this thesis may aid in the identification of somatizers among high-utilizing patients. Because this model is built on information routinely collected by HMO's on their patients, it may be applicable to other managed care settings.

Etiology

The majority of patients present to their doctors for the diagnosis and treatment of symptoms that they perceive as indicative of physical disease. Most bodily symptoms are minor and transient, which do not require special medical care. Some symptoms are indicative of a serious disease, usually requiring various medical treatments. Other somatic complaints are the result of stress or psychological factors (Robbins and Kirmayer, 1991). There are many reasons that somatizers medicalize their emotional problems.

Many have speculated about what causes somatization. Kellner (1985) lists some predisposing factors for somatization. First, genetics might play a role in somatization as it does in other psychological disorders. The immediate family, both adult and childhood, as well as personal social class and culture can influence how an individual views somatic distress. Lipowski (1988) suggests a multifactorial causal model for somatization and classifies the factors as predisposing, precipitating and maintaining. Predisposing factors include genetic, developmental-learning, personality and

sociocultural elements. Life events and stressful situations may be precipitating factors; maintaining factors would include individual predisposition and the interaction between the patient and their family, physicians and the social system. Barsky (1981) proposes that people are also motivated to visit doctors because of life stress, psychological disorders, social isolation, and informational needs. Being treated for illness allows the patient to cope with anxiety, grief, frustration and fear through postponement and avoidance of challenges and responsibilities by adopting the sick role. Socially isolated persons can turn to a physician for advice, interpersonal stimulation, consolation, care and nurturing. Patients also see their physicians to gather information and education such as etiology, treatment regimen and prognosis of their condition. Ford (1992) introduces several factors that may promote somatization. These include: The gains of illness; social isolation; amplification; symptoms used as communication; alexithymia; physiologic concomitants of psychiatric disorders; cultural attitudes; religious factors; stigmatization of psychiatric illness; economic issues; symptomatic treatment; fashionable diagnoses; solution to a systems problem. Each individual case may exhibit none, one or many of these factors.

Primary, secondary and tertiary gains may motivate an individual to somatize. Psychogenic psychiatric symptoms would be primary gains. Sympathy or disability payments would be secondary gains, and tertiary gains may apply to family members, physicians, and attorneys (Ford, 1992). Barsky and Klerman (1983) note that patients can derive both conscious and unconscious gratification from bodily symptoms and physical suffering. Monetary gain from lawsuits, sick days and disability payments may

induce one to somatize. Increased attention from the doctor, family and friends are other motivating factors.

Persons may visit physicians to compensate for social support. Katon *et al.* (1982) describe how the somatizer within a family can use their condition for control or manipulation over family members, avoiding responsibilities, and eliciting care and nurturance from an external source.

Barsky and Klerman (1983) remark that a patient may simply misinterpret their symptoms. For example, the average person may attribute nausea, fatigue or back pain to overwork, tension or aging. The average person would not, much less even consider, seeking medical attention. The somatizer would mistake these common symptoms for a serious illness and visit the doctor for treatment.

Somatizers may have increased sensitivity to negative somatic and psychic conditions (Simon and VonKorff, 1991). Differences in pain thresholds, perceptual reactance and selective perception in somatizers can contribute to their condition. Organic brain disease can affect how an individual perceives pain and other symptoms; bereavement or witnessing grave illness can also act as precipitating factors for somatization. Robbins and Kirmayer (1991) have also noted that first-hand experience with prior physical illness or psychiatric problems influence how a patient interprets somatic symptoms.

Numerous studies have demonstrated a link between somatic symptoms and depression and anxiety. Kroenke *et al.* (1997) found that 61% of patients with a DSM-III-R somatoform diagnosis had a coexisting mood disorder, and 50% had an anxiety disorder. Somatization might serve as a defense mechanism for depression and anxiety;

depression and anxiety might manifest themselves as somatic distress. Fear, stress, loneliness and other emotional stimuli are associated with peripheral physiological changes. Psychophysiological responses to autonomic nervous system to stress or voluntary nervous system responses to emotional conflict (DeVaul, 1980) indeed induce somatic sensations. These changes may be interpreted as symptoms of illness by the somatizer. Changes in endocrine activity at times of stress or a low pain threshold may intensify bodily sensations.

Somatic symptoms express an "external" illness, which is more acceptable in most societies than emotional illnesses. Certain cultures discourage open emotion, and some do not even acknowledge emotional disorders. In most societies, psychiatric illness carries such a negative stigma that patients will rationalize the cause of the symptom to be of somatic rather than psychiatric origin (Ford, 1995).

Most employees in the work force will take sick leave for a somatic illness; employees tend not to call in sick when they feel emotional stress or depression. Insufficient reimbursement for psychiatric visits is also to blame for somatization (Ford, 1995). Many health care plans will pay for treatment if one is diagnosed as having chronic fatigue, but considerably less if one is diagnosed with depression. This creates pressure for somatizers to medicalize their psychological difficulties in order to obtain treatment (Bruns, 1997). In addition, patients cannot seek psychiatric help without a referral under most health care policies.

Somatization may serve as a defense mechanism for denial, displacement or conflict resolution (Kellner, 1990). These emotional conflicts heighten sensitivity to bodily sensations, increasing the concern about illness, which the patient is likely to

dwell on (Barsky, 1981). This concern will exacerbate the initial stress the somatizer had and further cause somatic complaints. The majority of somatizers will not admit the possibility that their symptoms are the result of psychological stress. Using various attitude scales, Goldberg and Bridges (1988) observed that somatizers were more hostile to mental illness.

Rosen *et al.* (1982) present a biopsychosocial model of somatization. The individual produces a response to a stressful stimulus either somatically or psychologically. The stimulus can arise internally or externally. Internal stimuli include physiological and psychological stressors; external stimuli include environmental and social stressors. The response to the stimulus is influenced by the person's cultural beliefs and norms, childhood experiences, psychological and personality profile, and current environmental systems such as family dynamics, social networks, the medical care system and the socio-political condition. The response, in turn, can alter or add to both the stressors and the individual's response characteristics. The authors believe that somatization is an idiom for the expression of psychosocial stress and note that it is often the only legitimate and culturally accepted means of seeking and receiving care from the family, social network and medical system.

Ford (1983) also illustrates how the disease-illness process is influenced by psychosocial stress. First, physical or psychological stress modifies the body's defenses to increase susceptibility to pathogenic influences. Stress can also induce emotional responses, which in turn lead to physiologic changes. Stress may also intensify the perception of existing physical symptoms, or cause the individual to perceive the symptom differently than he or she would in a nonstressed state. Stress may influence an

individual to seek medical attention when experiencing a physical symptom. Lastly, illness, or the sick role, itself can be effective in reducing stress. Goldberg and Bridges (1988) explain that people who play the sick role can avoid responsibility and blame. The reduction in responsibilities and blame can save the individual from anxiety and depression. Bridges *et al.* (1991) feel that subacute somatization may be an adaptive response to psychiatric illness, but it carries the risk of becoming chronic and difficult to treat

In some instances, an organic disease may initiate somatization when it is in its early and undiagnosed stage. Lipowski (1988) explains that somatization might be mistaken for a disease such as multiple sclerosis or lupus in their early and undiagnosed stages. He also explains that physicians may not acknowledge illnesses deemed syndromes to be true diseases. Common psychosomatic syndromes include fibromyalgia, chronic fatigue syndrome, esophageal motility disorders, nonulcer dyspepsia, irritable bowel syndrome, urethral syndrome, and pain syndromes (Kellner, 1994). Escobar (1996) lists other common syndromes, what he terms as functional somatic syndromes, such as mitral valve prolapse, possible Lyme disease, reactive hypoglycemia, Gulf War syndrome, multiple chemical sensitivity, systemic yeast infection, and others. Kellner (1985) specifically lists several causes of somatic symptoms that cannot be detected with routine examinations and laboratory tests. The physician may conclude that the symptoms are not indicative of organic disease. These might originate from undetected physical disease, central pain mechanisms, psychogenic regional pain, endogenous depression, and chronic pain syndromes.

Diagnosis

The economic and emotional costs due to the incorrect classification of somatization status must be weighed (Rost and Smith, 1997). The misclassification of a truly diseased person can be lethal, and treatment undergone for somatization adds to the cost. Unidentified somatizers will continue being treated for what is presumed organic illness. The costs due to numerous medical visits, treatment and potential iatrogenic disease will be high. Correct diagnosis is important.

To diagnose somatizers, the physician needs to be able to identify high-utilizers and to rule out organic disease. Many physicians believe that additional aspects of the patient's medical history and personality need to be explored in order to diagnose somatization. Rosen *et al.* (1982) stress that a thorough past history should be obtained to include both recent and childhood illnesses, drug and alcohol use, the number of physicians consulted and the count of medical visits made in the past year. Roberts (1994) recommends that the physician assess both somatic and psychosocial aspects of the patient's life. The physician should inquire specifically about any recent stresses such as death of a spouse or parent, problems with their marriage, childbirth, job relocation or loss, and the quality of their emotional support network of friends and family.

Patients suffering from a somatoform disorder present to their doctor with physical symptoms characteristic of somatic illness yet organic findings are not detected. Once organic disease has been ruled out, psychological factors should be explored for treatment of somatization. The fourth and most recent edition of the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders (DSM-IV, 1994) defines the following seven disorders as somatoform disorders: somatization

disorder, undifferentiated somatoform disorder, conversion disorder, pain disorder, hypochondriasis, body dysmorphic disorder and somatoform disorder not otherwise specified (NOS). Strict categorization is not feasible because the criteria for diagnosing the specific disorders overlap considerably. Nearly all somatizers do not meet the narrow DSM-IV criteria for somatization disorder. Somatizers who do not meet the DSM-IV criteria but who are high utilizers with no detectable organic disease have been termed "subsyndromal". The specific diagnostic criteria for somatization disorder according to the DSM-IV is as follows:

1) patients must have a history of many physical complaints beginning before the age of 30 years persisting over several years and result in treatment being sought or significant impairment in social or occupational functioning;

2) each of the following criteria must be met: A history of pain related to at least four different sites or functions, a history of at least two gastrointestinal symptoms other than pain, a history of at least one sexual or reproductive symptom other than pain, a history of at least one symptom or deficit suggesting a neurological condition not limited to pain (psuedoneurological symptom);

3) after appropriate investigation, each of the symptoms cannot be fully explained by a known general medical condition or the direct effects of a substance (e.g., drug or alcohol abuse, medication); if there is a related organic pathology, the physical complaints or impairment are in excess of what would be expected from the history, physical examination, or laboratory findings.

Bias in Somatization Studies

The sources of bias in somatization studies are varied and many. Bias can be attributed to patient characteristics such as health-seeking behavior, doctor's education and judgment such as diagnosing certain types of syndromes as true illness or unexplained, the investigators. The inherent bias in the investigators' study design is also

apparent; the selection process, collection of data, diagnosis of somatizers, and data analysis need to be carefully planned.

When primary physicians are employed to refer high-utilizing patients to a study, a selection bias occurs. Here, somatizing patients with fewer overall visits are underrepresented and those patients with an abundance of visits are overrepresented (Smith *et al.*, 1986, deGruy *et al.*, 1987). Using medical records or a database would correct this problem.

