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AIDING LERDSIN ORTHOPEDIC TO ACHIEVE EXCELLENCE

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Abstract

This project assisted Lerdsin Hospital's Orthopedic Department, located in Bangkok, Thailand, in achieving its goal of becoming a Center of Excellence. To this end, we evaluated the Department's information management system and determined its weaknesses. Solutions came from an examination of other information management systems and the specific needs of the Department. Finally, we designed a proof of concept information management system to assist the department in its goals.

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Executive Summary

The Ministry of Public Health in Thailand realizes the importance of excellent health care for all Thai citizens. It is continually striving to improve the levels of service in each of the dozens of hospitals under its control. During the past four years, it has been developing a program in which each public hospital is strongly encouraged to enforce one of its departments to become a Center of Excellence. This program is a tool the Ministry of Public Health is using to achieve its goal of providing superb health care throughout the country.

In order for a hospital department to become a Center of Excellence, it must fulfill seven requirements as specified by the Ministry of Public Health. These criteria are:

- Providing tertiary care
- Running a training program
- Conducting research and development
- Being a referred center
- Networking with other hospitals
- Being a reference center
- Advocating national policy

All of these criteria are equally important, and must be maintained in order for a department to remain a Center of Excellence.

Lerdsin Hospital, a general hospital located in the Bangkok metropolitan area, is a hospital capable of becoming a Center of Excellence in the area of orthopedics. There are many factors that are currently preventing the Orthopedic Department from achieving this goal. The most significant impediment is the Department's current information management system. Due to the limitations of their current system, Lerdsin Hospital is dealing with problems such as the inability to meet external reporting to the Ministry of Public Health, the inability to meet the Training Program requirements and the ability to manage patient records and digitally register patients. Therefore, it is imperative that they adopt a new information management system. By implementing a new information management system, the Department will be able to accurately proof its excellence to the Ministry of Public Health.

Due to the standards that Lerdsin Hospital must comply, primarily the Ministry of Public Health regulation that paper records be stored for five years, their only option for an improved information management system is a paper-computer hybrid. In this system, paper records would still be stored, satisfying the government regulation, while also making it more efficient and easier for accessing data.

In early 2007, Lerdsin will have a hospital information management system implemented by a Thai software company known as SSB. However, until this software is implemented, the Orthopedic Department is in need of a proof of concept information management system that will help them ease their transition from a paper information management system to a hybrid one. The goal of our project was to provide the Orthopedic Department with a proof of concept information management system that will begin to assist the process of becoming a Center of Excellence.

In order to accomplish this goal, we determined two objectives. The first one was to determine the strengths and opportunities of hybrid information management systems.

This helped us achieve our second objective which was to design a proof of concept system that supports the Orthopedic Department's goal of becoming a Center of Excellence. The combination of these two objectives led us to form recommendations for the Orthopedic Department's future plans of implementing a new information management system.

We accomplished our objectives conducting case studies at two public hospitals, Nakornping Provincial Hospital and Saraburi Central Hospital. These institutions shared the same goal of attaining Center of Excellence standing, although working with a hybrid information management system. The data collected helped us to develop accurate and realistic recommendations for an appropriate information management system that should be implemented in the Orthopedic Department at Lerdsin Hospital.

Finding #1

A hybrid system in the Orthopedic Department will be a crucial step in attaining the Center of Excellence recognition.

As Table 1 shows, there is a clear difference illustrated between the three systems. In the first chart, we can see how Lerdsin Hospital has a 37.5% of completion with respect to the subcategory: Ability to manage digital patient records / electronically register patients. For each subcategory, there are a specific number of variables identified; for this one there are eight. Lerdsin Hospital only fulfilled three of the eight variables identified, thus the percentage figure was determined as a result of this relationship.

The second chart shows the subcategory: Ability to meet training program requirements. The variables pertaining to this subcategory are shown on the left of this chart. Nakornping and Saraburi completed only one of the variables identified, patient records database. This variable was fulfilled because the SSB system utilized at these institutions provided such a feature. However, Lerdsin Hospital showed null performance in meeting any of the three variables for this subcategory.

The third chart shows the subcategory: Ability to meet external reporting to the Ministry of Public Health. In this chart we can identify the reporting capabilities of the information management systems of the three institutions. Lerdsin Hospital shows clear deficiencies with respect to their reporting abilities since none of the variables identified were met. Nakornping Hospital shows an average performance of 40% since the SSB platform reports only Procedure Breakdowns, Financial Statements such as Income Statement, Balance Sheet, and the Cash Flows Statement. It also reports two medical indicators, Relative Weight and the classification code for each procedure. However there are other several medical indicators that must be reported as Ministry of Public Health requirement, which Nakornping is not able to report. Saraburi's performance is extremely better compared to that of Lerdsin and Nakornping. The SSB system utilized at Saraburi is complemented with a custom designed system that features all the reporting requirements, and also had the ability to view an in-patient laboratory analysis, diagnosis, medical report, condition progress, among other documents. This custom designed system was the main tool that enabled this hospital to report all the medical indicators as well as their financial status, achieving 100% completion for this subcategory. The comparison between the three medical institutions clearly identified the strengths of the

hybrid systems, and emphasized the weaknesses of the information management system in the Orthopedic Department.

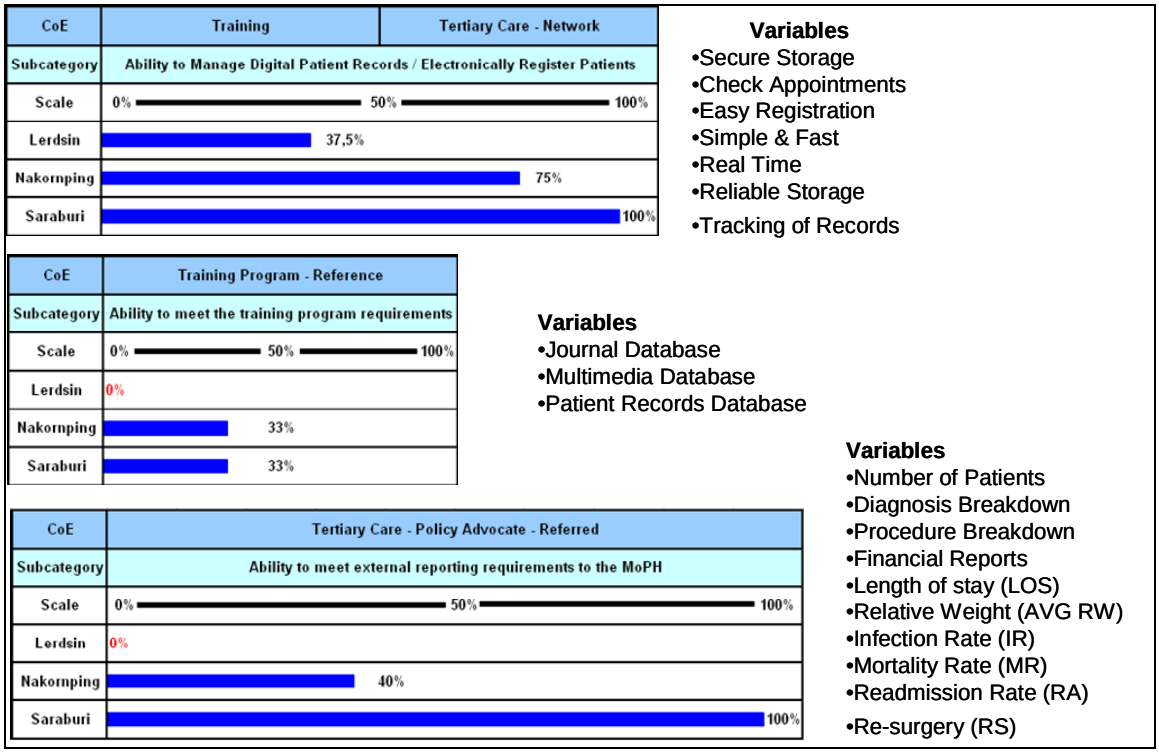

Table 1: Comparison of IMS at Lerdsin, Saraburi and Nakornping Hospitals

This comparison analysis between the hybrid systems was vital in completing our project goal. It demonstrated the significant assistance a hybrid system provides to the information management requirements of a Center of Excellence. Without such a system, the performance of Saraburi would have been similar to that of Nakornping. Overall, Lerdsin fulfilled 14% of the variables, Nakornping 52% and Saraburi 90%. These percentages reveal the importance of implementing a hybrid information management system and that establishing such a system in the Orthopedic Department will be a crucial initial step in assisting its Center of Excellence recognition goal. Although this process is simplified when utilizing a hybrid information management system, it is not sufficient to meet all the requirements of a Center of Excellence.

Finding # 2

Implementing the SSB platform alone will be insufficient for the Orthopedic Department in fulfilling the goal of becoming a Center of Excellence

SSB was far too limited to fulfill Lerdsin Orthopedic Department's goal of becoming a Center of Excellence. The SSB systems evaluated at Nakornping and Saraburi Hospitals were very similar to the one being installed at Lerdsin Hospital in 2007. During the visit to Saraburi, we learned that one of the main limitations of this system is its inability to analyze incomplete patient records. When a patient record is entered into the system, it needs to contain all the necessary forms in order to be

complete. If a certain form is omitted during entry, then the SSB would not be able to analyze this record. Hence, the main consequence of this limitation is how it adversely affects the reporting aspects of several criteria of a Center of Excellence.

One of the criteria affected in the reporting aspect was tertiary care. While limited data are recorded in the system, it can not be displayed for analysis. The SSB system only determines the Infection Rate and the Relative Weight of the procedures conducted. The general medical information that SSB includes is hospital capacity, such as the number of beds available, the number of patients admitted (In Patient Department, IPD), and the number of patients in the Out Patient Department (OPD). The rest of the medical indicators can't be determined or analyzed by this system; therefore the reporting aspect of the Tertiary care criterion is negatively affected. Until the Orthopedic Department is able to report all the medical indicators required by the Ministry of Public Health, the Tertiary care criterion will not be completely fulfilled. The indicators that were not calculated by SSB are shown in bold in the Table 2.

List of Medical Indicators		
▪ **# of patients operated**	▪ Infection rate	▪ AVG relative weight
▪ # of IPD patients	▪ **Complication rate**	▪ **Outcome reports**
▪ # of OPD patients	▪ **Patient file completion**	▪ **Sudden death rate**
▪ **# of cases treated**	▪ **Morbidity rate**	▪ **Mortality rate**
▪ **By doctor**	▪ **Re-surgery rate**	

Table 2: List of Medical Indicators

In addition, the SSB system is more data entry oriented than search oriented. In searching for records, the only searchable criteria are: patient identification data, patient number, and admission number. Ideally, doctors or residents should be able to search by criteria such as the procedure, diagnosis code, complications, and medical indicators among others, but this is not the case. Residents also access to this data for educational purposes, and the staff doctors frequently use these diagnoses as sample data for research. If they are not able to perform these activities, then the Reference Center and the Training program criteria are also being affected by these information management limitations.

Concerning the educational aspect of the training criterion, we identified the inability to store multimedia documents. Once we evaluated the SSB system at Saraburi and Nakornping, it was clear that there were no features that allowed the storage of X-rays, laboratory results, images concerning the progress of a surgical procedure, or surgical videos. All this information was required by the medical staff in the Orthopedic Department, but SSB was not able to comply. The reason for this is that SSB is a general hospital information system that was not designed to comply with the specific requirements of each hospital. This system was not customized for the information management requirements that involve being a Center of Excellence. Since the multimedia documents could not be stored in the SSB software, the training program criterion was also being negatively affected, impeding its fulfillment.

The information management system in the Orthopedic Department has several weaknesses that negatively affect the progress of being recognized as a Center of Excellence. These limitations concern reporting, storing, searching, viewing, and analyzing information that the SSB system does not feature, which affect several criteria concerning the Center of Excellence information management aspects. Therefore, the

implementation of this system will not be sufficient if the Orthopedic Department wants to become an excellent center.

Finding # 3
Lerdsin Orthopedic Department Does not Have the Required Hardware to Support a Hybrid Information Management System

We found that the Orthopedic Department at Lerdsin Hospital did not have the hardware capabilities to support a hybrid information management system. Primarily, the hardware available at Lerdsin would not be able to sustain the SSB implementation nor a custom designed system.

The hardware resources encountered at Nakornping were strictly powering the SSB software. The processing resources of the SSB system at this hospital were three standard Pentium 4 computers, which did not show any signs of overburden during its operation. The storage hardware at Nakornping consisted of three 72.8 GB hard drives (not in a redundant array) and a DAT (Digital Audio Tape) tape backup drive. The information was kept on the hard drives until it aged five years, and then it is transferred to the DAT cassettes for archiving. These processing and storage capabilities were sufficient for the SSB system being utilized. However since the SSB system was not able to meet the requirements of the Orthopedic Department, we also identified the hardware capabilities of the customized system at Saraburi.

Saraburi utilized one Xeon 3 GHz processor for its customized system as well as for the SSB platform. Since this is a single processor it yields more processing power in server applications, compared to the consumer oriented Pentium 4's at Nakornping. The storage system in place at Saraburi Hospital was responsible for the SSB data as well as the scanned patient records and other related information stored in their custom software. The storage capacity of the central server was 240 GB (8 Drives), in a RAID 1 + 0 configuration, meaning there was actually 480 GB of storage, four of the drives are used as mirrors, containing only redundant data incase of hardware failure. In addition to the main server, two data servers were used for additional storage. Each of these contained 240 GB of storage. This hard drive setup, RAID 5, was slightly different from the central server, but still offered data integrity protection. These hardware capabilities allowed Saraburi to store and process all the information efficiently and reliably as possible.

After comparing the capabilities of Nakornping and Saraburi with the ones at Lerdsin, we determined that the hardware installed in the latter will be insufficient in supporting a hybrid information management system. The Orthopedic Department's computer system was composed of a server and 25 computers in use. These computers were located in the two libraries and computer lab, used solely for research and internet access. The server was used as an internet gateway, providing only a secure internet connection to the department. This server had a 450 MHz Pentium 3 processor. It had 160 gigabytes of storage, and there was no data redundancy or backup capabilities. These hardware capabilities were not sufficient enough to sustain the SSB platform or a customized information management system. The processing capabilities are too limited and there is minimal storing capacity. This hardware implemented would not allow the Orthopedic Department to operate a reliable and efficient information management

system that fulfills the reporting requirements and the educational database enforced by the Ministry of Public Health.

In order to assist the Orthopedic Department in their initial steps of becoming a Center of Excellence, we developed a Proof of Concept information management system. The focus of this proof of concept was to show how some of the Orthopedic Department's needs, which would not be satisfied by the SSB system, could be satisfied by a custom-designed information management system. The Proof of Concept provided to the Orthopedic Department addressed three specific problems: Searchable Criteria, Storing Multimedia Documents and Reporting Medical Indicators.

Including accurate searching capabilities would allow more easily to reference view and analyze previous cases and basing treatment decisions on these. Consequently this allows them to provide better care based on the research of the procedures conducted at the hospital. This certainly influence the tertiary care and reference criteria since it provides easier means to reference previous cases, and real patient information that would allow the specialists to improve the quality of the care provided. Since the Proof of Concept system stores multimedia documents, it positively affects the Training program criterion because it can act as a central repository which allows easier access to multimedia documentation of complex procedures. By providing a multimedia database, the educational material is more easily accessible for the residents, which improves the quality of the training program. Reporting eases the monthly reporting to the MOPH and serve as benchmarking indicators in order to analyze and evaluate the performance of the Orthopedic Department. By addressing these issues, the Proof of Concept provides possible solution to the major issues that the Orthopedic Department was facing in their current information management system. This Proof of Concept was a tangible information management system that would help the Orthopedic Department visualize how important the implementation of such a system is in becoming a Center of Excellence.

We used these findings to form recommendations for the Orthopedic Department in order to facilitate the implementation of a new, hybrid information system. Our first recommendation was for the Orthopedic Department to add new features to the Proof of Concept in the future. We also recommended that the Department refine the current features of the system. Our third recommendation was the creation of a development team to expand upon the Proof of Concept. Finally, we recommended the adaptation of the Proof of Concept to the SSB implementation.

Our first recommendation was for the Orthopedic Department to add new features to the Proof of Concept in the future. This included the recommendation to incorporate a feature that allows patient records editing, as well as to incorporate a data validation feature. Both of these would help improve upon the functionality of the system. In addition, we recommended that the Proof of Concept's database structure be altered in order to store more information if the Department considers it necessary. This would help with adapting the system to any future changes.

Our next recommendation was that the Department should refine the current features of the system. Since the Proof of Concept does not report all the necessary medical indicators, we recommended a continuous development to the reporting features. In order to provide additional search functionality, we recommended that the search features in the Proof of Concept be modified to allow users to search by multiple criteria

simultaneously. Along with adding new features, this would help the Orthopedic Department to create their ideal information management system.

Our third recommendation was the creation of a development team to expand upon the Proof of Concept. In doing so, we also we recommended that the development team consist primarily of IT and Orthopedic Department staff. This was due to the fact that these are already existing personnel and would be familiar with the needs and operation of the Orthopedic Department. In addition, if more personnel are needed for the development team and resources are available, we recommended that the hospital should consider reallocating its staff.

Our final recommendation was the adaptation of the Proof of Concept to the SSB implementation. While doing so, we also we recommended that the development team establishes an effective communication channel with SSB. This will hopefully enable them to obtain system structure information faster that the personal examination and evaluation of the system. In addition to communicating directly with SSB, we recommend that the development team correspond with other medical institutions that have already implemented a custom-designed system that interacts with the SSB system.

All of these recommendations were made in order to help the Orthopedic Department take the Proof of Concept we provided and improve it in the future to suit its needs. This process would allow the Department to take control in achieving its goal of becoming a Center of Excellence.

Through our data collection and analysis, we addressed the problems facing Lerdsin Hospital's Orthopedic Department in its goal of being recognized by the Ministry of Public Health as a Center of Excellence. Using what we found through comparing Lerdsin's paper-based information management system, its major impediment, with hybrid systems at Nakornping and Saraburi hospitals, we formed appropriate recommendations for the Orthopedic Department. These recommendations, which addressed the Proof of Concept system we created, will help the Department in its future endeavors regarding its information management system. All of this will help Lerdsin Hospital's Orthopedic Department begin to achieve their goal of attaining the Center of Excellence recognition.

1. Introduction

Medical institutions are one of the main contributors to an individual's quality of life. Their primary goal is to ensure the health of all patients, as suggested by their mission statements. Moreover, medical institutions are expected to provide greater quality and quantity of services as new technologies and treatments are developed (Robeznieks, 2005). This expectation may arise from an institution's governing body or government regulations in the form of standards. In order for the whole system to improve the overall quality of health care, those hospitals that provide excellent service, be it overall or in specific areas of medicine, would need to be recognized and be able to be benchmarked against other hospitals in the system. In doing so, other hospitals would be provided with resources to improve their health care.

Lerdsin Hospital, operated by the Thai Ministry of Public Health, provides medical services to the greater Bangkok area. The Orthopedic Department at Lerdsin Hospital is widely recognized because of successful complex procedures performed at this institution. However, Lerdsin's Orthopedic Department would like to be closer to the target set by the Ministry of Public Health, known as a Center of Excellence. This recognition will open new opportunities that will further improve the quality of care that the Orthopedic Department at Lerdsin Hospital can provide, not only to the people of Bangkok, but to all of Thailand.

