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The purpose of this study was to determine the most cost effective method of diagnosing sleep disorders in patients of the Harris County Hospital District (HCHD). Four alternatives were evaluated: 1) continue HCHD's existing contractual agreement with Methodist Diagnostic Hospital; 2) terminate the existing contract and initiate request for bids from local health care facilities and freestanding sleep laboratories; 3) instigate a joint venture to furnish equipment and expertise that would allow HCHD to provide services on-site; and 4) solely fund and construct a sleep laboratory utilizing existing Harris County Hospital District space. A business cases analysis was conducted using the PSI Arista's Executive Checklist Series. Based on the analysis, the author recommended that HCHD initiate a joint venture.

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Feasibility Study: Sleep Services for the Harris County Hospital District
A Graduate Management Project Submitted in Candidacy for the Degree of Master in Health
Administration

By

Lieutenant Commander Donna M. Jefcoat, Medical Service Corps, U.S. Navy

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Abstract

The purpose of this study was to determine the most cost effective method of diagnosing sleep disorders in patients of the Harris County Hospital District (HCHD). Four alternatives were evaluated: 1) continue HCHD's existing contractual agreement with Methodist Diagnostic Hospital; 2) terminate the existing contract and initiate request for bids from local health care facilities and freestanding sleep laboratories; 3) instigate a joint venture to furnish equipment and expertise that would allow HCHD to provide services on-site; and 4) fund and construct a sleep laboratory utilizing existing Harris County Hospital District space. A business cases analysis was conducted using the PSI Arista's Executive Checklist Series. Based on the analysis, the author recommended that HCHD initiate a joint venture.

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Feasibility Study: Sleep Services for the Harris County Hospital District

Chapter 1

Introduction

Conditions Which Prompted the Study

In the last 24 months, Ben Taub General Hospital and Lyndon Baines Johnson General Hospital have expended \$400,000 to have approximately 430 sleep studies performed under contracts with Methodist Diagnostic Hospital, Houston Veterans' Affairs Medical Center (VAMC) and Baylor College of Medicine. Currently, the only contract actively in use is with Methodist Diagnostic Hospital. Baylor's sleep laboratory has been incorporated into Methodist Diagnostic Hospital's sleep center, and VAMC now has a six-month backlog for its own beneficiary population and is neither willing nor able to perform studies for other facilities (M. Hirshkowitz, Director, VAMC Sleep Research Center, personal communication, September 18, 2002).

The annual sleep study budget allocation for Ben Taub's Respiratory Care Department is \$50,000 (T. Force, Ben Taub General Hospital's Director, Respiratory Care, personal communication, September 9, 2002). Under the current contract rate of \$950 per study, approximately 52 examinations can be completed within that budget (State of Texas & DCH Health Services, 2001). Lead pulmonary physicians at Ben Taub General Hospital and Baylor College of Medicine faculty pulmonary medicine physicians Dr. V. Bandi and Dr. E. Guy, estimate that the district has 1,000 patients who should be referred for sleep studies annually (personal communication, October 2, 2002). An additional \$900,000 would therefore be needed to complete the estimated 948 additional studies deemed necessary. According to T. Force, such a large, unfunded budget variance is well beyond Ben Taub's capability. To contain costs, the pulmonary physicians have therefore set such stringent criteria that only the most serious sleep-related cases are referred for study. This has resulted in a diagnosis of sleep disorder in over 90% of patients referred for examination (V. Bandi and E. Guy, personal communication, October 2, 2002). This is much higher than the national average positive diagnostic rate of 40%

to 60% (Heitman & Flemons, 2001), and implies that the financially imposed selection criteria are resulting in many hospital district patients going undiagnosed for sleep disorders.

Harris County Hospital District has not kept pace with the demand for sleep studies, and it is not meeting the standard of care required to properly diagnose and adequately treat its patients (V. Bandi & E. Guy, 2002). The current method of contracting for sleep evaluations is costly and meets neither current nor predicted requirements. The proposed solution offered by the Pulmonary Medicine Department was the creation of a two-bed, American Academy of Sleep Medicine (AASM) accredited sleep disorders laboratory at Ben Taub General Hospital. The department believed such a laboratory could accommodate district's unmet demand for sleep studies at a substantial savings compared to the estimated cost of \$950,000 that would be incurred through contracting studies to other providers.

Statement of the Problem

The original purpose of this study was to determine the most cost effective method of diagnosing sleep disorders of Ben Taub General Hospital patients, but the project was expanded to encompass all 21 facilities within the Harris County Hospital District. Four alternatives were identified: 1) continuing HCHD's existing contractual agreement with Methodist Diagnostic Hospital; 2) terminating the existing contract and initiating a request for bids from local health care facilities and freestanding sleep laboratories; 3) instigating a joint venture to furnish equipment and expertise that would allow HCHD to provide services on-site; and 4) solely funding and constructing a sleep laboratory utilizing existing Harris County Hospital District space.

Background

The Harris County Hospital District is the fourth largest public health system in the United States and operates one of only two Level I Trauma Centers in the Houston metropolitan area (Harris County Hospital District, 2002). The district was established in 1965 and consists of

Ben Taub General Hospital, Lyndon Baines Johnson General Hospital, Quintin Mease Community Hospital, 12 community health centers and specialty clinics and six Houston Independent School District school-based clinics. Eligibility for access to Harris County Hospital District institutions is broad, as any person who has established a 24-hour residency in Harris County can be enrolled in the health system. While the 4.5 million residents of Harris County (U.S. Census, 2002) are all potential beneficiaries, the hospital district estimates that its current beneficiary population is 600,000, with 300,000 currently enrolled (Health/Outreach Education, 2002).

The hospital district's financial status has been precarious for many years. During the mid-1990's, the Commissioners' Court (the governing board of the hospital district consisting of members appointed by the Harris County Judge) voted to transfer \$60 million out of the district's reserve funds. Those funds had been slated for debt retirement and unexpected shortfalls. The Court also voted to reallocate six cents of the district's share of county tax revenues to Harris County, thereby eliminating an annual revenue stream of about \$60 million from the hospital district (More Rancor, 1999). As a result of these actions, the hospital district was forced to borrow money through bank signature loans to remain in operation (Brewer, 2001). By 2002, the district's financial status had improved somewhat due to a county tax increase and an infusion of state and federal funds (Turner, 2002). However, in 2003, the district is once again facing significant cutbacks in state funding (potentially as much as \$60 million), as the Texas Legislature attempts to reconcile a \$9.9 billion shortfall (Schwartz, 2003).

In addition to financial difficulties, the hospital district has been plagued by political infighting and reports of fraud and waste. This led to the forced resignation of the district's prior Chief Executive Officer and criminal conviction of several hospital administrators

(Stinebaker, 1999). Political infighting between the Commissioners' Court and the district's current Chief Executive Officer, John Guest, is ongoing. On May 1, 2003, Mr. Guest submitted his resignation, citing significant differences with the court. On May 7th, fallout from Mr. Guest's resignation led to the removal of a Commissioners' Court board member by the Harris County Judge (Hospital District Board Member is Removed, 2003), and on May 9th, the remaining Commissioners' Court members voted to table the issue of Mr. Guest's resignation (G. Masi, Ben Taub General Hospital, Associate Administrator, personal communication, May 9, 2003).

The flagship hospital of the Harris County Hospital District is Ben Taub General Hospital, a 651 bed academic medical center located within the Texas Medical Center campus and operating on an annual budget of \$131.7 million (W. Benedict, Ben Taub General Hospital, Senior Management Accountant, personal communication, October 11, 2002). With over 40 medical specialties, Ben Taub provides services to 143,000 patients a year (Harris County Hospital District, 2002). This scope of care includes all short-term acute medical needs except for major burn injuries and organ transplantation. Ben Taub's medical staff is affiliated with the Baylor College of Medicine and the hospital supports approximately 340 residents and 40 fellows during each academic year. Baylor faculty, fellows, residents and medical students provide all physician services within Ben Taub General Hospital. Approximately 1,200 of the 5,500 nursing and ancillary support personnel employed by the Harris County Hospital District are assigned to hospital.

The majority of Ben Taub's patients are admitted through the Medicine Service. The hospital's caseload is primarily made up of obstetrics (24.5% of admissions), injury (9.9%), circulatory disease (8.4%) and respiratory conditions (3.8%) (Information Management Systems,

2002). Nearly 93% of the 43,070 admissions to Ben Taub in 2001 were unscheduled, with 71.3% being emergency/urgent cases and 21.6% deliveries (Information Management Systems, 2002). This large percentage of unscheduled admissions creates significant operational problems for the hospital. Management and employees are so focused on crisis management that minimal time and effort is expended on long-term goals or objectives, resulting in short term solutions that are neither efficient nor economical.

Ben Taub's average length of stay is 5.3 days, which slightly exceeds the national average of 5.2 days (Information Management Systems). The hospital's average case mix index of .93 (Information Management Systems, 2002) is substantially below the national average of 1.3 for academic medical centers (The Advisory Board, 2002) and also trails the 1.2 case mix average of the other Texas Medical Center facilities (David Lopez, Chief Operating Officer for the Harris County Hospital District, Personal communication, October 9, 2002). This does not bode well for the hospital's financial strength, as payor reimbursement is based on case mix average, meaning a facility with a lower score earns lower reimbursements. Ben Taub, on average, keeps patients longer than its competitors in the Texas Medical Center, but is reimbursed less for their care.

Like many other inner city academic medical centers, Ben Taub is perceived as being a hospital for the indigent. This is largely borne out by the hospital's payor mix. In 2001, 57.1% of inpatient admissions were self-pay/no-pay cases, 31.8% used Medicaid, 7% used Medicare, and 1.5% employed various other sources while only 2.6% possessed commercial insurance (Information Management Systems, 2002). The combination of the often negative perception of indigent care hospitals, Ben Taub's poor case mix average, and an unplanned admission rate of nearly 93% presents unique management, marketing and fiscal challenges for the facility. These

limit the hospital's ability to improve its bottom line through marketing its high quality services to Houston's more lucrative insured population.

Literature Review

In the U.S., diagnosed sleep disorders affect 24% of male and 9% of female middle-age adults (Young, Palta, Dempsey, Skatrud, Weber & Badr, 1993) and 40% of all American adults complain of some type of sleep problem (Digital Schools, 2002). Chronic sleep disorders deprive nearly 40 million Americans of the rest needed to function normally, making sleep medicine a rapidly growing field (Merritt, 2000). These disorders consist of difficulties with both sleeping and with staying awake, and affect all age groups from the neonatal to the elderly (Accreditation Committee, 2002). The American Sleep Disorder Association recognizes 77 specific disorders of sleep and sleep arousal (Clinical Practice Review Committee, 1998), with the most common conditions being insomnia, narcolepsy, abnormal sleep behavior, and sleep apnea (Merritt, 2000).

Polysomnography, a recording of physiological measurements during sleep, is routinely indicated for the diagnosis of sleep-related breathing disorders. Polysomnography is used in conjunction with the patient's history, other laboratory tests and observations, and the physician's knowledge of sleep disorders to reach a diagnosis and recommend appropriate treatment. It is employed in continuous positive airway pressure (CPAP) titration in patients with sleep-related breathing disorders, documenting the presence of sleep apnea in patients prior to laser-assisted uvulopalatopharyngoplasty (UPPP), sleep latency testing in the evaluation of suspected narcolepsy, and in evaluating sleep-related behaviors that are violent or otherwise potentially injurious to the patient or others (Standards of Practice Committee of the Sleep Disorders Association, 1997). In addition to sleep apnea, another syndrome often evaluated by

polysomnography is narcolepsy. People with narcolepsy suffer sudden attacks of sleep and/or cataplexy (temporary loss of muscle tone which causes people to slump or fall in response to fear, anger, or surprise), sleep paralysis or hallucinations at the onset of sleep. Polysomnography is often used to evaluate parasomnias (abnormal behaviors or movements during sleep), such as sleep walking, talking in one's sleep, nightmares, and bedwetting. It can also be used to detect or evaluate seizures that occur in the middle of the night, when patients and their families are unlikely to be aware of them (Pascualay & Soest, 1996).

Sleep apnea is the most common sleep disorder. An estimated 2% of women and 4% of men in the middle-aged work force meet the minimum diagnostic criteria for apnea (Young et al., 1993). Sleep apnea is characterized by repeated pauses in breathing during sleep, which leads to sleep fragmentation and a decrease in oxyhemoglobin saturation (Young et al., 1993). The physiologic spectrum of sleep apnea runs the gamut from a partial airway collapse and increased upper airway resistance to complete airway collapse and episodes of apnea lasting 60 seconds or more (Young et al.). Sleep apnea is diagnosed when the apnea index is greater than 15 events (or pauses) per hour (Dobbins & Strollo, 2002). Symptoms include snoring, excessive daytime sleepiness, morning headaches, hypertension, difficulty concentrating, sexual dysfunction and personality changes (Digital Schools, 2002). The condition is recognized as a leading contributor to poor sleep quality, which can further aggravate diseases commonly found in aging populations (Dobbin & Strollo, 2002). Sleep apnea robs individuals of vitality, health, and sometimes, life itself. Untreated, it puts people at high risk for motor vehicle accidents, hypertension, stroke, (Pascualay & Soest, 1996), cardiovascular disease, impaired cognitive function (Dobbin & Strollo), depression (Reimer & Flemons, 1999), and diabetes (Resnick et al.,

2002). Despite these severe impacts, it has been estimated that only 12% of patients who have sleep apnea have been clinically diagnosed (Kapur et al. 2002).