There is also inherent gender bias in many studies. Although it may be more acceptable for women to express pain and emotions than men, the majority of diagnosed somatizers tend to be women. This may be that men prefer not to present to a physician for fear that they will be labeled "weak". Golding *et al.* (1991) have found that men are less likely to be perceived as having multiple unexplained symptoms; it has been a cliché for women to be "hysterical" in this case. Thus, the number of somatizing men will be underestimated when sampling from medical records. Recall bias occurs when interviews are used instead of medical records (Kirmayer and Robbins, 1991, Robins *et al.*, 1984).

Classification bias can occur when patients are misdiagnosed due to incomplete medical records or undiscovered pathological findings (Smith *et al.*, 1986). Inconsistencies among studies in the definition of a somatizer are problematic.

Prevalence

Studies have found that high utilizers tend to be women, the very young and old, and those with easy access to medical services (Robins *et al.*, 1984; deGruy *et al.*, 1987; Roberts, 1990; Campo and Fritsch, 1994; Kroenke *et al.*, 1997).

The prevalence of somatizers in the general population is difficult to estimate and has ranged from less than 1% to almost 50%. The figures vary across studies due to the characteristics of the sample population and what the authors use for selection and diagnostic criteria. Authors vary in the manner that high-utilizers are identified and selected for further analysis. There has been little consistency between studies in the definition of somatization and the criteria to diagnose it. Often the DSM criteria are used, but definitions vary according to the version used, e.g. DSM-III published in 1980, DSM-III-R published in 1987, and DSM-IV published in 1994. Various studies have compared current diagnostic criteria and many authors have invented their own (Rief *et al.*, 1996; Portegijs *et al.*, 1996; Kirmayer and Robbins, 1996;Verhaak and Tijhuis, 1994; Tómasson *et al.*, 1993; Bucholz *et al.*, 1993; Katon *et al.*, 1991; Yutzy *et al.*, 1992; Escobar *et al.*, 1989, Aug 1987, July 1987; Goldberg and Bridges, 1988; Robins *et al.*, 1988, 1985). A problem caused by these varied definitions is that the sociodemographic and illness behavior profiles of somatizers have been shown to deviate significantly across the definitions (Kirmayer and Robbins, 1991).

Kroenke *et al.* (1997) developed criteria to diagnose undifferentiated somatoform disorder, "mulitsomatoform disorder", defined as having a two year history of three or more symptoms form a list of 15 somatoform symptoms. Using data from the Primary Care Evaluation of Mental Disorders (PRIME-MD) study, 8.2% were diagnosed with "mulitsomatoform disorder". Based on DSM-III-R criteria, 14% had a somatoform disorder; 4.2% had diagnosis of somatoform disorder NOS, hypochondriasis in 2.2% and pain disorder in 0.8%.

The 1-year prevalence rate of DSM-III-R somatoform disorders was studied in Florence, Italy (Faravelli *et al.*, 1997). Six hundred seventy three cases were randomly selected and interviewed by their own, as well as four other, general practitioners to obtain information on symptoms. Medical records were also consulted. The rates are as follows: 0.7% somatization disorder; 0.7% body dysmorphic disorder; 4.5% hypochondriasis; 0.6% somatoform pain disorder; 0.3% conversion disorder; and 13.8% undifferentiated somatoform disorder. Somatoform disorder NOS was found in 37.9% of the patients who had no explainable organic disease.

Portegijs *et al.* (1996) used the somatic symptom index (SSI) developed by Escobar *et al.* (1989) to study the prevalence of somatization in Dutch general practice patients. They selected patients aged 20-44 years with at least 12 visits without a somatic diagnosis within the past three years. Of 80 cases, 45 satisfied the minimum five complaints from the DSM-III-R list, 36 of which began before age 30, indicating a prevalence of 45%. They also found that women had twice the risk of somatization.

Fink (1992) reports a prevalence of 19.6% of patients with 10 or more hospital admissions based on a study conducted in The Netherlands. Records were selected from individuals aged between 17 and 49 years who were admitted to a hospital at least 10 times between 1977-1984. Patients with a somatic disease were excluded from the initial sample. With further exclusions such as pregnancy, substance abuse, and psychiatric patients, final sample size consisted of 113 patients. Somatizers were defined as those with six or more medically unexplained complaints or symptoms and comprised 56 (49.6%) of the sample of 113. Of the 56 somatizers, 84% were women and 16% were men.

In their study, Kirmayer and Robbins (1991) calculated the prevalence of three types of somatization in primary care. The sample was based on 685 patients who had initiated a medical visit to one of two hospitals in Montreal, Canada. The overall prevalence was 26.3%. Somatization based on the DSM-III criteria was found to be only 1% and SSI criteria was 16.6%. Hypochondriasis was measured on high scores from an illness worry measure and was found in 7.7% of their sample.

Using data is from the Epidemiologic Catchment Area (ECA) program, Escobar *et al.* (1989, Aug 1987, July 1987) discovered a prevalence of somatization disorder using DSM-III criteria in Puerto Rico to be 0.7%. When based on SSI criteria, the prevalence in males was 18% and for females was 20%. In Los Angeles, DSM-III diagnosed somatization disorder was calculated to be 0.03% but using the SSI increased to 4.4%.

Goldberg and Bridges (1988) selected patients with DSM-III criteria for psychiatric illness from patients presenting with new illnesses from 15 family practices in the Manchester, U.K. area. They found that 5% had 'entirely psychiatric' illnesses, and 19% fulfilled their criteria for somatization. The patient's diagnosis for somatization needed to satisfy four criteria: consult for somatic symptoms; attributed symptoms to physical disease; a DSM-III psychiatric disorder was present; finally, a research psychiatrist felt that treatment of the affective disorder would reduce or eliminate symptoms.

Two definitions of somatization were used in the study by deGruy *et al.* (1987) at the University of South Alabama Family Practice Center. The 111 cases were derived from patients visiting the center during a five-week period in 1986 who were interviewed

using DSM-III criteria to diagnose somatization disorder. Medical charts of those with 10 or more symptoms were reviewed. "Definite somatization disorder" (DSD) was based on diagnosis of 14 symptoms for women and 12 for men among 37 symptoms, and constituted only 5% of the sample. "Borderline somatization disorder" (BSD) was diagnosed with 10 to 13 unexplained visits and was found in 4% of the cases.

In Arkansas, Smith *et al.* (1986) asked physicians to refer patients that they believed were somatizers. Of the 51 patients referred to the investigators, 41 (80%) had a DSM-III somatization diagnosis. It is interesting to note that when prompted to identify somatizers within their care, these physicians diagnosed correctly (according to the DSM-III) the majority of the time.

Using data from the ECA program, Robins *et al.* (1984) report somatization disorder rates to be 0.1% in New Haven, CT, Baltimore, MD, and St. Louis, MO based on DSM-III criteria.

The Physician

The role of the physician in the management of their somatizing patients is complex. Physicians are primarily trained to diagnose and treat only somatic conditions (Rosen *et al.*, 1982). Many physicians become frustrated and angry by the somatizing patient; it is often impossible to uncover any organic illness and consequently the course of their treatment is unsuccessful. The physician might deem the somatizer as "difficult" or a "crock". The physician must be trained to recognize that the somatizing patient is substituting somatic complaints for psychological distress.

Lipowski (1988) stresses that the doctor's attitude, statements and actions may either counteract or encourage somatization. Somatizers present difficult diagnostic and

management problems; they may or may not suffer from other psychiatric disorders. Their office visits consume an inordinate amount of time and money for physicians, laboratory personnel, the health insurance provider, and the patients themselves. When a patient presents to their physician with bodily complaints, it is the physician's duty to correctly diagnose, provide relief and attempt to cure the patient. Somatizers are a source of frustration and wasted time for the physician. The somatizing patient will likely be subjected to numerous laboratory tests and diagnostic procedures, drug treatments, and possibly exploratory surgery (Monson and Smith, 1983), yet the physician will not be able to diagnose an organic illness.

The undiagnosed somatizing patient presents symptomatically to their physician, and does not usually disclose psychological tensions. The somatizer believes that he or she is truly suffering from somatic disease and may not report emotional stressors to the physician. The physician might not suspect somatization until the cycle has become a habit to the patient. Early detection and treatment of somatization saves time and money: fewer workdays lost due to appointments and illness, fewer diagnostic tests, less unnecessary medical consultations. There will be less frustration to the doctor and resentment toward the patient when the disorder is recognized. Both the patient and doctor will be more satisfied with the course of the treatment, and the doctor-patient relationship itself.

Barsky (1981) notes that some patients may visit a variety of different doctors until they encounter one that satisfies their needs. The patient may feel that a doctor does not care, is incompetent or did not spend enough time with them. The somatizer is often dissatisfied with their primary doctor for not diagnosing and treating their condition that

they will move on to another doctor and start the whole cycle over again. It is important that the somatizer develops a strong, trusting relationship with their primary physician so that he or she is deterred from "doctor shopping".

Salmon and May (1995) believe that patients can in fact coerce their doctors into the outcome they seek. These patients present symptoms to their physician and tend exaggerate their emotional distress so that the physician feels that he or she is incompetent, or possibly fears being charged with malpractice. Because of this effort to treat and diagnose, the physician's actions can be viewed as an additional stimulus to the somatization process.

Treatment and Management

Early detection of somatization is essential to spare the patient from the numerous physical investigations and chance for iatrogenic illness. It is important that physicians be trained to recognize the somatizing patient under their care and for these patients to have easy access to psychiatric services. Severe forms of somatization are best treated by a collaboration of medical and mental health professionals (Bruns, 1997). Physicians are able to rule out and treat physiological conditions; psychiatrists are more qualified to treat the underlying psychological component of somatization.

The treatment process has many phases. The regimen has several steps that both the physician and patient must comply with for effective management. First, the patient's physical and psychological history must be examined as well as a thorough physical investigation to rule out organic disease. The doctor should then explain symptoms and discuss the patient's beliefs and lifestyle. The physician should discuss the role of psychological factors with the patient and they should mutually agree on a treatment plan,

such as behavior modification or therapy. When physicians do make referrals for mental health treatment, it is important to do so in a supportive manner. Somatizers may think that they are being labeled as mentally ill, and experience shame and embarrassment caused by that stigma. Consequently, they may be more reluctant in the future to discuss their emotions with their doctor (Bruns, 1997). The physician should attempt to control medical care, promote compliance, and avoid reinforcing the patient's erroneous beliefs (Mayou, 1993). Smith (1991) proposes that successful treatment depends on negotiation and compromise between the doctor and patient. Smith (1991) further proposes that the physician and patient establish a contract to set realistic goals, agree on diagnostic work-ups, naming of the diagnosis and eventual treatment regimen for successful management of the condition.

Once any organic and psychological illnesses are taken into account and treated, the physician must establish a long-term empathetic relationship with the somatizing patient. The physician must rule out depression, anxiety and schizophrenia (Barsky and Klerman, 1983). This may require a psychiatric consultation. It is important for the physician to recognize that somatizers' lives revolve around physical distress. When new symptoms originate, the physician should assess any signs of true organic disease without extensive diagnostic work-ups or prescribing any medication. The physician will then follow the patient over time.