Becoming a Center of Excellence involves meeting several requirements that show outstanding quality of medical services in one specific department of a medical institution. These requirements are: offering tertiary care, being a research and development center, a training center, a reference center, a national body and policy advocate, a referral center, and being a node in the inter-hospital network (National Center of Excellence in Otolaryngology, 2004). In order to achieve Center of Excellent status, a hospital must demonstrate achievement of these criteria by reporting hospital performance to the Ministry of Public Health. Our project consisted of investigating the problems facing the Orthopedic Department in becoming a Center of Excellence, as well as to provide appropriate solutions.

It was our goal to assist the Orthopedic Department in becoming a Center of Excellence by providing it with solutions and recommendations to overcome their current problems. In the process of achieving this goal, we will identify the problems existing in the Orthopedic Department and then investigate possible solutions through various research methods. Once this information is collected, an appropriate solution will be developed and recommended to Lerdsin Hospital's Orthopedic Department.

2. Background

Medical service for orthopedics, trauma, cancer, and cardiac, along with other areas of medicine require advanced facilities, equipment, and well-trained staff. The Thai Ministry of Public Health is determined to improve these services in public hospitals. In order to complete this task, the Thai government must establish centers that provide excellent patient care, have modern equipment, and have particularly specialized medical staff. The Orthopedic Department at Lerdsin Hospital believes that it is such a center. However, the Orthopedic Department must be able to prove itself to the Ministry of Public Health by accurately reporting its excellent performance. The goal of this project was to assist the Orthopedic Department in its effort to officially become a Center of Excellence.

In this chapter we will introduce the framework for our research. We will expand upon Lerdsin Hospital's current situation, discussing both internal and external factors that affect the hospital with respect to the Center of Excellence standard. We will further describe the characteristics and requirements that the Orthopedic Department at Lerdsin Hospital needs to meet in order to be recognized as a Center of Excellence. We will then identify the metrics involved in measuring these requirements. Furthermore, this section will address the major obstacle that the Orthopedic Department must overcome in order to officially be recognized as a Center of Excellence: its current information management system.

2.1. What is a Center of Excellence?

A Center of Excellence is a leading medical institution which not only provides excellent patient care, but also contributes to the medical community by conducting complicated procedures and documenting them for future research (Dr. Thavat, personal communication, January 13, 2006). The vision of the Orthopedic Department is to become a Center of Excellence within the next four years. In order to be certified as a

Center of Excellence, there are seven requirements established by the Ministry of Public Health.

- Providing tertiary care
- Running a training program
- Conducting research & development
- Being a referred center
- Being a reference center
- Networking with other hospitals
- Advocating national policy

If the Orthopedic Department is to be recognized as a Center of Excellence, all of these criteria will have to be met and exceeded. The following sections will describe each of the criteria and its metrics, as specified by the Ministry of Public Health. Each criterion must be fulfilled with respect to each of the metrics described in order to gain the Center of Excellence recognition.

2.1.1. Providing Tertiary Care

In the medical service industry, there are three types of patient care: primary, secondary, and tertiary care. Primary care refers to the level of health care at which a patient is evaluated and treated by a family doctor or nurse, or, if necessary, is referred to a specialist. Secondary care is typically provided in local hospitals usually on referrals from primary care. Tertiary care is a specialized consultative care, usually on referral from primary or secondary medical care personnel. It is provided by specialists working in a center that has personnel and facilities for special investigation and treatment for unusual and complex medical problems (Johns Hopkins Medicine Org, 2006).

To be recognized as a Center of Excellence, a department should offer the best patient care. It should also have the finest surgical performance records and must employ the best specialists and sub-specialists in tertiary care services (Dr. Thavat, personal communication, January 13, 2006). Although this is the general description of tertiary care, the specific metrics and standards are set by leaders in the medical industry.

- Metrics

Measuring the performance of any tertiary care unit is complicated because there are several variables involved. The variables involve specific statistics that characterize the hospital's level of patient care. More specifically, they evaluate and assess the quality of the service provided by a tertiary care unit. The metrics that can be used to evaluate the quality of the tertiary care unit are shown in Table 2.1.

- Average length of stay
- Average number of complications
- Average number of infections
- Average number of beds per patient
- Average patient return

Table 2.1: Tertiary Care Metrics

The evaluation of these metrics applies to orthopedic departments that are attempting to be recognized as Centers of Excellence.

2.1.2. Running a Training Program

Training programs are another factor that will be evaluated in the Orthopedic Department's effort to become a Center of Excellence. Training programs are especially important because a well-established program ensures future success of the hospital. The model training program is composed of four years of resident training, during which each resident must specialize in one of the seven areas of orthopedics: arthroplasty, arthroscopy, micro surgery and reconstruction, spine, musculoskeletal tumor, hand, or pediatric surgery. However, in addition to the specialization, during the first year of residency, a resident must complete a rotation between these seven areas of orthopedics. Furthermore, an extensive research paper must also be completed by the resident in his area of specialization. As a government requirement, the resident must also complete a final exam after his fourth year of residency. After passing this exam he is recognized as

a doctor (MOPH, 2005). There are specific metrics to measure the quality of such a training program.

- Metrics

In order to become a Center of Excellence, it is critical for a department to show that its program is superior to other medical training programs. The metrics set by the Ministry of Public Health used to evaluate the quality of a training program are shown in Table 2.2.

- Faculty member to resident ratio
- National examination grades
- Internal Examination (two per semester)
- Faculty recognition
- Awards

Table 2.2: Training Program Metrics

A Center of Excellence must show outstanding performance in each of these metrics in order to be recognized for its excellent training program. By establishing an excellent training program, the future success of the hospital is secured through the education of residents.

2.1.3. Conducting Research and Development

A department which fulfills the research and development criterion of an orthopedic Center of Excellence attracts the brightest minds from academia, industry, and medicine. These Centers of Excellence are focused on finding innovative cures to the medical conditions of patients from several demographics (Dr. Thavat, personal communication, January 13, 2006). The successful conduct of research and development can build on a department's reputation in the medical industry. In addition, research and development will enable Thailand's health care system to excel and improve its image. There are specific requirements regarding the research and development criterion that need to be met by an orthopedic department.

- Metrics

Medical research, if significant, is presented in the form of the research papers and published in medical journals. The residents, as mentioned previously, must complete an extensive research paper in a specific area previously unexamined (Dr. Nok, personal communication, January 12, 2006). Conducting research and development in a Center of Excellence can be measured by the metrics in Table 2.3.

- Number of journal publications
- Ratio of journal publications to doctors

Table 2.3: Research and Development Metrics

Furthermore, it is required by the Medical Board of the Ministry of Public Health that each doctor in a Center of Excellence publishes at least one document in an international medical journal every year (Dr. Thavat, personal communication, January 13, 2006). This requirement encourages every doctor to continue their field research and sets the standard for future residents.

2.1.4. Being a Referred Center

In Thailand, there is a medical network of 25 provincial general hospitals. One of the main attributes needed to be recognized as a Center of Excellence is to be a referred center among these provincial institutions. A referred center, according to Dr. Thavat, is a medical institution specialized in orthopedics, obstetrics, trauma, cancer, etc., to which other medical institutions refer their patients (Dr. Thavat, personal communication, January 13, 2006). For example, being a referred center in orthopedics would involve receiving patients that have critical orthopedic disorders and need to be treated in a specialized care unit such as a Center of Excellence (Dr. Nok, personal communication, January 12, 2006).

In becoming a Center of Excellence, a department should focus on specializing services to treat more complex cases. For example, an orthopedic department will limit its

specialized services to patients who have the most critical conditions and require tertiary care. Patients who are not in need of such care will not be treated by the experts at the center. These patients will be treated by residents and, if appropriate, referred to another institution. This way each Center of Excellence distinguishes itself by specializing in one specific area and treating those patients in need of specialized care.

- Metrics

Measuring how frequently an institution is referred to can only be done by quantification of the referred patients. The metrics established to determine how frequently an orthopedic department is being referred from other institutions, are shown in Table 2.4.

- Number of referred patients
- Percentage comparison of referred patients versus non-referred patients
- Number of referred patients admitted
- Number of referred outpatients treated
- Percent of patients treated with specific tertiary care conditions
- Percent of patients treated with primary or secondary care conditions

Table 2.4: Referred Center Metrics

Although these metrics apply to the Center of Excellence standard, there are other internal aspects that should be addressed beforehand in order to achieve optimal results. For example, to have a larger number of referred patients, the department must have nationwide prestige which is only attained by successfully performing complex procedures. These complex procedures are performed by specialists in an orthopedic department.

2.1.5. Networking with Other Hospitals

A network can be defined as a large and widely distributed group of people that communicate with one another and work together as a unit or system (Encarta, 2005). In

the Center of Excellence context, a network involves having faculty members give lectures and demonstrate special medical procedures at other facilities. It also involves being able to share patient information between all the 25 hospitals. (Dr. Nok, personal communication, January 12, 2006).

- Metrics

Measuring how well a network is implemented can not be quantified with the current information management systems in place at any of the 25 provincial institutions. However, the Ministry of Public Health has been able to compile a list of metrics that apply to the operation of a medical network. The metrics used to quantify this network's performance are shown in Table 2.5.

- Number of residents and doctors interchanged between facilities
- Percent of faculty members lecturing

Table 2.5: Networking Metrics

The network involves exchanging residents from one institution to another, providing residents with a better understanding of the medical industry throughout Thailand. Therefore, the number of residents and doctors from one hospital who are exchanged between the 25 provincial hospitals is a variable that can be measured and benchmarked against other institutions. The second metric relates to the number of faculty members lecturing outside an orthopedic department in relation to the entire medical personnel.

2.1.6. Being a Reference Center

A reference center is an information resource for doctors, residents in training, and scholars. This center acts as a resource for medical information regarding interesting and complex cases, as well as statistical data concerning diagnoses, surgical procedures, and other medical treatments. In addition, it is an institution that hosts and participates in international conferences and lectures. Furthermore, being a reference center involves

contributing information to the National Report of Orthopedics. The Ministry of Public Health uses this information to develop an accurate representation of the current state of Thai health care.

- Metrics

The specific metrics pertaining to being a reference center are shown in Table 2.6.

- Number of international conferences hosted
- Number of international conferences attended
- Number of doctors lecturing internationally
- Number of times referenced in national report

Table 2.6: Reference Center Metrics

Quantifying the number of international conferences hosted and attended by the different medical institutions is the most appropriate metric in evaluating the performance of a reference center. Besides this, it is also important to determine the number of doctors who are lecturing internationally since this reflects the quality and expertise of the medical staff trained in Thailand.

2.1.7. Advocating National Policy

A Center of Excellence must be able to act as a policy advocate, acting in the best interest of the Thai population. The primary purpose of being a policy advocate is to serve as a reliable source providing preventative medical recommendations to the general population through the Ministry of Public Health (Dr. Thavat, personal communication, January 26, 2006). For example, promoting an osteoporosis awareness weekend, holding seminars, exercise classes, etc. With this information in hand, the Ministry of Public Health will be able to run medical campaigns attempting to reach the entire population providing it with knowledge about preventions concerning possible conditions.

- Metrics

The Ministry of Public Health will evaluate the performance of an institution as a policy advocate using the metrics shown in Table 2.7.

- Number of radio addresses
- Number of television appearances
- Volume of printed matter
- Number of public screenings (e.g. Mammograms offered free of charge)
- Number of public educational lectures

Table 2.7: National Policy Advocate Metrics

The number of television, radio appearances, and printed matter is used to measure the influence the policy maker has on the general population. As the number of appearances and prints increases, it is assumed that the population will become more informed, increasing the success of the campaign. Screenings and educational lectures provide direct contact with the public. Public screenings are an attempt by the medical industry to broadly expose preventative services to the population.

The criteria described above are essential in a department's quest to become a Center of Excellence. In combination, meeting these criteria will provide preventative medical services to less fortunate individuals, as well as making the general public more health conscious. Each national policy advocate established will further improve the quality of the public health care system, which is the Ministry of Public Health's goal.

2.2. Lerdsin Hospital

Originally opened in 1889 as a nursing home called Bangrak Hospital, Lerdsin Hospital was transferred to the control of the Thai Ministry of Public Health in 1957. After a generous donation by Khunying Pakdi Norased Sin Settabut in the amount of $27,000, Bangrak Hospital was renamed Lerdsin Hospital after the donor's late husband Praya Pakdi Norased Lerd Settabut (Giddings et al, 2005). In the past, Lerdsin Hospital has received the distinguished award for best hospital care (See A5). Of all the

departments at Lerdsin Hospital that helped attain this distinction, the Orthopedic Department is one of the most prestigious and recognized.

2.2.1. The Orthopedic Department at Lerdsin Hospital

The Orthopedic Department is a tertiary care facility with a full staff of specialists and general practitioners. In addition, it is a research center and an academic institute with training programs in all areas of orthopedics. Lerdsin Hospital hosts numerous meetings and international conferences in the orthopedics field. Furthermore, research performed in the Orthopedic Department is often published in international journals. Frequently, this research is used to develop national health policies. As part of its networking strategy, the Orthopedic Department sends doctors to train medical staff at other facilities. Being a tertiary care facility, the Orthopedic Department often receives referred patients from these other facilities. These characteristics describe a Center of Excellence. However, Lerdsin Orthopedic has to overcome several challenges that prevent it from fully meeting the Center of Excellence criteria.

2.2.2. Evaluating the Orthopedic Department as a Center of Excellence

In order to assist the Orthopedic Department in achieving its goal of being recognized as a Center of Excellence, we first needed to identify the factors preventing it from fulfilling each criterion. The following sections will describe the weaknesses present in the Orthopedic Department within each criterion of the Center of Excellence.

2.2.2.1. Problems With Respect to Tertiary Care

A Center of Excellence must show success in treating the most advanced cases. In order to show this success, the institution is responsible for reporting statistical data with respect to the metrics previously mentioned. Only after reporting consistently good performance, is an institution recognized as a tertiary care unit.

In order for Lerdsin Orthopedic to submit reports to the Ministry of Public Health, the information has to be gathered manually from paper records. This process is time consuming and inaccurate. In order to address this issue, there must be a means to easily generate the necessary reports. If implemented correctly, an information management system can efficiently manage and report these data.

2.2.2.2. Problems With Respect to Training

An excellent training center must provide a successful education program as evaluated using the metrics previously stated. While this is based on educational doctor-resident interaction, educational resources available to the residents are also critical.
The excellent education of residents is a top priority in the Orthopedic Department at Lerdsin Hospital. Currently there are three main educational resources: medical records, library, and practical experience.

Although the Orthopedic Department's library's collection of books, encyclopedias, and journals support the theoretical component of the resident education, it lacks technological features of a modern library. Ideally, a digital collection of multimedia archives would be present in the educational facilities of an orthopedic department, providing a technologically-enriched education. Currently, the information management system lacks a digital medium that can be used for educational purposes, thus impeding the Orthopedic Department in achieving its goal. The inception of an information management system able to archive multimedia would therefore assist the Orthopedic Department in becoming a model Center of Excellence (Dr. Thavat, personal communication, January 13, 2006).

2.2.2.3. Problems With Respect to Research and Development

Research and development excellence is achieved by demonstrating successful research through journal publications. Lerdsin Orthopedic Department already has stringent publication requirements. In order to access information on these publications

the department relies on an external source, Pub Med, which has limited capabilities. These capabilities include searching by author, subject, and title and viewing the abstract of a publication. Unfortunately, the user can rarely view the entire article online. These limitations make the research process difficult. Therefore, it would be ideal to have an information management system that can manage and store journal publications by the medical staff at Lerdsin Hospital.

2.2.2.4. Problems With Respect to Referred Center

Being a referred center complies with the Ministry of Public Health's goal of creating a network of tertiary care units. The main problem concerning being a referred institution is the inability to determine the volume of referred patients to the Orthopedic Department. Since the Orthopedic Department is such a recognized institution, several provincial hospitals refer patients to seek tertiary care at Lerdsin Hospital. The ability to easily measure this information will assist the Orthopedic Department in reporting it to the Ministry of Public Health. Currently, the information management system does not provide an automated process that reports the number of referred patients, referred patients admitted, referred patients treated, etc. Even though there are fewer metrics involved when compared to the tertiary care metrics, it is still a time consuming process to manually collect the data. It would be optimal to have an information management system capable of easily and quickly generating reports containing this information.

2.2.2.5. Problems With Respect to Networking

Networking with other hospitals requires the frequent exchange of medical staff, for both lecturing and practicing. Lerdsin Orthopedic frequently exchanges residents and doctors between institutions, however there is not a simple way to collect these data and report them to the Ministry of Public Health. Implementing an information management system with such capabilities will demonstrate the Orthopedic Department's networking performance.

2.2.2.6. Problems With Respect to Being a Reference Center

As a Center of Excellence, an institution must be able to report the number of international conferences hosted, as well as the ones attended at other institutions. In fact, it should be able to provide detailed information about these lectures, concerning the subject, attendees, speakers, etc. This information is important to the Orthopedic Department since it serves as a record of international recognition and conference participation. However, the medical staff is not able to access and reference this information easily since the current information management system does not have these features. This information is required in the reports to the Ministry of Public Health because it provides data reflecting a hospital's participation and involvement in the international health care community.

Another aspect of being a reference center is to become a source of medical data for doctors, residents, or other medical professionals. This is closely related to the educational aspect of being a Center of Excellence, but involves supplying information to medical personnel who are not in-house residents. This means that the Orthopedic Department must provide a means of external access for those in need of information previously collected through research at Lerdsin Hospital. In relation to the metrics in Table 2.6, by determining the number of individuals who reference the Orthopedic Department as a source of information it will be able to benchmark these figures against other institutions, measuring its own prestige in the medical community. This could be achieved though an information management system that facilitates external access by users who are not residents in training at the Orthopedic Department.

2.2.2.7. Problems With Respect to Policy Advocacy

The Ministry of Public Health requires any hospital with Center of Excellence status to frequently reach out to the public, by initiating preventative health care. In addition to providing these services, a Center of Excellence must also provide data to the Ministry of Public Health indicating the need for such programs. In order to comply with

the requirements of the Ministry of Public Health, the Orthopedic Department needs to report statistics concerning major conditions or diseases that could be prevented through mass communication with the public in the form of public service announcements. This information is obtained through research and development done in the Orthopedic Department. With this information, the Ministry of Public Health, in collaboration with the Orthopedic Department, provides preventive campaigns that act in the best interest of the general public. One way of measuring the department's performance is by utilizing the metrics in Table 2.7. Under the current information management system there is not a simple and efficient way to compile this information. Implementing an information management system with capabilities to report this information, as well as acting as a reliable source in recommending policies, would allow the Orthopedic Department to overcome this impediment.

2.2.3. Problem Synthesis

The aforementioned weaknesses with the current information management system at Lerdsin's Orthopedic Department are the primary reason why the Department is struggling to become a Center of Excellence. These weaknesses are outlined in Table 2.8.