Patients with untreated sleep apnea are more likely to be hospitalized and incur higher health care costs than are matched control subjects (American Academy of Sleep Medicine, 2000). In one two-year study of 97 untreated patients, days hospitalized were 2.8 times higher, resulting in excess hospital costs of \$100,000 to \$200,000 (Canadian) and doubled physician costs when compared to the control group (Kryger, Roos, Delaive, Walld, & Horrocks, 1996). A 10-year follow-up study of 181 patients by the same authors demonstrated a 2.5-day increase in hospital stays and a 101% increase in physician costs for sleep apnea patients as compared to control subjects (Roland et al. 1999). A separate study compared 238 patients with sleep apnea to age and gender-matched control subjects. Prior to diagnosis, the mean annual medical cost for apnea patients was \$2,720 versus \$1,384 for control subjects. The magnitude of medical costs incurred correlated with the intensity of sleep apnea (Kapur et al. 2002).

Male gender, increased age and obesity are the greatest risk factors that have been identified in the development of sleep apnea. Middle age men have a three to four times greater risk of developing sleep apnea than women in the same age group. When compared to a normal body mass index of between 18.5 and 24.5 kg/m² (according to the National Institutes of Health), a body mass index (BMI) of greater than 29 kg/m² has been estimated to cause a 8 to 12-fold increase in the likelihood of older adults developing sleep apnea (Dobbin & Strollo, 2002).

Davies and Strandling (1996) analyzed 12 studies of sleep apnea prevalence in populations and estimated that one to five percent of adult men have sleep apnea syndrome. Lindberg and Gislason (2000) considered prevalence estimates for undiagnosed sleep apnea syndrome from nine studies that used two-stage sampling procedures and in which sleep studies were conducted

on subsets of participants drawn from large-sample surveys. Prevalence of undiagnosed sleep apnea syndrome in these studies ranged from 0.3 to 5%, with samples from countries with lower mean body mass index (BMI) tending to yield lower prevalence. However, some of these estimates were based on a conservative assumption that all survey participants who did not report snoring and sleepiness were free of sleep apnea. Young, Peppard, and Gottlieb (2002, p. 1223) believe that this assumption is “almost certainly false and could lead to a serious underestimation of prevalence.” Thus, up to 5% of adults in Western countries are likely to have undiagnosed sleep apnea syndrome, and hence be candidates for treatment. Earlier population based studies suggested that sleep apnea prevalence is higher in African Americans than Caucasians. Ancoli-Israel, Klauber, Stepnowsky, Chinn, and Fell (1995) studied community dwelling (nursing home) adults, and found that the odds of having sleep apnea was 2.5 times greater in African-Americans relative to Caucasians, controlling for BMI and other confounding factors. However, in the ongoing Sleep Heart Health Study, a multi-center cohort study sponsored by the National Heart, Lung and Blood Institute the prevalence of sleep apnea (adjusting for age, sex, and BMI) has been found to be no higher in African-Americans or Hispanics than in Caucasians (Young, Shahar, Nieto et al., 2002). Based on the estimated prevalence of this condition, the resources required to identify and to treat 5 % of the middle-aged adult population constitutes a minimum need (Young, Peppard, & Gottlieb, 2002).

Treatment of sleep apnea falls into six categories: behavior modification, positional therapy, surgical intervention, medical treatment (Dobbin & Strollo, 2002), mandibular advancement (Heitman & Flemons, 2001) and drug therapy (National Center for Cost Containment, 1998). Behavior modification includes weight loss and avoiding alcohol and sedatives (Pasculay & Soest, 1996). Positional therapy may be effective if the patient has apneas

while sleeping supine (Dobbin & Strollo). A mandibular advancer is an intra-oral appliance worn while sleeping that works by holding the lower jaw and the tongue in a forward position, thereby keeping the airway open and preventing its collapse when the soft palate and tongue lose their muscle tone during sleep. Unfortunately, patients who have artificial dentition cannot use a mandibular advancer (Heitman & Flemons). Drugs, including medroxyprogesterone acetate, theophylline, nicotine, acetazolamide, and modafinil have all been used to treat sleep apnea, but their efficacy is in doubt and they are now seldom used. However, tricyclic antidepressants and selective serotonin reuptake inhibitors can decrease sleep apnea severity by reducing the amount of REM sleep (the stage where sleep apnea is usually the most frequent and severe) (National Center for Cost Containment, 1998).

Surgical intervention in apnea patients is controversial because the reconstructive procedures currently available are generally considered ineffective (Pascualay & Soest, 1996). The four types of surgery that can be used singly or in combination are rhinoplasty, UPPP, mandibular reconstruction and tracheostomy. The most widely performed surgical procedure is UPPP. It has an initial success rate of about 50%, which after five years may fall to as low as 25% (Pascualay & Soest). Other surgical procedures, including the removal of tonsils, portions of the soft palate, adenoids or excess tissue at the back of the throat, have a success rate of only 30% to 50% (Brody, 2002).

The cornerstone of medical treatment for sleep apnea is continuous positive airway pressure, or CPAP (Dobbin & Strollo, 2002). CPAP is delivered through a mask and creates a “pneumatic splint” (Drazen, 2002), which keeps the airway open. Determining the amount of positive pressure necessary to maintain patency of the upper airway regardless of patient position is called titration, and is normally done during sleep study (Dobbin & Strollo). Ideally, this

study is completed in one evening, called a split night because the patient is first diagnosed with sleep apnea and the remainder of the night is spent calibrating the CPAP. If not, the patient must return on a subsequent night for calibration of the CPAP. Treatment with appropriate levels of CPAP eliminates snoring, apnea and oxygen desaturation. The daytime symptoms of excessive sleepiness and impaired cognitive function, which accompany sleep apnea, are also improved with the use of CPAP (Dobbin & Strollo, 2002).

Only one study was identified pertaining to the impact of sleep apnea treatment on the cost of subsequent health care utilization (American Academy of Sleep Medicine, 2000). Bahammam et al. (1999) investigated hospitalization and physician costs related to 344 clinically diagnosed sleep apnea patients. Patients were followed for two years post diagnosis and compared with control subjects matched for gender, age, and location. In patients adhering to treatment protocols there was a significant difference in both the duration of hospitalization and in physician costs (Bahammam et al.). Hospital stays decreased from 1.27 days (± 0.25 SE) per patient per year, one year before diagnosis to 0.54 (± 0.13 SE) per patient year ($p=0.01$). After treatment, the difference of physician claims costs between patients and matched control subjects was reduced by 33%.

Despite the pervasiveness of sleep apnea in the general population, physician recognition of this condition remains poor (Rahaghi & Basner, 1999). Haponik et al. (1996) found that when presented with a simulated patient, none of the primary care physicians practicing in a university hospital setting asked appropriate questions regarding sleep patterns. This may result from the lack of sleep disorder education in the U.S. medical education system, where on the average, only two hours of sleep medicine content is provided over a four-year medical school curriculum (Rosen, Rosekind, Roseyear, Cole, & Dement, 1993).

Rahaghi and Basner (1999) found that the average time between patients' first recognition of a major feature of sleep apnea event and referral to a sleep center was 87.5 months. During that time, the patients averaged 25.8 visits to health care providers (including the provider responsible for the sleep referral). This included an average of 17.2 visits to primary care physicians, 9.0 visits to specialists and 6.2 visits to a dentist.

Given these profound health and economic effects, it should not be surprising that many health care organizations are exploring the feasibility of establishing diagnostic centers for sleep disorders. A primary concern for a hospital-based service is that the site selected for a sleep laboratory be located away from normal traffic flow and loud departments or offices. Basements and top floors are good choices, as they minimize surrounding activity and reduce errant noise problems. Isolating the facility, with its own dedicated restroom facility, on a dead end corridor would be ideal. Most hospital rooms should be large enough to meet accreditation requirements without modification (Belcher, 2002). Sleeping rooms should be comfortable and provide basic amenities such as a double bed, chair, a place to hang clothes, and a small table, as the goal is to make the room as appealing as a pleasant hotel or a bedroom in a private home (Accreditation Committee, 2002).

Utilization of a business plan is critical in evaluating capital projects, as it provides a standard framework for lower level managers to prepare and present proposals as well as prompting them to explore crucial questions before forwarding projects to senior management. There is no one correct business plan format (Bangs, 2002) and the majority of models contain the same basic parts: Business Description; Products and Services; Marketing; Operational Plan; Management and Organization; and Finance. The scope and size of the project should determine the model, and then it should be tailored to the projected audience (Bangs). Three models were

evaluated for use in this study: Ernst & Young's model, authored by Siegel, Ford, and Bornstein (1993), the Burch Outline (Burch, 1986), and the PSI Arista Business Plan (2002).

The Ernst & Young model varied in two aspects from the elements identified by Bangs. First, this model is designed as a retrospective tool, against which a manager can assess a project's actual performance over time, and second, it also adds a Structure and Capitalization section. According to Siegel, Ford, and Bornstein (1993), structure is defined as the legal format of the business (such as sole proprietorship, partnership, corporation, etc.) while capitalization is the financial instrument used identify the capital necessary for the success of the project. The Capitalization and Structure section of the business plan allows the author to explain to the reviewer "You've reviewed my business plan. If you are interested, here's what the business requires" (Siegel et al., 1993). Additionally, this is where the writer identifies how the venture will be capitalized and outlines the benefits and risks to the investor. "This is one of the most critical parts" of the business plan and it is where the author "must convey what kind of resources are required in order for the venture to succeed during its early life" (Siegel et al., p. 129). The Ernst & Young model is appropriate for entrepreneurs who are in the planning stages of starting, expanding or acquiring a business and determining how to organize it to attract investors and venture capitalists (Siegel et al.). It would not, however, be a suitable model for use by a taxpayer-funded hospital district.

The Burch Outline model is consistent with the business plan elements identified by Bangs (2002) except for a Risk Analysis section not included in the other two models. It also incorporates a listing of the key people in the organization (which, interestingly, includes consultants). The Burch Outline is logical and provides for a thorough review of an intended project, particularly in the financial section, which is split into two stand-alone portions. The

Financial Plan and Projections section would be more applicable for a taxpayer supported hospital system as it includes the budget projection as well as key assumptions and estimates.

The second financial section, Financing Program, “outlines the reason for financing, the sources of financing, the financial package, the timing and stages of financing, and equity, control and valuation pricing” (Burch, p. 398). This requires a level of depth and detail unsuitable for a small project like a sleep disorders lab.

The third model reviewed was that of PSI Arista, a Colorado health-consulting group. In addition to all the essential elements identified by Bangs (2002), this model also contains sections addressing Volume Forecast and Regulatory and Licensure Issues, and of all the models considered, it is the only one that was specifically created for use by health care organizations. The Volume Forecast feature is significant, as estimation of the number of patients who would use the proposed sleep laboratory is one of the more subjective elements of the study. Licensure Issues are also important as the Pulmonary Department wishes to gain accreditation from the American Academy of Sleep Medicine (Bandi & Guy, 2002) and questions on the requirements and the cost would be answered by using this model.

The PSI Arista business plan addresses the need for proper recognition of internal customers for a new service and how the service would relate to existing services offered by the organization. Perhaps most valuable component is PSI Arista’s expanded Staffing section. New health care ventures often require specialized and scarce staff (PSI Arista, 2002), and with a rapidly growing field such as sleep medicine, the demand for qualified staff exceeds supply. The PSI Arista model requires the organization to resolve personnel issues, such as where and how staff members will be obtained, the availability of internal candidates, the length of training

required and what financial incentives will be required to retain an adequate cadre of qualified staff. The Ernst & Young model and the Burch Outline do not address these salient issues.

This side-by-side comparison of the three business plan models illustrates why PSI Arista is the preferred tool for Ben Taub business plans (T. Cunningham, Administrator, Ben Taub General Hospital, personal communication, December 12, 2002) and the model recommended by the American College of Healthcare Executives (American College of Healthcare Executives, 2002). The PSI Arista business plan will therefore be adopted as the most appropriate model for this project.

Purpose

This study was undertaken to execute a thorough analysis of how to most effectively provide sleep disorder services to the hospital district's beneficiary population, to explore development of an additional source of revenue by marketing sleep services to Houston's more lucrative insured population, and to evaluate the impact of sleep services on the mission and patient population of the hospital district.

Chapter 2

Methods and Procedures

This analysis was performed following PSI Arista's recommended actions for developing and fine-tuning a business plan. The analysis included business description, market analysis, service delivery, volume forecast, staffing, management, organization, and financial analysis (PSI Arista, 2002).