The physician must reassure the patient that there is no serious illness and that they understand that the patient feels hindered, concerned, preoccupied, and emotionally and physically distressed by their symptoms. The physician should also provide the opportunity for the patient to express any worries and answer any questions the patient

might have. The physician should become skilled on how to listen, talk, encourage and ease the fears of their somatizing patients. The physician should never frighten the patient by diagnosing a condition that a patient might interpret as life threatening (Kellner, 1990). On the contrary, the physician should avoid telling a somatizer that there is nothing physically wrong with him. Somatizers interpret negative diagnoses as having been misunderstood or rejected by the doctor. Diagnoses such as chronic fatigue or panic attack may alleviate their distress, as well as introduce them to the psychosomatic element of their condition. These explanations may, however, reinforce the patient's somatizing tendencies if they feel that they have a serious illness.

The physician will primarily concentrate on alleviating the physical symptoms together with helping the patient learn to live with the pain and distress caused by the disorder. Smith (1985) maintains that their primary physician can successfully manage most somatizers. He also states that the joint efforts of the primary physician and a psychiatrist can be effective in treating difficult and severely somatizing patients. As a precaution, regular appointments with the physician should be scheduled. This serves to monitor the health of all patients, and more importantly any nonsomatizers who were incorrectly misdiagnosed. Scheduling regular appointments will also prevent the development of new symptoms in somatizers. The somatizer will already have a "ticket" to visit the doctor, thus precluding the need to present only when symptomatic. Smith *et al.* (1995) noted significantly better physical functioning in somatizing patients assigned to an intervention that advised physicians to space visits, perform less diagnostic tests and provide positive diagnoses. Roberts (1994) suggests variable spacing between visits; time

intervals between appointments should initially be short and gradually lengthen over time.

Drugs such as antidepressants may help treat psychiatric aspects of somatization. Relaxation and stress reduction techniques can reduce arousal levels as well as distract the somatizer from their symptoms (Lolas, 1991). Counseling or psychotherapy may also be needed to treat anxiety and/or depression. Meeuwesen *et al.* (1994) found that 49 somatizers assigned to psychiatric intervention had a decrease in depressive symptoms compared with 57 somatizers who had none. Patients should be educated to modify the behaviors that cause emotional tension in their lives, to use medical services judiciously, and to manage stressful events such as loss. The patient should understand that these stressors might manifest themselves somatically if not managed properly.

Nonsteroidal anti-inflammatory drugs may be prescribed for particular physical symptoms. Escobar (1996) also recommends MAO inhibitors and selective serotonin reuptake inhibitors (SSRIs) for treatment of pain. Physical therapy, acupuncture, biofeedback and transcutaneous electrical nerve stimulation may also be recommended to the somatizer for relief of somatic symptoms.

CHAPTER 2

DATA AND METHODS

Objective

The aim of this thesis is to develop an effective screening algorithm for somatizing patients within an HMO setting. A mathematical model will be formulated to predict the somatization status in high-utilizing patients using demographic and clinical information abstracted from the patients' medical record.

Overview

After routine data management and cleaning, the data set was separated into derivation and validation sets. A randomly selected two-thirds sample was used for the derivation set and the remainder formed the validation set. Differences between patients in the two sets were investigated on characteristics that were regarded as important for this study. Only the amount of copayment charge was found to significantly differ between patients in the two data sets.

The next task was to identify variables that would be good predictors of somatization status. The logistic model was fitted to predict the likelihood of somatization from the derivation set. A receiver operating characteristic (ROC) curve was graphed to find optimal cutoff points. The predictive power of the model was then tested on the validation set. Goodness-of-fit tests and residual analysis were also conducted.

Data Collection

Patient level data were obtained from computerized member records of all three sites of the Blue Care Network of Mid Michigan (BCNMM) in the Lansing area. A

BCNMM Management Information System (MIS) Programmer/Analyst was employed to extract the records of high medical care utilizers from computerized data tapes. High utilizers were defined as those having six or more medical visits (65th percentile) during the 1995 calendar year. The MIS maintains a complete record of all patient encounters by date, type of service, primary and secondary diagnoses by ICD-9 code. Additionally, information about the specialty of the medical provider is available.

The criteria for preliminary inclusion were continuously covered members between the ages of 21-55 years who had at least one visit to a physician, physician's assistant, specialist or nurse practitioner on an outpatient basis, emergency room visit, or a hospital admission between January 1, 1995 and December 31, 1995. This generated an initial sample of 15,505 patients. From these records, members having less than six visits during the 1995 calendar year were excluded, resulting in a sample of 5,423 high utilizers.

The information base provided by BCNMM on these patients included demographic data, itemizations of medical visits and hospital admissions, and prescription record. A unique patient identification number tracked services provided to each patient. Basic demographic data used in this study include gender (male/female), relationship to subscriber (self/spouse/dependent), date of birth, type of employee (Michigan State University (MSU)/State of Michigan/General Motors (GM) /other), office visit copayment amount ($0/$5/$7/$10), copayment amount ($0/$5/$7/$10). Each medical visit records the following information: service date, provider type/specialty code (e.g., cardiology, family practice), type of service code (e.g., medical visit, surgery), place of service code (e.g., doctor's office, inpatient hospital), and primary diagnosis and

secondary diagnoses identified by ICD-9-CM codes. Service dates were used to compute the number of visits a patient made during the 1995 calendar year. Hospital admission and prescription data were not used in this present study.

The study was supported by a grant from the Institute for Managed Care at Michigan State University (Robert C. Smith, MD, Principal Investigator).

Data Cleanup and Counting Medical Visits

We randomly selected a sample of 1,000 patients for inclusion into the study from the 5,423 member records provided by BCNMM. A first-year resident physician was trained by the Principal Investigator to review and rate the medical charts of these selected patients to determine the presence of organic disease, somatization or if data was inadequate to determine status, the latter rarely occurring. The chart rating form can be viewed in the appendix of this thesis. The internal reliability and validity of the determination of outcome, either somatization, nonsomatization or incomplete was assessed by periodic rating of charts by both the resident and the principal investigator. The resident physician trained to review and rate the charts was provided with specific written instructions and the level of agreement with the principal investigator varied between 97% and 100%.

Upon chart review of these 1,000 patients, 27 were excluded because they were BCNMM employees, 66 were excluded because of pregnancy, substance abuse or psychiatric diagnoses and 23 were excluded due to incomplete data. One duplicate record was eliminated from the data set. These 117 exclusions yielded a final sample size of 883; true organic disease was found in 761 patients and somatization in 122 patients.

The first step in counting the number of medical visits was to identify and count only the visits where the patient presented due to a physical complaint. Patients undergoing treatment for substance abuse or psychiatric therapy were excluded because of the comorbidity associated with somatization, and the need for a different regimen for treating somatization. The following procedure refines the definition of a medical visit so that encounters or claims such as laboratory, radiology, pharmacy, allergy shots, dialysis, and physical therapy, are not counted as a visit. To warrant its count, a visit must be comprised of one of the following eight combinations of type and place of service in Table 1; however, medical visits with the particular provider types listed in Table 2 were not counted as a visit.

Table 1 - Included Visits

	Type of Service	*Place of Service*
1	Medical Visit	Doctor's Office
2	Consultation	Doctor's Office
3	Medical Visit	Emergency Room
4	Surgery	Emergency Room
5	Surgery	Ambulatory Surgical Center
6	Consultation	Emergency Room
7	Outpatient Services	Emergency Room
8	Other Medical Services	Emergency Room

Table 2 - Excluded Provider Types

Provider Type	*Provider Type*
Allergy	Pathology
Ambulance	Pediatric Surgery
Anesthesiology	Pediatric
Audiology/Hearing Aids	Pediatric Allergy
Chiropractic	Pediatric Cardiology
Dental Endodontics	Pediatric Endocrinology
Dental General	Pediatric Hematology/Onocology
Dental Oral Surgery	Pediatric Neurology
Dental Orthodontics	Pediatric Opthalmology
Dental Periodontics	Pediatric Pulmonology
Dental Surgery - Med.	Pharmacy
Geriatrics	Physical Therapy
Home Health Care	Podiatry
Laboratory	Prosthodontics
Maternal Fetal Medicine	Psychiatric/Substance Abuse Facility
Neonatology	Purchase/Rental Order
Nuclear Medicine	Radiology
Nursing Home	Terminations
Oral Surgery	

Creation of New Variables

After these exclusions, the encounter file for the 883 patients contained 20,807 service records. A program was written using the statistical software SAS to count the number of visits for each patient in the data set. For each patient there exists a record for each encounter or other service based on the ICD-9-CM code and the date associated with it. The number of distinct service dates was counted individually for all primary diagnoses consisting of:

1. Digestive System diagnoses (ICD-9-CM codes 520 through less than 580) denoted by "Number of GI Visits"

2. Symptoms, Signs, and Ill-defined Conditions diagnoses (ICD-9-CM codes 780 through less than 800) denoted by "Number of MISC Visits"

3. Musculoskeletal and Connective Tissue diagnoses (ICD-9-CM codes 710 through less than 740) denoted by "Number of MS Visits"

4. Nervous System and Sense Organs diagnoses (ICD-9-CM codes 320 through less than 390) denoted by "Number of NS Visits"

5. All other ICD-9-CM codes are denoted by "Number of OTHER Visits". The supplemental coding system using E- prefixed ICD-9-CM billing codes was not included in the count of Number of OTHER Visits. Diagnoses prefixed by the letter V were included. Specific diagnoses included:
   Infectious and Parasitic Diseases (ICD-9-CM codes 001 through less than 140);
   Neoplasms (ICD-9-CM codes 140 through less than 240);
   Endocrine, Nutritional, Metabolic, and Immunity Disorders (ICD-9-CM codes 240 through less than 280);
   Blood and Blood Forming Organs (ICD-9-CM codes 280 through less than 290);
   Mental Disorders (ICD-9-CM codes 290 through less than 320);
   Circulatory System (ICD-9-CM codes 390 through less than 460);
   Respiratory System (ICD-9-CM codes 460 through less than 520);
   Genitourinary System (ICD-9-CM codes 580 through less than 630);
   Skin and Subcutaneous Tissue (ICD-9-CM codes 680 through less than 710);
   Congenital Anomalies (ICD-9-CM codes 740 through less than 760);
   Injury and Poisoning (ICD-9-CM codes 800 through less than 1000).

   Based on the five variables that were computed above, the following additional

variables were calculated:

1. The total number of visits, "Number of TOTAL Visits", was computed by combining the above five subtotals for each patient.

2. The variables "Percent GI Visits", "Percent MISC Visits", "Percent MS Visits", "Percent NS Visits", and "Percent OTHER Visits" were created by taking the appropriate number of visits in each category and dividing by the number of total visits, "Number of TOTAL Visits", for each patient.

   Grouping the above variables created the following categorical variables:

1. The variable "SOMATIC POTENTIAL" is a dichotomous variable that indicates if the sum of the variables Percent GI Visits, Percent MISC Visits, Percent MS Visits and Percent NS Visits exceeds Percent OTHER Visits.