Tertiary Care	Training	R&D	Referred
Cannot report tertiary care Indicators	No multimedia or educational database	No journal database	Cannot report referral rate
Cannot access patient records in real-time	Cannot search by procedure	Cannot search by procedure	

Networking	Reference	Policy Advocate
Cannot report sending and receiving staff for practice	No multimedia or educational database	Cannot report diseases
Cannot report sending and receiving staff for lectures	Cannot report conference attendance	Cannot report efforts in promoting policies

Table 2.8: Weaknesses Identified at Lerdsin Hospital (By Criterion)

Examination of Table 2.8 reveals that there are three categories of weaknesses preventing Lerdsin Orthopedic from becoming a Center of Excellence, as shown in Table 2.9.

Ability to Meet External Reporting Requirements (MoPH)	Ability to Manage Digital Patient Records / Electronically Registered Patients	Ability to Meet the Training Program Requirements
Cannot report tertiary care indicators	Cannot search by procedure	No journal database
Cannot report diseases		No educational database
Cannot report referral rates		No multimedia database
Cannot report conference attendance		
Cannot report efforts in promoting policies		
Cannot report staff visitations		

Table 2.9: Weaknesses Identified at Lerdsin Hospital (By Weakness Category)

Since the major problem facing the Orthopedic Department's goal is the current, paper-based system with its multiple weaknesses, the logical solution to their problem is the implementation of a new information management system. The new information management system should include reporting, searchable digital patient records, and multimedia database functions in order to provide solutions to Lerdsin Orthopedic's dilemma. Since there are two options regarding which type of information management system would work best, it is important to know the differences between them.

2.3. Possible Solutions for the Orthopedic Department

Information management systems can be classified into three groups: paper systems, computerized systems, and a hybrid of the both. A paper system is currently in place in the Orthopedic Department, and unfortunately it has several weaknesses and limitations to consider an improved paper system as a possible solution. Computer systems are a product of relatively new technological developments and provide an increase in productivity, since it automates several previously manual processes, among other advancements. However, there are two major constraints that do not allow the Orthopedic Department to adopt this type of system.

The first constraint is that current government regulations require paper records to be kept for a period of five years after a patient's discharge. Thusly, Lerdsin Orthopedic

is restricted from going paperless. The second constraint is the lack of financial resources for adopting a completely computerized information management system. Since this constraint also prevents the orthopedic department from adopting a fully computerized system, the only option left is the implementation of a hybrid information management system.

2.3.1. Description and Benefits of Hybrid Information Management Systems

A hybrid system can be anywhere between a paper system and a computerized system. Realistically, this is where most real systems lie. Implementing a balance between paper and computer system, a hybrid system can achieve benefits of both types. Benefits of a hybrid paper-computer system can be numerous depending on the requirements and constraints of the implementation. More specifically, any possible benefit to a computer system such as, versatility, efficiency, or sophistication is a function of the weaknesses: high start-up cost and highly trained staff. With the benefits as variable functions, the hybrid system can be implemented to meet specific needs provided the given constraints. This requires a significant amount of research in order to customize a system for a department. However, as is in the case of Lerdsin's Orthopedic Department, it is the only option for improvement.

2.4. Conclusion

This section provided a clear description of the requirements in becoming a Center of Excellence and the metrics of evaluation. It also included a detailed assessment of the Orthopedic Department's current status with respect to the Center of Excellence criteria, identifying major weaknesses and limitations that are related to the information management system in place. Since the Orthopedic Department's staff wants a faster, software-based system but are required to maintain the paper system by Ministry of Public Health regulations, the only possible solution would be a paper-computer hybrid

system. The next step in our project is to investigate possible hybrid information management systems that will overcome these limitations. By completing this we will be able to provide thorough and accurate recommendations as to what is the best approach to solve this information management problem, henceforth assisting the Orthopedic Department in achieving its goal.

3. Methodology

The goal of our project was to assist the Lerdsin Orthopedic Department in becoming a Center of Excellence by providing a proof of concept hybrid information that addresses the weaknesses identified in our Background chapter. In order to attain this goal, our first objective was to determine the strengths and opportunities of hybrid information management systems with respect to the Center of Excellence criteria. Our second objective was to design a proof of concept information management system that will support the Orthopedic Department's goal of becoming a Center of Excellence, including recommendations for implementation. This chapter will explain the methods used to collect and analyze information needed to complete our objectives, ultimately achieving the goal of our project.

3.1. Determining the Strengths and Opportunities of Hybrid Information Management Systems

In the previous chapter, we identified numerous weaknesses in the current information management system. This chapter will be focusing on determining the strengths and opportunities of existing hybrid systems. In order to do this, we visited hospitals that shared characteristics with Lerdsin Hospital, but utilized a hybrid information management system. The similar characteristics we were looking for were that the institutions chosen must be funded by the Ministry of Public Health and share the same goal of having one of their departments become a Center of Excellence.

Nakornping Provincial Hospital and Saraburi Central Hospital were chosen as our sample space. We chose these two hospitals based on two sampling types: purposive and convenience. Purposive sampling was the primary reason since both hospitals utilize hybrid systems and this directly relates to our objective. In addition, convenience sampling was our second reason, due to pre-existing relationships between our sponsor and these institutions, as well as our geographic and time constraints. The methods by

which we evaluated the information management systems are explained in the following sections.

3.1.1. Evaluating Hybrid Information Management Systems

In order to accurately identify the strengths and opportunities of the hybrid systems at Nakornping Provincial Hospital and Saraburi Central Hospital we employed the same approach for both visits. The methods used to identify strengths and opportunities were standardized interviews, non-standardized interviews, and field observation. Standardized interviews were used because the questions asked followed a specific order and concerned a subject that was extremely familiar to us, the Center of Excellence criteria. Non-standardized interviews were focused on the actual hybrid systems in place at each institution, since we were not as familiar with the actual features and capabilities of them. Furthermore, probing questions were asked during the interviews if we felt they would contribute important information to our analysis. We conducted interviews with individuals who were familiar with the subject matter: specialists in the Information Technology Department, executives, and medical specialists from each hospital. Field observation provided a direct and unbiased perspective on the operation of the hybrid information management systems. The following subsections will provide a detailed description of the methods composing this systematic approach.

3.1.1.1. Conducting Standardized Interviews

Standardized interviews were chosen as a research method for collecting information concerning the status of the Trauma Departments in Nakornping and Saraburi Hospitals with respect to Center of Excellence criteria. In addition, these interviews were used to collect general information about each institution. Due to the nature of the data being collected, the target population needed to be familiar with the mission, goals, and present state of the medical institution.

In Nakornping hospital, we interviewed key personnel including the Director of the Orthopedic Department, one of the specialists of the Trauma Department, and the

Director of Nursing in the Orthopedic Department. In Saraburi Central Hospital we interviewed the following staff: the Director of the Orthopedic Department and two specialists who worked in the out-patient unit of the Orthopedic Department.

Evaluating the hospitals with respect to their fulfillment of Center of Excellence requirements provided a framework for analyzing their hybrid information management systems. In this manner we assessed the performance of their information management system in supporting the goal of becoming a Center of Excellence. The variable for which we collected data using these standardized interviews was the progress of the institution in fulfilling the Center of Excellence criteria. The interviews conducted to measure this variable were structured as shown in Table 3.1.

- What is the overall mission of the medical institution?
- What departments are striving to become Centers of Excellence?
- What is currently impeding these departments from being Centers of Excellence?
- What is the patient capacity of the hospital?
- What type of care is provided: primary, secondary, or tertiary?
- Explain the details of the training program
- How frequently are patients referred to this institution?
- What kind of research is conducted by specialists here?
- Does the institution host and/or attend international conferences?
- Is the computerized system used for educational purposes?
    - If yes, how?
- What information is included in reports to the Ministry of Public Health?

Table 3.1: Nakornping and Saraburi Standardized Questions

These raw data were then analyzed in order to identify the standing of each medical institution with respect to the Center of Excellence criteria. To quantify this variable, we classified it into three distinct stages of fulfilling each Center of Excellence criterion: nonexistent, partial, and complete. Presenting the analysis of the data in a visual manner showed if there was a relationship between the Center of Excellence achievement and the presence of a hybrid information management system. This relationship would

indicate the impact that a hybrid information management system has on the medical institution's status of becoming a Center of Excellence.

3.1.1.2. Conducting Non-Standardized Interviews

Non-standardized interviews were used to collect information about the hybrid information management systems. This data collection method was used because the characteristics of each system were different. Therefore, the questions asked at each institution pertained to the characteristics of each of their systems. Open-ended questions were asked regarding the capabilities of the hybrid systems, more specifically identifying the strengths and opportunities of each one. The questions were asked specifically to the Director of the Orthopedic Department and the Director of the Information Technology Department at both institutions. These executives had extensive knowledge concerning the subject of our questions and provided accurate information for our analysis. The variables pertaining to this data collection method were:

- Ability to manage digital patient records and electronically register patients
- Ability to meet the external reporting requirements of the Ministry of Public Health
- Ability to meet the training program and reference center requirements

It is important to note that the hybrid information system at Saraburi Central Hospital was composed of two software programs: SSB and a custom designed system. Hence, the questions asked at each institution differed since they addressed specific characteristics of each hybrid system. The questions shown in Table 3.2 were asked at both Nakornping Hospital and at Saraburi Hospital to both the Director of the Orthopedic Department and the Director of the Information Technology Department.

- Is the hybrid information management system used for education, such as referencing interesting or special cases?
- Is the hybrid information management system capable of storing and cataloging multimedia?
- How does the medical staff conduct research? Is the hybrid information

management useful? Why?

- Is the hybrid system used to generate the monthly reports to the Ministry of Public Health? If yes, what data is included in the monthly reports to the Ministry of Public Health?
- Is there any information in the monthly reports that is not stored in the hybrid information management system? If so, what is this information, and where does it come from?
- Is there a digital copy of the patient record in the hybrid information management system?
- Is the entire patient record digitally stored or only specific information? What information?
    - Does the medical staff publish journals? If yes, are they stored as digital copies in the hybrid information system?

Table 3.2: Nakornping and Saraburi Non-Standardized Questions

The questions in Table 3.3 concerned the custom designed system at Saraburi Central Hospital.

- Can financial and/or non-financial information be accessed in real time?
- What type of documents does the custom-designed system store
- How long did development take?
- Is the custom-designed system used for reporting?
- What were the reasons for designing this additional system?
- What features did the custom-designed system add to the information management system?
- What other benefits are provided by this custom-designed system?

Table 3.3: Saraburi Hospital Non-Standardized Questions Regarding Custom-Designed System

The information gathered from responses to these questions provided us a clear description of the capabilities of the hybrid information management systems. We used these descriptions in order to evaluate and compare the hybrid systems in these medical institutions to the information management system in the Orthopedic Department. We compared the capabilities of the hybrid systems using a binary classification. This means that we indicated the presence or absence of the capabilities evaluated. The presence of

each capability was considered a strength or opportunity; the absence was considered a weakness. Although the standardized and non-standardized interviews provided valuable information, we needed to observe the hybrid systems in operation to gain a more in depth perspective.

3.1.1.3. Performing Field Observation

The field observation research method was used to obtain first hand information concerning the operation and capabilities of the hybrid information management systems at Nakornping and Saraburi Hospitals. At both institutions, we examined each stage of the patient flow process that involved the utilization of the information management system. This first hand experience complemented the interviews, giving us a clear standpoint in order to complete our first objective.

During this field observation, we needed to evaluate several variables that would enable us to determine the capabilities of the information management systems. We used the variables from the previous method, but addressed the specific weaknesses identified in our Background chapter. The following list identifies the general and the specific variables:

1. Ability to meet external reporting requirements (MoPH)
    - Number of patients
    - Diagnosis breakdown
    - Procedure breakdown
    - Financial reports
        - Income statement
        - Balance sheet
        - Cash flows
    - Length of stay (LOS)
    - Average Relative Weight (AVG RW)
    - Infection Rate (IR)
    - Mortality Rate (MR)
    - Readmission Rate (RA)

- Re-surgery (RS)

2. Ability to manage digital patient records / electronically register patients
    - Secure storage
    - Check appointments
    - Easy registration
    - Simple & Fast
    - Real time
    - Reliable storage
    - Tracking of records
    - Search records
3. Ability to meet the training program requirements
    - Journal database
    - Multimedia database
    - Patient records database

After identifying these variables, it was important to conduct the tours at each medical institution systematically in order to ensure the precision of the information obtained. Table 3.4 lists the activities, describing in detail, the field observation conducted at Nakornping and Saraburi.

- Patient Registration/Verification
- Orthopedic Out-Patient Department and waiting room
    - Diagnosis
    - Treatment
- Orthopedic In-Patient Department
- Information Technology Department

Table 3.4: Field Observation at Nakornping and Saraburi

In each of the departments listed in Table 3.4, we observed how the hybrid information management system was utilized. In the first activity, we observed the efficiency of the hybrid system in quickly registering the patient. In the next, we observed how the system was used to record the entrance of a patient to the Orthopedic

Department. We evaluated the data entry method and rapidness. In this activity, we observed how a patient was diagnosed, treated, and how this information was entered into the system. Once we completed this, we continued to observe how the hybrid system was utilized in the In-patient Department. In doing so we observed how the system aided the medical staff in tracking the status of the patient. After completing the tour of the medical facilities, we visited the Information Technology Department. There we observed how the information was managed and updated using the hybrid system. More specifically, we were able to see, first hand, the capabilities of the system with respect to the problems identified in the Orthopedic Department. After completing this observation, we needed to analyze these data.

The data collected concerning the features and capabilities of the systems falls under the classification of qualitative data. In order to analyze this qualitative information we expanded the binary classification used in the analysis of the non-standardized interviews. Since the information collected during the field observation pertained to the same material as the data from the interviews, we were able to analyze it in the same manner. This provided a systematic approach in combining the information gathered from the various research methods. Data collected from field observation verified and complemented the information collected through interviews. By choosing this method, we were able to see all the features of the hybrid information management systems in operation. This supported the information gathered from the interviews and helped us to complete our first objective.

3.2. Designing a Proof of Concept System that Supports the Orthopedic Department's Goal of Becoming a Center of Excellence

This objective focuses on determining the needs and requests of the Orthopedic Department, specifically pertaining to information management. However, we needed to consider that the Orthopedic Department had already scheduled the implementation of the SSB hospital system for 2007. Therefore the design of the proof of concept system needed to satisfy the needs and requests of the medical staff, as well as to be able to

adjust to the SSB platform. In order to achieve this objective, it was necessary to complete the following three stages: identifying the specific information required by the Orthopedic Department, determining the limitations of the SSB system, and determining hardware requirements of hybrid information management systems. Once this information was collected it was possible to determine an appropriate implementation strategy for the Orthopedic Department.

3.2.1. Determining the Needs and Requirements of the Orthopedic Department

In determining the needs and requirements of the Orthopedic Department, we selected non-standardized interviews as our data collection method. The reason behind using this method was that the medical staff working in the Orthopedic Department will be the primary beneficiaries of the implementation of a hybrid information management system. Therefore, it was important to consider what the system will be used for in order to make it as effective as possible. The method of doing this was interviewing the medical staff in order to gain their perspective on the features of an effective information management system implemented in the Orthopedic Department.

3.2.1.1. Conducting Non-Standardized Interviews

The first stage in completing our second objective was to determine the information requirements of the Orthopedic Department. We collected these data using non-standardized interviews with members of the medical staff of the Orthopedic Department. The staff selected formed a purposive sample. This sample included the Director of the Orthopedic Department, Dr. Thavat, a fourth year resident and information technology specialist, Dr. Chavanont, third year resident, Dr. Deb, and second year resident, Dr. Visit. The Director of the Orthopedic Department was a key member of our sample space due to his expert knowledge of the needs and operations of the Orthopedic Department, as well as his leadership role. In addition, our sample included the aforementioned resident doctors due to their English proficiency, time

availability, and the fact that they will be the primary users of the information management system.

The variables identified in this first stage were the main features and capabilities required by the Orthopedic Department. These were classified into three categories: searchable fields, report generation, and multimedia capabilities. This classification was based on the weaknesses identified in the information management system of the Orthopedic Department and is outlined in the Background chapter. In order to gather data concerning these variables, the questions in Table 3.5 were asked in the form of non-standardized interviews.

- What data must be included in the system concerning:
  - Searchable Data?
  - Multimedia documents?
- What data needs to be reported to the Ministry of Public Health?
- What data needs to be reported internally?
- Where is this data coming from?
- Are there interdependencies among the information required?
- In what form is this data currently stored?
- Will the current information be updated to the new system?

Table 3.5: Lerdsin Hospital Non-Standardized Interview Questions

The information collected was analyzed in order to design a generalized database structure. This analysis was performed by identifying data dependencies along with data association, in order to define a suitable structure for the database. A normalized structure can be derived from analyzing the relationships between different pieces of information, eliminating the presence of redundant data. We used a qualitative analysis technique in order to classify it into the three categories identified: searchable fields, report generation, and multimedia capabilities. Once we determined and analyzed the needs and requirements of the Orthopedic Department, we needed to identify what information would be provided by the SSB platform in order to realize its limitations.

3.2.2. Determining the Limitations of the SSB System

Since our Proof of Concept will work in conjunction with the new SSB system it was imperative that we understand how the system worked so that the new database could be adapted to the new SSB system. Research on the SSB system was primarily done at Nakornping and Saraburi Hospitals in the form of non-standardized interviews and field observation. Both institutions currently use an SSB system. Demonstrations of the software and interviewing the staff members who used it provided us with insight on what information was stored. At both hospitals we focused our technical questions on what data SSB handled, and how it handled it.

3.2.2.1. Conducting Non-Standardized Interviews

Non-standardized interviews were used to collect information about the two SSB systems. This data collection method was used because the daily users of the systems could provide specific information about the limitations of the system concerning: searchable fields, report generation, and multimedia capabilities. These daily users were the Director of the Information Technology Department and the Director of the Orthopedic Department at Saraburi and Nakornping Hospitals, who formed the sample from which we collected data. Specific questions were asked regarding the constraints of the SSB systems.

In order to determine whether the SSB software fulfilled the specific needs and requirements identified in the previous section, we needed to gather information on the ability to:

- Search by the criteria identified by the Orthopedic Department
- Generate reports regarding the information required by the Orthopedic Department
- Store multimedia documents similar to those required by the Orthopedic Department

Therefore, the questions asked in Nakornping and Saraburi hospitals concerned the ability of the SSB platform to fulfill these requirements. In addition, since Saraburi

Hospital designed a custom complementary system, we were able to ask similar questions addressing the capabilities of this system. Besides these questions, we were also interested in the interaction of the SSB and the custom designed system. Table 3-6 contains questions that were asked concerning this interaction.

- Is there information stored that can be viewed, but can't be used to generate reports or searched, in the SSB system?
  - If yes, what kind of information?
- Can this information be accessed by the custom-designed system?
  - If yes, how?

Table 3.6: Non-Standardized Questions Regarding Saraburi's Custom-Designed System

After collecting the information concerning the limitations of SSB and the interaction with the custom designed system, we were able to determine the actual capabilities of these hybrid platforms. Furthermore, with the information gathered at Saraburi Hospital, we were able to determine how the SSB platform can interact with custom designed software. In order to analyze this information we developed a comparison chart that helped us assess the ability of SSB to store multimedia documents, generate reports, and search throughout the system. This comparison tool classified the information gathered into three levels: absence of information, presence of information but lack of means of access, and presence of information including means of access. By doing this we fully understood the capabilities and limitations of the SSB system, and how the limitations can be circumvented with the implementation of a custom designed system.