The business description includes a description of the sleep laboratory and the objectives in starting this service within the hospital district, a profile of the markets to be served, and a presentation of the key financial aspects of the business. The description will also describe the

specific service to be provided, its relation to other services offered by the organization, potential customers, and the expected benefits for the hospital district and its beneficiary population.

The market analysis defined potential patients and customers for sleep services as well as the possible ways competitors may respond to the hospital district's entry into the market. Following the market analysis is a description of service delivery, with concentration on location, facilities, equipment, supplies, and the facility's hours of operation. The volume forecast describes where the business will come from and projects potential referrals for sleep services.

The staffing, management, and organization section identified the manager's responsibilities and qualifications, to whom the manager will report in the hospital district, the number of staff members required by skill level, the estimated wages and salaries required to staff a sleep laboratory, and a description of how staff will be recruited and trained.

Finally, a financial analysis was performed with special attention paid to billing and fee structure, estimation of expenses and cost per test and the expected revenue to be gained. This involved consideration of four alternatives to determine the most cost effective method of diagnosing sleep disorders, along with the a recommendation of the best alternative.

Chapter 3

Business Plan Development

Business Description

A sleep center is an organizational unit of a hospital, established to diagnose and treat abnormalities associated with sleep. The center is a full-service unit, designed to diagnose and treat the wide range of sleep disorders. In contrast, a sleep laboratory is a limited service unit, specializing in the diagnosis and treatment of sleep apnea (National Center for Cost

Containment, 1998). The proposal under review is for Harris County Hospital District to create a sleep laboratory.

The gold standard for the diagnosis of sleep apnea is a polysomnogram examination (Chervin, Murman, Malow & Totten, 1999). A polysomnogram (or sleep study) is an all night, comprehensive examination using an attending sleep technician (also known as a polysomnographic technologist or polysomnographic technician) who works with specialized equipment. The sleep technician collects data from electroencephalograms, respiratory effort, airflow, oxygen saturation, electromyograms, electro-oculography and electrocardiograms (Digital Schools, 2002). Electroencephalogram data are necessary to distinguish the stages of sleep as well as arousals from sleep (Dobbin & Strollo, 2002). Electro-oculography distinguishes between REM (rapid-eye-movement) and NREM (non-rapid-eye-movement) stages of sleep. Electromyography data are used to detect atonia (partial paralysis of major muscles during sleep), which is associated with REM stages of sleep (Dobbin & Strollo). Typically, the muscles beneath the chin are used to record the electromyogram activity (Friedman, et al., 1999). Additionally, infrared video monitoring and sound recordings are made to assist in diagnosis (Accreditation Committee, 2002). The overall examination provides quantitative measures of total sleep time and number of awakenings, sleep-stage distribution, respiratory dysfunction, cardiac arrhythmias, atypical movements and nocturnal seizures.

Organizations considering a sleep disorders program must realize that the program can be expensive (Accreditation Committee, 2002). It is a labor-intensive process requiring a highly trained staff and a substantial investment in equipment. Prior commitment on the part of the parent institution is essential and a program should not be established just to generate revenue, but rather to provide a needed clinical service. This is an important factor, as Harris County

Hospital District has minimal capital, intense organizational competition for scarce resources, and there is a question of how the hospital will pay for sleep laboratory services. Additionally, a sleep laboratory can be expected to generate requests for consultative tests from other clinical services within the parent institution. These may include pulmonary consultation and function tests, radiology, clinical electroencephalograms, Holter (24-hour electrocardiogram) monitoring, clinical laboratory or hematological tests, and consultations to otolaryngology, surgery, psychiatry and psychology, urology consultations and others (Accreditation Committee, 2002). Due to the district's mission, this may increase workload (and cost) without a corresponding increase in revenue to these other services.

The growth and expansion of a sleep laboratory may be desirable, but is not guaranteed. Growth will be affected by many factors, including the surrounding population base, competition, the amount of time and energy invested by the medical director and other key personnel in development of the program, and the level of interest and involvement of the local medical community (Accreditation Committee, 2002).

Anecdotal information gleaned from briefings and interviews with physicians, respiratory technicians and ancillary support personnel imply that a significant portion of the Harris County Hospital District's population is at risk for sleep disorders (especially sleep apnea), and that this population is underserved. According to a recent Community Health Assessment (Health/Outreach Education, 2002), a large percentage of the district's pulmonary medicine patients are overweight, smoke, have chronic pulmonary obstructive disease (COPD) and are middle aged—all predictors for sleep disorders (Pascualay & Soest, 1996). Sleep disordered breathing likely plays a causal or contributing role in the development of comorbidities such as hypertension and cardiovascular events (American Academy of Sleep Medicine, 2000).

Unfortunately, due to financial concerns most at risk patients are not referred to a sleep laboratory for definitive diagnosis.

While all 4.5 million residents of Harris County (U.S. Census, 2002) are potential beneficiaries of the care provided by the hospital district, the district estimates that its functional beneficiary population is 600,000, with 300,000 currently enrolled (Health/Outreach Education, 2002). The prevalence statistics provided by Young et al. suggest that potential sleep lab customers include 49,500 current enrollees and a total of 99,000 within the district. This cannot be viewed as a lucrative market however, as 78% of the district's population between 40 and 64 years of age are termed self-pay patients (no insurance), 20% are covered by government insurance (Medicare, Medicaid, etc.), 1.2% by commercial insurance and 0.80% by other insurance (Health/Outreach Education, 2002). Bandi and Guy (2002) suggest, however, that with an American Academy of Sleep Medicine accredited program, Ben Taub could capture part of the private market. The perceived quality of the lab would be a major determinant of success, as beneficiaries with insurance could choose to have sleep study evaluations done by other facilities.

While the sleep lab's development as a new revenue center would be desirable, its selling point remains avoiding the costs associated with providing unnecessary/symptomatic care for the district's undiagnosed patients. As previously noted, patients with untreated sleep apnea are more likely to be hospitalized and incur higher health care costs than matched control subjects (Kryger et al., 1996). If the findings of Bahammam et al. are applied to Ben Taub's current enrollees, the sleep lab (and appropriate outpatient treatment) could eventually eliminate between 6,000 and 7,000 bed-days per year. Of particular interest are the 12% of Ben Taub's admissions that are cardio-pulmonary in nature (Information Management Systems, 2002). Any decrease in

admissions for cardio-pulmonary patients would not only improve patient health and quality of life, but also would significantly lower costs and increase available bed capacity. As Dr. Bandi has aptly stated: “We either treat them [patients] now for sleep problems, or we’ll see them later in our ICUs” (personal communication, October 5, 2002).

Internal customers for this service are the pulmonary, neurology, cardiology, psychology, psychiatry, otolaryngology, urology, and surgery departments. Tachibana, Ayas, & White (2002) found that 50.8% of referrals for sleep studies were generated by pulmonary services, with neurology generating 16.4%, sleep medicine 6.5%, psychology 6.5%, psychiatry 4.2% and pediatrics 2.7%. Except for a sleep medicine service, all the other services listed by Tachibana et al. are present within the Harris County Hospital District.

Market Analysis

Houston is the nation’s fourth largest city, with a metropolitan population of over 4.5 million (U.S. Census, 2002). The city is home to the Texas Medical Center, which represents the largest concentration of medical facilities in the world (Gilmer, Hodgin & Schiflett, 2001). Collectively, the medical center is the largest employer in Houston, with an annual \$11.5 billion impact on the local economy (Texas Medical Center, 2002). The 42 non-profit and government institutions of the Texas Medical Center encounter over 157,000 patients and visitors each day and treat over 5.4 million patients annually. Fourteen of these institutions (including Ben Taub General Hospital) are either medical centers or hospitals (Texas Medical Center, 2002), resulting in a highly competitive health care environment. This competition may be the reason that *U.S. News and World Report* recognized six of these facilities as being “Best Hospitals” in 10 medical specialties in the United States (Comarow, 2002).

As of this writing, there are 28 sleep centers/laboratories in the Houston metropolitan area. There are five sleep centers (Texas Children's Hospital, Hermann Memorial, St. Luke's Episcopal, Methodist Hospital and Methodist Diagnostic Hospital) within the Texas Medical Center itself. Two hospitals (St. Luke's Episcopal and Hermann Memorial Hospital) are planning to add beds and increase services at their sleep centers. Additionally, there are three other sleep centers/laboratories within a mile of the Texas Medical Center campus. Appendix A lists all known sleep centers/laboratories in the Houston metropolitan area.

Bandi and Guy (2002) note that achieving American Academy of Sleep Medicine (AASM) certification is a major goal for the Harris County Hospital District sleep laboratory. While neither Medicare nor private payors currently require studies be completed by an accredited sleep center/laboratory, the American Academy of Sleep Medicine is lobbying to link reimbursement with national accreditation. To date, reimbursement for sleep studies by the federal government or the state of Texas is not linked to AASM certification. Nonetheless, the quality and accreditation status of a sleep laboratory may result in a competitive advantage. Nationally, only 29% of sleep centers/laboratories have AASM accreditation (Tachibana, Ayas, & White, 2002), and only two of the 28 sleep centers/laboratories in the Houston metropolitan area (Methodist Diagnostic Hospital and the Houston Veterans Affairs Medical Center) currently hold AASM accreditation. This implies that earning accredited status could increase public awareness of the high quality services provided by Harris County Hospital District.

Full AASM accreditation is for a term of five years, during which the facility is granted full rights of membership and benefits. Benefits include use of the American Academy of Sleep Medicine logo, listing on the Academy's website, web page linking, and personalized,

discounted brochures produced by the Academy (Accreditation Committee, 2002). The associated accreditation fee and expenses are \$3,350 with annual dues of \$1,000.

Competitor reaction to the hospital district's entry into the sleep laboratory market should not be an issue. The district's poor payor mix (greater than 75% uninsured) renders its beneficiaries an unattractive target population. However, evolving technology may provide competition from another source. Home studies can now be performed at lower cost, but results are currently viewed as less reliable than examinations performed in a sleep center (Chervin et al., 1999, and Gagnadoux, Pelletier-Fleury, Philippe, Rakotonanahary & Fleury, 2002). For example, in September 2002 the Food and Drug Administration approved a device for at-home diagnosis of sleep apnea. It collects three nights of data, is convenient for the patient, and its use for that period represents a lower cost than the traditional one night stay in a sleep center (Brody, 2002). However, studies have shown most patients prefer their examinations be done in a sleep laboratory due to minor inconveniences and apprehension regarding the acquisition of data during the home study (Fry, DiPhillipo, Curran, Goldberg & Baran, 1998) and (Gagnadoux et al.). This may change if technology advancements allow in home studies to be monitored through a remote connection to a sleep laboratory. Currently, home evaluation is only considered useful when the results are clearly positive; but since negative results do not rule out the presence of a sleep disorder, additional clinical studies are still required in many cases. This may minimize any overall cost savings achieved through home studies (Victor, 1999).

Service Delivery

As mentioned, polysomnography, in conjunction with the patient's history, other laboratory tests and observations, and the physician's knowledge of sleep disorders is used to reach a diagnosis and recommend appropriate treatment. Polysomnography is the major

diagnostic test used in a sleep laboratory, and two sites in the hospital district were identified as possible locations: 1) Ben Taub General Hospital Respiratory Therapy's EMG rooms, as recommended by Ben Taub Pulmonary Department; and 2) fourth floor (Ward 4B) of Lyndon B. Johnson General Hospital. Respiratory Therapy at Ben Taub General Hospital is the less attractive of the two locations. At 90 square feet, the rooms are too small to meet AASM's minimum 140 square feet accreditation standard (Accreditation Committee, 2002). Bathrooms within Respiratory Therapy are not handicapped accessible (another AASM requirement), creating additional construction costs. Attempting to share space with the EMG section could also lead to problems with scheduling, missing equipment or supplies, and storage of consumables. A dedicated area would better serve the service.

Ward 4B on the fourth floor of Lyndon B. Johnson General Hospital, HCHD's other community hospital, is a more feasible site. On site parking is adequate, and metro bus stops are close by. The ward is partially closed, with four patient rooms currently being used for storage and IV day care. Office space and waiting rooms are adequate, the patient room size is greater than that recommended by AASM, handicapped bathrooms are available within the rooms, showering facilities are operable, and interior oxygen is available. There is also an unused and centrally located nursing station that is lockable and enclosed by a Plexiglas partition, making it ideal for the security of equipment and charts and as a separate control room. Importantly, this space is also away from the normal flow of traffic and requires minimal rehabilitation or repair.

Purchasing the medical and non-medical equipment necessary to perform polysomnogram studies makes opening a sleep laboratory an expensive endeavor. Most state of the art equipment is digital, computer-based and software driven. Sleep laboratories involved in research, however, also still use analog paper systems (M. Hirshkowitz, Director, VAMC Sleep Research

Center, personal communication, September 18, 2002). The benefits of using digital equipment are its ease of scoring and data manipulation, automatic report generation and minimal storage and archival space needs (Belcher, 2002), while a significant drawback of an analog system is its higher operating and maintenance costs (M. Hirshkowitz). Choosing between an analog or digital system is difficult, due to the district's mission of providing care while training the next generation of health professions and conducting research. However, as interviews with Ben Taub's Pulmonary Medicine physicians did not reveal a pressing need for the sleep research component, purchasing digital equipment was recommended.