   SOMATIC POTENTIAL = "Yes" if
   (Percent GI Visits + Percent MISC Visits + Percent MS Visits +Percent NS Visits)
   > 50% of the Number of TOTAL Visits.

SOMATIC POTENTIAL = "No" if
(Percent GI Visits + Percent MISC Visits + Percent MS Visits +Percent NS Visits) ≤ 50% of the Number of TOTAL Visits.
Therefore, a patient with visits indicative of "somatic potential" would have more than 50% of his or her visits labeled as Digestive System diagnoses; Symptoms, Signs, and Ill-defined Conditions diagnoses; Musculoskeletal and Connective Tissue diagnoses; or Nervous System and Sense Organs diagnoses.

2. "TOTAL" categorizes the Number of TOTAL Visits as:
   1. 0 to 7 total visits
   2. 8 to 11 total visits
   3. 12 to 17 total visits
   4. 18 or more total visits

   Although the initial sampling procedure selected patients with six or more visits, a small number of patients in our final data set had fewer than six visits. This was a result of further exclusions and missing data.

Demographic Information

Table 3 describes the demographics of the 883 patients in our study.

Table 3 – Characteristics of Participants (N = 883)

Characteristic	*Subgroup*	*Total N (%)*	*Somatizer N (%)*	*Nonsomatizer N (%)*
Age Group, years	20–29	118 (13.4)	16 (13.1)	102 (13.4)
	30–39	277 (31.4)	30 (24.6)	247 (32.5)
	40–49	376 (42.6)	59 (48.4)	317 (41.7)
	50+	112 (12.7)	17 (13.9)	95 (12.5)
Gender	Male	283 (32.0)	21 (17.2)	262 (34.4)
	Female	600 (68.0)	101 (82.8)	499 (65.6)
Employer	State of MI	208 (23.6)	31 (25.4)	177 (23.3)
	GM	246 (27.9)	27 (22.1)	219 (28.8)
	Other†	429 (48.6)	64 (52.5)	365 (48)
Copay, $	0	487 (55.2)	67 (54.9)	420 (55.2)
	5	275 (31.1)	35 (28.7)	240 (31.5)
	7 or 10	121 (13.7)	20 (16.4)	101 (13.3)
Relationship to Subscriber	Self	554 (62.7)	71 (58.2)	483 (63.5)
	Spouse	296 (33.5)	48 (39.3)	248 (32.6)
	Dependent	33 (3.7)	3 (2.5)	30 (3.9)

†BCNMM employees were excluded from sample

The distribution of somatization status by gender is given below in Table 4 and igure 1. There are twice as many females in the somatizer group.

Table 4 - Distribution of Somatization Status by Gender

Somatization Status	*Male %*	*Female %*
Nonsomatizer	92.6	83.2
Somatizer	7.4	16.8

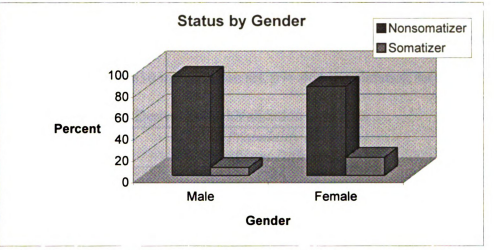

Figure 1 - Distribution of Somatization Status by Gender

Comparability of the Data Sets

In order to derive and test a logistic model to predict somatization status, separate derivation and validation sets were created. The derivation data set was composed of a randomly selected two-thirds of the total 883 patients (588 patients) and the validation set the remaining one-third (295 patients). It is important to assess comparability of the two data sets to construct an adequate model and to test its reliability with another similar data set.

For continuous variables, the nonparametric Mann-Whitney/Wilcoxon Test was used to test for any differences between the cases selected for the derivation and the validation data sets. Despite the large sample size, the Mann-Whitney/Wilcoxon Test was preferred because the underlying distributions were extremely skewed and did not

approximate a normal distribution. For categorical variables, we used chi-square tests. The validation data set had slightly higher Number OTHER Visits but the more meaningful variable Percent OTHER Visits did not significantly differ between the sets. The results from these analyses are shown in Table 5. A statistical difference was detected between the data sets in office visit copayment amounts. Within the derivation set and validation sets there was no association between copayment amount and somatization status (p = .810 in derivation set, p = .464 in validation set).

Table 5 – Comparison of Derivation and Validation Data Sets

Variable	*Probability of Significant Difference*
Number of GI Visits	.246
Number of MISC Visits	.592
Number of MS Visits	.603
Number of NS Visits	.268
Number of OTHER Visits	.055
Percent GI Visits	.336
Percent MISC Visits	.450
Percent MS Visits	.469
Percent NS Visits	.301
Percent OTHER Visits	.436
Number of TOTAL Visits	.405
Age in Years	.104
Somatization Status	.643
Relationship to Subscriber	.589
Employee Group	.653
Copayment Amount	.017*
Gender	.191
Age Group	.653
TOTAL	.333
SOMATIC POTENTIAL	.096

Preliminary Analysis

The derivation data set was used to assess differences between somatizers and nonsomatizers on the above variables. The best predictors were hypothesized *a priori*

and labeled as having "somatic potential", which can be found in a later section of this thesis titled "Best Predictors". This preliminary analysis was an aid to the selection of candidate variables that will be entered in the logistic regression model.

Derivation Data Set Univariate Analyses

The Mann-Whitney/Wilcoxon Test was used to detect any differences between somatizers and nonsomatizers for continuous variables. The results in Table 6 indicate that Percent GI Visits, Percent MISC Visits, Percent MS Visits, and Percent OTHER Visits differ between the groups in the derivation data set.

Table 6 - Mann-Whitney/Wilcoxon Tests and Univariate Comparisons for Continuous Variables in the Derivation Data Set for Somatizers vs. Nonsomatizers (N = 588)

Variable	*Somatizers*		*Nonsomatizers*		*Probability of Significant Difference*
	Median	*Interquartile Range*	*Median*	*Interquartile Range*	
Percent GI Visits	0.00	0.00 – 10.00	0.00	0.00 – 0.00	.004*
Percent MISC Visits	8.33	0.00 – 25.00	0.00	0.00 – 14.29	.001*
Percent MS Visits	34.62	11.11 – 57.14	0.00	0.00 – 16.67	<.0001*
Percent NS Visits	0.00	0.00 – 10.00	0.00	0.00 – 10.82	.267
Percent OTHER Visits	36.00	22.22 – 50.00	71.43	50.00 – 87.08	<.0001*
AGE	40.84	35.54 – 46.84	40.74	33.75 – 46.83	.830

Chi-square tests were performed to detect any statistically significant differences between somatizers and nonsomatizers in categorical variables. As indicated in Table 7, somatization status differs between GENDER, TOTAL and SOMATIC POTENTIAL. There are significantly fewer male somatizers than female somatizers. There are fewer somatizers with less than eight visits and more somatizers with twelve or more visits.

Somatizers are more likely than nonsomatizers to have visits indicative of having somatic potential than would be expected by chance alone. There is no reason to believe that somatization status differs among any other categorical variables.

Table 7 – Chi-Square Tests and Univariate Comparisons for Discrete Variables in the Derivation Data Set for Somatizers vs. Nonsomatizers (N = 588)

Variable	*Somatizer N (%)*	*Nonsomatizer N (%)*	*Probability of Significant Difference*
Age Group, years			.932
20–29	12 (15.2)	70 (13.8)	
30–39	23 (29.1)	166 (32.6)	
40–49	34 (43.0)	208 (40.9)	
50+	10 (12.7)	65 (12.8)	
Gender			.001*
Male	14 (17.7)	183 (36.0)	
Female	65 (82.3)	326 (64.0)	
Employer			.414
State of MI	22 (27.8)	122 (24.0)	
GM	17 (21.5)	145 (28.5)	
Other†	40 (50.6)	242 (47.5)	
Copay, $			.810
0	46 (58.2)	287 (56.4)	
5	20 (25.3)	146 (28.7)	
7 or 10	13 (16.5)	76 (14.9)	
Relationship to Subscriber			.550
Self	46 (58.2)	316 (62.1)	
Spouse	31 (39.2)	172 (33.8)	
Dependent	2 (2.5)	21 (4.1)	
TOTAL			<.0001*
0 – 7 Visits	4 (5.1)	202 (39.7)	
8 – 11 Visits	16 (20.3)	188 (36.9)	
12 - 17 Visits	30 (38.0)	82 (16.1)	
18+ Visits	29 (36.7)	37 (7.3)	
SOMATIC POTENTIAL			<.0001*
Yes	58 (73.4)	102 (20.0)	
No	21 (26.6)	407 (80.0)	

† Does not include BCNMM employees.

Validation Data Set Univariate Analyses

The results in Table 8 indicate that Percent MISC Visits, Percent MS Visits, Percent OTHER Visits and AGE differ between the groups in the validation data set.

Table 8 - Mann-Whitney/Wilcoxon Tests and Univariate Comparisons for Continuous Variables in the Validation Data Set for Somatizers vs. Nonsomatizers (N = 295)

Variable	*Somatizers*		*Nonsomatizers*		*Probability of Significant Difference*
	Median	*Interquartile Range*	*Median*	*Interquartile Range*	
Percent GI Visits	0.00	0.00 – 9.09	0.00	0.00 – 4.71	.073
Percent MISC Visits	12.50	0.00 – 27.78	0.00	0.00 – 14.29	.001*
Percent MS Visits	15.38	0.00 – 33.33	0.00	0.00 – 17.80	.001*
Percent NS Visits	0.00	0.00 – 11.11	0.00	0.00 – 11.11	.436
Percent OTHER Visits	50.00	40.91 – 58.33	70.29	50.74 – 85.71	.000*
AGE	45.96	39.25 – 49.76	41.67	34.96 – 47.02	.007*

Chi-square tests were performed to detect any statistically significant differences in the following categorical variables between somatizers and nonsomatizers. As indicated in Table 9, somatization status differs between GENDER, TOTAL and SOMATIC POTENTIAL.

There are significantly fewer male somatizers than female somatizers. There are fewer somatizers with less than eight visits and more somatizers with at least twelve visits. These results are similar in the derivation data set. The distribution of SOMATIC POTENTIAL among somatizers and nonsomatizers is statistically significant yet does not agree with the associations in the derivation data set.