3.2.3. Determining the Hardware Requirements of the Hybrid System

In addition to the specific data desired within a new system, we had to be concerned with what hardware would be required to support it. Due to Lerdsin Orthopedic operating on a paper system, they currently do not have the necessary hardware to support a hybrid system. In order to make this recommendation, hybrid

systems at Nakornping and Saraburi were evaluated using standardized interviews with the IT staff. Supplementary archival research was done to calculate the hardware requirements specific to the unique needs of the Lerdsin Orthopedic Department.

3.2.3.1. Conducting Standardized Interviews

In order to collect data on the specifications of hardware supporting hybrid systems, standardized interviews were utilized. Standardized interviews were used because we were aware of what specific data needed to be collected. These interviews were specifically conducted with the information technology personnel at Nakornping and Saraburi Hospitals since they are experts in the hardware specifications. To select our sample space, we relied on purposive and convenience sampling. Nakornping and Saraburi were the most convenient samples since Nakornping and Saraburi utilized SSB; although Saraburi Hospital complemented the SSB platform with a custom system. Since Saraburi utilized this custom designed system, we interviewed the Director of the Information Technology Department who personally designed and implemented this system.

In supporting a hybrid system, there are several variables involved in hardware selection, such as processing power, storage capacity, storage redundancy, and backup storage. Processing regards how many simultaneous users the system can support and the speed at which reports are generated and searches completed. Storage deals with the sheer information capacity of the system, as well as the reliability of the information.

In order to systematically collect information regarding how each of the two hospitals addressed these hardware needs, we devised standardized questions relating to processing and storage requirements. These questions are listed in Table 3.7.

- What are the specifications of the computers used to support the system?
- How many of these computers are used to support the system?
- What medium is used for backing up data?
- How much storage does the system require?
- Is any data redundancy method used in this configuration?

- How long do you retain digital patient records? - On average, how big is each patient file?

Table 3.7: Standardized Questions Involving Hardware Requirements

From the information collected about the hybrid hardware configurations, we could set a basis on which we could build our recommendation. In analyzing this information, we considered the functions the hybrid systems were responsible for in comparison to the functions required of our system. Using the data collected about patient record retention and file size, we could calculate if Lerdsin Orthopedic would require more or less hardware.

From interviewing the IT staff at the two hospitals we could create a partial recommendation for what hardware was required to support the functionality of the systems. Although since the custom system for Lerdsin Orthopedic has its own unique features, the recommendation needed to account for these additional features.

3.2.3.2. Performing Archival Research

The custom system for Lerdsin Orthopedic is unique in the fact that it will be used as a multimedia database. Since there was no sample available to provide information on the multimedia database hardware requirements, archival research was the selected data collection method. The internet was used as a resource for acquiring information pertaining to digital photograph and video file formats. This was the selected resource due to the abundance of information available on different format standards.

Numerous video and photograph formats are available, each with strengths and weaknesses. In order to select the most appropriate formats for hospital use, we devised a list of variables we could measure, described in Table 3.8.

Photos - Image compression (mono) - Image quality (mono) - Image compression (color)

- Image quality (color) Videos - File size to quality ratio

Table 3.8: Multimedia Format Variables

To collect these data, we cited the official specifications of the most popular formats. Additionally, we complemented the official data with numerous technical reviews. The official specifications provided us hard data on the formats, while the technical reviews gave us practical insight into exactly how well each of them performed.

In order to analyze this information, we created a comparison chart in which we identified how well each of the formats satisfied each variable from a scale of 1-10. This provided us with a visual tool to supply evidence as to which was the best choice for each variable. Once the formats were selected, we could calculate the additional requirements of the custom system.

With the information found through standardized interviews, in conjunction with the archival research conducted, enough data was provided to calculate an estimate as to what the hardware requirements of the system would be. These data were also used to construct the multimedia elements of the proof of concept system.

3.3. Barriers encountered in the data collection process

Until now we have discussed all the research conducted at Saraburi and Nakornping Hospitals. However, we encountered several barriers and limitations before its completion. One of the first limitations we came across was that most of the hospitals that had departments in the process of becoming Centers of Excellence were outside of the Bangkok province. Since our time frame was seven weeks, we were not able to allocate much of our resources in traveling. In addition to this, our sponsor, Dr. Thavat, had limited time with us and asking him to arrange such visits and attend them with us was unreasonable and unnecessary. However, due to the convenience of our agenda during the beginning of the project, we were able to visit Nakornping Hospital located in the Chiang Mai province. While researching for another institution to visit, we discovered Saraburi Hospital, in Saraburi province. This institution is located 155 km away from the

Bangkok metropolitan area. The location of these two hospitals was convenient at the time of visit, helping us overcome this limitation. Since we were in Chiang Mai on a trip with the project center, the trip to Nakornping was feasible. The visit to Saraburi was arranged by our sponsor, and his connections between both hospitals helped facilitate our observation of the two institutions.

Another explicit limitation for us was the language barrier. During the interviews, we attempted to be as clear as possible with each question asked. Even though most of the executives and specialists were proficient in English, sometimes the question was perceived in a different context, thus it was not accurately answered. If this occurred, we had to rephrase the question, conveying the intended message in a different clearer manner in order to receive the most accurate answer. We faced and addressed this problem throughout both visits in order to collect the most reliable data.

The barriers we encountered did not greatly hinder our data collection process. Though it was difficult at times to communicate with certain staff at all three hospitals due to the language barrier, our data collection did not suffer greatly because we were able to solve the problem through simple rephrasing.

3.4. Conclusion

To meet the goal of our project, we set two objectives. The first was to determine the strengths and opportunities of hybrid information management systems with respect to the Center of Excellence criteria. We did this by investigating the systems in place at Nakornping and Saraburi Hospitals. This was done to determine what aspects of a hybrid system through which Lerdsin would benefit most.

Our second objective was to design a proof of concept information management system that will support the Orthopedic Department's goal of becoming a Center of Excellence, including recommendations for implementation. The purpose of this was to determine the nature and details of the content of the information management system that Lerdsin wanted. In doing so, we also discovered the limitations of the SSB system and also ascertained the hardware requirements that the Orthopedic Department would need in order for a new system to be installed and maintained.

Using these data, we formulated recommendations for the implementation of a new information management system in Lerdsin Hospital's Orthopedic Department. This implementation will assist them to achieve their goal of becoming a Center of Excellence.

4. Findings and Discussion

Once we completed the analysis of the information gathered from Lerdsin, Nakornping, and Saraburi, we identified two key factors relevant to the implementation of a new hybrid system in the Orthopedic Department. The first major finding was that implementing a hybrid system in the Orthopedic Department will be a crucial step in attaining the recognition of a Center of Excellence. This finding was the result of a comparison between the features and capabilities of the hybrid systems evaluated at Nakornping and Saraburi. The second major finding was that the SSB system to be implemented at Lerdsin will be insufficient in fulfilling the goal of becoming a Center of Excellence. This was the result of determining the limitations of the SSB system with respect to the reporting aspects of several Center of Excellence criteria. Our last finding was that the hardware capabilities in place at the Orthopedic Department will be inadequate in supporting the implementation of a hybrid information management system. The analysis of these findings explained in the following sections helped us design a proof of concept information management system and formulate solid recommendations for the Orthopedic Department.

4.1. Implementing a Hybrid System in the Orthopedic Department Will Be a Crucial Step in Attaining the Center of Excellence Recognition

Our first finding was that implementing a hybrid information management system in Lerdsin's Orthopedic Department will be a major step in attaining the Center of Excellence recognition. This finding was the result of identifying the strengths and opportunities in the hybrid systems at Nakornping and Saraburi Hospitals. In doing so, we concluded that the Orthopedic Department will need a hybrid information management system similar to those in place at the institutions visited in order to become a Center of Excellence.

The qualitative analysis of the data gathered was conducted by determining the capabilities of each hybrid system using a binary classification table. This table was organized by indicating the presence or absence of the variables identified in order to determine whether or not the information management systems fulfilled the requirements for Center of Excellence. The variables were identified by conducting non-standardized interviews while determining the needs and requirements of the Orthopedic Department in Section 3.2.1 of our Methodology chapter. The creation of this table provided a graphic illustration of the state of each of the information management systems at Lerdsin, Nakornping, and Saraburi. On the horizontal axis of the table we categorized each of the variables identified from the current information management system in place at the Orthopedic Department, underneath a main subcategory. These subcategories, already established in Table 2.9 of our Background chapter, were the main information management problems identified in the Orthopedic Department:

1. Ability to meet external reporting requirements (MoPH)
    - Number of patients
    - Diagnosis breakdown
    - Procedure breakdown
    - Financial reports
        - Income statement
        - Balance sheet
        - Cash flows
    - Length of stay (LOS)
    - Average Relative Weight (AVG RW)
    - Infection Rate (IR)
    - Mortality Rate (MR)
    - Readmission Rate (RA)
    - Re-surgery (RS)
2. Ability to manage digital patient records / electronically register patients
    - Secure storage
    - Check appointments
    - Easy registration

- Simple & Fast
- Real time
- Reliable storage
- Tracking of records
- Search records

3. Ability to meet the training program requirements
    - Journal database
    - Multimedia database
    - Patient records database

CoE	Training	Tertiary Care - Network
Subcategory	Ability to Manage Digital Patient Records / Electronically Register Patients	
Scale	0% — 50% — 100%	
Lerdsin	37.5%	
Nakornping	75%	
Saraburi	100%	

CoE	Tertiary Care - Policy Advocate - Referred
Subcategory	Ability to meet external reporting requirements to the MoPH
Scale	0% — 50% — 100%
Lerdsin	0%
Nakornping	40%
Saraburi	100%

CoE	Training Program - Reference
Subcategory	Ability to meet the training program requirements
Scale	0% — 50% — 100%
Lerdsin	0%
Nakornping	33%
Saraburi	33%

Table 4.1: Comparison of IMS at Lerdsin, Saraburi and Nakornping Hospitals

Table 4.1 is divided into the subcategories listed above. Each subcategory contains a specific number of variables which are the main problems identified in the information management system of the Orthopedic Department at Lerdsin. The number of variables fulfilled relative to the number of variables in each subcategory signifies the completion percentage for each subcategory of each of the three hospitals' systems. For example, the Orthopedic Department at Lerdsin Hospital was 37.5% complete, related to the Ability to Manage Digital Patient Records / Electronically Register Patients. The percentage was calculated by identifying the number of variables being fulfilled in this subcategory, three, relative to the total amount of variables in this subcategory, eight. The same analysis was conducted for each of the remaining subcategories, as well as for both Nakornping and Saraburi Hospitals' systems.

As Table 4.1 demonstrates, the Orthopedic Department at Lerdsin showed poor performance in completing all three subcategories. Overall, Lerdsin fulfilled three of the 21 variables, or approximately 14%, compared to the completion rate of Nakornping and Saraburi, approximately 52% and 90% respectively. The variables measured at Saraburi Central Hospital showed fulfillment in the first two subcategories, and 33% of the third subcategory. The variables in the third subcategory comprised the training program and reference criteria of a Center of Excellence. Nakornping Hospital's hybrid system fulfills more variables than the system at Lerdsin, but fewer than the system at Saraburi Hospital. Since the custom designed system included 90% of all the variables identified, we concluded that implementing a hybrid information management system with these characteristics will solve the majority of the problems identified in the Orthopedic Department.

The systems observed at Nakornping and Saraburi fulfilled more than three times as many of the variables pertaining to Center of Excellence criteria than the Orthopedic Department at Lerdsin. This significant difference in completion indicated that the information management system at Lerdsin needed several major improvements in order to match the performance of the systems of the other two hospitals. The cause of this gap in performance was the type of information management system in place at the three hospitals. Lerdsin was operating under a paper system; Nakornping was under a hybrid system operated by SSB; Saraburi was utilizing a hybrid system with SSB as well as an

internally-designed, customized system. The combination of the SSB platform with the custom designed system explained the superior performance of Saraburi's information management system.

The greater issue behind this finding was the ability for Lerdsin's Orthopedic Department to prove itself as a Center of Excellence to the Ministry of Public Health. Though it met many of the criteria, namely the well-known training program and networking criteria, Lerdsin needed to show the Ministry that it was such a center by reporting medical information pertaining to tertiary care statistics. With the paper system, it was unable to perform this reporting in an efficient manner. The systems at Nakornping and Saraburi, the latter of which featured a customized system with excellent reporting capabilities, allowed their host hospitals to demonstrate their performance in a more efficient manner. As stated previously, the system at Lerdsin did not feature the same reporting capabilities as Nakornping's and, especially, Saraburi's. If Lerdsin were to implement a system as Saraburi's it would overcome the limitations previously identified and meet the majority of the information management requirements of a Center of Excellence.

4.2. Implementing the SSB Platform Alone will be insufficient for the Orthopedic Department in Fulfilling the Goal of Becoming a Center of Excellence

After analyzing the data collected from the interviews conducted and the SSB demonstrations observed, at Nakornping and Saraburi Hospitals, we were able to evaluate the capabilities and features of each system. As previously mentioned, the features of the SSB software concern mostly the financial aspects of the hospital, as well as limited reporting of medical indicators. However, several Center of Excellence criteria require the reporting of these medical indicators as well as other clinical information that SSB is not able to report. The following Center of Excellence criteria are not fully satisfied by the SSB platform from the reporting standpoint:

4.2.1. Tertiary Care

As we observed during a demonstration of the system, the SSB platform had the ability to determine the infection rate (IR) of all procedures performed at a hospital. This platform also searched the procedures by the International Classification of Disease (ICD), and stored the patient record until the patient was discharged. However, according to the Director of the Information Technology Department, the actual patient record was still managed under a paper system. Furthermore, the SSB platform was unable to report clinical info such as:

- Relative weight (RW)
- Re-admission rate
- Re-surgery rate
- Complication rate
- Patient diagnosis

The inability to report these medical indicators would still prevent the Orthopedic Department from becoming a Center of Excellence since the Ministry of Public Health requires the reporting of medical indicators concerning its tertiary care performance.

4.2.2. Training Program

The SSB platform also had several limitations concerning this criterion. The main limitation was that it can not store information concerning complex procedures in an educational database. In addition, this educational database must be able to store images, videos, X-rays, and other important documents that provide information concerning the results and outcomes of each case. Unfortunately, the Directors of the Information Technology Department at Nakornping and Saraburi Hospitals stated that none of this information could be stored by the SSB platform. Thus, SSB had insufficient features to fulfill this criterion from an information management perspective.

4.2.3. Research and Development

During the demonstrations of the SSB system at Nakornping and Saraburi, we determined that it was not able to record and store all the published works by the doctors at any medical institution. This information was corroborated during the interview with the IT Director of Saraburi Hospital, who explicitly stated that the SSB system was not designed to store any journal or magazine publications; therefore, it did not fulfill this criterion from the reporting aspect of an information management system. At Nakornping Hospital we also interviewed the IT Director, who was not aware of whether or not the SSB system included such a feature. Since Nakornping Hospital was not requiring its doctors to publish their research papers, there was no need for them to identify such a feature in the SSB system.

4.2.4. Referred Center

While observing the features and capabilities of the SSB platform, we identified that this platform did not include a feature that would report the number of patients being referred to each hospital. Once we observed this limitation, the IT director at Nakornping Hospital clarified that the SSB platform was a general hospital management system that had not been designed to fulfill the referred center variables identified in our Background chapter. Since the Center of Excellence program was developed during 2004, these SSB systems were certainly not able to fulfill all the new Ministry of Public Health reporting requirements.

4.2.5. Networking

Following the previous explanation, the SSB platform had not been designed to fulfill any of the networking requirements. The Director of the Orthopedic Department at Saraburi stated that the institution was currently allowing and encouraging doctors from General hospitals to practice at this facility. When we asked the IT director if the SSB

platform allowed such reporting, we were not surprised to receive a negative answer. He restated that the SSB platform was too limited with respect to the reporting capabilities; therefore, they had to design the customized system to fulfill these requirements.

4.2.6. Reference Center

One of the main limitations of the SSB platform was the inability to serve as an adequate source of information for other hospitals. During the demonstration of this system at Nakornping Hospital, we saw that the patient record was only stored digitally until the patient is discharged. Once the patient was discharged the record was deleted from the system. The IT director reminded us that the Ministry of Public Health requires the storing of paper records for five years after the patient is discharged, before the records are destroyed. When the SSB platform was designed, there was no need at that time to include a digital feature that stored the patient record because of this regulation. Therefore, the creation of the custom designed system helped Saraburi Hospital with this criterion, specifically by establishing a patient records database that could be used as reference for other institutions.

4.2.7. Policy Advocate

The SSB software did not allow accurate reporting concerning the medical conditions of the patients treated at a hospital. This information was necessary for the Ministry of Public Health to establish policies preventing the aggravation of these conditions amongst the Thai population. The SSB software was not capable of storing such information, which again showed its insufficiency in reporting pertinent information to the Ministry of Public Health.

The SSB systems evaluated at Nakornping and Saraburi Hospitals were very similar to the one to be installed at Lerdsin in the near future. However the limitations of the SSB system discussed above will still prevent the Orthopedic Department from storing, reporting, searching and viewing all the information required by the Ministry of

Public Health in order to become a Center of Excellence. Therefore, the implementation of this system will not be sufficient if the Orthopedic Department wants to become an excellent center.

This finding reveals an impediment in the Department's current plan for reaching their goal. The implementation of the SSB system, with such limitations, will not significantly assist the Orthopedic Department in becoming a Center of Excellence. The Department needs a system that fully complements the aspects of the criteria already achieved: it is a specialized tertiary care unit, has a well established educational training program, advocates preventive policy, conducts extensive research, treats patients from other hospitals, and encourages its specialists to lecture at other medical institutions. However, the Department must accurately report the performance metrics related to these criteria, as well as develop an educational database. Once these are fully attained, with the assistance of a hybrid information management system that overcomes the limitations of the SSB system, the Orthopedic Department can then be recognized as a Center of Excellence.

4.3. Lerdsin Orthopedic Department Does Not Have the Required Hardware to Support a Hybrid Information Management System

The Orthopedic Department at Lerdsin Hospital does not have the hardware capability to support a hybrid information management system. Primarily, the hardware available at Lerdsin would not be able to support a transition from the Proof of Concept system to a custom designed hybrid information management system.

Evaluating the hybrid systems in the two institutions we investigated, Nakornping and Saraburi, provided us initial documentation regarding the hardware requirements of a limited hybrid information management system such as SSB. However, the custom designed system at Saraburi had different hardware requirements than SSB; therefore this hardware analysis was far more extensive since this system was the target for our proof of concept.

The hardware resources encountered at Nakornping Hospital were strictly powering the SSB software. The processing resources of the SSB system at Nakornping Hospital were three standard Pentium 4 computers. During a demonstration, the system did not show any signs of overburden. It was responsive and access time to patient information was almost instantaneous. According to the medical staff at Nakornping, it had never shown signs of instability or unreliability. This led us to conclude that Nakornping system's processing capability was adequate according to the needs of the SSB software.