The cost of digital sleep systems varies from \$15,000 to \$35,000 depending on manufacturer, location, and additional options offered (ECRI, 2002) and (Advance for MRC, 2002). Grass-Telefactor's Aurora™ has the advantages of being configurable for either analog or digital studies (in case research becomes a priority in the future) and being in use at VAMC. The VAMC staff is willing to assist in training Ben Taub's polysomnographers. This is important, as training on similar equipment is highly advisable (M. Hirshkowitz & M. Bibbs, VAMC Sleep Research Center, personal communication, September 18, 2002). The recommended Grass-Telefactor Aurora™ system costs on average, \$25,000 per patient bed.

Pulse oximetry equipment with memory, a printer and polysomnograph interface (for recordings), as well as CPAP and BiPAP (Bilevel Positive Airway Pressure) machines must be available for each room. Also, a portable air compressor or compressed air outlets are required to power the CPAP. This equipment must be purchased separately and, in aggregate, costs approximately \$14,800 per patient bed (some equipment can be shared by two beds). Automation requirements to support a sleep lab include dedicated computers and small networks including associated computer-networking hardware, Ethernet adapters (Hub) and cards

(Network card), proprietary polysomnographic software, and devices (Belcher, 2002). The computers must have at least an 800MHz processor and 128K RAM (ECRI, 2002) in order to be compatible with software requirements. A high quality LAN hub and cabling to link the computers is desirable (Belcher, 2002). This will add to overall Information Management costs if a facility has to upgrade its network systems. Further requirements include infrared (IR) capable video cameras for each bed, IR lights and video monitors/recorders (Accreditation Committee, 2002). Cameras can have built-in microphones for sound, but a two-way intercom with VCR output is advisable (M. Bibbs, President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center, personal communication, September 18, 2002).

Table 1 presents the estimated cost of equipping both a 2-bed/400 study per year and a 4-bed/900 study per year sleep facility. Consumables and supplies are estimated to be \$64 per study (Breus, 2001).

The services provided by a sleep laboratory consist of outpatient services, including consultation and regular follow-up for patients with sleep-related disorders; inpatient consultations for hospitalized patients referred for assessment of primary and secondary sleep disorders; comprehensive, overnight polysomnography; daytime nap recordings, including standardized Multiple Sleep Latency Testing (MSLT) and Maintenance of Wakefulness Testing (MWT). Additionally, technical interpretation of recordings and clinical interpretation of recordings are part of a sleep laboratory's scope of services. Finally, the laboratory should participate in educational programs for medical students, residents, fellows and staff physicians in affiliated medical centers; and assisting in in-service education for allied health personnel, nurses, physicians, and patients (National Center for Cost Containment, 1998).

Table 1

Estimated Equipment Costs for a Sleep Laboratory

Equipment	Cost		
	Each	2-Bed	4-Bed
Polysomnogram sleep system	\$25,000	\$50,000	\$100,000
Pulse oxymeters	1,500	3,000	6,000
CPAP machines	1,500	3,000	6,000
BiPAP machines	2,500	5,000	10,000
Hospital-grade furnishings	4,000	8,000	16,000
Infrared video equipment	500	1,000	2,000
Reading stations*	9,350	28,050	28,050
Computer/printer/supplies**	2,000	2,000	2,000
Consumables/transducers	64	25,600	57,600
Total	\$46,414	\$121,650	\$227,650

* Reading stations can be shared by two beds, so the cost of two beds or four beds will be the same.

** Network upgrades are not included.

Standard polysomnographic studies take place during sleep hours, typically from 8:00 p.m. to 7 a.m. However, the majority of hospital-based sleep laboratories operate on a 24-hour basis, with the majority of sleep studies conducted during evening hours and interpretative readings completed during the day (M. Hirshkowitz, Director, VAMC Sleep Research Center, personal communication, September 18, 2002). A four-bed lab should have at least two night technologists and be open four to five nights per week, depending on scheduling and shifts. Scheduling either 12-hour shifts three nights per week or 10-hour shifts four nights per week is standard practice for a laboratory (Belcher, 2002).

A standard work schedule would be to schedule night technicians three nights per week, 12 hours each and a daytime technologist for five days per week in eight-hour shifts, thus spreading the workload during the day and allowing daytime personnel to function in several capacities without compromising the quality of data collection and work production. Daytime staff would be responsible for daytime examinations (such as Multiple Sleep Latency Tests), secretarial support, scheduling, pre-screenings, insurance and coding issues. Whether or not the night shift staff should help with scoring examinations is a matter of ongoing debate (M. Bibbs, President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center, personal communication, September 18, 2002). Certainly during times when the sleep laboratory is not full, or when a patient cancels, one technologist could be diverted to scoring records, restocking supplies or other tasks as needed. The major concern is making sure that patients are constantly monitored and attended (M. Hirshkowitz & M. Bibbs, VAMC Sleep Research Center, personal communication, September 18, 2002).

Volume Forecast

Pulmonary medicine physicians Dr. V. Bandi and Dr. E. Guy estimate that the district has 1,000 patients that could be referred for sleep studies annually (personal communication, October 2, 2002). Sleep apnea prevalence has been established in few populations other than those of Western nations, and therefore the worldwide importance of sleep apnea as well as potentially important racial or ethnic prevalence patterns are poorly understood (Young, Peppard, & Gottlieb, 2002). At present, data from studies of groups other than Caucasians are too sparse even to determine with confidence if prevalence differs worldwide (Young, Peppard, & Gottlieb, 2002). This is no small matter, as the majority of middle-aged Harris County Hospital District patients are African American or Hispanic.

Patients between the ages of 45 and 65 (Medicare eligible) comprised nearly 40% of Harris County Hospital District's patient population in 2001 (Health/Outreach), creating a target group of 120,000. Young, Peppard, and Gottlieb's (2002) estimate that 5% of middle-aged adults have undiagnosed sleep apnea implies that 6,000 Harris County Hospital District patients may potentially suffer from this disorder. In 2001, nearly 40% of all deaths in Harris County were due to four illnesses that are exacerbated by sleep apnea (Pascualay & Soest, 1996 and Dobbin & Strollo, 2002). These were heart disease (27.1%), cerebrovascular disease (8.4%), respiratory disease (3.1%), and hypertension (.08%) (Health/Outreach Education, 2002). Yet despite its potential impact on patients and the community, estimates are that only 12% of sleep apnea patients have been clinically diagnosed (Kapur et al. 2002). According to Kapur's estimate, 720 Harris County Hospital District patients could potentially be referred initially for further evaluation and treatment. An aggressive education effort by providers could be used to identify the district's additional 5,000 or more undiagnosed sleep apnea patients. If the findings of Bahammam et al. (1999) are applied to Ben Taub's current enrollees, the sleep lab (and appropriate outpatient treatment) could eventually eliminate between 6,000 and 7,000 bed-days per year among this population.

Bandi and Guy (2002) propose a two-bed sleep laboratory, operating 46 weeks per year, seven nights per week resulting in a potential 644 sleep studies a year (see Table 2). However, Belcher (2002) recommends a four or five night per week schedule, with two night technicians, and scheduling either 12-hour shifts three nights a week, or 10-hour shifts four nights per week. Based on Bandi and Guy's proposal, and allowing for a 15% no show rate, the two-bed laboratory could be expected to produce 547 examinations per year. This initial analysis must be modified based on more realistic no-show rates for the district and the fact that some patients

may need more than one visit. According to Dr. Max Hirshkowitz, Director of the VAMC Sleep Research Center, 80% of patients referred for sleeping disorders can have both their examination and CPAP calibration completed in one night (referred to as a split night). The remaining 20%, however, must return for a subsequent night for calibration of the CPAP.

Table 2

Initial Estimate for a 2-Bed, 7 Night per Week, 46 Week per Year Sleep Laboratory with No Split Night Studies

Beds available per night	2
Nights per week	7
Polysomnograms per week	14
Weeks per year	46
Polysomnograms per year	644
15% no show	97
Adjusted polysomnograms per year	547

Table 3 provides a breakout of the potential workload for a 2-bed, 7 night per week, 46 week per year sleep laboratory with no show rates of 15 and 20%. Using Bandi and Guy's initial projection of 644 potential examinations, a 20% return rate and a 15% no show rate, it appears 493 examinations could be completed (438 split night and only 55 dual night examinations). However, a no show rate of 15% is unrealistic. Ambulatory clinics at Ben Taub average a 35% no show rate for scheduled patients (M. Stancil, Director, Ambulatory Care Clinics, Ben Taub General Hospital, personal communication, November 19, 2002) and VAMC experienced a 40% no show rate in sleep studies completed for the Hospital District (M. Hirshkowitz, Director, VAMC Sleep Research Center, personal communication, September 18, 2002). It should be

noted, however, that a performance improvement project completed by the Harris County Physical Rehabilitation Director resulted in no show rates dropping from 50% to 20% due to a patient self-scheduling system and aggressive follow up by clinic staff (C. Oddo, personal communication, November 19, 2002).

Table 3

Estimate for 2-Bed, 7 Night per Week, 46 Week Schedule Based on 15 and 20% No Show Rates

	No show rates	
	15%	20%
Adjusted polysomnograms per year*	547	515
Single night	438	412
Two nights	55	52
Adjusted studies per year	493	464

* Based on possible polysomnograms per year from Table 2.

The calculations in Table 3, based on a 20% no show rate, result in an estimate of 464 polysomnograms a year. Split nights are estimated to comprise 80% of all studies (412 examinations), with 20% (52 examinations) being two night studies. Tables 2 and 3 illustrate that a two-bed unit is inadequate to address the estimated 1,000 patients per year who require sleep study evaluations. All demand calculations presented are conservative as they exclude an estimated a return rate of 10% (M. Hirshkowitz and R. Castriotta, 2002).

Both Kapur's initial patient volume estimate of 720 and the 1,000 estimated by Bandi and Guy would require a four-bed sleep laboratory to meet demand. Table 4 outlines a 4-bed, 4 night per week schedule. Calculations are based on availability of 16 bed nights per week, 80% split nights (one night examinations) and 20% multiple night examinations. For example, 736 bed nights are available in a 46 week per year operation, 147 of which are multiple night

examinations and 589 are single night studies. As the 147 multiple night examinations will require two nights each, 294 nights will be needed to complete those 147 studies. The total estimated bed night need is therefore 883 (the multiple night total of 294 added to the single night total of 589). Applying a 20% no show rate reduces the projected number of annual studies to 707. Even if the sleep laboratory operates 52 weeks per year, only 799 studies can be completed with a 20% no show rate. Even with aggressive management of no shows, this still falls short of demand (based on a projected volume of 1,000).

Table 4

Estimate for a 4-Bed, 4 Night per Week Schedule

	Weeks per year			
	46	48	50	52
Bed nights available per year	736	768	800	832
Multiple night studies (20% of bed nights available)	147	153	160	166
Multiple night total required (estimated 2 nights each)	294	307	320	333
Split night studies (80% of bed nights available)	589	614	640	666
Estimated bed night requirement	883	922	960	998
20% no shows per year	(177)	(184)	(192)	(200)
Estimated polysomnograms per year	707	737	768	799

Table 5 depicts estimates for a four-bed, five night per week sleep laboratory. Based on the needs of a potential volume of 1,000 studies, a 4-bed, 5 night operation of a minimum of 48 to 50 weeks per year would be necessary. This would require a minimum staffing of two night

technicians, 1.5 clinical-clerical technicians, one day technician and a chief technologist.

Vacations and sick leave would be covered by temporary workers.

Table 5 Estimate for a 4-Bed, 5 Night per Week Schedule

	Weeks per year			
	46	48	50	52
Bed nights available per year	920	960	1,000	1,040
Multiple night studies (20% of bed nights available)	184	192	200	208
Multiple night total required (estimated 2 nights each)	368	384	400	416
Split night studies (80% of bed nights available)	736	768	800	832
Estimated bed night requirement	1,104	1,152	1,200	1,248
20% no shows per year	(221)	(230)	(240)	(250)
Estimated polysomnogram studies per year	883	922	960	998

Follow-up polysomnography examinations will further impact volume (M. Hirshkowitz, Director, VAMC Sleep Research Center, personal communication, September 18, 2002 and R. Castriotta, Medical Director, Memorial Hermann Sleep Disorders Center and Sleep Clinic, personal communication, October 10, 2002). According to the Standards of Practice Committee of the Sleep Disorders Association (1997), follow-up polysomnography is routinely indicated after surgical treatment of sleep apnea patients and in patients with moderate to severe apnea in order to ensure that there has been a good clinical response to oral appliance treatment. Also, follow-up polysomnography is routinely recommended when substantial weight change has occurred in patients on CPAP treatment. However, follow-up polysomnography is not routinely indicated in patients whose symptoms continue to resolve with CPAP treatment

Staffing, Management and Organization

Utilizing AASM standards as a guide, the sleep laboratory should have an appointed Medical Director, who is licensed in the state, and who is responsible for the overall patient care provided by the program. Ideally, the medical director should be a Diplomate of the American Board of Sleep Medicine (ABSM) (Accreditation Committee, 2002). If the Medical Director has not been certified as a sleep specialist by the ABSM, another physician or Ph.D., (with certification through the ABSM) must be an active member of the staff and be responsible for interpretation of sleep studies. Currently, Harris County Hospital District does not have any staff with the desired qualifications.