Table 9 – Chi-Square Tests and Univariate Comparisons for Discrete Variables in the Validation Data Set for Somatizers vs. Nonsomatizers (N=295)

Variable	*Somatizer N (%)*	*Nonsomatizer N (%)*	*Probability of Significant Difference*
Age Group, years			.122
20–29	4 (9.3)	32 (12.7)	
30–39	7 (16.3)	81 (32.1)	
40–49	25 (58.1)	109 (43.3)	
50+	7 (16.3)	30 (11.9)	
Gender			.044*
Male	7 (16.3)	79 (31.3)	
Female	36 (83.7)	173 (68.7)	
Employer			.652
State of MI	9 (20.9)	55 (21.8)	
GM	10 (23.3)	74 (29.4)	
Other†	24 (55.8)	123 (48.8)	
Copay, $			.464
0	21 (48.8)	133 (52.8)	
5	15 (34.9)	94 (37.3)	
7 or 10	7 (16.3)	25 (9.9)	
Relationship to Subscriber			.457
Self	25 (58.1)	167 (66.3)	
Spouse	17 (39.5)	76 (30.2)	
Dependent	1 (2.3)	9 (3.6)	
TOTAL			<.0001*
0 – 7 Visits	7 (16.3)	88 (34.9)	
8 – 11 Visits	11 (25.6)	94 (37.3)	
12 - 17 Visits	14 (32.6)	55 (21.8)	
18+ Visits	11 (25.6)	15 (6.0)	
SOMATIC POTENTIAL			.009*
Yes	16 (37.2)	49 (19.4)	
No	27 (62.8)	203 (80.6)	

† Does not include BCNMM employees.

Best Predictors

The benefits of effective screening of somatizing patients have been presented. This thesis will offer an algorithm to aid physicians in the BCNMM ascertain if a high-utilizing patient is a somatizer. A logistic regression model was used to calculate the

probability of somatization. The hypothesized best predictors were system-based symptoms, based on the ICD-9-CM classifications, that had "somatic potential". The symptoms identified as having "somatic potential" were diagnoses from the digestive system; musculoskeletal and connective tissue; nervous system and sense organs; and symptoms, signs, and ill-defined conditions based on ICD-9-CM codes. The choice of predictor variables was primarily based on a pilot study conducted at St. Lawrence Family Health Center in Lansing, Michigan by the principal investigator Robert C. Smith, MD, of Michigan State University. In this study, it was found that patients having eight or more visits with "somatic potential" were indicative of chronic somatization. The predictor variables were also selected from a review of the literature (Saxe *et al.*, 1994; Escobar *et al.*, 1987, 1989; Smith *et al.*, 1986); preliminary analysis of the current data; and the clinical experience and expertise of Robert C. Smith, MD, the principal investigator of this study. Next, an ROC curve was graphed using the model's predicted probabilities. The ROC curve was used to aid in the selection of optimal cutoff points in determining somatization status. The derivation data set, consisting of two-thirds of the sample provided by BCNMM, was used to build the logistic model and calculate the ROC Curve. The model was validated using the validation data set, contained the remaining third of the BCNMM data.

Three types of variables were considered for entry into the logistic model: demographic variables; variables possessing "somatic potential"; and the total number of visits. Examples of demographic variables include gender and age. In the St. Lawrence pilot study, medical visits for gastrointestinal (GI), musculoskeletal (MS), nervous system (NS) and ill-defined conditions (MISC), were found predictive of somatization, or

that they possessed "somatic potential". Findings from the pilot study also revealed that 25% of patients with eight or more medical visits were somatizers. When only diagnoses with "somatic potential" were counted, 36% of patients having eight or more visits were somatizers.

In this thesis, the dichotomous variable SOMATIC POTENTIAL equals "Yes" when the percent of visits with "somatic potential" exceeds 50% of the Number of TOTAL Visits. Otherwise, it is "No" when the percent of visits with "somatic potential" is less than 50% of the Number of TOTAL Visits. In the derivation data set, 73.4% of somatizers and 80.0% of nonsomatizers were classified correctly using SOMATIC POTENTIAL as previously shown in Table 7. The positive predictive value is 36.3% and negative predictive value is 95.1%. In the validation data set, 37.2% of somatizers and 80.6% of nonsomatizers were classified correctly using SOMATIC POTENTIAL as was exhibited in Table 9. The positive predictive value here is 24.6% and negative predictive value is 88.3%.

Simple inspection of the total number of visits relating to somatization status results in another interesting relationship. To simplify the relationship, reduce the variable denoting the total number of visits in grouped form, "Number of TOTAL Visits", as displayed in Table 7 and Table 9, to a dichotomous variable called "TOTAL(2)". If TOTAL(2) is dichotomized (no significant difference between derivation and validation data sets, $p = .403$) at eight visits, prediction of somatization by eight or more visits and nonsomatization by less than eight visits results in high sensitivity and negative prediction value. In the derivation data set, 94.9% of somatizers and 39.7% of nonsomatizers were classified correctly using TOTAL(2) as shown in Table

10. The positive predictive value here is 19.6% and negative predictive value is 98.1%. In the validation data set, 83.7% of somatizers and 34.9% of nonsomatizers were classified correctly using TOTAL(2) as shown in Table 11. The positive predictive value here is 18.0% and negative predictive value is 92.6%.

Table 10 - Distribution of Somatization Status by TOTAL(2) in the Derivation Data Set

TOTAL(2)	*Somatizer*	*Nonsomatizer*
< 8 Visits	4	202
≥ 8 Visits	75	307
Total	79	509

Table 11 - Distribution of Somatization Status by TOTAL(2) in the Validation Data Set

TOTAL(2)	*Somatizer*	*Nonsomatizer*
< 8 Visits	7	88
≥ 8 Visits	36	164
Total	43	252

Contingency table analyses with the dichotomous variables SOMATIC POTENTIAL and TOTAL(2) variables are simple ways to tentatively predict somatization status of a patient if the clinician knows the total number of visits or the relative percents of the various classifications of visits as given above. These variables have high negative predictive values.

CHAPTER 3

THE LOGISTIC MODEL

Main Effects Logistic Regression Model

The logistic model is given by the following equation:

$$\text{logit}(p) = \ln(p/1 - p) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k$$

$$= \ln(\text{odds of being a somatizer})$$

where $0 < p < 1$, $x_1, x_2, \ldots, x_k$ are either continuous or categorical predictor (independent) variables; $\beta_1, \beta_2, \ldots, \beta_k$ are weights, called regression parameters, estimated by the method of maximum likelihood; and α is a constant called the intercept parameter.

The probability of somatization given by the logistic regression model is of the form:

$$p = \text{probability} = P(\text{somatizer} \mid x_1, x_2, \ldots, x_k) = 1 / (1 + e^{-(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)})$$

$$= e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)} / (1 + e^{(\alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)})$$

The following dichotomous variables were selected for entry into the main effects model because of their association with somatization status in the derivation data set:

GENDER: The variable GENDER is coded 1 for female and 0 for male genders. Males have been designated as the referent group for GENDER.

TOTAL(2): This variable is coded 1 if the Number of TOTAL Visits is greater than or equal to eight and coded 0 if the Number of TOTAL Visits is less than eight.

SOMATIC POTENTIAL: SOMATIC POTENTIAL = 1 ("Yes") if the sum of Percent GI Visits, Percent MISC Visits, Percent MS Visits, and Percent NS Visits exceeds 50% of the Number of TOTAL Visits. SOMATIC POTENTIAL = 0 ("No") if the sum of Percent GI Visits, Percent MISC Visits, Percent MS Visits, and Percent NS Visits is less than or equal to 50% of the Number of TOTAL Visits.

Model Fitting Steps

Many steps were involved in developing a model to fit these data. First the variables hypothesized to differentiate between somatizers and nonsomatizers were entered: GENDER, TOTAL(2) and SOMATIC POTENTIAL. Next, other potential predictive factors were entered: Age group, Employer, Copay and Relationship to Subscriber. None were significant nor were they determined to be confounders. Using a hierarchical model, all interactions were eliminated because of non-significant p-values. Steps are given in Table 12 below. SPSS software was used in these analyses.

Table 12 – Model Entry and Elimination Procedures

Logistic Model Stages
Hypothesized main effects are entered into model
SEX (p = .0014)
TOTAL(2) (p < .0001)
SOMATIC POTENTIAL (p < .0001)
All main effects are significant and will be retained in model.
Main effects entered using forced entry; other covariates tested for remaining in model using stepwise backward procedure
Relationship to Subscriber (p = .8369)
Copay (p = .8217)
Age Group (p = .7431)
Employer (p = .2446)
These variables were removed from the model. The above main effect model using GENDER, TOTAL(2) and SOMATIC POTENTIAL will be maintained.
Confounder Assessment
Compare odds ratios of main effects with and without each separate covariate (see above) to assess confounding. Odds ratios are not significantly altered between models.
Beta Coefficients for Main Effects Model:
SEX 1.1262
TOTAL(2) 2.6476
SOMATIC POTENTIAL 2.6263
Beta Coefficients with Age Group Added to Main Effects Model:
SEX 1.0983
TOTAL(2) 2.6659
SOMATIC POTENTIAL 2.6833
Beta Coefficients with Employer Added to Main Effects Model:
SEX 1.1063
TOTAL(2) 2.6858
SOMATIC POTENTIAL 2.6638
Beta Coefficients with Copay Added to Main Effects Model:
SEX 1.1629
TOTAL(2) 2.6368
SOMATIC POTENTIAL 2.6177
Beta Coefficients with Relation Added to Main Effects Model:
SEX 1.1081
TOTAL(2) 2.6417
SOMATIC POTENTIAL 2.6326
Interaction Assessment Using Hierarchical Model
SEX*TOTAL(2)*SOMATIC POTENTIAL eliminated (p= .9504)
SEX*TOTAL(2) (p = .8850)
TOTAL(2) * SOMATIC POTENTIAL (p = .6817)
SEX*SOMATIC POTENTIAL (p = .5136)
No significant interaction effects between main effects.

Constructed Model

The final model and information pertaining to its fit are given below. Interactions and potential confounders are not included in the final model, as they were of no importance. All independent variables are indicator variables.

The final model is given by the following equation where GENDER, TOTAL(2) and SOMATIC POTENTIAL are previously detailed:

$$\ln(\text{odds}) = -6.0552 + (1.1262 \times \text{GENDER}) + (2.6476 \times \text{TOTAL(2)})$$

$$(2.6263 \times \text{SOMATIC POTENTIAL})$$

The probability of being a somatizer can be calculated by the following formula:

P = odds/(1+odds), where odds can be derived by exponentiating the ln(odds) above.

Interpretation

The probability of being a somatizer can be computed from the logistic regression model. The parameters to be used in the model are given in Table 13. The decision rule, or cutoff point, will be decided upon according to the desired sensitivity and specificity. Contingency table analysis and the ROC curve aid in this determination.

Table 13 - Parameter and Odds Ratio Estimates Using the Method of Maximum Likelihood

Variable	Parameter Estimate	Chi-Square (d.f.)	Probability	Odds Ratio	Lower 95% C.I.	Upper 95% C.I.
CONSTANT (α)	-6.0552	10.2234 (1 d.f)	< 0.0001*			
SEX (β_1)	1.1262	23.9777 (1 d.f)	0.0014*	3.0838	1.5463	6.1501
TOTAL(2) (β_2)	2.6476	76.4793 (1 d.f)	< 0.0001*	14.1207	4.8934	40.7472
SOMATIC POTENTIAL (β_3)	2.6263	88.8915 (1 d.f)	< 0.0001*	13.8219	7.6727	24.8994

*All independent variables are significant.

Odds ratios and their confidence intervals for the three variables in the model are shown in Table 14. An independent variable's regression parameter can be exponentiated to obtain the odds of being a somatizer. It is the odds of being a somatizer for that independent variable while controlling for all other independent variables.