Storage hardware at Nakornping was also strictly powering their SSB system. The hardware consisted of three 72.8 GB hard drives (not in a redundant array) and a DAT (Digital Audio Tape) tape backup drive. The 72.8 GB drives were real time accessible patient files stored in SSB. The DAT tape drives served as a backup for the hard drives. The information was kept on the hard drives until it aged five years, and then it is transferred to the DAT cassettes for archiving. Since Nakornping Hospital's information management system was designed specifically for SSB, the storage and processing requirements were not as complex as Saraburi's.

Saraburi Hospital's custom system complementing the SSB system had more capabilities and features than SSB, hence it required more extensive hardware. Processing at Saraburi was done on one Xeon 3 GHz processor. This processing hardware was responsible for handling the SSB system as well as the custom designed platform. While this was only a single processor, Xeon is Intel's specifically designed server processor that yields more processing power in server applications, compared to the consumer oriented Pentium 4's at Nakornping (Intel, 2006). Saraburi's processing capabilities, as well as the storage efficiency of its system, surpass those Nakornping.

The storage system in place at Saraburi Hospital was responsible for the SSB data as well as the scanned patient records and other related information stored in their custom software. The storage capacity of the central server was 240 GB (8 Drives), in a RAID 1 + 0 configuration, meaning there was actually 480 GB of storage, four of the drives are used as mirrors, containing only redundant data incase of hardware failure. In addition to the main server, two data servers were used for additional storage. Each of these

contained 240 GB of storage. This hard drive setup, RAID 5, was slightly different from the central server, but still offered data integrity protection.

The amount of data storage at Saraburi was significantly larger than the amount at Nakornping, which could be attributed to two things: the need to store scanned patient documents and not utilizing DAT backup cassettes. Since backing-up patient records on DAT cassettes was a time consuming process, data redundancy was definitely the preferred option. However, Saraburi's information management system was not able to fulfill the multimedia requirements needed by the Orthopedic Department. This multimedia database required specific evaluation of storage needs that were could not be determined at Saraburi Hospital.

Lerdsin Orthopedic Department's computer system was composed of a server computer and 25 computers in use. These computers were located in the two libraries and computer lab, used solely for research and internet access. The server was used as an internet gateway, providing only a secure internet connection to the department. This server had a 450 MHz Pentium 3 processor. It had 160 gigabytes of storage, and there was no data redundancy or backup capabilities. These hardware capabilities were sufficient for the internet access and the medical research conducted at the Orthopedic Department. However, these capabilities will be completely insufficient for the implementation of the SSB platform.

Capability / Hospital	Nakornping	Saraburi	Lerdsin
Processing	3 Pentium 4's	Xeon 3 GHz	Pentium 3 450 MHz
Storage	218.2 GB	720 GB	160 GB
Data redundancy		RAID	
Data backup	DAT Tapes		

Table 4.2: Hardware Capabilites Comparison

As can be seen in Table 4.2, Saraburi's system's processing and storing capabilities exceed those of Lerdsin and Nakornping. Since the hybrid system at Saraburi had the RAID feature that minimizes the risk of losing information, this system did not need data backup. The hardware capabilities at Nakornping were sufficient for the SSB platform they are utilizing. However, as stated in our second finding, implementing the SSB platform alone will be insufficient for the Orthopedic Department in fulfilling the goal of

becoming a Center of Excellence, the hardware capabilities at Nakornping were also not sufficient. On the other hand, Saraburi's system did not only meet the majority of the reporting features required but it also had the hardware capabilities to support efficiently the software platform.

This finding established that the hardware requirements in place in the Orthopedic Department will not be sufficient in order to sustain an information management system that features all the reporting required by the Ministry of Public Health. This meant that the Orthopedic Departments needed to completely modify its hardware capabilities since it will be implementing the SSB system in 2007. Furthermore, as our second finding states, the SSB system will not be sufficient to provide all information management requirements of the Ministry of Public Health. Thus, the Orthopedic Department needs to implement hardware capabilities focusing on an information management system that will fulfill the Center of Excellence criteria from the information management perspective.

4.3.1. The Most Appropriate Multimedia Formats are DivX 5 for Videos and JPEG for Images

Through conducting archival research on several multimedia formats, we found that the most appropriate for the Orthopedic Department's requirements: DivX 5 format for digital video storage and the JPEG format for digital images, both color and monochromatic.

During our preliminary archival research, we decided to evaluate three video formats and four image formats. The three video formats analyzed were: QuickTime, Windows Media, and DivX 5. These formats were selected because they were the three most popular formats and they can be used free of charge (Cross, 2004). Selecting a free use format was important because it would not add any cost to the system and these three free formats offered the best features. Concerning the image formats researched, we identified and analyzed the following ones: Joint Photographic Experts Group (JPEG), Graphical Interchange Format (GIF), Portable Network Graphic (PNG), and Bitmap

(BMP). These formats were selected because these encompass the majority of digital imaging. In order to analyze each of these formats, we constructed the following table.

Video Format	File Size to Quality Ratio
QuickTime	3
Windows Media	8
DivX 5	9

Image Format	Image Compression (Mono)	Image Quality (Mono)	Image Compression (Color)	Image Quality (Mono)
JPG	6	9	8	9
GIF	8	5	2	1
PNG	2	9	7	9
BMP	1	10	1	10

Table 4.3: Multimedia Format Comparison

Table 4.3, describes how each format scored from 1-10, with respect to videos and images. Videos can be compressed to nearly as small or as large as desired, but as the file size gets smaller, the quality suffers. When evaluating the QuickTime format, the file size of the video was extremely large for its quality. The Windows Media format file size was far less the QuickTime, and displayed the same quality. However, the DivX 5 file size was even smaller compared to QuickTime, as well as to Windows Media format. In order to conduct this analysis, the length and the resolution of the video file were the same for the three formats. By doing this, we were standardizing these variables (resolution and length), so they would not be affected by the format used. The DivX 5 format was selected because it performed best for the needs of the Orthopedic Department: surgical and potentially pre and post operational videos.

Image compression, being far less complicated than video compression, offers different results based on the type of image (eg. photographs, drawings, scanned documents etc.). In order to provide an accurate analysis for the files that will be stored in the proof of concept system, we divided the images into monochromatic and color categories. By doing this, we were able to determine what the best quality is for the X-rays, and what the best quality is for images in general. The best image quality for monochromatic pictures was achieved by the BMP format, however it offered very little

compression; an inefficient use of space. The JPEG format offered the same quality to that of BMP, but its compression was more effective. The same situation was true when evaluating color images. The BMP format offered the highest quality, but was not storage efficient; therefore the most appropriate format considering both compression and quality was the JPEG.

The analysis of these multimedia requirements was performed in order to determine accurate storage and processing requirements for the proof of concept system. As part of the Orthopedic Department's requirements, videos, X-rays, and images must be stored in a future information management system as part of an educational database. After conducting the previous analysis, we identified the most appropriate multimedia formats that will fulfill the requirements of the Department By doing this, the training and the reference criteria will be significantly improved since it will solve the problems identified in our Background chapter.

Thus far, we found that implementing a hybrid information management system will be a crucial step for the Orthopedic Department in becoming a Center of Excellence. Since the Department is going to implement the SSB system in 2007, we evaluated this system to determine if it complies with the requirements and needs of the department, and it did not. Finally, the hardware capabilities of the Orthopedic Department were insufficient to sustain a hybrid information management system that fulfills all the reporting and multimedia requirements of being a Center of Excellence. Considering this valuable information, the next step in our project was to develop a proof of concept information management system for the Orthopedic Department, assisting it in becoming a Center of Excellence.

5. Proof of Concept

In order to assist the Orthopedic Department, we developed a proof of concept information management system. The focus of this proof of concept was to show how some of the Orthopedic Department's needs, which would not be satisfied by the SSB system, could be satisfied by a custom-designed information management system. This section describes the underlying database along with the features and capabilities of the Proof of Concept system regarding searching, storing and retrieving multimedia, and reporting.

5.1. Database Design

The database software utilized in the Proof of Concept is MySQL, a free open-source database. The database structure, shown in Figure 5.1, was developed by initially determining what information needed to be stored. We then determined what information was dependent on other pieces of information, in addition to determining what pieces of information uniquely identify each form in a patient record. Finally, the structure was optimized using normalization, the "process of removing redundant data from tables in order to improve storage efficiency, data integrity and scalability" (Hillyer, 2006). Figure 5.1 shows the tables in the database with arrows indicating data dependencies between them.

For the storage of multimedia documents, we decided to store the documents outside the database. Thus, the documents were stored in the computer's standard file system, and the database stored information regarding how to access the file. This allowed the administrator of the system, if necessary, to move a directory of documents to a new hard drive and only have to update a configuration file with the directory's new location. In this manner, the Proof of Concept's design allowed fluid transition when upgrading storage hardware.

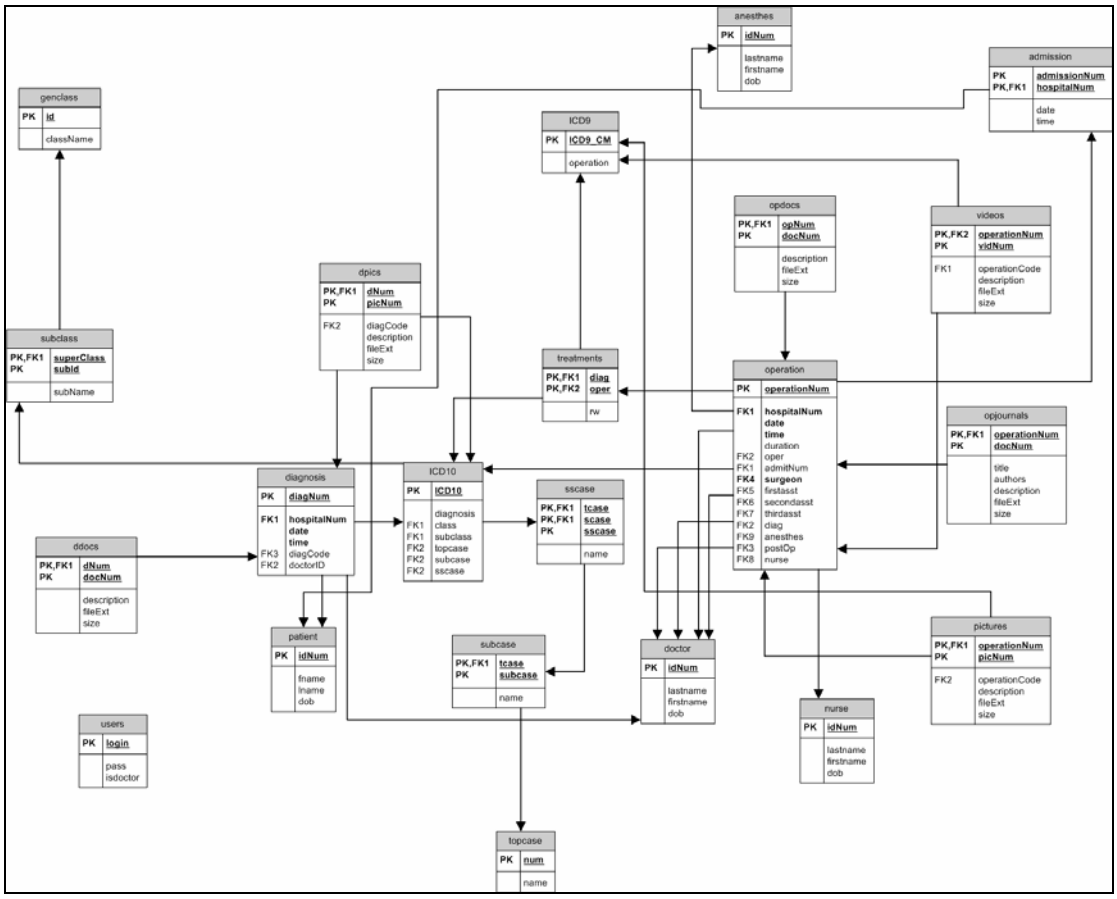

Figure 5.1: Proof of Concept Database Structure

5.2. Searching Features and Capabilities

The Proof of Concept system provides a means to search for patient records using several methods. As shown in Figure 5.2, the web interface of the Proof of Concept allows the user to search for diagnoses and operations by:

- Patient information
- Diagnosis (ICD10) code
- Diagnosis classification
- Case type of diagnosis
- Operation number
- Diagnosis number
- Operation (ICD9-CM) code

- Doctor information

For the Proof of Concept, the operation number and diagnosis number were developed so that specific diagnoses and operations could be easily referenced after being entered into the system.

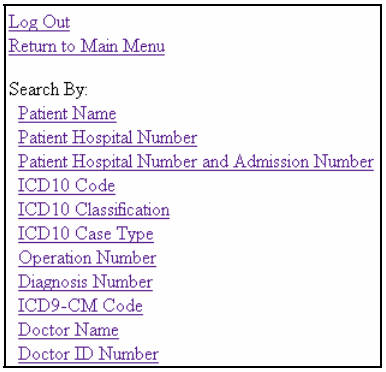

Figure 5.2: Search Page

Each time a search is executed, the Proof of Concept system references real-time data in the database. Therefore, once information is entered, it is immediately available in searches. This provides real-time access to patient diagnoses, addressing this weakness from Table 2.8 and Table 2.9. The ability to search by these criteria allows the Proof of Concept to be utilized for educational purposes, such as searching for similar cases and operations, shown in Figure 5.3. This provides a solution to the weakness related to lacking an educational database in Table 2.8 and Table 2.9.

Log Out
Return to Main Menu
Back to Main Search Page

ICD10 General Classification: Hand / Wrist

Diagnoses:

Diagnosis Number	Hospital number	Date	Time	Diagnosis (ICD10)	Doctor ID	Pictures	Scanned Documents
3	2	1999-02-15	09:55:59	M653	1		
4	2	2003-09-14	21:22:56	S625	3		

Operations with Clinical Diagnosis in Classification:

Operation Number	Hospital Number	Date	Time	Duration	Procedure (ICD9-CM)	Admission Number	Surgeon	First Asst.	Second Asst.	Third Asst.	Anesthesiologist	Nurse	Clinical Diagnosis	Post-Op Diagnosis	Pictures	Videos	Relevant Journals	Scanned Documents
2	2	1999-02-15	13:00:00	00:20:00	8044	2	4	2			2	3	M653	M653	Pic 1 Pic 2	Vid 1	Journal 1	Doc 1
3	2	2003-09-15	01:00:00	02:00:15	7903	3	1	4			2	3	S625	S625				
4	2	2003-09-15	04:00:00	01:00:00	7914	3	3	2			3	1	S625	S625				
5	2	2003-09-15	05:15:00	01:00:00	7934	3	3	2			3	1	S625	S625				

Operations with Post-Op Diagnosis in Classification:

Operation Number	Hospital Number	Date	Time	Duration	Procedure (ICD9-CM)	Admission Number	Surgeon	First Asst.	Second Asst.	Third Asst.	Anesthesiologist	Nurse	Clinical Diagnosis	Post-Op Diagnosis	Pictures	Videos	Relevant Journals	Scanned Documents
2	2	1999-02-15	13:00:00	00:20:00	8044	2	4	2			2	3	M653	M653	Pic 1 Pic 2	Vid 1	Journal 1	Doc 1
3	2	2003-09-15	01:00:00	02:00:15	7903	3	1	4			2	3	S625	S625				
4	2	2003-09-15	04:00:00	01:00:00	7914	3	3	2			3	1	S625	S625				
5	2	2003-09-15	05:15:00	01:00:00	7934	3	3	2			3	1	S625	S625				

Figure 5.3: Sample Search by Diagnosis Classification

5.3. Multimedia Database Features and Capabilities

In addition to using the Proof of Concept to reference previous cases, it can be utilized as a multimedia database. The Proof of Concept was designed to allow users to attach pictures, videos, journals, and scanned documents to a specific operation. For a specific diagnosis, the Proof of Concept allows the user to attach pictures and scanned documents. While searching diagnoses and operations, attached documents are noted, as shown in Figure 5.4.

Log Out
Return to Main Menu
Back to Main Search Page

Records for Patient with Hospital Number: 2

Diagnoses:

Diagnosis Number	Date	Time	Diagnosis (ICD10)	Doctor ID	Pictures	Scanned Documents
3	1999-02-15	09:55:59	M653	1		
4	2003-09-14	21:22:56	S625	3		

Operations:

Operation Number	Date	Time	Duration	Procedure (ICD9-CM)	Admission Number	Surgeon	First Asst.	Second Asst.	Third Asst.	Anesthesiologist	Nurse	Clinical Diagnosis	Post-Op Diagnosis	Pictures	Videos	Relevant Journals	Scanned Documents
2	1999-02-15	13:00:00	00:20:00	8044	2	4	2			2	3	M653	M653	Pic 1 Pic 2	Vid 1	Journal 1	Doc 1
3	2003-09-15	01:00:00	02:00:15	7903	3	1	4			2	3	S625	S625				
4	2003-09-15	04:00:00	01:00:00	7914	3	3	2			3	1	S625	S625				
5	2003-09-15	05:15:00	01:00:00	7934	3	3	2			3	1	S625	S625				

Figure 5.4: Sample Search Results with Multimedia Documents

By clicking on the web links to the documents, the user can view the document and its description, shown in Figure 5.5.

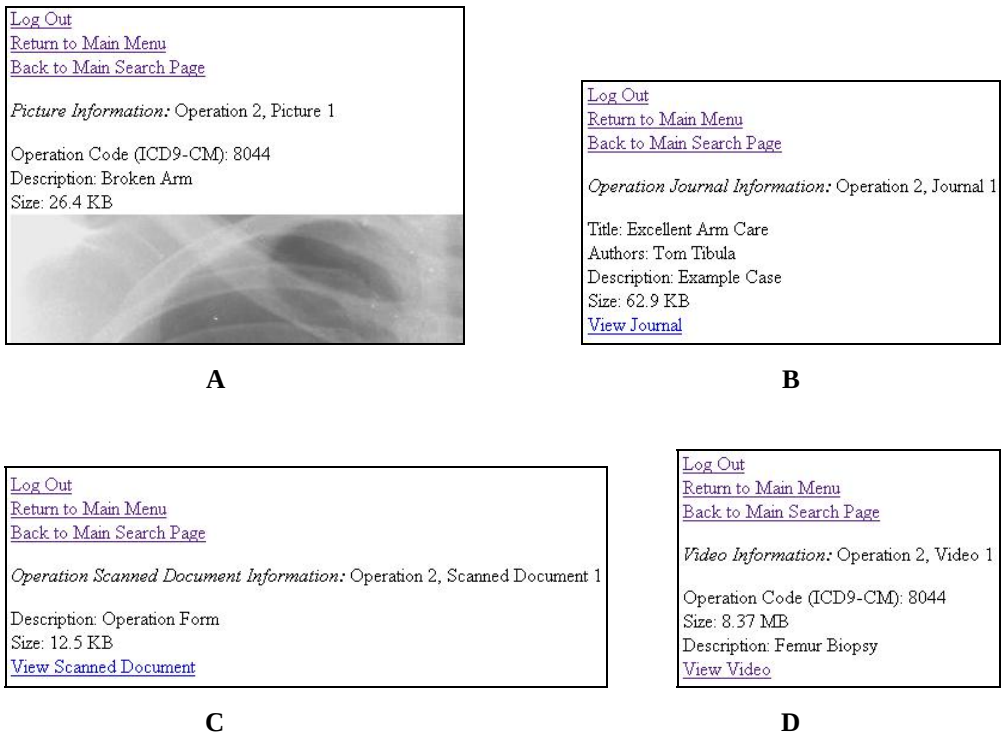

Figure 5.5: Viewing Attached Document Information
(A) Pictures
(B) Relevant Journals
(C) Scanned Documents
(D) Videos

To enter documents into the Proof of Concept system, the user can attach documents when initially recording the diagnosis or operation, or afterwards. The operation record update page, Figure 5.6, shows how a user can browse for files to attach, and then fill out the description field, etc. The ability of the Proof of Concept to store and retrieve multimedia documents addresses this weakness identified in Table 2.8 and Table 2.9.