The sleep program may also have a Director of the Sleep Laboratory. The director is a Ph.D trained polysomnographer, trained to evaluate (but not to treat) sleep disorders and who has been certified as a sleep specialist by the ABSM. Such sleep specialists are also referred to as ABSM diplomates (Accreditation Committee, 2002). The Director is responsible for the management of the program, administrative requirements, technical personnel, quality control, and similar issues. This individual usually reports to the Pulmonary Service. Harris County Hospital District does not have an individual so qualified, but the Director, VAMC Sleep Research Center may be available to act as director on a part time, interim basis (M. Hirshkowitz, Director, VAMC Sleep Research Center, personal communication, September 18, 2002). The proposed staffing model is based on a 0.5 full time equivalent (FTE) medical director (who may not be a physician) and a 0.5 FTE physician who will be responsible for patient actual treatment, with reporting responsibilities through the Pulmonary Service.

A Registered Polysomnographic Technologist (RPSGT) is a technician who has passed the examination given by the Board of Registered Polysomnographic Technologists (M. Bibbs,

President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center,, personal communication, September 18, 2002). Currently, there are approximately 5,000 RPSGTs worldwide (M. Bibbs). A sleep technician is a health care technician trained in the technical aspects of obtaining a sleep recording. Training should be equivalent to recommendations published by the American College of Chest Physicians and by the AASM (National Center for Cost Containment, 1998).

Staffing requirements for night technicians or technologists are well-defined. One technician can be expected to handle two patients per night (M. Bibbs, President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center, personal communication, September 18, 2002), and the American Academy of Sleep Medicine's staffing standard recommends (under most circumstances), a ratio of two patients to one technologist (Accreditation Committee, Unkn). Additional patients can compromise study quality, patient care and attention to detail, while a one to one technologist to patient ratio will seriously cut into profitability (Belcher, 2002). Under 1998 National Center for Cost Containment standards, the minimum polysomnogram technologist/sleep technician staffing for a four bed center which produces 600 to 900 studies per year is 2.0 FTE day technologists/technologists, 2.0 FTE night technicians and between 0.5 and 1.0 FTE technician as a floater. Table 6 lists the suggested staffing, with registry personnel used to cover employee absences.

An office manager, such as a clinical/clerical technician, is necessary to facilitate patient flow and to coordinate visits to consulting laboratories. The coordinator serves as the primary contact for patients who inquire about program services, and arranges preliminary visits, routine tests within the program, and the services of other departments as required. Minimum staffing

would be one FTE, but this plan estimates that 1.5 FTEs will be needed to cover staffing absences.

Table 6

Estimated FTE Staffing for a 4 and 5 Night Sleep Laboratory

Position	FTEs	
	4 Night	5 Night
Physician	0.5	0.5
Sleep Specialist – Ph.D.	0.5	0.5
Chief Technologist	1.0	1.0
Day Technician	1.0	1.0
Night Technicians	2.0	2.0
Clinical – Clerical Technician	1.5	1.5
Registry Technician	0.5	1.0
Total	7.0	7.5

Wages and salaries for sleep laboratories are competitive in the Houston metropolitan area (HRSC Inc, 2003) so Harris County Hospital District must pay comparable salaries to attract employees to its service. Filling the Chief Polysomnographic Technologist position is vital, as the technologist will be responsible for initial scoring of examinations, management of the laboratory and providing the bulk of on-the-job training for technologists.

Table 7 lists estimated wages and salaries for sleep laboratory employees based on surveys of the Texas Medical Center by HRSC, Incorporated and utilizing an estimated 2080 work hours per year. Harris County Hospital District employees' benefits are calculated as being 25% of wages (K. Riker). Registry technicians are estimated to work 624 hours per year (K. Riker, Compensation Coordinator, Harris County Hospital District, personal communication, February

28, 2003), and as registry personnel and the Sleep Specialist are contract employees, no benefits are included.

Table 7

Estimated Wages, Salaries and Benefits for a Sleep Laboratory

Position	Hourly			
	wage	Salary	Benefits	Total
Physician		\$72,110	\$18,028	\$90,138
Sleep Specialist – PhD		41,200		41,200
Chief Technologist	25.41	52,853	13,213	66,606
Clinical-Clerical Technician	12.61	26,299	6,557	32,786
Night Technician	18.55	38,584	9,646	48,230
Day Technician	16.86	35,069	8,767	43,836
Registry Technician (Night)	23.00	14,352		14,352
Registry Technician (Day)	22.55	14,071		14,071

Table 8 is the estimated yearly wages, salaries and benefits budget for a 4-bed, 5 night sleep laboratory, which will total \$415,602 for Year One, based on 7.5 FTEs.

Table 8

Estimated Yearly Personnel Budget for a 4-Bed, 5 Night Sleep Laboratory

Position	FTE	Estimated wages, salaries and benefits			
		Hourly wage	Salary	Benefits	Total
Physician	0.5		\$72,110	\$18,028	\$90,138
Sleep Specialist – Ph.D.	0.5		41,200		41,200
Chief Technologist	1.0	25.41	52,853	13,231	66,066
Day Technician	1.0	16.86	35,069	8,767	43,836
Night Technician	2.0	18.55	77,168	19,292	96,460
Clinical – Clerical Technician	1.5	12.61	39,343	9,836	49,179
Registry Technician (Night)	0.5	23.00	14,352		14,352
Registry Technician (Day)	0.5	22.55	14,071		14,071
Total	7.5				\$415,602

There are approximately 10 polysomnographic technologist/technician training programs in the U.S. (Association of Polysomnographic Technologists, 2002), making trained sleep technicians scarce and in demand. The majority of sleep technicians learn through on the job training (M. Bibbs, President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center, personal communication, September 18, 2002). The American Academy of Sleep Medicine recommends that one Registered Polysomnographic Technologist be on staff, but this is not required (Accreditation Committee, 2002). Care must be taken in choosing staff members, especially those without certification or

several years experience in a quality laboratory (R. Castriotta, Medical Director, Memorial Hermann Sleep Disorders Center and Sleep Clinic, personal communication, October 10, 2002). Respiratory care practitioners, registered nurses, licensed vocational/practical nurses and emergency medical technicians are good candidates for sleep technicians. However, the training of respiratory care practitioners and electroencephalographic technologists is not equivalent to that of a polysomnographic technologist, although there may be some areas of overlap. Without specialized training, other technical personnel are not qualified to perform the functions of a polysomnographic technologist (Clinical Practice Review Committee, 1998). Dr. Castriotta states that Memorial Herman's sleep center program has a successful "in house" training program that recruits from a pool of long-time staff LVNs for polysomnogram technical training.

Overall knowledge and expertise of the staff will impact the quality of any sleep laboratory. According to Marietta Bibbs, Chief Polysomnographer of VAMC sleep Research Center and President of the Board of Registered Polysomnographic Technologists, "Trainees should be introduced to, and learn about sleep medicine on the job, not *in* a job". In other words, training a technician should be done under the direct supervision of a RPSGT, Medical Director or someone with a good deal of experience. Ms. Bibbs states that a technician needs at least six months of on-the-job training to achieve a basic level of competency.

Retention of qualified sleep technicians will be difficult, as the demand far exceeds supply (M. Bibbs, President, Board of Registered Polysomnographic Technologists and Chief Polysomnographer, VAMC Sleep Research Center, personal communication, September 18, 2002 and R. Castriotta, Medical Director, Memorial Hermann Sleep Disorders Center and Sleep Clinic, personal communication, October 10, 2002). This is especially true in the Houston area, as the large number of sleep centers leads to competitive bidding for qualified employees

(Andrea Clark, Chief Polysomnographer of HMS Diagnostics, personal communication, September 23, 2002 and Donte Williams, Administrative Director of Sleep Centers International, personal communication September 25, 2002). Ben Taub General Hospital's Emergency Center nursing service should serve as a warning in this regard. The department provides outstanding training and experience for nurses and has little difficulty in filling empty positions. However, the annual turnover rate in the department is nearing 50%; as nurses gain expertise and certification, they leave to take other positions, resulting in continuous staff turnover (M. Ashley, Chief Nursing Officer, Ben Taub General Hospital, personal communication, September 25, 2002).

Financial Analysis

The estimated fiscal year (FY) 2004 budget for Harris County Hospital District is \$600 million (J. Guest, personal communication, October 9, 2002). Ben Taub General Hospital will receive \$131.7 million of that total, part of which is an annual capital equipment budget of \$7 million (W. Benedict, Ben Taub General Hospital, Senior Management Accountant, personal communication, October 11, 2002). The majority of the Hospital District's annual budget (50%) comes from an assessed 19 cent per \$100 of real estate value within the county. This is low compared to San Antonio and Dallas, both of which allocate 24 cents per \$100 in property value (Brock, 2002). The remaining funding comes from Medicare and Medicaid reimbursements, disproportionate share monies and tobacco settlement dollars (J. Guest, personal communication, July 15, 2002). In the view of Mr. Guest, "We are volume rich and capital poor." He estimates that the district needs to double its resources to adequately serve the needs of the current beneficiary population (Personal communication, July 15, 2002 and October 9, 2002).

Most sleep programs bill all of their services as outpatient procedures even though the patient remains overnight in the sleep laboratory. Polysomnography may also be required for some inpatients. However, as with other clinical services, the institutional component of charges for polysomnography performed on inpatients may not be recoverable because of insurance plans limit (Accreditation Committee, 2002). Table 9 lists CPT codes for sleep studies, description of tests, and Medicare reimbursement rates for the Houston metropolitan area (American Medical Association, 2003). CPT codes 95810 and 958011 are the most commonly used codes for sleep studies (Breus, 2001).

Table 9

CPT Codes for Sleep Services with Geographic Adjustment for Houston, Texas

CPT code	Description	Total payment
95805	Multiple sleep latency test	\$293.58
95806	Sleep study, unattended	\$227.70
95807	Sleep study, attended	\$461.91
95808	Polysmnography, sleep staging, with 1-3 parameters; attended	\$457.21
95810	Polysmnography, sleep staging, with 4 or more parameters; attended	\$757.30
95811	Polysmnography, sleep staging, with 4 or more parameters; with CPAP	\$777.58

Table 10 lists customary charges for CPT codes 95810 and 95811 in the Houston metropolitan area (Hirshkowitz, 2001).

Table 10

Customary Charges for Sleep Evaluations in the Houston Area

Sleep center/laboratory	CPT 95810	CPT 95811
SE Memorial	\$1,700.00	\$1,700.00
Bellaire Medical Center	1,172.00	1,172.00
St. Luke's Episcopal	1,700.00	1,700.00
Methodist Hospital	2,079.70	2,079.70
Houston Sleep Center	1,100.00	1,200.00
Sleep Technology Institute (Kindred)	1,400.00	1,600.00
Methodist Diagnostic Hospital	1,200.00	1,600.00
Memorial Hermann	1,500.00	1,700.00
SW Memorial	1,536.75	1,728.25
Health Management Services	1,500.00	1,700.00
Clear Lake Sleep Laboratory	1,609.00	1,702.00

Recovery of charges ranges from 70% to 90% for patients who directly pay for their evaluations, and from 50% to 70% for charges billed to health care insurance plans (Accreditation Committee, 2002). The American Academy of Sleep Medicine suggests using an average recovery of 50% to 70% as a planning factor. Tables 11 and 12 represent an estimate of fees recovered at 50%, 60% and 70% for CPT codes 95810 and 95811 respectively.

Table 11

Estimated Fee Recovery for CPT 95810 by Sleep Laboratory/Center in Houston Area

Sleep center/laboratory	Percentage of fee reimbursements		
	50%	60%	70%
SE Memorial	\$850.00	\$1020.00	\$1,190.00
Bellaire Medical Center	586.00	703.20	820.40
St. Luke's Episcopal	850.00	1,020.00	1,190.00
Methodist Hospital	1,039.85	1,247.82	1,455.79
Houston Sleep Center	550.00	660.00	770.00
Sleep Technology Institute	700.00	840.00	980.00
Methodist Diagnostic	600.00	720.00	840.00
Memorial Hermann	750.00	900.00	1,050.00
SW Memorial	768.38	922.05	1,075.73
Health Management Services	750.00	900.00	1,050.00
Clear Lake Sleep Laboratory	804.00	965.00	1,126.30

Table 12

Estimated Fee Recovery for CPT 95811 by Sleep Laboratory/Center in Houston Area

Sleep center/laboratory	Percentage of fee reimbursements		
	50%	60%	70%
SE Memorial	\$850.00	\$1020.00	\$1,190.00
Bellaire Medical Center	586.00	703.20	820.40
St. Luke's Episcopal	850.00	1,020.00	1,190.00
Methodist Hospital	1,039.85	1,247.82	1,455.79
Houston Sleep Center	600.00	720.00	840.00
Sleep Technology Institute	800.00	960.00	1,120.00
Methodist Diagnostic	800.00	960.00	1,120.00
Memorial Hermann	850.00	1,020.00	1,190.00
SW Memorial	864.13	1,036.95	1,209.78
Health Management Services	750.00	900.00	1,050.00
Clear Lake Sleep Laboratory	860.00	1,032.00	1,204.00

Harris County Hospital District's current contract with Methodist Diagnostic Hospital pays \$950 per study (State of Texas & DCH Health Services, 2001). Tables 11 and 12 indicate that Bellaire Medical Center and Houston Sleep Center may offer less costly alternatives. If these facilities were willing to contract at 70% of charges, the average cost to the Hospital District would be \$820 and \$805 respectively for CPT codes 95810 and 95811.