Table 14 – Adjusted Odds Ratios for Somatization Status

Variable (Referent)	Odds Ratio	95% Confidence Interval
SEX (MALE)	3.0838	1.5463 - 6.1501
TOTAL(2) (<8 Visits)	14.1207	4.8934 - 40.7472
SOMATIC POTENTIAL (GI+MISC+MS+NS ≤ 50%)	13.8219	7.6727 - 24.8994

For example, the odds of somatization for a female compared to a male is 3.0838 when all other variables are held fixed. The odds of somatization for an individual with eight or more visits versus an individual with less than eight visits is 14.1207. With all other variables held fixed, the odds of somatization for an individual with more than 50% of total visits having "somatic potential", i.e. GI+MISC+MS+NS > 50%, versus an individual with 50% or less is 13.8219.

Various combinations of independent variables can produce up to eight different predicted probabilities. For an individual in the referent group (male with less than eight visits and 50% or less visits with "somatic potential") odds for somatization is exp(-6.0552) = .0023. Odds for all predictors are listed in Table 15.

Table 15 – All Possible Predicted Probability and Odds

SEX	*TOTAL(2)*	*SOMATIC POTENTIAL*	*PREDICTED PROBABILITY*	*ODDS*
Female	8+ Visits	GI+MISC+MS+NS > 50%	.58537	1.4118
Female	8+ Visits	GI+MISC+MS+NS ≤ 50%	.09268	.1021
Female	<8 Visits	GI+MISC+MS+NS > 50%	.09089	.1000
Female	<8 Visits	GI+MISC+MS+NS ≤ 50%	.00718	.0072
Male	8+ Visits	GI+MISC+MS+NS > 50%	.31404	.4578
Male	8+ Visits	GI+MISC+MS+NS ≤ 50%	.03206	.0331
Male	<8 Visits	GI+MISC+MS+NS > 50%	.03140	.0324
Male	<8 Visits	GI+MISC+MS+NS ≤ 50%	.00234	.0023

ROC Curve

The ROC curve is a plot of the false positive rate (1 – specificity) by the true positive rate, (sensitivity) for various probability cutoffs. The SAS procedure PROC LOGISTIC calculates the sensitivity and specificity for these probabilities using 2x2 contingency tables based on each cutoff. The ROC curves were then constructed using Microsoft Excel.

The area under the ROC curve as well as the height above the diagonal, or chance line, are important attributes of the curve. (Hanley and MCNeil, 1982) Perfect prediction by the model would yield an area exactly equal to one; prediction based on chance would have an area equal to 0.5. The ROC curve for the final model has area equal to .8640 in the derivation data set and .6651 in the validation data set. The greater the height above the chance line indicates better discrimination between the somatizer and nonsomatizer groups. The ROC curve in Figure 2 indicates that the optimal probability cutoff is when $p > .03206$ to predict somatization since this value is furthest from the chance line. In the data set, this cutoff yields 96.2% sensitivity and 51.47% specificity. In the validation

data set, this cutoff has 79.07% sensitivity and 44.84% specificity. These values are shown in Table 16 and Table 17.

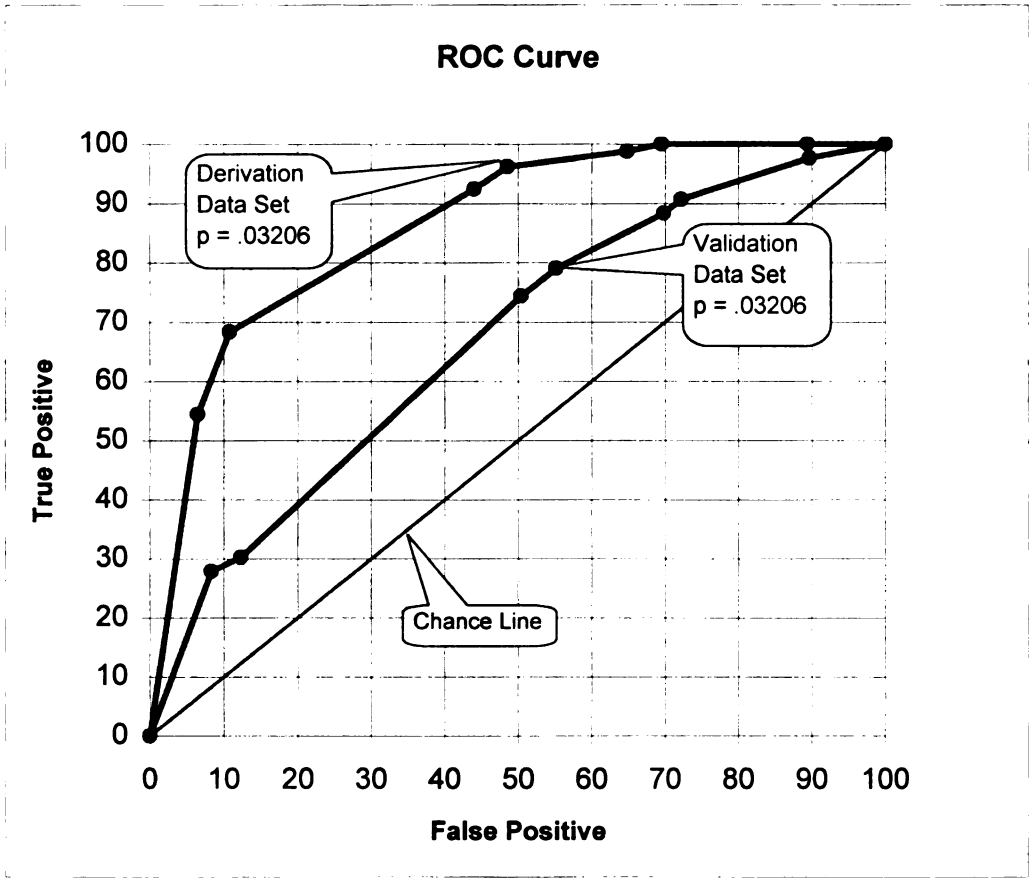

Figure 2 – ROC Curve

Choice of Cutoff Values

The desired sensitivity and specificity can be modified as needed. Depending on the cost of making a true or false prediction, the choice of cutoff points can be altered. The cutoff value p = .03206 is the best choice when high sensitivity is needed; it is approximately 96% sensitive and 51% specific in the derivation set. The positive predictive value is 23.53% and the negative predictive value is 98.87%. This decision

rule has 79% sensitivity and 45% specificity in the validation set, with positive predictive value 19.65% and negative predictive value 96.62%.

Table 16 – Prediction in the Derivation Set

Probability	*Prediction*	*Diagnosed Nonsomatizers*	*Diagnosed Somatizers*
P < .03206	Nonsomatizer	262 (51.47%)	3 (3.8%)
P ≥ .03206	Somatizer	247 (48.53%)	76 (96.20%)

Table 17 – Prediction in the Validation Set

Probability	*Prediction*	*Diagnosed Nonsomatizers*	*Diagnosed Somatizers*
P < .03206	Nonsomatizer	113 (44.84%)	9 (20.93%)
P ≥ .03206	Somatizer	139 (55.16%)	34 (79.07%)

Appropriateness of the Model

Table 18 indicates that the null hypothesis that the independent variables in the model are not significant is rejected. The variables used to calculate the logistic regression parameters are significant. Pseudo R-Squared measures were computed: Cox & Snell's = .220 and Nagelkerke's = .404.

Table 18 - Model Fitting Information and Testing the Global Null Hypothesis $\beta = 0$

Test Statistic	*Intercept Only*	*Intercept and Covariates*	*Chi-Square (d.f.)*	*Probability*
-2 Log L	317.589	225.152	146.437 (3 d.f.)	< 0.0001

Hosmer and Lemeshow's goodness-of-fit test confirms that the data fits the model very well.

Table 19 - Goodness-of-Fit Test

Test Statistic	*Chi-Square (d.f.)*	*Probability*
Hosmer and Lemeshow	1.6404 (6 d.f.)	0.9496

We should examine potential outliers in the data. Table 20 exhibits 26 cases from the derivation data set with large residual values. Residual analysis indicates that the following might be considered outliers because the difference between their true somatization status and their expected probabilities was large. These cases are close in value to the small value used for the probability cutoff. Only one somatizer who had a large residual value was misclassified. No outliers were eliminated from the data; all cases were used to construct the logistic regression model.

Table 20 - Residual Analysis

Status	*GENDER*	*TOTAL(2)*	*SOMATIC POTENTIAL*	*Model's Predicted Probability*	*Studentized Residual*
Somatizer*	male	<8 Visits	GI+MISC+MS+NS > 50%	0.0314	5.5537
Somatizer	male	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0321	5.4946
Somatizer	male	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0321	5.4946
Somatizer	female	<8 Visits	GI+MISC+MS+NS > 50%	0.0909	3.1626
Somatizer	female	<8 Visits	GI+MISC+MS+NS > 50%	0.0909	3.1626
Somatizer	female	<8 Visits	GI+MISC+MS+NS > 50%	0.0909	3.1626
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289
Somatizer	female	8+ Visits	GI+MISC+MS+NS ≤ 50%	0.0927	3.1289

*Misclassified case

Strengths and Limitations

The strengths of this study outweigh any shortcomings. One discrepancy was between the number of visits computed in our analysis and those counted by BCNMM. The algorithm used by BCNMM was to extract only those patients with six or more visits, the lower cutoff value for high-utilization set by the principal investigator. However, when applying our exclusion criteria to the data set, the total number of visits was diminished in many cases, which lead to 3.4% (30 cases) of our sample to have less than six visits. All these were nonsomatizers. Excluding these cases from the data did not significantly alter the results of this thesis.

Examination of the data indicated that 3.4% (30 cases) of our sample had less than six visits and that these were all nonsomatizers. Excluding these cases from the data did not significantly alter the results of this thesis.

Table 21 - Visit Count Discrepancy

Number of Visits	*Frequency*	*Percent of 883 cases %*
3	3	0.34
4	10	1.13
5	17	1.93
Total	30	3.4

Another limitation of the study is that without direct patient contact, the investigators were not able to diagnose a specific somatoform disorder had to exclude organic disease using just chart review.

The extraction of cases through BCNMM computerized database eliminates any selection, measurement, and participation bias. Classification bias might exist in this study if the chart rater misdiagnosed the somatization status of any patients. If this were

the case, the discriminatory capability of the model would be reduced. The more cases that are classified correctly will enhance the model's ability to predict somatization status.

Potential interactions were carefully considered. Effect modification and confounding would have been adjusted for in the logistic regression model had they existed.

A model including continuous variables utilizes much more information from the collected data compared to categorical, and especially dichotomous, variables. There is only one β-coefficient to estimate for each continuous variable; for categorical variables, one must estimate β-coefficients for one less than the total number of categories. For example, if there are five categories for variable X then four β-weights will need to be estimated. The use of arbitrary cutoff points as in categorical variables is not an issue when using continuous variables. The ROC curve is constructed with several more points giving a greater choice of potential cutoff points. The continuous model is not sensitive to empty cells, which can be problematic in categorical models.