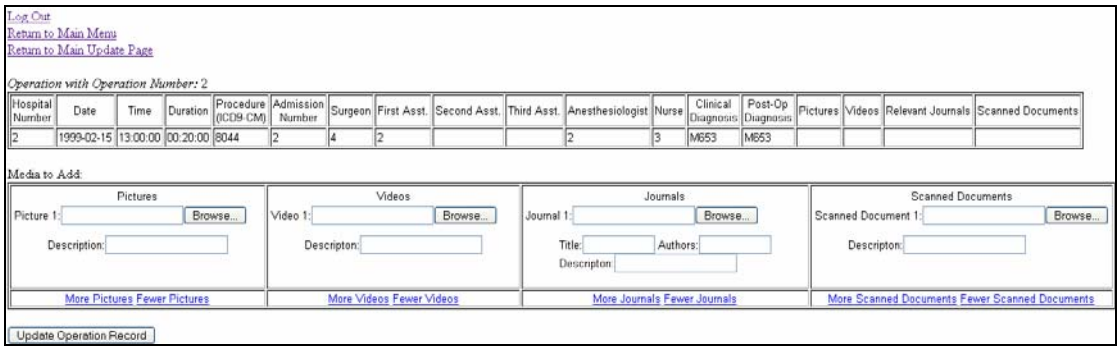

Figure 5.6: Operation Record Update Page

5.4. Reporting Features and Capabilities

In addition to acting as a multimedia database, the Proof of Concept provides sample reporting. In the sample reporting, the Proof of Concept can provide some of the information needed for the monthly report to the Ministry of Public Health. For example, the Proof of Concept provides a list of the top ten most common diagnoses and operations, shown in Figure 5.7.

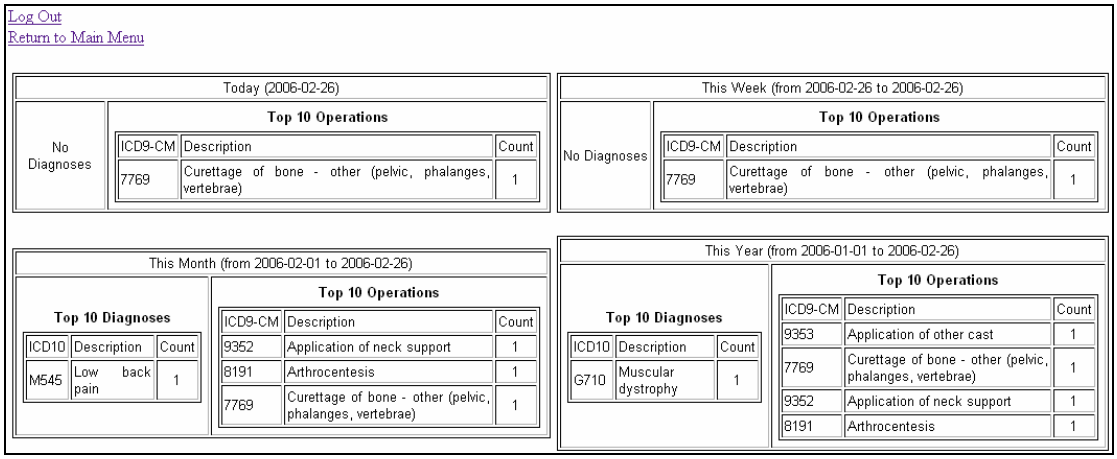

Figure 5.7: Sample Reporting of Top Ten Diagnoses and Operations

The Proof of Concept system also provides breakdowns by classification and case type of all operations and diagnoses entered. Breakdown by classification deals with identifying the number of cases for each type of injury, shown in Figure 5.8 A. Breakdown by case type determines the number of cases for each type of orthopedic treatment or procedure,

shown in Figure 5.8 B. These breakdowns provide valuable information describing the treatments provided by the Orthopedic Department. This information is required in monthly reports to the Ministry of Public Health, and the Proof of Concept provides a means to collect information for such reports quickly and efficiently.

Classification	Number of Diagnoses	Number of Operations
Fracture (exclude spine)	1	3
-Fracture of shoulder and upper arm	0	0
-Fracture of forearm	0	0
-Fracture of femur	0	0
-Fracture of lower leg, including ankle	0	0
-Fracture of foot, except ankle	1	2
-Fracture involving multiple body regions	0	1
Dislocation	1	1

A

Case	Number of Diagnoses	Number of Operations
Trauma Case	2	4
-Pelvis, Sacrum, Coccyx, Acetabulum	0	0
-Shoulder and Upper Arm	0	0
-Forearm	0	0
-Femur	0	0
-Lower Leg Including Ankle	0	0
-Foot	1	2
-Multiple fracture + dislocation	1	2
Tumor Case	0	3

B

Figure 5.8: Sample Reporting – Breakdown of Diagnoses and Operations
(A) By Classification
(B) By Case Type

In addition to being able to generate breakdowns of diagnoses and operations, the Proof of Concept system can provide information regarding the relative weight of operations in the Orthopedic Department. The average relative weight of all procedures performed in a certain department, according to Dr. Thavat, can be compared between hospitals to compare performance and the specialization of care (personal communication, January 16, 2006). In addition, the average relative weight of procedures performed by each doctor can used to compare individuals' performances. The Proof of Concept system provides information regarding both the overall average relative weight for the Orthopedic Department, shown in Figure 5.9, and the average relative weight for each doctor, shown in Figure 5.10. Therefore, the Proof of Concept system demonstrates the ability to easily generate reports regarding certain tertiary care performance indicators.

Average Relative Weight of All Operations			
Today (2006-02-27)	This Week (2006-02-26 to 2006-02-27)	This Month (2006-02-01 to 2006-02-27)	This Year (2006-01-01 to 2006-02-27)
1.61	1.335	1.2565	1.1812

Figure 5.9: Sample Reporting - Overall Average Relative Weight

Average Relative Weight of All Operations By Doctor ID				
Doctor ID	Today (2006-02-27)	This Week (2006-02-26 to 2006-02-27)	This Month (2006-02-01 to 2006-02-27)	This Year (2006-01-01 to 2006-02-27)
0	No Operations	No Operations	No Operations	No Operations
1	No Operations	No Operations	1.35	1.35
2	1.61	1.335	1.2253333333333	1.139
3	No Operations	1.06	1.06	0.97
4	No Operations	No Operations	No Operations	No Operations

Figure 5.10: Sample Reporting - Average Relative Weight for each Doctor

6. Recommendations

6.1. Proof of Concept Recommendations

As the Proof of Concept system we developed did not fulfill all of the Orthopedic Department's needs, there are several areas that require further development. These areas include the addition of new features, the refinement of existing features, and the adaptation to the SSB once the platform is implemented at Lerdsin. In order to complete these areas, it will be necessary to assemble a development team. The details of these recommendations are explained in the following sections.

6.1.1. We Recommend the Addition of New Features to the Proof of Concept System

Currently, the Proof of Concept provides only general functionality. It allows the user to enter patient information, digitally retrieve the patient records, and add images or other various multimedia documents. One feature that is currently absent is the editing of records, a feature that would be useful if some of the data entered were inaccurate. This feature could be implemented in a similar manner to how documents are later added to records. *We recommend to the Orthopedic Department to incorporate a feature that allows patient records editing*. In doing this, the Proof of Concept would be able to correct mistakes during data entry. In relation to the ability of correct existing mistakes, another useful feature would be data validation. This feature would assist users in entering accurate and reliable data. In the event of an error, data validation could provide users with much more descriptive and precise explanations of why the error occurred. Besides, this feature would ensure the validity of the information, such as entering a correct procedure code or entering a valid patient identification number. *Therefore, we also recommend the Orthopedic Department to incorporate a data validation feature in the Proof of Concept.*

The Proof of Concept system has many areas where the amount of data stored is minimal. For example, for a new patient entry in the system, other than hospital number and name, the only personal information stored is the date of birth and address, as seen in Figure 6.1. As the abundance of patient personal information was not a priority when designing the Proof of Concept, it was not considered. At a later point in time, if storing more personal information becomes necessary, the structure of the database would have to be altered, possibly by the addition of another field to the patient table. This kind of addition enables the system to evolve with the needs of the Orthopedic Department. *Due to these reasons, we recommend that the Proof of Concept's database structure be altered in order to store more information if the Department considers it necessary.*

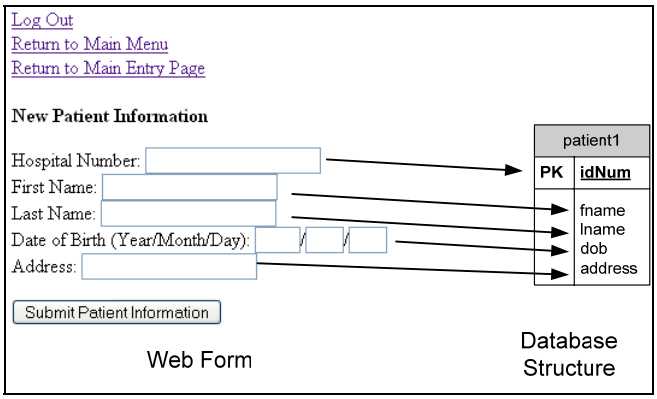

Figure 6.1: Data entry on web form to storage in the database

6.1.2. We Recommend to Refine the Existing Features of the Proof of Concept

As the Proof of Concept is a rough example of a possible information management system, there are many features that are not fully developed. One of them is reporting. Due to the numerous types of reports for the Orthopedic Department, the sample reporting page was developed. The sample reporting page demonstrates the ability to analyze the information input to the database in several ways. It also provides sample queries that can be utilized in generating specific reports. Currently the Proof of Concept determines the Relative Weight of the procedures conducted, which is an important feature that the SSB platform does not report. However, the Proof of Concept

does not report all the necessary medical indicators, which still prevents the Orthopedic Department in fulfilling the reporting requirements concerning Tertiary care. In order to provide more specific or additional types of reports that would fulfill these requirements, *we recommend a continuous development to the reporting features provided in the Proof of Concept.*

In addition to refining reporting features, there are searchable features that can also be refined. Due to the nature of the Structured Query Language (SQL) that is utilized in the database, queries can be combined with simple logic, and nesting if necessary. For example, combining the search for operations within a date range with a search for operations performed by a certain doctor can be done by joining the criteria with an 'AND' logical operator. Thus, combining several different search criteria can yield specific search results. In order to provide this additional search functionality, *we recommend that the search features in the Proof of Concept be modified to allow users to search by multiple criteria simultaneously.*

While refinement in searching is important, so is overall usability. The Proof of Concept was designed to focus more on functionality than usability. Therefore, there are many areas that could be improved in order to make this Proof of Concept even more user-friendly. For example, the functionality of the admission and operation entry page could be combined, so that a patient admission is automatically recorded with data from fields in the operations form. This feature would reduce the amount of data entry to the system, which increases its efficiency and performance. In order to apply and implement these changes, we recommend that the Proof of Concept be refined to improve the overall usability. In order to implement these refinements, it will be necessary to assemble a development team.

6.1.3. We Recommend the Creation of a Development Team to Expand upon the Proof of Concept

In order to expand upon the Proof of Concept, *we recommend the Orthopedic Department to assemble a development team.* This team should focus on adding and refining features that would modify the Proof of Concept and gradually develop it into a

hybrid information management system that adequately meets the needs of the Orthopedic Department.

The easiest way to assemble this team would be to examine current personnel, primarily in the IT Department. As personnel in the IT Department are experienced in the use of databases, programming, and the operations of the hospital, they are ideal candidates. A second place to find current personnel for the team is the Orthopedic Department itself. Unfortunately, as they are doctors, they most likely will not be able to dedicate a significant amount of time to the development team. Through interaction with staff and residents, we found that several of the staff members have an interest in databases and programming. In addition, during our visit to Saraburi Hospital we found that their IT director was also a doctor specialized in Pathology. As doctors and residents are the primary users and beneficiaries of an information management system, they provide valuable perspectives on how the system should be used and designed. *Therefore, we recommend that the development team consist primarily of IT and Orthopedic Department staff.*

After examining current personnel in the IT and Orthopedic Departments, if more staff members are needed, the hospital should consider reallocating its personnel. We were informed that once SSB was implemented, several positions in the registration and out-patient department would no longer be necessary due to the automation of processes in these departments (Dr. Thawat, personal communication, January 23, 2006). These labor resources could become part the development team since they are also familiar with the information flow of the Orthopedic Department. *Therefore, if more personnel are needed for the development team and resources are available, the hospital should consider reallocating its staff.*

To continue the development of the Proof of Concept and achieve a fully functional information management system in the shortest period of time, it will be necessary to have the adequate number of developers that could complete this design process. Initially, the development team should be small, composed of at most two staff members who could allocate extra time to this development process. The initial team should focus primarily on continuing the development of features that SSB will not provide. It should not be larger than two people. Once the SSB system is implemented,

the team should be expanded to consist of four or five staff members. This team should consist of four to five people due to the extent and volume of work, initially adapting the Proof of Concept system to interact with the SSB system. One of the team members should be leading and managing the project, while other members can develop features and test the software. This managing role is critical to developing an effective software system, as appropriate resource allocation is essential for the completion of desired features.

Before the SSB system is implemented, we recommend that the team should update the system to improve usability, begin developing additional features, start refining existing features, and fixing any bugs that are encountered. Recommended features to add and refine during this time period are shown in Table 6.1.

Recommended Features to Add	Recommended Features to Refine
- Data Validation - Altering Database to Store Additional Pieces of Information	- Searching - Reporting

Table 6.1: Recommended Features to Add and Refine Before SSB Implementation

Once the SSB system is implemented, we recommend that the team should initially focus on adapting the Proof of Concept to integrate with the SSB system. After this, the team should focus on further developing the reporting features, along with any additional features that may be desired.

In order for the development team to be successful in their development, they should employ appropriate practices. Due to the number of personnel on the development team, one of these practices should be Extreme Programming. When Extreme Programming (XP) practices are used, a "small team of XP programmers [can] be more effective than a large team" (Wells, 2006). Extreme Programming also addresses issues arising from dynamically changing requirements, something that will most likely be a factor in development. Extreme Programming practices will be useful once the SSB system is implemented, as it will help minimize the length of time needed to develop new parts and adapt the Proof of Concept to integrate with the SSB system. For these reasons,

we recommend that the development team should utilize Extreme Programming practices.

In addition to Extreme Programming, the development team should employ the practice of iterative development. To do this, the team should have almost constant contact with the Orthopedic Department. This will provide feedback on the software so that the development team will be able to continually improve it to meet the needs of the Orthopedic Department. Due to the benefits provided by this practice, *we recommend that the development team should employ the practice of iterative development*.

6.1.4. We Recommend the Adaptation of the Proof of Concept to the SSB Implementation

When the SSB system is implemented at Lerdsin Hospital, it will contain much of the information that is currently stored in the Proof of Concept. In order to prevent the storage of redundant data and ensure data consistency, *we recommend the adaptation of the Proof of Concept to interact with the SSB system.* The goal of this adaptation is to be able to provide all the functionality of the Proof of Concept but minimize the amount of redundant information between the custom designed and SSB systems This goal can be accomplished by identifying what data in the Proof of Concept are already contained in the SSB system, and then modifying the Proof of Concept to reference the SSB system for the information. From our observations of existing SSB implementations, we have determined that the variables shown in Table 6.2 are partially stored in the SSB system.

- Personnel Information
- Patient Information
- Diagnoses
- Admissions
- Operations

Table 6.2: Information Partially Stored in the SSB System

In adapting the Proof of Concept to the SSB system, it would be critical to determine specifically what information is present or absent in the SSB system. This requires an in-depth evaluation of the SSB system. To understand the structure of the database in SSB, it will be necessary to work in cooperation with the technical support personnel of SSB. From our visit to Saraburi, we learned that finding the location of desired information was problematic, even through contact with support personnel from SSB. *Therefore, we recommend that the development team establishes an effective communication channel with SSB. This will hopefully enable them to obtain system structure information faster that the personal examination and evaluation of the system.*

In addition to communicating directly with SSB, we recommend that the development team correspond with other medical institutions that have already implemented a custom-designed system that interacts with the SSB system. This relationship would focus in the exchange of information between the medical institutions utilizing SSB. This would allow developers to quickly retrieve information, as interaction with individuals who are familiar to the system is often direct and helpful. This, in conjunction with utilizing a communications channel with SSB, will help significantly in determining how to adapt and modify the SSB features in order to complement the custom designed information management system.

6.2. Hardware Recommendations

In order to allow the Proof of Concept to be developed into a fully operational information management system, it must reside on hardware that does not impede its growth. As stated in the previous chapter, the Orthopedic Department's current hardware is not capable of supporting expansion of the proof of concept system. Using the best suited multimedia formats found, we calculated the hardware required to allow the unobstructed growth of the Proof of Concept.

6.2.1. We Recommend the Following Server Hardware Selection

Processor: Intel Xeon 3 GHz

Storage: 1140 GB in a RAID 1+0 configuration

With the best suited image formats selected, a complete hardware recommendation could be made. As stated in the previous chapter we showed that Saraburi's system achieves 90% of all the variables identified. This means that Lerdsin Orthopedic should aim at implementing a system that features searchable fields, as well as report generation. *We recommend that the Orthopedic Department implements processing hardware capabilities of comparable performance to the information management system at Saraburi.* The system at Saraburi anticipated the decreasing storage availability, once multimedia documents where constantly entered into the database, by implementing hardware capabilities sufficient enough to handle large amounts of data. Since the multimedia database requires very little processing power but large amounts of storage, the Orthopedic Department should implement similar hardware capabilities, taking into consideration the increasing size of the multimedia database.

During our data collection process, we identified statistical and multimedia information in order to approximate the storing capabilities needed by the Orthopedic Department; which are shown in the following:

Video Storage Requirements

Video frequency average: 26 per year

Video length average: 15 minutes

Video encoding bit rate: 8MB/Min

26 video clips*15 Min*8 MB/Min = 3,120 MB/Year = **3.05 GB/Year**

Image Storage Requirements

Patient visitation average: 250 per day

Number of X-rays per patient, per day average: 2

Number of photographs per patient, per day average: 1

Size of high resolution monochromatic image: 200KB

Size of color image: 100KB

2 pictures*250 patients*365 days = 91,250 monochromatic pictures per year.