Care must be taken to assure that the sleep examinations completed by the new provider meet a standard of quality set by the Hospital District that is comparable to, or exceeds the standard of care currently provided by Methodist Diagnostic. The American Academy of Sleep Medicine's standards can be used to measure examination quality and performance. Care should

also be taken to assure that the Hospital District receives the best possible bid pricing by following its established contract bid proposal guidelines that delineate secrecy, quality and fairness (G. Masi, Ben Taub General Hospital, Associate Administrator, personal communication, November 11, 2003).

In interviews, sleep center managers stressed, “You make your money with the even beds, not the odd beds in a laboratory” (Andrea Clark, Chief Polysomnographer of HMS Diagnostics, personal communication, September 23, 2002). In other words, the standard practice of having a polysomnographic technician monitoring two patients per shift promotes profitability. If Bed One is filled, a technician must be present. Having Bed Two filled during the same shift does not increase fixed costs, and the low variable cost of supplies and consumables (\$64 per study) makes Bed Two (the “even bed”) “highly remunerative” (A. Clark). Due to its potentially attractive volume of 1,000 studies per year, Harris County Hospital District may be able to leverage that volume into lower charges per study. As long as they are under capacity, an argument could be made that taking on the district’s patients would significantly increase the outside facilities’ profit margin. At the very least, this analysis coupled with the threat of opening its own service should allow Harris County Hospital District to lower its contractual cost from \$950 to something closer to the \$777.58 Medicare reimbursement rate.

Tables 13 and 14 are estimates of the expenses and cost per test incurred for a sleep laboratory at Lyndon B. Johnson Community Hospital. Table 13 depicts estimated Year One through Year Four expenses for that facility. Calculations include a 4% increase in wages, salaries and expenses each year and a 2% annual increase in Medicare reimbursement. Year Three wages and salaries increase by \$41,000 due to the hiring of a full time sleep specialist that

year. The Grass-Telefactor's Aurora™ sleep systems employed have an estimated service life of 12 years and a lifetime warranty for parts and repair (ECRI, 2002).

Table 13

Estimated Expenses for a 900 Study, 4-Bed, 5 Night Sleep Laboratory

Expenses	Years			
	Year One	Year Two	Year Three	Year Four
Wages and salaries	\$415,602	\$432,226	\$490,515	\$510,136
Capital equipment	170,000			7,200
Administrative expenses	2,000	2,200	2,420	2,662
Computers/printer	2,000			2,000
Maintenance and repair	1,000	1,040	1,082	1,125
Miscellaneous expenses	4,600	4,692	4,786	4,882
Training and travel for technical staff	1,000	1,000	1,000	1,000
Consumables/transducers	57,600	59,904	62,300	64,792
Total expenses	\$653,852	\$501,062	\$562,103	\$593,797

Note. No site preparation required in this case.

Table 14 provides each year's estimated cost per test based on a volume of 900 studies, and utilizing the total expenses estimated in Table 13 for Years One through Four.

Table 14

<i>Estimated Cost per Test for a 900 Study, 4-Bed, 5 Night Sleep Laboratory</i>				
	Years			
	Year One	Year Two	Year Three	Year Four
Cost per test	\$725	\$557	\$625	\$660

Although Lyndon B. Johnson's Year One cost of \$725 was above the national average of \$630 (Breus, 2001), the cost per test dropped in Year Two and becomes comparable to Breus' estimate in the out years. This "in-house" estimate is well below the \$950 the Hospital District is currently paying Methodist Diagnostic for sleep studies. While only 52 examinations can be completed at \$950 per study, if Harris County could create a sleep laboratory, the Pulmonary Service could potentially complete up to 900 studies per year.

It must be noted however, that lower than anticipated volume could present a significant risk. Table 15 provides a volume-based cost per test projection for Year One through Year Four. Experiencing Year One workload below 650 studies would result in a higher cost per study than under the Methodist Diagnostic Hospital contract.

Table 15

<i>Estimated Cost per Test for Years One through Four by Study</i>				
	Cost per test			
Studies per year	Year One	Year Two	Year Three	Year Four
900	\$725	\$557	\$625	\$660
800	816	626	703	742
700	933	716	803	848
600	1,88	835	937	990

Revenue from this project will not cover expenses. Of the district's population between the ages of 40 and 64, 78% are self-pay patients (no insurance/largely charity care), 20% are covered by government insurance (Medicare, Medicaid, etc.), 1.2% by commercial insurance and .80% by other insurance (Health/Outreach Education, 2002). Although Bandi and Guy (2002) estimate that 35% of patients have Medicare coverage, a more conservative estimate of 15% of paying patients was used in this analysis. Table 16 compares estimated collections versus expenses for Years One through Four. Revenue projections are based on 15% of 900 studies at the Medicare reimbursement rate of \$777.58 in Year One, with a 2% annual increase thereafter.

Table 16

Estimated Revenues Versus Expenses

	Years			
	Year One	Year Two	Year Three	Year Four
Revenue	\$107,073	109,214	111,399	113,626
Expenses	(652,902)	(501,062)	(562,103)	(593,797)
Total	(\$545,829)	(\$391,848)	(\$450,704)	(\$480,171)

Savings from a sleep laboratory will, however, come from other areas. As mentioned previously, there may be a significant impact on the district's patient Length of Stay (LOS) and number of admissions. Ben Taub General Hospital had 5,168 admissions in 2002, with 12.2% being due to circulatory disease and respiratory conditions (Information Management Systems). The average cost per a Medicine Bed Day for a patient in the Harris County Hospital District is \$1,748.48 (G. Masi, Ben Taub General Hospital, Associate Administrator, personal communication, November 11, 2003), with an average LOS of 5.2 days (Information Management Systems).

Table 17 is an estimation of cost avoidance if admissions were decreased for cardiac and pulmonary conditions based on an average LOS of 5.2 days. Of the 5,168 patients admitted to Ben Taub in 2002, 12.20% admissions (approximately 630) were due to heart disease and/or hypertension. Any decrease in these admissions and/or their LOS would help the district's financial bottom line and potentially increase the quality of life of Harris County Hospital District patients. A 10% drop in admissions stemming from these conditions could create a potential cost avoidance of \$573,253, thereby making opening the sleep laboratory a "break even" proposition.

Table 17

*Cost Avoidance Based on 5.2 Average Length of Stay at Ben
Taub General Hospital*

Percentage Drop in Admissions	Number of Patients	Bed Days	Cost Per Bed Day
10%	63	327.86	\$573,253
11%	69	360.64	630,578

Bandi and Guy (2002) suggest that Harris County Hospital District could also market sleep laboratory services once its internal backlog is resolved. It is doubtful, however, that the district would ever be without a backlog. It has been the experience of most sleep specialists in the VAMC system (a system comparable to HCHD) that once a sleep disorders program is established, it quickly reaches maximal utilization (National Center for Cost Containment, 1998). Also, the brand image of being Houston's indigent or safety net hospital works against the district, and the public's perception of care provided by Harris County Hospital District will be difficult to change.

Chapter 4

Alternatives Considered

Continue With Current Contractual Arrangement

The current contract that Harris County Hospital District with Methodist has no end date (State of Texas & DCH Health Services, 2001) and is not under consideration for renegotiation by either party (G. Masi, Ben Taub General Hospital, Associate Administrator, personal communication, November 11, 2003). Methodist currently charges HCHD \$950 for sleep

studies falling under CPT codes 95810 and 95811 (State of Texas & DCH Health Services, 2001). Unfortunately, the \$950 fee has caused Harris County Hospital District's pulmonary physicians to set such stringent criteria that only the most serious cases are referred for sleep study. This has resulted in a diagnosis of sleep disorder in over 90% of patients referred for examination (V.Bandi & E. Guy, personal communication, October 2, 2002). This is far greater than the national average diagnosis rate of 40% to 60% of patients referred to sleep laboratories (Heitman & Flemons, 2001) and implies much needed diagnostic work is not being accomplished. Continuing to utilize the current contract does not meet HCHD's need for sleep services; nor does this continuance assist HCHD contain costs. Other facilities, such as Bellaire Medical Center and the Houston Sleep Center charge less for such services (See Tables 11 and 12.) Maintenance of the current contract with Methodist should not be an option.

Joint Venture

PSG Professional Services, Incorporated, has proposed a joint venture with Harris County Hospital District to provide comprehensive, high quality diagnostic and treatment services (Professional Services, Incorporated, 2002). PSG Professional Services would bill the hospital \$300 per patient for night time polysomnography, with an additional \$300 per night fee while PSG Professional Services personnel are on site during the initial training. The contractor would be responsible for providing updated software and hardware during the life of the contract and would retain termination rights should monthly studies fall below an average of five. At the end of the four-year contract, the Hospital District would have the option of purchasing the polysomnographic equipment at a cost of \$900 per bed (Professional Services, Incorporated, 2002).

Table 18 outlines both parties' responsibilities.

Table 18

Listing of PSG Professional Services and Harris County Hospital District Responsibilities

PSG Professional Services	Harris County Hospital District
32-channel digital polysomnograph	Physical facility
Oximeter	Initial off-site training (approx. \$1,500)
Start-up transducers	Patient scheduling
Pentium 4 computer	Insurance pre-authorization
Monitor 17" – 19"	Billing and collection
CD-ROM writer	Supplies and consumables
On site training	Remote CPAP (\$40 mo/rental each)
Scoring and analysis of data*	Attended data collection
Formatting of data reports	Staffing sleep laboratory
Questionnaires/forms	
On line review of data over Virtual Private Network (VPN) connection	

*Note. Analysis completed by a Diplomat of the American Board of Sleep Medicine within 24-48 hours of completion and placed on VPN for hospital viewing.

Table 19 provides estimated contract expenses based on 900 studies per year. Table 20 displays five-year comparative cost per test data between a joint venture between PSG Professional Services, Incorporated and HCHD and creating and performing sleep services without support from Methodist. HCHD cost estimates are outlined in Table 13, *Estimated Expenses for a 900 Study, 4-Bed, 5 Night Sleep Laboratory*.

In Table 19, no sleep specialist was included in the joint venture calculations for Years One through Four, but a 1.0 FTE sleep specialist would be required in Year Five. That cost was estimated at \$90,000. The district would be responsible for capital equipment not covered by the contract (furniture, BiPAP, etc.), as well as an estimated \$3,000 training fee to the polysomnographer for 10 nights of training sleep technicians. Four CPAPs would be rented at \$1,920 per month from PSG Professional Services, Incorporated. There would be no change in

other expenses previously calculated in Table 13. The contract expires after Year Four, and the estimated \$270,000 analyst fee charged by PSG Professional Services, Incorporated terminates at that time. By Year Five, a qualified sleep specialist is slated to become a faculty member for Baylor College of Medicine (V.Bandi and E. Guy, personal communication, October 2, 2002) and will be able to provide services to Harris County Hospital District.

Table 19

Estimated Expenses of a PSG Services, Incorporated Contract at \$300 per Study

Expenses	Estimated Annual Expenses				
	Year One	Year Two	Year Three	Year Four	Year Five
Wages/salaries	\$374,402	\$389,378	\$404,953	\$421,151	\$527,997
Initial training site fee	1,500				
Capital Equipment	26,000			32,200	
Technician training	3,000				
Administrative expenses	2,000	2,200	2,420	2,662	2,928
Computers/printers	2,000			2,000	
Interpretation fee	270,000	270,000	270,000	270,000	
CPAP rental	1,920	1,920	1,920	1,920	
Miscellaneous expenses	4,600	4,692	4,786	4,882	4,979
Technician training/travel		1,000	1,000	1,000	1,000
Consumables/transducers	57,600	59,904	62,300	64,792	67,384
Total expenses	\$745,022	\$729,094	\$747,379	\$835,807	\$604,288

Table 20

*Estimated Cost Per Test Comparison Between PSG-Sponsored and HCHD Sleep**Laboratory for a 4-Bed, 5 Night per Week, 900 Studies per Year at \$300 per Study*

Organization	Estimated cost per test by year				
	Year One	Year Two	Year Three	Year Four	Year Five
PSG	\$709	\$689	\$706	\$802	
HCHD	\$725	\$557	\$625	\$660	\$675

Note. Contract ends Year Four and sleep data analyzed thereafter by Harris County Hospital District.