A model consisting of three dichotomous variables results in the estimation of one β-coefficient for each variable in the model, thus a total of eight possible predicted probabilities for somatization. The benefits of a model containing only categorical variables include an uncomplicated calculation of predicted probabilities as well as a model that makes intuitive sense.

The derivation and validation data sets do not significantly differ on any of the variables entered into the final model. The sample sizes were large in both data sets. It is expected that the results will vary when the model is tested with a different data set. The

differences in sensitivity, specificity and predictive value are due to slight differences between the data sets. Overall, the validation step in the analysis showed that the model was capable of good discrimination and predictive value.

The model's sensitivity, specificity, positive and negative predictive values indicate that the model is reliable and can be used as an aid for diagnosis of somatization. It should be noted that changes in the distribution of somatization status within different populations and differences in a physician's skill at diagnosing symptoms would alter the relative prevalence of somatizers. The positive predictive value can be compared from the following formula (Schulzer, 1994):

Positive predictive value = Pr (somatizer | predicted somatizer using decision rule)

$$= (\text{sensitivity} \times \Pr(\text{somatizer})) / ((\text{sensitivity} \times \Pr(\text{somatizer})) + (\text{false positive rate} \times \Pr(\text{nonsomatizer}))).$$

Changes in prevalence of somatization would affect the predictive value of the logistic regression model as well as the selection of optimal cutoff values.

A shortcoming of the logistic regression model is that it predicts only slightly better than the simple variables SOMATIC POTENTIAL and TOTAL(2) in contingency tables. If the percentage of GI, MISC, MS and NS visits exceed the number of OTHER visits (SOMATIC POTENTIAL), or if the patient has eight or more total number of visits (TOTAL VISITS), suggest that somatization is very likely. This is an extremely uncomplicated and reliable way to identify somatizers among high-utilizers.

Conclusion

The resulting model can serve as a guideline for physicians in the BCNMM to identify their high-utilizing somatizing patients. It is important that the physician

continue to trust their own clinical experience, judgement, and familiarity with the individual patient rather than rely solely upon the results of the model. The methods described here can be used to develop models for other HMOs. This specific model may be applicable to other HMOs, but it is recommended that each individual HMO develop its own model. Differences in the patient demographics and prevalence of somatization, will influence the logistic regression model. Consequently, the variables and their weights will change and the predicted probabilities will vary accordingly. Cutoff values will have to be modified for the distribution of predicted probabilities among somatizers and nonsomatizers for the desired levels of sensitivity and specificity.

APPENDICES

APPENDIX A

APPENDIX A

SPECIAL TREATMENT PROJECT CHART RATING FORM

DATE:

PATIENT ID #: DOB:_____

RATER:

PERIOD OF TIME RATED_____

OF VISITS RATED_____ # OF PHONE CONTACTS_____

COMPLAINTS/SYMPTOMS (combine symptoms that occur together as one complaint) DIAGNOSES

1._____ _____

2._____ _____

3._____ _____

_____ _____

_____ _____

DOCUMENTATION TO DETERMINE PERSENCE/ABSENCE OF ORGANIC DISEASE (for each complaint/symptom)

1._____

2._____

3._____

_____

_____

OVER

CONCLUSION (For each complaint, assign one of the following letters:)

A. ORGANIC DISEASE (assign Charleston weight to each applicable organic disease)

B. SOMATIZATION

C. DATA INADEQUATE TO DETERMINE CLASSIFICATION (no more than 10% of all patients rated)

1. A_____ WEIGHT_____ B_____ C_____

2. A_____ WEIGHT_____ B_____ C_____

3. A_____ WEIGHT_____ B_____ C_____

A_____ WEIGHT_____ B_____ C_____

TOTAL _____

WEIGHTED INDEX OF COMORBIDITY

ASSIGNED WEIGHTS FOR DISEASES	CONDITIONS
1	Myocardial infarct
	Congestive heart failure
	Peripheral vascular disease
	Cerebrovascular disease
	Dementia
	Chronic pulmonary disease
	Connective tissue disease
	Ulcer disease
	Mild liver disease
	Diabetes
2	Hemiplegia
	Moderate or severe renal disease
	Diabetes with end organ damage
	Any tumor
	Leukemia
	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumor
	AIDS

Assigned weights for each condition that a patient has. The total equals the score.
Example: chronic pulmonary (1) and lymphoma (2) = total score (3).

REFERENCES

REFERENCES

American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Washington DC: American Psychiatric Association, 1994

Barsky, AJ, "Hidden Reasons Some Patients Visit Doctors". Ann Intern Med, 1981; 94(1): 492-98

Barsky, AJ, Klerman, GL, "Overview: Hypochondriasis, Bodily Complaints, and Somatic Styles". Am J Psychiatry, March 1983; 140: 273-83

Barsky, AJ, Borus, JF, "Somatization and Medicalization in the Era of Managed Care". JAMA, 1995; 274(24): 1931-4

Bridges, K, Goldberg, D, Evans, B, *et al.*, "Determinants of Somatization in Primary Care". Psychol Med, 1991 May; 21(2): 473-83

Bruns, D. The Problem of Somatization. [Online] Available http://www.healthpsych.com, 11/26/97.

Bucholz, KK, Dinwiddie, SH, Reich, T, *et al.*, "Comparison of Screening Proposals for Somatization Disorder Empirical Analyses". Compr Psychiatry, 1993 Jan-Feb; 34(1): 59-64

Campo, JV, Fritsch, SL, "Somatization in Children and Adolescents". J Am Acad Child Adolesc Psychiatry, 1994 Nov-Dec; 33(9): 1223-35

Cantor, C, Phantom Illness: Shattering the Myth of Hypochondria. New York, NY: Houghton Mifflin Company, 1996

deGruy, F, Columbia, L, Dickinson, P, "Somatization Disorder in a Family Practice". J Fam Pract, 1987; 25(1): 45-51

DeVaul, RA, "Hysterical Symptoms" In: Hall, CW (editor), Psychiatric Presentations of Medical Illness. Somatopsychic Disorders. Chicago, IL: Spectrum Publications, 1980

Dickson, LR, Hays, LR, Kaplan, C, *et al.*, "Psychological Profile if Somatizing Patients Attending the Integrative Clinic". Int J Psychiatry Med, 1992; 22(2): 141-53

Escobar, JI, Golding, JM, Hough, RL, *et al.*, "Somatization in the Community: Relationship to Disability and use of Services". Am J Public Health, July 1987; 77(7): 837-40

Escobar, JI, Burnam, MA, Karno, M, *et al.*, "Somatization in the Community". Arch Gen Psychiatry, Aug 1987; 44: 713-8

Escobar, JI, Rubio-Stipec, M, Canino, G, *et al.*, "Somatic Symptom Index (SSI): A New and Abridged Somatic Construct. Prevalence and Epidemiological Correlates in Two Large Community Samples". J Nerv Ment Dis, 1989; 17(3): 140-6

Escobar, JI, "Overview of Somatization Diagnosis, Epidemiology, and Management". Psychopharmacol Bull, 1996; 32(4): 589-96

Faravelli C, Salvatori S, Galassi F, *et al.*, "Epidemiology of Somatoform Disorders: A Community Survey in Florence". Soc Psychiatry Psychiatr Epidemiol, 1997 Jan; 32(1): 24-9

Fink, P, "The Use of Hospitalizations by Persistent Somatizing Patients". Psychol Med, 1992 Feb; 22(1): 173-80

Fink, P, "Somatization-Beyond Symptom count". J Psychosom Res, 1996; 40(1): 7-10

Ford, CV, The Somatizing Disorders. New York, NY: Elsvier Science Publishing Co., 1983

Ford, CV, "Illness as a Lifestyle. The Role of Somatization in Medical Practice". Spine, 1992 Oct; 17(10 Suppl): S338-43

Ford, CV, "Dimensions of Somatization and Hypochondriasis". Neurol Clin, 1995 May; 13(2): 241-53

Goldberg, DP, Bridges, K, "Somatic Presentations of Psychiatric Illness in Primary Care Setting". J Psychosom Res, 1988; 32(2): 137-44

Golding, JM, Smith, GR Jr., Kashner, TM, "Does Somatization Disorder Occur in Men?". Arch Gen Psychiatry, 1991 Mar; 48: 231-5

Hanley, JA, McNeil, BJ, "The Meaning and Use of the Area under a Receiver Operator Characteristic (ROC) Curve". Radiology, 1982 Apr; 143(1): 29-36

Katon, W, Kleinman, A, Rosen, G, "Depression and Somatization: A Review, Part I". Am J Med, Jan 1982; 72: 127-35

Katon, W, Kleinman, A, Rosen, G, "Depression and Somatization: A Review, Part II". Am J Med, Jan 1982; 72: 241-7

Katon, W, Lin, E, Von Korff, M, *et al.*, "Somatization: A Spectrum of Severity", Am J Psychiatry, 1991 Jan; 148(1): 34-40

Kellner, R, "Functional Somatic Symptoms and Hypochondriasis". Arch Gen Psychiatry, Aug 1985; 42: 821-33

Kellner, R, "Psychosomatic Syndromes, Somatization and Somatoform Disorders". Psychother Psychom, 1994; 61(1-2): 4-24

Kellner, R, "Somatization. Theories and Research". J Nerv Ment Dis, 1990 Mar; 178(3): 150-60

Kirmayer, LJ, Robbins, JM, "Three Forms of Somatization in Primary Care: Prevalence, Co-occurrence and Sociodemographic Characteristics". J Nerv Ment Dis, 1991 Nov; 179(11): 647-55

Kirmayer, LJ, Robbins, JM, "Patients Who Somatize in Primary Care: A Longitudinal Study of Cognitive and Social Characteristics". Psychol Med, 1996 Sept; 26 (5): 937-51

Kroenke, K, Spitzer, RL, deGruy, FV, *et al.*, "Multisomatoform Disorder. An Alternative to Undifferentiated Somatoform Disorder for the Somatizing Patient in Primary Care". Arch Gen Psychiatry, Apr 1997; 54: 352-8

Lipowski, ZJ, "Somatization: The Concept and Its Clinical Application". Am J Psychiatry, Nov 1988; 145: 1358-68

Lolas, F, "Attention, Meaning and Somatization: A Psychophysiological View". Psychopathology, 1991; 24(3): 147-50

Mayou, R, "Somatization". Psychother Psychom, 1993; 59(2): 69-83

Meeuwesen, L, Huyse, FJ, Meiland, FJM, *et al.*, "Psychiatric Consultations in Medical Outpatients With Abdominal Pain: Patient and Physician Effects". Int J Psychiatry Med, 1994; 24(4): 339-56

Monson, RA, Smith, GR Jr., "Current Concepts in Primary Care. Somatization Disorder in Primary Care". N Engl J Med, June 1983; 308(24): 1464-5

Pathak, D, "Multiple Logistic Regression Analysis". Class Notes HM826 Research Methods in Epidemiology: Michigan State University, Fall Semester 1996

Portegijs, PJM, van der Horst, FG, Proot, IM, *et al.*, "Somatization in Frequent Attenders of General Practice". Soc Psychiatry Psychiatr Epidemiol, 1996 Jan; 31(1): 29-37