91,250 * 200KB = 18,250,000 KB = **17.4 GB/Year**

1 picture*250 patients*365 days = 45,625 color pictures per year.

45,625 * 100 KB = 4,562,500 KB = **4.35 GB/ Year**

3.05 GB + 17.4 GB + 4.35 GB = **24.8 GB/ Year**

The frequency of each type of multimedia was provided by Dr. Thavat. The file size of each of the formats was found through the research done during the format selection process. Using these figures, we could roughly calculate the storage requirements per year.

The multimedia database will require approximately 25 gigabytes of storage per year. Although this estimate is based on an average patient flow during 2005 25 gigabytes is not a very large amount of storage, it will be in their best interest to estimate an increasing storing rate. In order to allow 5-10 years of records in the system, we recommend a bare minimum of 300-400 gigabytes of storage. *In order to ensure the integrity of this data, we also recommend implementation of larger storage hardware*

than Saraburi, using a RAID 1 + 0 configuration. Again, this estimate is the requirement in supporting the multimedia database.

The total suggested hardware consists of what Saraburi utilizes, as well as additional storage required for the multimedia database. As stated previously, this will store between 5-10 years of records, which should be sufficient time to allow for the final implementation of the customized system.

7. Summary

The recommendations presented in our report were given to Lerdsin Hospital's Orthopedic Department in order to improve their information management system and helping them in the next step to becoming a Center of Excellence. Our proof of concept system and hardware recommendations gave the Department a clear idea of what their future information management system would look like. We also gave recommendations pertaining to the adaptation of the system with the SSB software to be used throughout Lerdsin Hospital in 2007.

Our first major finding was that a new hybrid information management system would significantly help the Orthopedic Department in becoming a Center of Excellence. After analyzing hybrid systems at Nakornping and Saraburi Hospitals, we determined that the gaps that need to be filled by Lerdsin would best be addressed with the implementation of a new hybrid system. This was because the strengths and opportunities of such a system, like those in place at the two hospitals we visited, included most of Lerdsin's unattained Center of Excellence criteria.

The second finding was that an SSB system, which will be put into place at Lerdsin in the near future, will not be enough for them to attain Center of Excellence standing. This fact was discovered through the analysis of the capabilities of the SSB systems in place at Nakornping and Saraburi. Though the systems did run much more efficiently than the paper-based system at Lerdsin, neither hospital was a Center of Excellence. We did, however, find Saraburi to be very close to achieving the standard, and that their customized information management system was not their major problem. After considering what solutions such a customized system, which complemented the working SSB system at Saraburi, would have to the information management problems at Lerdsin Orthopedic, we recommended to the Orthopedic Department that they use a customized system. We used our proof of concept system, along with suggestions for future adaptation to the SSB system, to perform this recommendation.

Our third finding was that the Orthopedic Department does not have the required hardware to support a hybrid information management system. This was discovered by examining the hardware in use at Nakornping and Saraburi, and comparing that to

Lerdsin's hardware. From examining the requirements of these two systems, specifically those of the customized system at Saraburi, as well as an estimation based on multimedia file sizes, we were able to provide the department with hardware recommendations.

Throughout the course of the project, our sponsor, Dr. Thavat, asked us for a plan for future stages of the creation, implementation, and maintenance of a new information management system. Though we had a general idea as to what needed to be done to accomplish these three tasks, we did not give him a concrete plan because we did not know enough details about the SSB system.

We were limited in some of our research because of issues out of our control, including a language barrier, time constrictions, and the nature of a hospital working environment. The language barrier was encountered frequently at Lerdsin, most notably during a trip to the Operating Room when were investigated multimedia capabilities. The problem was not a great burden overall, however, because our sponsor and liaison, Dr. Chavanont, were well versed in the English language. The obvious time constriction of a seven week term came into play during the data collection period, and we were forced to limit our field observation and interviews at other hospitals as result. Another issue with limiting such visitations was that the nature of our project made it so we only could visit hospitals at which our sponsor had connections. We also only visited the hospitals that also had a department that, like Lerdsin, was striving to become a Center of Excellence. The nature of a hospital working environment, which consisted of busy schedules and unpredictable occurrences, left us with limited time for interviews with our sponsor and other staff members. We had to plan certain interviews around such an environment, but were able to collect the necessary amount of data.

Our suggestion for future WPI projects, specifically those who are asked to work on continuing our project, would be to complete this project as an MQP. Due to the technical nature of the project, we found it difficult to approach the process as an IQP. The social problem was found early on in the process through interviews with the staff at Lerdsin, and we felt we dealt with the issue as best we could. If a project were to be done in the future to continue with the implementation of the SSB-complemented, customized system, we do not foresee any new social issues can be addressed. From the standpoint of our sponsor, we were completing an information technology project. Therefore, should a

project be done for Lerdsin Orthopedic in completing what we started, it would have to be done as a Computer Science MQP.

The findings and recommendations of this report can aide any hospital department or medical institution in general in improving its quality of service. Though some of our recommendations were specific to the needs of Lerdsin Hospital's Orthopedic Department, the basic message of the project was that the inclusion of a more high-technology approach to information management would help to quell information-related issues at medical institutions. This type of approach would then help improve the overall quality of health care by providing the institution with better training, reporting capabilities, and faster access to medical information. All of these apply to the Thai standard of Center of Excellence, but can also relate to standards in other countries.

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Appendices

A1: Day 1 – Meeting Concerning Full Project Description

Lerdsin Hospital Project Group
IQP Meeting
Wednesday, January 11, 2006
10:00 AM
Resident's Library, 9th Floor, Lerdsin Hospital

Attendees:

- Nick Bold
- Pat Canny
- Sam Foss
- Esteban Paez
- Dr. Chavanont
- Dr. Apinan

Topics Discussed:

- What the sponsor wants
  - A system for the staff, education of the staff, for the patient and to improve the quality of treatment
  - More information on patient
- The Database
  - First for educational purpose
  - Patient Records
    - Electronic documents
    - Date, procedure, code, length of time, what doctor – who is responsible
  - Be able to scan the document in
  - Include video, pictures (video of things like joint motion)
  - Paper form then scanning
  - There are different fields for different ailments
  - Scanning system – possible problem: knowing what is being scanned
  - Big reason: **No More Lost Documents**!
  - Primary User: Doctors
  - Existing paper forms filled in with Thai and English
    - Patient's medical history in Thai (like patient's account of medical history to doctor)
    - Physical examination and diagnosis in English
  - Paper documents must be kept for at least 5 years (Federal Regulation)
  - Database will only have a little interaction with SSB System
    - SSB System

        - Used in outpatient department
        - Manages patient queues
        - Contains patient information
            - Name
            - Address
            - Hospital Number (patient's unique ID at this hospital)
        - Has no educational purpose
    - 2 of the doctors (residents) will categorize processes for us
    - Security is very important – patient data is confidential
    - Database doesn't have to do anything with accounting
    - Want to able to scan literature (such as journals, etc) into database
- X-Rays are odd dimensions, some very large
    - Scanners for X-Rays are extremely expensive
        - Cost 300,000 – 400,000 Baht
    - Digital X-Ray machines even more expensive
    - Currently only option is to take digital pictures of X-Rays
- Database Search Criteria
    - By Patient (for past information)
    - By Category (type of injury)
    - By Doctor
- Looking through the forms that they currently use
    - Don't need plan management document (it changes throughout a patient's stay)
    - Don't need nursing diagnosis
    - X-Ray
    - Photograph (such as pre-op, post-op)
    - Movie

A2: Nakornping Hospital Visit – Notes

1/23/06

- General Information about Nakornping Hospital
  - 500 beds (inpatient)
  - Mostly tertiary care
  - SSB System used in all departments
    - Patient data, OPD registration
    - Separate programs for different purposes
      - Ex. Financial, registration, IPD, operation room
    - Use of hospital number (unique patient identification)
    - Used for prescriptions (pharmacy)
    - In offices – used for stock control, financial
    - Doctors don't have time to input data into SSB System
    - Users are primarily nurses
  - Resident doctors for 2 years
  - Receive referrals from urban hospitals
    - 23 in Chiang Mai
  - Patients referred away from Nakornping
    - Pediatric surgery
    - Other very complicated cases
  - Reference
    - For research
      - Search internet
      - Consult Chiang Mai University Hospital
        - Sometimes University Hospital doctors help in procedures
    - Guest Speakers
      - Joint events with University
      - Not very often
- Registration
  - Admission # each time patient is admitted
  - Unique patient identification # - called the hospital number
  - Visitor #, used for queuing patients
- Orthopedic OPD
  - Exam room doesn't have a computer
  - Paper forms filled out by doctor
    - Forms given to nurse, who inserts the data into the SSB System
  - SSB will soon have computer system for doctors
  - Takes 5 minutes to insert data into SSB (data for diagnosis)
  - Talking with Dr. Wathanay (sp?)
    - Thinks that SSB is a good system, containing basic data
    - Learned how to use SSB at another hospital

        - Felt that it was easy to use about after 1 month
    - Currently, for studying records, it is hard, because sometimes the records are lost
        - Records stored for 5 years
    - Useful applications of a (new) system
        - X-rays – showing progression of treatment
        - Digital CAT scans possibly in the future
        - Possible problem with computer system
            - Image on small monitor – not as much detail
        - In current system, to retrieve X-rays, doctors need to get admission number from SSB, then send number to file management, who will retrieve the physical file
    - Q: Would it be useful for residents (to be able to search for similar cases)?
        - A: Yes
            - Benefits from studying previous cases, interesting cases, complications, etc.

- IT office
    - SSB
        - Every procedure is recorded in the SSB system
        - Can view patient procedures on specific dates
        - Outcomes, complications, diagnoses all stored in SSB
        - Used for scheduling operations
        - Can't store media files
        - Not able to access patient records from outside hospital
            - Confidentiality
        - System is customized for each hospital
        - Able to look up infection rate for a specific operation
            - This information is for this specific hospital
        - Hospital number / Admission number entered to look up records or past history
        - Registration
            - Stores past patient records in paper form
            - Each visit scans history
            - After discharge, records are scanned into the system
            - Scanned documents (need to have doctors' signature on forms)
        - SSB system searchable only for current patients (patients currently in the hospital)
            - Discharged => patient info is removed from SSB [removed from searchable material]
        - Electronic records are saved for 5 years (in backups)
            - To search for past medical records, have to contact the IT department

        - SSB will store data for 5 years, but only current records will be accessible online
        - Relative weight not stored (as far as our contacts knew)
        - Unique identifier for this hospital? No
    - Hardware / Storage is outsourced, Software is SSB
    - Financial records kept for 3 years
    - Records of service kept for 5 years
    - Electronic documents are automatically destroyed/deleted after this time
    - Government will pay a standard amount for a specific operation
        - Hospital will not get more money if there are complications
            - Loss of money
    - Nakornping Hospital not benchmarked with Lerdsin
        - Different province, type of hospital
    - SSB system not stable yet…
        - (We didn't see any problems)
    - Other hospitals use SSB for certain departments
    - Problem with SSB
        - Doctors sometimes don't put in information on a treatment => forget
            - Results in loss of data (record can't be analyzed by the system)
    - 30 Baht plan
        - What the government pays is based on ICD10, ICD9 CM
            - If the hospital provides good service => makes money
            - If the hospital provides poor service => loses money
    - Center of Excellence title is given out by the government
        - Government tries to make each (general) hospital a center of excellence in one or more departments
        - Nakornping will be a Center of Excellence in Trauma in 2 years
- Observation of hardware for SSB system for OPD, IPD (not for registration)
    - Data storage – 72.8 GB x 3 Computer
    - Backup (5 years of records) on DAT drives
- SSB can search by operation code (ICD9 CM)
- Published papers?
    - 2 journals a year
    - Newsletter to employees
    - Group research, individual research
        - Sometimes case study
        - Doctors, nurses, pharmacists
- Monthly report to government
    - Use SSB to do this (using Crystal Report and Excel)

Questions left for head of Nakornping's Orthopedic Department

1. In the orthopedic department, when is the SSB system accessed by doctors? What kind of information are the doctors accessing?

2. Is the SSB system used for education, such as referencing interesting or special cases?
3. Where do resident doctors currently collect information from in conducting research? (such as referencing past patient records)
4. Does the SSB system contain information about the relative weight (a value based on the cost and complexity) of an operation?
5. What data is included in the monthly reports to the Ministry of Public Health?
6. Is the SSB system used to generate the monthly reports to the Ministry of Public Health?
7. Is there any information in the monthly reports that is not stored in the SSB system? If so, what is this information, and where does it come from?

A3: Saraburi Hospital Visit – Notes

January 27, 2006

6:00 A.M. - Dr. Thavat

- Saraburi
  - Bigger than Nakornping
  - One of 25 General Hospitals
  - Not orthopedic center of excellence
- Most systems do not have ways to measure performance
  - Lazy, active doctor could be paid the same amount
- Random: In 2 or 3 years, Thavat foresees privatization of hospital system
- Saraburi
  - has teaching activities
    - Lerdsin sends doctors to teach at Saraburi
  - 5 Orthopedic Doctors
    - Lerdsin sends residents for 1 month
      - For Trauma surgery
- Random: Worker insurance organizations
  - Make more $$ from workers
- Random: Software – something wanted
  - Record expense from 30 Baht Scheme
    - Sometimes government only pays part of cost
    - Ex: 100,000 prosthetic hip (hospital pays for it)
      - Reimbursed only 30,000 by government

7:45 A.M. – Meeting with Saraburi Orthopedic Staff (Department Head, some doctors, some residents)

- 200-300 OPD patients for OD each day
- 3 wards, 30 beds each – can be extended to 120 total beds
- 6 Orthopedic Doctors
- Saraburi a Central Hospital
- Questions for Head of Orthopedic Department
- Many Central Hospitals have lots of technology
  - Depends on how well run / managed
- Central Hospital bigger than General Hospital – more beds, etc.
- Residents Timeline
  - 6 years as medical student in university hospital
  - 1 year of internship
  - 2 years in provincial hospital
  - Then back again (to university hospital) if they want to be a specialist
- To be a Central Hospital – need more than 600 beds
- GIS

    - Geographic Information System
    - For government to decide where central hospitals should be located
- 80 doctors at Saraburi (Central Hospital), 100 at Lerdsin
- Residents visit Saraburi, not trained here (at Saraburi)
- Saraburi – CoE for Trauma & Cancer
- Referred patients depends on patient's right (30 Baht Scheme, worker's insurance, etc.) and budget
- Lerdsin – only CoE in orthopedics
    - If Lerdsin can't do a complex case, usually refer to University Hospital
        - Ex: Tumor operation
- CoE requirements for Trauma
    - Dr. Thavat, no one present knew what they were
- In 2 or 3 years in Saraburi, a training program will be in place *(how is it a CoE, then??)*
- Possibly consult over internet in the future
    - Internet teleconferencing / video conferencing, etc.
- Saraburi – area of many high-velocity accidents
    - In Bangkok, most trauma is less complex
- No research yet for orthopedics – inadequate amount of staff
- Barriers to CoE
    - Budgetary
- Referred to by some General Hospitals
- Satisfaction with software in Saraburi Hospital
    - "More excellent IT Center" – very satisfied
- Lack of staff because the number of staff is provided by the area/location
- 72 orthopedic specialists a year graduate from Royal College
    - Specialists want to stay in Bangkok
- CoE in Trauma
    - Library, journal, use of internet
    - Practical learning here
        - Theoretical learning from books, takes place elsewhere
    - Research paper for residents
    - Thavat: 7 criteria for CoE for Orthopedic may not be the same as for Trauma
    - Policy Advocate, campaign
        - Reduced death toll in the 4-day vacation before April
    - Trauma is complex – multiple regions and systems of body

Touring Saraburi Hospital with 2 doctors, 2 residents

- Some injections are done in OPD
    - Release trigger finger, etc
- SSB - Patient ID # is a National ID # (like SSN)
- 2000 people/day in OPD in whole hospital
- OPD card (diagnosis) scanned into SSB system – can view
- Dr. Thilachay @ Lerdsin – in charge of talking to SSB about what they want

Meeting with Saraburi IT Department

- SSB system
  - Not complete EMR (electronic medical record)
  - Can't track patient, only know what happened to patient in general
- New SSB – souped up old SSB with new interface to make EMR more accessible
- SSB is missing clinical information
- Data inputted by staff – nurse, other
  - Not usually doctors
- In-patient records scanned to PDF
- Head IT Manager – a Doctor of Pathology
- Saraburi developed own intranet, can search by HN & AN
  - Took 2 years with 7 staff members
  - Accesses SSB database
    - About 400 tables in SSB database
    - No API or documentation on SSB system
    - Found location of desired information by dragging SSB support in and twisting their arms
  - SSB system monthly reports sometimes can be wrong
    - Data often checked with own internal system
  - Borrowing records in OPD – signing out of records (tracking)
  - Able to see data like the average wait time of patients before they are seen
  - Able to see scanned medical records
    - Document scans and comments
  - Storage for records – on average 1-2 MB
    - Special server just for scanned records
    - Low quality
    - Average size is 10 MB per patient
  - Database server – Xeon 3 GHz, 8 GB RAM
    - Storage: 8 – 70 GB Drives in Raid 1 + 0
    - SSB database is 34 GB for 8 years of data
    - Additional database (their additional information) – 500 MB
  - 2 Servers with special configuration for pictures
    - 4 Hard drives, 80 GB in RAID 5 => 240 GB of storage per server
    - One for medical records, one for internal documents
  - Backup for SSB and own database
  - Personnel Data
    - Income, etc.
  - SSB only unstable when administrator is tweaking it
  - Laboratory database system
    - Separate from SSB
    - Specifically developed for laboratories
  - Relative Weights?

  In SSB system – no

- Electronic Number
- Room, Dr, Medication
- Diagnosis
- ID – basic
- X ray, EKG, Lab results
- Doctor
- Complication

SSB

- Transactional process
- Semi Medical Electronic Record System
- Input Basic info
- Missing
    - Clinical info
    - Complete info
- Nurses staff (non medical personnel does input)
- Scanned in medical registration unit

E-code	diagnosis method	thai	english	illness
Remarks	suggestion	misc	complaints	summary
Physical Ex	major problem	family history	allergies	progress

ERP

- statistical data
    - real time reports
        - financial
        - customer
        - internal
- record creation
- record management
- 400 MB of monthly reports

Borrow record / tracking system.

A4: Ministry of Public Health Conference Document

Ministry of Public Health
Tiwanon Road, Nonthaburi, Thailand 11000
http://www.moph.go.th

The Development of Excellent Medical Services in Thailand

1. Principle and development concept

Thailand is having epidemiological transition and seeing increasing non-communicable diseases particularly coronary heart diseases, diabetes, cancer and accidents. The treatments and cares for these patients require sophisticated equipments, facilities, and well-trained human resources embedded in excellent medical centres. These are mainly in the medical schools in the capital and a few major cities. Patients from other provinces have to travel long distances to get the services and have difficulties in receiving continuous care. The Thai government, in its aspiration to improve the equity of delivering quality cares to all its citizens, aims at establishing many more centers that can provide excellent medical services. This will allow more access, better care and also more efficient use of limited resources.