As shown by Table 20, the cost per test would be higher through PSG Professional Services, Incorporated than if Harris County Hospital District provides the service in its entirety. However, the PSG contract would offer two advantageous clauses. The first would be a No-Loss Clause, whereby the contract could be renegotiated on its anniversary if the hospital is losing money. This is an important clause, as the district anticipates a loss on this service and the clause offers an exit strategy. While there is little likelihood that PSG would be willing to drop fees far enough to eliminate the loss (to approximately \$120 per study), any reduction in fees in the out years of the contract would be beneficial to the district. For instance, a \$100 reduction per reading would lead to a \$90,000 drop in expenses and a lowering of the cost per study to \$589 in Year Two and \$607 in Year Three. Tables 21 and 22 outline resulting expenses and a comparison of cost per study between the district and PSG if the company was to lower its reading fees to \$200 per study in Years Two through Four.

Table 21

Estimated Expenses of a PSG Services, Incorporated Contract at \$200 per Study

Expenses	Estimated Annual Expenses				
	Year One	Year Two	Year Three	Year Four	Year Five
Wages/salaries	\$374,402	\$389,378	\$404,953	\$421,151	\$527,997
Initial training site fee	1,500				
Capital Equipment	26,000			32,200	
Technician training	3,000				
Administrative expenses	2,000	2,200	2,420	2,662	2,928
Computers/printers	2,000			2,000	
Interpretation fee	270,000	180,000	180,000	180,000	
CPAP rental	1,920	1,920	1,920	1,920	
Miscellaneous expenses	4,600	4,692	4,786	4,882	4,979
Technician training/travel		1,000	1,000	1,000	1,000
Consumables/transducers	57,600	59,904	62,300	64,792	67,384
Total expenses	\$745,022	\$639,094	\$657,379	\$745,807	\$604,288

Table 22

*Estimated Cost Per Test Comparison Between PSG-Sponsored and HCHD Sleep**Laboratory for a 4-Bed, 5 Night per Week, 900 Studies per Year at \$200 per Study*

Organization	Estimated cost per test by year				
	Year One	Year Two	Year Three	Year Four	Year Five
PSG	\$826	\$589	\$607	\$702	
HCHD	\$725	\$557	\$625	\$660	\$675

A second, key termination clause would allow Harris County Hospital District to terminate the contract due to nonperformance. Per the offeror's proposal, nonperformance is termed less than an average of 5 studies conducted monthly by HCHD (PSG Professional Services, Incorporated, 2002). If the hospital district cannot successfully perform such a low number of sleep studies per month due to personnel losses, scheduling problems or a significant patient no show rate, HCHD will have an opportunity to quickly void the contract.

In combination, these clauses would provide the district a great deal of flexibility. The contractor's investment of significant capital equipment and training serves as motivation to provide timely and quality service. However, the contract could be voided quickly if PSG does not meet Harris County's needs. Other advantages of the joint venture are lower initial capital equipment costs (\$26,000 vice \$130,050), and using the contract as a "learning curve" for technicians, providers and managers of the laboratory operation. As volume estimates for this service are not well established, the contract would facilitate a quick and less expensive exit if the perceived demand does not materialize. Ideally, caseload would grow and at the end of four years the services of PSG would no longer be required. In the meantime, the four-year contract would allow time for a Baylor College of Medicine faculty member to become a Diplomate of the American Board of Sleep Medicine, or for the district to hire a Sleep Specialist who is an ABSM Diplomate. Should this alternative be selected, it would be advisable to hire a Chief Technologist, two polysomnographic technicians and to recruit a likely in house candidate (such as a LVN-or EEG technician) to fill the third technician position. PSG Professional Services, Incorporated will provide initial orientation and training.

The main disadvantage of the joint venture is the geographic separation of the Sleep Specialist (in Utah) from HCHD in Houston, Texas. Adherence to the contract in terms of

timeliness and the quality of reports would have to be monitored closely. Another disadvantage is that AASM accreditation is not possible under this alternative unless a Baylor College of Medicine faculty member becomes a Diplomat of the American Board of Sleep Medicine prior to termination of the contract.

Initiate a New Contract With Local Sleep Laboratories/Centers

The district's potential volume of 1,000 patients per year should be attractive to area service providers and may provide leverage for renegotiating a lower rate. The potential exists for at least 5 facilities to contract with Harris County Hospital District for sleep services: Bellaire Medical Center, Houston Sleep Center, Health Management Services, Sleep Technology International, and Methodist Diagnostic Center. There are, however, two disadvantages to using an outside organization. First, the district would continue to pour funds into the service with no opportunity for the partial reimbursement afforded by the in-house alternative. Nine hundred studies at the Medicare reimbursement rate of \$777.58 per test equates to an annual outlay of \$699,822. While this would be substantially less than the joint venture with PSG (average four year cost of \$839/study, or \$755,100 per year), it is far more expensive than conducting studies internally (average four year cost of \$659/study, or \$593,100 per year). Unless a change in technology makes home sleep studies more reliable and/or lessens the need for interpretation of results by highly skilled personnel, the district would continue to pay a significant amount to an outside service indefinitely.

A second disadvantage is the historically high no show rate among Hospital District patients. Under the current contract with Methodist Diagnostic Hospital, the district does not pay for patients who fail to appear for their scheduled examinations (State of Texas & DCH Health Services, 2001), which is a definite advantage of this contract. However, if Harris County

Hospital District is to offer volume to providers in exchange for favorable rates, the patients must show up, or the district may be liable for the empty beds. Creating a guaranteed annual floor of 450 sleep studies may be attractive enough to allow the district to avoid payment for no shows. This could, however, obligate the district to pay over \$350,000 a year for services that might not be provided.

Freestanding laboratories should be targeted if this option is to be explored further, as their lower operating costs should result in a lower charge per examination. Nonetheless, a contract with a hospital would still be required for patients who are too ill to be evaluated in an outpatient setting. A two-tier system could be initiated, where less ill patients are sent to freestanding laboratories, lessening the cost to the Hospital District and increasing service to its patients. Gurubhagavatula, Maislin, and Pack (2001) have established a two-stage risk-stratification algorithm to identify sleep apnea risk in patients referred to sleep clinics for evaluation. This algorithm could be used as a decision matrix to determine whether to send patients to a freestanding laboratory or to a hospital-based sleep center.

Construct a Harris County Hospital District Sleep Laboratory Utilizing Existing Space

By providing sleep studies within the district, Harris County would have an opportunity to expand its scope of services to patients and providers. This would also give the district greater control over scheduling and the quality of examinations, as well as achieving the lowest cost per test (\$725) of alternatives under consideration. Finally, American Academy of Sleep Medicine accreditation is probable, as either a Medical Director or a Director of Sleep Laboratory would head the new service.

There are several disadvantages to this alternative. As is the case with all options, revenues will not equal expenses, as the district's poor payor mix (75% uninsured) will make it unlikely

that the service can break even. The large initial outlay for capital equipment (estimated to be \$130,000) is a significant disadvantage, and rapidly developing technology may make equipment purchased obsolete if sleep tests can soon be performed at home. Finally, the demand for technicians/technologists exceeds supply in the Houston metropolitan area, generating concern that Harris County Hospital District may not be able to hire and/or retain qualified personnel.

Chapter 5

Recommendation and Conclusion

Harris County Hospital District has not kept pace with the demand for sleep studies, and is not meeting the standard of care required to properly diagnose and adequately treat its patients. The current method of contracting sleep evaluations through other facilities is costly and meets neither current nor predicted requirements. The proposed solution offered by the Pulmonary Medicine Department, creating a two-bed, American Academy of Sleep Medicine accredited sleep disorders center at Ben Taub General Hospital, was also found to be inadequate to meet patient demand. Four alternatives were therefore evaluated: 1) continue HCHD's existing contractual agreement with Methodist Diagnostic Hospital; 2) terminate the existing contract and solicit bids from local health care facilities and freestanding sleep laboratories; 3) initiate a joint venture to furnish equipment and expertise that would allow HCHD to provide services on-site; and 4) fund and construct a sleep laboratory utilizing existing Harris County Hospital District space. Appendix B lists advantages and disadvantages of each alternative.

The purpose of this study was to determine the most cost effective and efficient method of diagnosing sleep disorders of Harris County Hospital District patients. After a review of the available information, it is recommended that the district initiate a joint venture with PSG Professional Services, Incorporated. While this would result in a greater cost per test than

creating a sleep laboratory within the Hospital District (\$826 vs. \$725 for Year One), this option prevails based on its lower initial capital costs, greater flexibility, and easier exit strategy in case of technological changes or lower than expected volume.

Another recommendation is that the Hospital District not leave management of the laboratory, interpretation of sleep studies, supervision of technical personnel, and quality control to outside expertise. A Sleep Specialist who is a diplomate of the American Board of Sleep Medicine should be hired as Director of the Sleep Laboratory.

Appendix A

List of Sleep Centers/Laboratories in Houston Metropolitan Area

<u>Organization</u>	<u>Location</u>
Apinx	Bellaire
Bellaire Medical Center	Bellaire
Baylor College of Medicine – Methodist Hospital	Texas Medical Center
Clear Lake Regional Hospital	Clear Lake
Clear Lake Sleep Laboratory	Clear Lake
Diagnostic Clinic of Houston	Texas Medical Center
Digitrace	Houston
Hermann Memorial Hospital	Texas Medical Center
Methodist Diagnostic Hospital	Texas Medical Center
Memorial	Southeast
HMS Diagnostics	Texas Medical Center
Kindred Hospital Sleep Center	Northwest
Kindred Hospital Sleep Center	Texas Medical Center
Sleep Centers International	Bellaire
Sleep Technology Institute	Sugarland
Spring Branch Medical Center	Longpoint
Saint Luke's Episcopal	Texas Medical Center
Saint Luke's Episcopal	Kirby Glen
Texas Children's Hospital	Texas Medical Center
Texas Institute of Chest and Sleep Disorders	Pasadena
Texas Institute of Chest and Sleep Disorders	Houston
The Houston Sleep Center	Katy Freeway
The Sleep Center	Northwest
Tomball Regional Hospital	Tomball
Total Sleep Diagnosis of Houston	Southwest
Triumph Hospital	Houston
Veterans Administration Medical Center	Texas Medical Center

Appendix B
Decision Matrix

Continue With Current Contract	Joint Venture
Positives Contract in place No problems with quality of service Multiple nights same cost as single night No billing for no shows No additional staff required Negatives \$950 cost per test is highest of alternatives Not meeting need of patient population due to cost Only existing contract Large amount of money leaving district indefinitely	Positives Lower capital equipment outlay (\$26,000 vice \$130,000) Lower cost per test than current contract (\$826 vice \$950) Training for staff provided by contractor Flexibility of contract (can be renegotiated after 12 months) "Test drive" the service Negatives \$300 for interpretation higher than national average of \$200 Higher cost per test than doing study in house (\$826 vice \$727) No AASM accreditation possible Long distance from Utah to Texas
Initiate Local Contract with Sleep Centers/Laboratories	Create Service within Harris County Hospital District
Positives May be able to receive discounts due to volume of patients Keen competition between laboratories may lower cost per test Decrease patient backlog Multiple providers of service Negatives Large amount of money leaving district indefinitely Lack of contractual oversight by purchasing authority Quality control issues Will the algorithm be used effectively and efficiently? Pay for no shows?	Positives Provide needed service for patients and health care providers Control over entire operation Lowest cost per test (\$727) of alternatives AASM accreditation possible Negatives Revenues will not equal expenses Training and retention of technical staff High outlay for capital equipment (\$130,000) Rapid technology change possible Cost control at district suspect

References

- Accreditation Committee (Unknown). AASM standards "Technologist staffing". *Accreditation Committee, American Academy of Sleep Medicine, Unknown*, 1. Retrieved November 5, 2002, from <http://www.aasmet.org/positionpapers.htm>
- Accreditation Committee. *Application for accreditation of a sleep-related breathing disorders center* (2002). Winchester, IL: American Academy of Sleep Medicine.
- Advance for MRC. (2002, March). *Polysomnography and electroneurodiagnostic buyers guide*. Retrieved November 5, 2002: <http://advanceforsleep.com/pdfs/MR2002polysomn.pdf>
- American Academy of Sleep Medicine (2000). Position statement: cost justification for diagnosis and treatment of obstructive sleep apnea. *Sleep*, 23(8), 1-2. Retrieved February 28, 2003 from <http://www.aasmet.org/positionpaper.htm>
- American College of Healthcare Executives (2002). *2002-2003 the official tutorial for the ache board of governors examination in healthcare management* (Rev. ed.). Chicago, IL: American College of Healthcare Executives.
- American Medical Association. (2003). *CPT code/relative value search*. Retrieved March 7, 2003 from <http://ama-assn.org/search/CPTLookupResultsPage.jhtml>
- Ancoli-Israel, S., Klauber, M., Stepnowsky, C., Chinn, A., & Fell, R. (1995). Sleep-disordered breathing in African-American elderly. *American Journal Respiratory Critical Care Medicine*, 152, 1946-1949.
- Association of Polysomnographic Technologists. (2002). *Programs & schools preparing to work in sleep services* [Brochure]. Lenexa, KS: Author.