Rief, W, Heuser, J, Mayrhuber, E, *et al.*, "The Classification of Multiple Somatoform Disorders". J Nerv Ment Dis, 1999 Nov; 184(11): 680-7

Robbins, JM, Kirmayer, LJ, "Attributions of Common Somatic Symptoms". Psychol Med, 1991 Nov; 21(4): 1029-45

Roberts, SJ, "Psychosocial Assessment of the High Utilizer of Occupational Health Services". AAHONJ, 1990 Feb; 38(2): 62-6

Roberts, SJ, "Somatization in Primary Care. The Common Presentation of Psychosocial Problems Through Physical Complaints". Nurse Pract, 1994 May; 19(5): 47, 50-6

Robins, LN, Helzer, JE, Weissman, MM, *et al.*, "Lifetime Prevalence of Specific Psychiatric Disorders in Three Sites". Arch Gen Psychiatry, Oct 1984; 41: 949-58

Robins, LN, Helzer, JE, Orvaschel, H, *et al.*, "The Diagnostic Interview Schedule". In: Eaton, WW, Kessler, LG (editors), Epidemiological Field Methods in Psychiatry. The NIMH Epidemiologic Catchment Area Program. Orlando, FL: Academic Press, 1985

Robins, LN, Wing, J, Ulrich Wittchen, H, *et al.*, "The Composite International Diagnostic Interview. An Epidemiologic Instrument Suitable for Use in Conjunction With Different Diagnostic Systems and in Different Cultures". Arch Gen Psychiatry, Dec 1988; 45:1069-77

Rosen, G, Kleinman, A, Katon, W, "Somatization in Family Practice: A Biopsychosocial Approach". J Fam Pract, 1982; 14(3): 493-502

Rost, KM, Smith, GR Jr., "Improving the Effectiveness of Routine Care for Somatization". J Psychosom Res, 1997; 43(5): 463-5

Salmon, P, May, CR, "Patients' Influence on Doctors' Behavior: A Case Study of Patient Strategies in Somatization". Int J Psychiatry Med, 1995; 25(4): 319-29

Schulzer, M, "Diagnostic Tests: A Statistical Review". Muscle & Nerve, 1994 July; 17(7): 815-9

Simon, GE, VonKorff, M, "Somatization and Psychiatric Disorder in the NIMH Epidemiologic Catchment Area Study". Am J Psychiatry, 1991 Nov; 148(11): 1494-500

Smith, GR, Monson, RA, Ray, DC, "Patients With Multiple Unexplained Symptoms". Arch Intern Med, 1986 Jan; 146: 69-72

Smith, GR Jr., Post, K, Kashner, TM, "A Trial of the Effect of a Standardized Psychiatric Consultation on Health Outcomes and Costs in Somatizing Patients". Arch Gen Psychiatry, 1995 Mar; 52(3): 238-43

Smith, RC, "A Clinical Approach to the Somatizing Patient". J Fam Pract, 1985; 21(4): 294-301

Tómasson, K, Kent, D, Coryell, W, "Comparison of Four Diagnositc Systems for the Diagnosis of Somatization Disorder". Acta Psychiatr Scand, 1993 Nov; 88(5): 311-5

Verhaak, PFM, Tijhuis, MAR, "The Somatizing Patient in General Practice". Int J Psychiatry Med, 1994; 24(2): 157-77

Yutzy, SH, Pribor, EF, Cloninger, CR, *et al.*, "Reconsidering the Criteria for Somatization Disorder". Hosp Community Psychiatry, 1992 Nov; 43(11): 1075-6, 1149

GENERAL REFERENCES

American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Third Edition. Washington DC: American Psychiatric Association, 1980

American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Third Edition - Revised. Washington DC: American Psychiatric Association, 1987

Berkow, R (editor), The Merck Manual (16th edition). Rahway, NJ: Merck Research Labs, 1992

Cody, RB, Smith, JK, Applied Statistics and the SAS Programming Language(4th edition). Upper Saddle River, NJ: Prentice-Hall, 1997

D'Agostino, RB, "Two Group Logistic Regression Analysis". Class Notes MA684 Advanced Statistics: Boston University, Fall Semester 1991

de Blay, F, Zana, H, Offner, M, *et al.*, "Receiver Operating Characteristic Analysis: A Useful Method for a Comparison of the Clinical Relevance of Two *in vitro* IgE Tests". J Allergy Clin Immunol, 1993 Aug; 92(2): 255-63

Detrano, R, "Accuracy Curves: An Alternative Graphical Representation of Probability Data". J Clin Epidemiol, 1989; 42(10): 983-6

Dolin, L, "Somatization and Medicalization (Letter)". JAMA, May 1996; 275(18): 1398

Eliastam, M, "Somatization and Medicalization (Letter)". JAMA, May 1996; 275(18): 1398-9

Erdreich, LS, Lee, ET, "Use of Relative Operating Characteristic Analysis in Epidemiology". Am J Epidemiol, 1981; 114(5): 649-62

Fabian, RH, Langsjoen, HA, Kent, TA, "Somatization and Medicalization (Letter)". JAMA, May 1996; 275(18): 1398

Fedorkow, DM, Sand, PK, Retzky, SS, *et al.*, "The Cotton Swab Test. Receiver-Operating Characteristic Curves". J Reprod Med, 1995 Jan; 40(1): 42-6

Guess, HA, Resseguie, LJ, Melton, LJ, *et al.*, "Factors Predictive of Seizures Among Intensive Care Unit Patients with Gram-Negative Infections". Epilepsia, 1990 Sept-Oct; 31(5): 567-73

Hanley, JA, McNeil, BJ, "A Method of Comparing Areas under Receiver Operator Characteristic Curves Derived from the Same Cases". Radiology, 1983 Sept; 148(3): 839-43

Huguet, J, Castiñeiras, MJ, Fuentes-Arderiu, X, "Diagnostic Accuracy Evaluation Using ROC Curve Analysis". Scand J Clin Lab Invest, 1993; 53:693-9

Jensen, AL, Poulsen, JSD, "Evaluation of Diagnostic Tests Using Relative Operating Characteristic (ROC) Curves and the Differential Positive Rate. An Example Using the Total Serum Bile Acid Concentration and the Alanine Aminotransferase Activity in the Diagnosis of Canine Hepatobiliary Diseases". J Vet Med, 1992; 39(9): 656-68

Katz, D, Foxman, B, "How Well Do Prediction Equations Predict? Using Receiver Operating Characteristic Curves and Accuracy Curves to Compare Validity and Generalizability". Epidemiology, 1993; 4(4): 319-26

Kleinbaum, DG, Kupper, LL, Morgenstern, H, Epidemiologic Research. New York, NY: Van Nostrand Reinhold, 1982

Kleinbaum, DG, Kupper, LL, Muller, KE, Applied Regression Analysis and Other Multivariable Methods. Boston, MA: PWS-KENT Publishing Company, 1988

Lee, W-C, Hsiao, CK, "Alternative Summary Indices for the Receiver Operating Characteristic Curve". Epidemiology, 1996; 7(6): 605-11

Leibovici, L, Alpert, G, Laor, A, *et al.*, "A Clinical Model For Diagnosis of Urinary Tract Infection in Young Women". Arch Intern Med, 1989 Sept; 149: 2048-50

Leibovici, L, Greenshtain, S, Cohen, O, *et al.*, "Bacteremia in Febrile Patients". Arch Intern Med, 1991 Sept; 151: 1801-6

Linnet, K, Brandt, E, "Assessing Diagnostic Tests Once and Optimal Cutoff Point Has Been Selected". Clin Chem, 1986; 32(7): 1341-6

Loeb, S (editor), Professional Guide to Diseases (4^{th} edition). Springhouse, PA: Springhouse Corp, 1992

Plebani, M, Borghesan, F, Basso, D, *et al.*, "Receiver-operating Characteristic (ROC) Curves: A Fundamental Tool for Improving the Clinical Usefulness of *in vitro* IgE Tests". Allergy, 1996 June; 51(6): 407-11

Rodin, GM, "Somatization: A Perspective from Self Psychology". J Am Acad Psychoanal, 1991 Fall; 19(3): 367-84

Rosner, B, Fundamentals of Biostatistics (4th edition). Belmont, CA: Wadsworth Publishing Company, 1995

Saxe, GN, Chinman, G, Berkowitz, R, *et al.*, "Somatization in Patients with Dissociative Disorders". Am J Psychiatry, 1994; 151(9): 1329-34

Schuchter, L; Schultz, DJ, Synnestvedt, M, *et al.* "A Prognostic Model for Predicting 10-Year Survival in Patients with Primary Melanoma". Ann Intern Med, Sept 1996; 125: 369-75

Schultz, EK, "Multivariate Receiver-Operating Characteristic Curve Analysis: Prostate Cancer Screening as an Example". Clin Chem, 1995; 41(8B): 1248-55

Selvin, S, Statistical Analysis of Epidemiologic Data (2nd edition). New York, NY: Oxford University Press, 1996

Sensky, T, "Somatization: Syndromes or Processes?". Psychother Psychom, 1994; 61(1-2): 1-3

Simel, DL, Samsa, GP, Matchar, DB, "Likelihood Ratios with Confidence: Sample Size Estimation for Diagnostic Test Studies". J Clin Epidemiol, 1991; 44(8): 763-70

Smith, PJ, Thompson, TJ, Engelgau, MM, *et al.*, "A Generalized Linear Model for Analyzing Receiver Operating Characteristic Curves". Stat Med, 1996; 15: 323-33

Starlanyl, D, Copeland, ME, Fibromyalgia & Chronic Myofascial Pain Syndrome. A Survivors Manual. Oakland, CA: New Harbinger Publications, 1996

Swets, JA, "ROC Analysis Applied to the Evaluation of Medical Imaging Techniques". Invest Radiol, Mar-Apr 1979; 14(2): 109-21

Swets, JA, "Measuring the Accuracy of Diagnostic Systems". Science, 1988 June 3; 240: 1285-93

Tómasson, K, Kent, D, Coryell, W, "Somatization and Conversion Disorders: Comorbidity and Demographics at Presentation". Acta Psychiatr Scand, 1991 Sept; 84(3): 288-93

von Scheele, C, Nordgren, L, Kempi, V, *et al.*, "A Study of So-Called Hypochondriasis". Psychother Psychosom; 1990; 54(1): 50-6

Walker, LS, Garber, J, Greene, JW, "Somatization Symptoms in Pediatric Abdominal Pain Patients: Relation to Chronicity of Abdominal Pain and Parent Somatization". J Abnorm Child Psychol, 1991 Aug; 19(4); 379-94

Wasson, JH, Sox, HC, Neff, RK, *et al.*, "Clinical Prediction Rules. Applications and Methodological Standards". N Engl J Med, Sept 1985; 313(13): 793-9

Wickramasekera, IE, "Somatization. Concepts, Data, and Predictions from the High Risk Model of Threat Perception". J Nerv Ment Dis, 1995 Jan; 183(1): 15-23

Wright, AF, "A Study of the Presentation of Somatic Symptoms in General Practice by Patients with Psychiatric Disturbance". Br J Gen Pract, 1990 Nov; 40(340): 459-63