- Bahammam, A., Delavie, D., Ronald, J., Manfreda, J., Roos, L., & Kryger, M. H. (1999). Health care utilization in males with obstructive sleep apnea syndrome two years after diagnosis and treatment. *Sleep*, 22(6), 744-747.
- Bandi, V., & Guy, E. (2002). *Business plan for sleep disorders center*. Paper presented at a business meeting with Ben Taub General Hospital administrators. Houston, TX.
- Bangs, D. H. (2002). *The Business Planning Guide* (9th ed.). Chicago, IL: Dearborn Financial Publishing, Inc.
- Belcher II, R. M. (2002). *Sleeping: On the job! A technical resource guide for sleep labs*. Kearney, NE: Morris Publishing.
- Breus, M. J. (2001). Reimbursement part I: contracting. *Sleep Review the Journal for Sleep Specialists*, 3(3). Retrieved February 28, 2003 from <http://www.sleepreviewmag.com/issues.asp?issueid=0107>
- Brewer, S. (2001, February 28). Hospital district set budget/\$11 million increase in tax money sought. *Houston Chronicle*. Retrieved May 13, 2003 from <http://www.chron.com/content/archive/ysearch.hts?operation=getdoc&database>
- Brock, N. (2002 October 16). *Funding issues*. Paper presented at the meeting of the Texas Medical Center American College of Healthcare Executives Study Group. Houston, TX.
- Brody, J. E. (2002). Sleep apnea, a noisy but often invisible threat. *New York Times*. Retrieved September 17, 2002 from <http://www.nytimes.com/2002/09/17/health/anatomy/17BROD.html>
- Burch, J. G. (1986). *Entrepreneurship*. New York, NY: John Wiley & Sons, Inc.

Chervin, R. D., Murman, D. L., Malow, B. A., & Totten, V. (1999). Cost-utility of three approaches to the diagnosis of sleep apnea: polysomnography, home testing, and empirical therapy. *Annals of Internal Medicine*, 130(6), 496-505. Retrieved September 6, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>

Clinical Practice Review Committee (1998). Role and qualifications of technologists performing polysomnography. *Executive Committee of the American Sleep Orders Association, April 1998*, 1. Retrieved November 5, 2002 from <http://www.aasmet.org/positionpapers.htm>

Comarow, A. (2002). Special report: America's best hospitals. *U.S. News and World Report*.

Davies, R. J., & Strandling, J. R. (1996). The epidemiology of sleep apnoea. *Thorax*, 51, S65-S70.

Digital School of Health Professions. (2002). *Sleep disorders: One day course*. Stafford, TX: Digital School of Health Professions.

Dobbin, K. R., & Strollo, P. J. (2002). Obstructive sleep apnea: recognition and management considerations for the aged patient. *American Association of Clinical Care Nurses Clinical Issues*, 13(1), 103-113. Retrieved September 9, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>

Drazen, J. M. (2002). Sleep apnea syndrome. *The New England Journal of Medicine*, 346(6), 390. Retrieved September 6, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>

ECRI. (2002). *Healthcare product comparison system*. Retrieved October 22, 2002 from http://members.ecri.org/members/_Elements/HPCS/PCSDDefaultText.asp?ReportId=3665

- Friedman, M., Tanyeri, H., La Rosa, M., Landsberg, R., Vaidyanathan, K., Peri, S., Caldarelli, D. (1999). Clinical predictors of obstructive sleep apnea. *Laryngoscope*, 109(12), 1901-1907. Retrieved September 9, 2002 from <http://gateway2.ovid.com/pvidweb.cgi>
- Fry, J. M., DiPhillipo, M. A., Curran, K., Goldberg, R., & Baran, A. S. (1998). Full polysomnography in the home. *Sleep*, 21(6), 635-642. Retrieved October 10, 2002 from <http://ezproxy2.library.tmc.edu:2061/entrez/query.fcgi?cmd=Retrieve>
- Gagnadoux, F., Pelletier-Fleury, N., Philippe, C., Rakotonanahary, D., & Fleury, B. (2002). Home unattended vs hospital telemonitored polysomnography in suspected obstructive sleep apnea syndrome*: a randomized crossover trial. *Chest*, 121(3), 753-758. Retrieved October 26, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>
- Gilmer, R. W., Hodgin, R. F., & Schiflett, M. (2001). *Economic impact of the Texas Medical Center on Southeast Texas* (Federal Reserve Bank of Dallas Houston Branch October 2001). Washington, DC: U.S. Government Printing Office.
- Gurubhagavatula, I., Maislin, G., & Pack, A. I. (2001). An algorithm to stratify sleep apnea risk in a sleep disorders clinic population. *American Journal of Respiratory and Critical Care Medicine*, 164(10), 1904-1909. Retrieved October 23, 2002 from <http://arjccm.atsjournals.org/cgi/contnet/full/164/10/1904>
- Haponik, E. F., Frye, A. W., Richards, B., Wymer, A., Hinds, A., Pearce, K., McCall, V., Konen, J. (1996). Sleep history is neglected diagnostic information. *Journal of General Internal Medicine*, 11(12), 759-761.
- Harris County Hospital District. (n.d.). *Homepage*. Retrieved September 27, 2002 from <http://www.hchd.tmc>

- Harris County Management Services (December 2002). *Emergency/trauma system implementation team report to Harris County Commissioners Court*. Houston, TX: Office of Legislative Relations, Harris County.
- Health/Outreach Education (April 2002). *Community health assessment*. Houston, TX: Harris County Hospital District.
- Heitman, S. J., & Flemons, W. W. (2001). Evidence-based medicine and sleep apnea. *Respiratory Care*, 46(12), 1418-1434.
- Hirshkowitz, M. (October 2001). *Houston VAMC sleep program report*. Houston, TX: VAMC Houston, TX.
- Hospital district board member is removed. (2003, May 7). *Houston Chronicle*. Retrieved May 13, 2003 from <http://www.chron.com/content/archive/ysearch.hts?operation=getdoc&database>
- HRSC, Inc (2003). *Direct patient care compensation survey for the greater Houston area* (January, 2003). Lake Jackson, TX: HRSC, Inc.
- Information Management Systems, Inc. (2002 June 28). *Ben Taub General Hospital hospital/market profile q2'00-q1'01 discharges*. Miami, FL: WIN-State Analyst Reports.
- Kapur, V., Strohl, K. P., Redline, S., Iber, C., O'Connor, G., & Nieto, J. (2002). Underdiagnosis of sleep apnea syndrome in U.S. communities. *Sleep and Breathing*, 6(2), 49-54. Retrieved October 24, 2002 from <http://www.thieme-connect.com/BASScgi>
- Kryger, M. H., Roos, L., Delaive, K., Walld, R., & Horrocks, J. (1996). Utilization of health care services in patients with severe sleep apnea. *Sleep*, 19(9), S111-S116.

- Lamberg, L. (2000). Sleep disorders, often unrecognized, complicate many physical illnesses. *The Journal of the American Medical Association*, 284(17), 2173-2175. Retrieved September 6, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>
- Lindberg, E., & Gislason, T. (2000). Epidemiology of sleep-related obstructive breathing. *Sleep Medicine Review*, 4, 411-433.
- Merritt, S. L. (2000). Putting sleep disorders to rest. *Registered Nurse*, 63(7), 26-31. Retrieved September 6, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>
- More rancor/stop bickering over hospital district and fix its problems. (1999, February 11). *Houston Chronicle*. Retrieved March 13, 2003 from <http://www.chron.com/content/archive/search.hts?operation=getdoct&database>
- National Center for Cost Containment (1998). *Sleep-related breathing disorders: A source book*. Milwaukee, WI: Department of Veterans Affairs.
- National Institutes of Health. (2003). *Calculate your body mass index*. Retrieved March 10, 2003 from <http://nhlbisupport.com/bmi/bmicalc.htm>
- Pasculay, R. A., & Soest, S. W. (1996). *Snoring and sleep apnea: personal and family guide to diagnosis and treatment*. New York, NY: Demos Medical Publishing.
- Professional Services, Incorporated. (2002). *Opportunity assessment* [Proposal]. Farmington, UT: Jim Walker.
- PSI Arista. (2002). *Executive checklist series: developing and fine-tuning a business plan* (42nd ed.) [Brochure]. Denver, CO: PSI Arista, the Health Consulting Group of Policy Studies, Inc.

- Rahaghi, F., & Basner, R. C. (1999). Delayed diagnosis of obstructive sleep apnea: Don't ask, don't tell. *Sleep and Breathing*, 3(4), 119-124. Retrieved October 24, 2002 from <http://www.thieme-connect.com/BASScgi>
- Reimer, M., & Flemons, W. W. (1999). Measuring quality of life in disorders of sleep and breathing. *Sleep and Breathing*, 3(4), 139-145. Retrieved October 24, 2002 from <http://www.thieme-connect.com/BASScgi>
- Resnick, H. E., Redline, S., Shahar, E., Gilpin, A., Newman, A., Walter, R., Ewy, G., Howard, B., Punjabi, N. (2002). Sleep disturbances and diabetes mellitus: Cross-sectional results from the Sleep Heart Study. *Diabetes*, 51(Supplement 2), A235. Retrieved October 26, 2002 from <http://gateway2.ovid.com/ovidweb.cgi>
- Roland, J., Delaive, K., Roos, L., Manfreda, J., Bahammam, A., & Kryger, M. H. (1999). Health care utilized in the 10 years prior to diagnosis in obstructive sleep apnea patients. *Sleep*, 22(2), 225-229.
- Rosen, R. C., Rosekind, M., Roseyear, C., Cole, W. E., & Dement, W. C. (1993). Physician education in sleep and sleep disorders: a national survey of U.S. medical schools. *Sleep*, 16, 249-254.
- Schwartz, M. (2003, May 1). Hospital district's CEO quits. *Houston Chronicle*. Retrieved May 13, 2003 from <http://www.chron.com/content.archive/ysearch.hts?operation=getdoc&database>
- Siegel, E. S., Ford, B. R., & Bornstein, J. M. (1993). *The Ernst & Young Business Plan Guide* (2nd ed.). New York, NY: John Wiley & Sons, Inc.

- Standards of Practice Committee of the Sleep Disorders Association (1997). Practice parameters for the indications of polysomnography and related procedures. *American Sleep Disorders Association Report*, 20, 406-422. Retrieved February 28, 2003 from <http://aasmet.org/positionpapers.htm>
- State of Texas & Diagnostic Center Hospital Health Services (2001). *Agreement between Harris County Hospital District and Diagnostic Center Hospital Health Services* [01-HSP-0145 (LRJ)]. Houston, TX: Harris County Hospital District.
- Stienbaker, J. (1999, February 6). Hospital chief, others quizzed about scandal. *Houston Chronicle*. Retrieved May 13, 2003 from <http://www.chron.com/content/ysearch.hts?operation=getdoc&database>
- Tachibana, N., Ayas, N., & White, D. P. (2002). A quantative assessment of sleep laboratory activity in the United States. *AASM Bulletin*, 9(2), 26-28.
- Texas Medical Center. *Facts and figures about the Texas Medical Center*. Retrieved September 27, 2002 from <http://www.tmc.edu/tmc-facts.html>
- The Advisory Board (2002). *Introductory diagnostic: Setting the throughput ambition*. Retrieved May 5, 2003 from <http://www.advisory.com/members/default.asp?program=1&collectionid=736>
- Turner, A. (2002, September 30). Nursing shortage no longer critical/changes in hospital policies, infusion of state funds help. *Houston Chronicle*. Retrieved May 13, 2003 from <http://www.chron.com/content/archive/ysearch.hts?operation=getdoc&database>
- U.S. Census Bureau. *State and county quickfacts: Harris County, Texas*. Retrieved September 27, 2002 from <http://quickfacts.census.gov/qfd/states/48/48201.html>

Victor, L. A. (1999). Obstructive sleep apnea. *American Family Physician*, 60(6), 2279-2290.

Retrieved October 10, 2002 from

http://findarticles.com/cf_0/m3225/8_60/58267067/print.jhtml

Young, T., Palta, M., Dempsey, J., Skatrud, J., Weber, S., & Badir, S. (1993). The occurrence of sleep-disordered breathing among middle-aged adults. *The New England Journal of Medicine*, 328(17), 1230-1235. Retrieved September 19, 2002 from

<http://gateway2.ovid.com/ovidweb.cgi>

Young, T., Peppard, P. P., & Gottlieb, D. J. (2002). Epidemiology of obstructive sleep apnea. *American Journal of Respiratory and Critical Care Medicine*, 165(9), 1217-1239.

Retrieved October 24, 2002 from

<http://ajrccm.atsjournals.org/cgi/content/abstract/165/9/1217>

Young, T., Shahar, E., Nieto, F. J., Redline, S., Newman, A. B., Gottlieb, D. J., Walsleben, J. A., Finn, L., Enright, P. Samet, J. M. (2002). Predictors of sleep-disordered breathing in community dwelling adults: The sleep heart health study. *Archives of Internal Medicine*, 162(8), 893-900. Retrieved October 26, 2002 from

<http://gateway2.ovid.com/ovidweb.cgi>