The 4-year Centers of Excellence Development Plan (2006-2010) is prepared in cooperation with all stakeholders concerned. One of the most important issues is to invest in good quality medical equipment, including advanced technology in order to increase the potential for early detection and diagnosis as well as to provide better care and treatment. The specific aims of this project include:

1.1 Development of excellence medical services in the regional referral hospitals in 3 main areas, i.e., excellent medical services for cardiac, cancer and trauma treatment.

1.2 Capacity strengthening of medical and health personnel in efficiently and sustainably providing the good quality services in the three areas mentioned in 1.1

1.3 Efficiently maintain the quality of services.

2. Scope of work

The interested partners are required to conduct some rapid surveys and studies in order to come up with innovative proposals for the development of the excellent medical services in the three above-mentioned areas. Both diagnostic and treatment facilities and capacities for complete circle services are expected. It is expected that with these facilities scattered all over the countries, there should be very few cases that need to be referred.

3. Project proposal should include:

3.1 Technical proposal on each of the three excellent medical services including the mapping of their location and distribution.

3.2 Innovative model for the acquisition of high quality, high technology diagnostic and therapeutic equipment with reasonable price, and good post-service to those facilities mapped out in 3.1.

3.3 Capacity building and strengthening plan.

3.4 Financial proposal for all the services and equipment

A5: Lerdsin Hospital History

บทวิดีทัศน์
โรงพยาบาลเลิดสิน

24/1/49

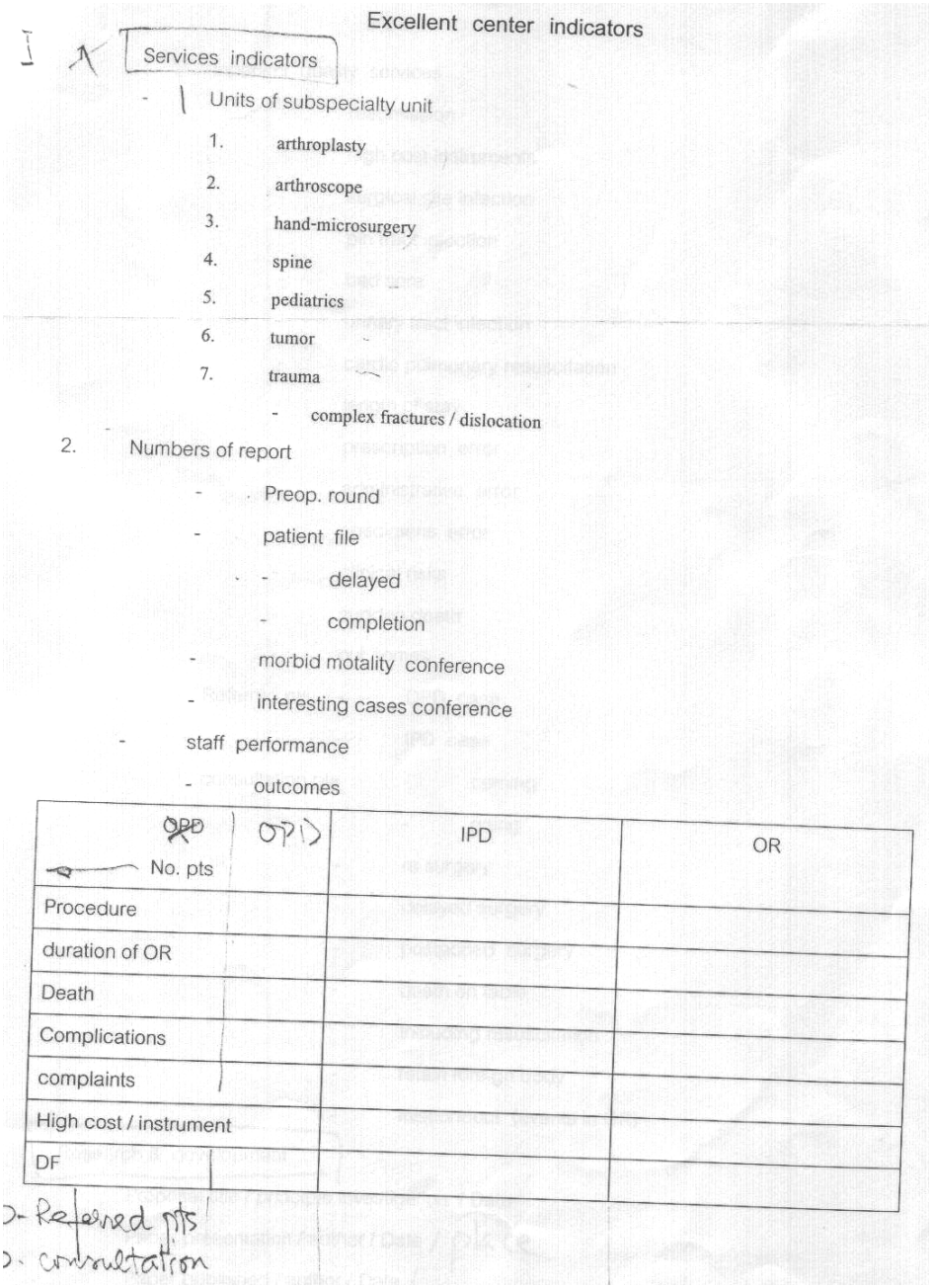
ภาพ	บรรยาย
— 8-10 วิ — ของเดิม —	In 1889 during the reign of King Rama V, His Majesty the King granted permission to Dr.T. Hayward Hays, a Scottish-American missionary, to use the Royal House as a nursing home for foreigners living in Thailand. Located at the beginning of Silom Road, the building officially was called Bangrak Hospital, but locally was known as Dr, Hay's Clinic. — 30 วิ —
— ของเดิม —	During the reign of King Rama VI, Bangrak Hospital was transferred to the Department of Public Health, Ministry of the Interior. In 1957 , it was transferred again to the Department of Medical Services, within theMinistry of Public Health. The hospital under the supervision of the Ministry was officially opened on June 28, 1959. Khunying Pakdi Norased Sin Settabut kindly donated approximately 27,000 US dollars for construction of patient wards and a doctors' residential area, in memory of her late husband Praya Pakdi Norased Lerd Settabut. The hospital has been called "Lerdsin Hospital" since then.
หน้า ร.พ. ฉาก (VDO ร.พ. เลิดสิน ความยาว 25.57 นาที)	Lerdsin Hospital is located on Silom Road, an area with the most expensive land in Thailand, Formerly,the hospital occupied about 2.5 acres of land, However, the second stage of the Bangkok expressway has allowed the hospital to add adjacent property. At present, the hospital compound includes approximately 4 acres.

ภาพ	บรรยาย
([illegible]) VDO ([illegible]) VDO ([illegible] Denver) Title [illegible] [illegible] ([illegible]) [illegible]	Lerdsin Hospital is a tertiary care facility with a full array of specialists, subspecialists and general practitioners. The hospital can accommodate up to 485 beds. With continous improvement in both service quality and organizational structure, the hospital receives 1,900 outpatients per day. Under the social insurance plan, the hospital now welcomes between 70,000 and 90,000 insured members per year and has received the distinguished award for best hospital care under the social insurance plan. — 30 —
[illegible] [illegible] [illegible]	In addition to providing medical care, the hospital's first priority, Lerdsin also serves as an academic institution. The hospital offers an extensive training program for all levels of medical personnel, including medical students, interns, residents, nursing students, anesthetic nurses and interns from neigh - boring countries, Every year, the hospital organizes many short courses and scientific meetings including international conferences with world renown guest speakers. — 30 —
VDO ([illegible]) ↓ OPD	Lerdsin Hospital is transforming its appearance through various projects. The interior environment is being upgraded, the air conditioning system replaced and full amenities introduced. The hospital can provide the services expected by more affluent patients and their relatives — 30 —

ภาพ	บรรยาย
VDO → [illegible] อบรม 5 ส / TQM (3-4 [illegible])	The hospital has developed its organization to improve service quality. The 5S and Total Quality Management programs now are carried out and will lead to Hospital Accreditation, recently introduced to Thailand.
Shot กลุ่ม ([illegible]) + ใน VDO.	The hospital has developed an information technology system, most notably, fully computerized medical records. This system guarantees fast and accurate service. — 30 —
VDO (Title ของ Denver.) ([illegible]) VDO ([illegible])	The Kanchanapisek project, for the construction of a 24-storey building, will be completed in the year 2000. Her Royal Highness Princess Mahachakri Sirindhorn laid the cornerstone for this building on June 28,1996. With this tower, the hospital's capacity will increase to 648 beds. The expansion also includes a new Intensive Care Unit and ten additional operating rooms. Equally important, the hospital will increase its car park capacity to 170 cars. — 30. —
VDO (Denver [illegible]) [illegible] + LOGO ↓ [illegible] ↓ [illegible] ↓ [illegible] → VDO [illegible]	The Lerdsin Hospital Foundation began in 1981. Its main objective is to promote study and research in patient care and prevention of illness. The Foundation also helps support government and hospital employees and any charity organizations not related to politics. At present, the Foundation is under the patronage of Her Royal Highness Princess Kalyanlwattana.

ภาพ	บรร ยาย
VDO [illegible] OPD / [illegible] ward. Shot [illegible]	Lerdsin Hospital will become a hospital for all people, with services equal to any private hospital. The privatization systems for the state hospitals will allow more flexible operations and enough income to support the less fortunate in today's society.
Shot [illegible]	With its Foundation that can be traced back for decades. Lerdsin Hospital has gone through the process of continuous development and has achieved high standing as an academic medical enter in the Department of Medical Services, within the Ministry of Public Health. — 30 —
VDO - [illegible] - [illegible] Ward ([illegible]) [illegible]?	For today and tomorrow, Lerdsin Hospital is folly committed to the best medical care for people in all walks of life. Our vision is the University's Hospital quality and the mission is to develop high standards of cure with the most impressive care. — 10-15 [illegible] —

A6: Center of Excellence Criteria – Ministry of Public Health



Excellent center indicators

Services indicators

- Units of subspecialty unit
  1. arthroplasty
  2. arthroscope
  3. hand-microsurgery
  4. spine
  5. pediatrics
  6. tumor
  7. trauma
     - complex fractures / dislocation
2. Numbers of report
   - Preop. round
   - patient file
     - delayed
     - completion
   - morbid motality conference
   - interesting cases conference
- staff performance
  - outcomes

~~OPD~~ OPD / No. pts	IPD	OR
Procedure		
duration of OR		
Death		
Complications		
complaints		
High cost / instrument		
DF		

- Referred pts
- consultation

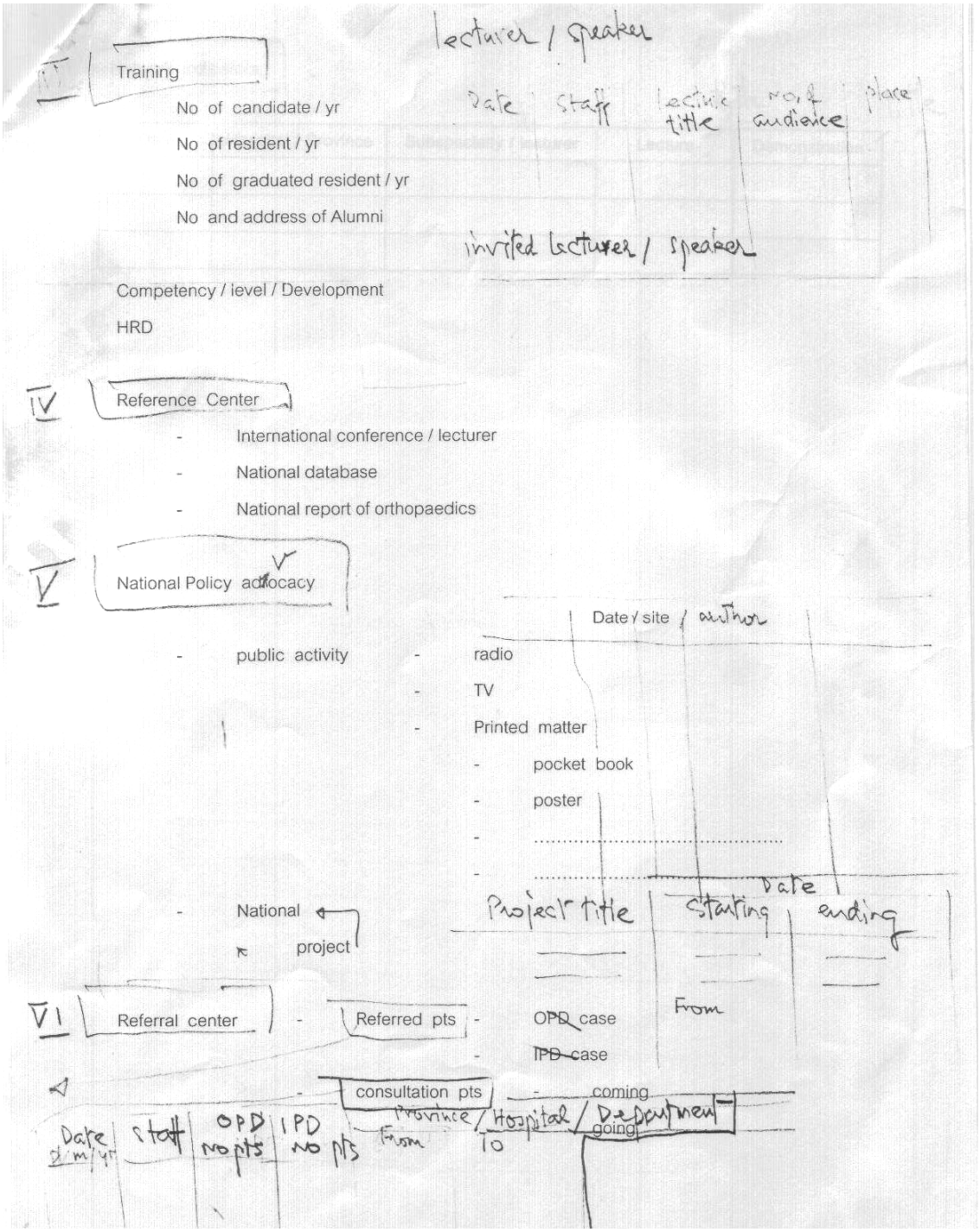
- 3 inpatient quality services
  - readmission
  - high cost instruments
  - surgical site infection
    pin tract infection
  - bed sore
  - urinary tract infection
  - cardio pulmonary resuscitation
  - length of stay
  - prescription error
  - administrative error
  - specimens error
  - clinical risks
  - sudden death
  - out comes
- Referred pts
  - OPD case
  - IPD case
- consultation pts
  - coming
  - going
- OR
  - re surgery
  - delayed surgery
  - postponed surgery
  - death on table
    Including resuscitation
  - retain foreign body
  - misconduct (events in OR)

II Research & development

Proposal title / principle investigation / Date

Paper presentation / author / Date / place

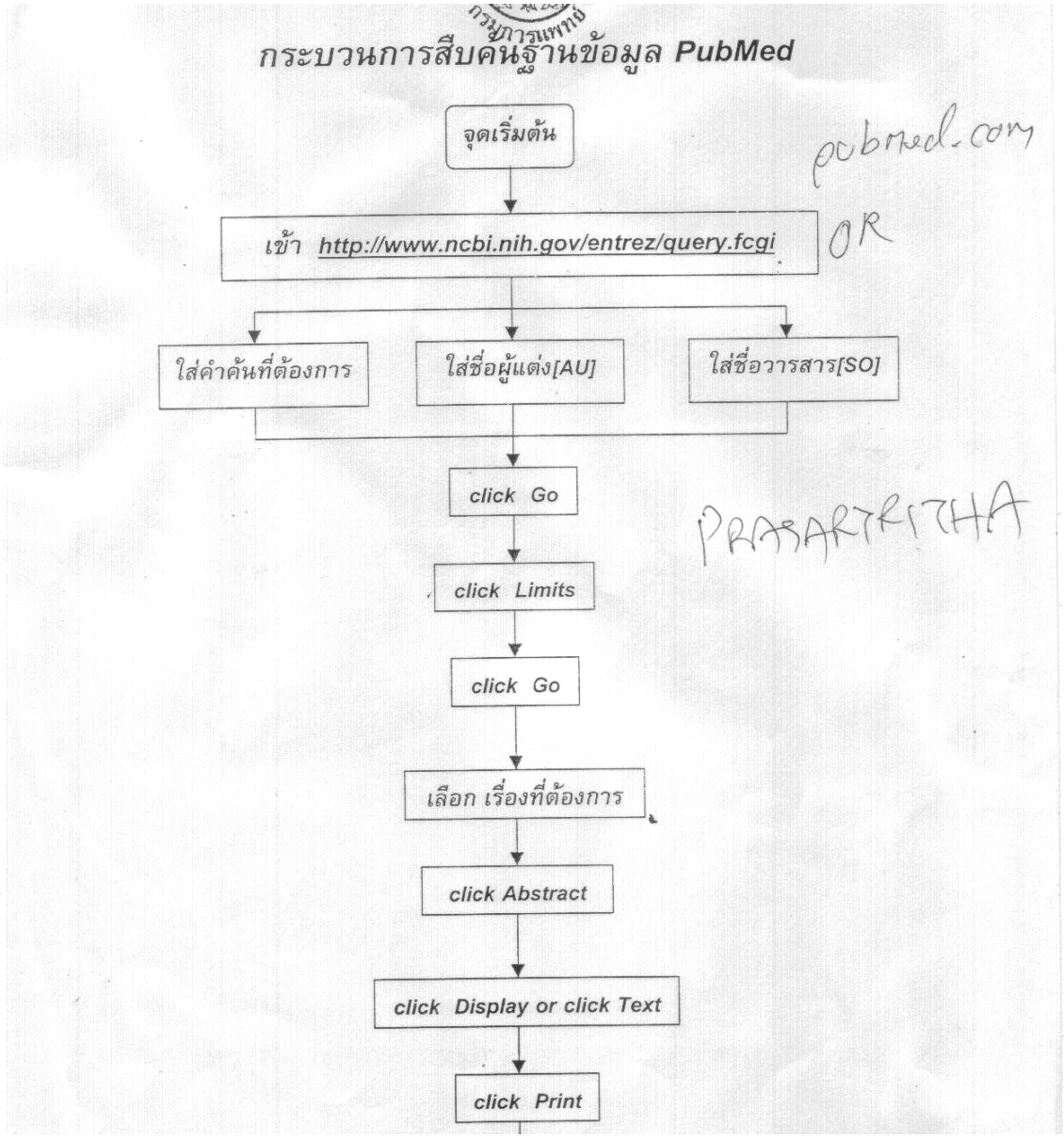
Paper published / author / Date /


lecturer / speaker
III Training
No of candidate / yr
No of resident / yr
No of graduated resident / yr
No and address of Alumni
Date Staff Lecture title No of audience place
invited lecturer / speaker
Competency / level / Development
HRD
IV Reference Center
- International conference / lecturer
- National database
- National report of orthopaedics
V National Policy advocacy
Date / site / author
- public activity
- radio
- TV
- Printed matter
- pocket book
- poster
- .....
- .....
- National project
Project title Starting date ending
VI Referral center
- Referred pts
- OPD case
- IPD case
From
- consultation pts
- coming going
Date d/m/yr Staff OPD no pts IPD no pts From Province / Hospital / Department To

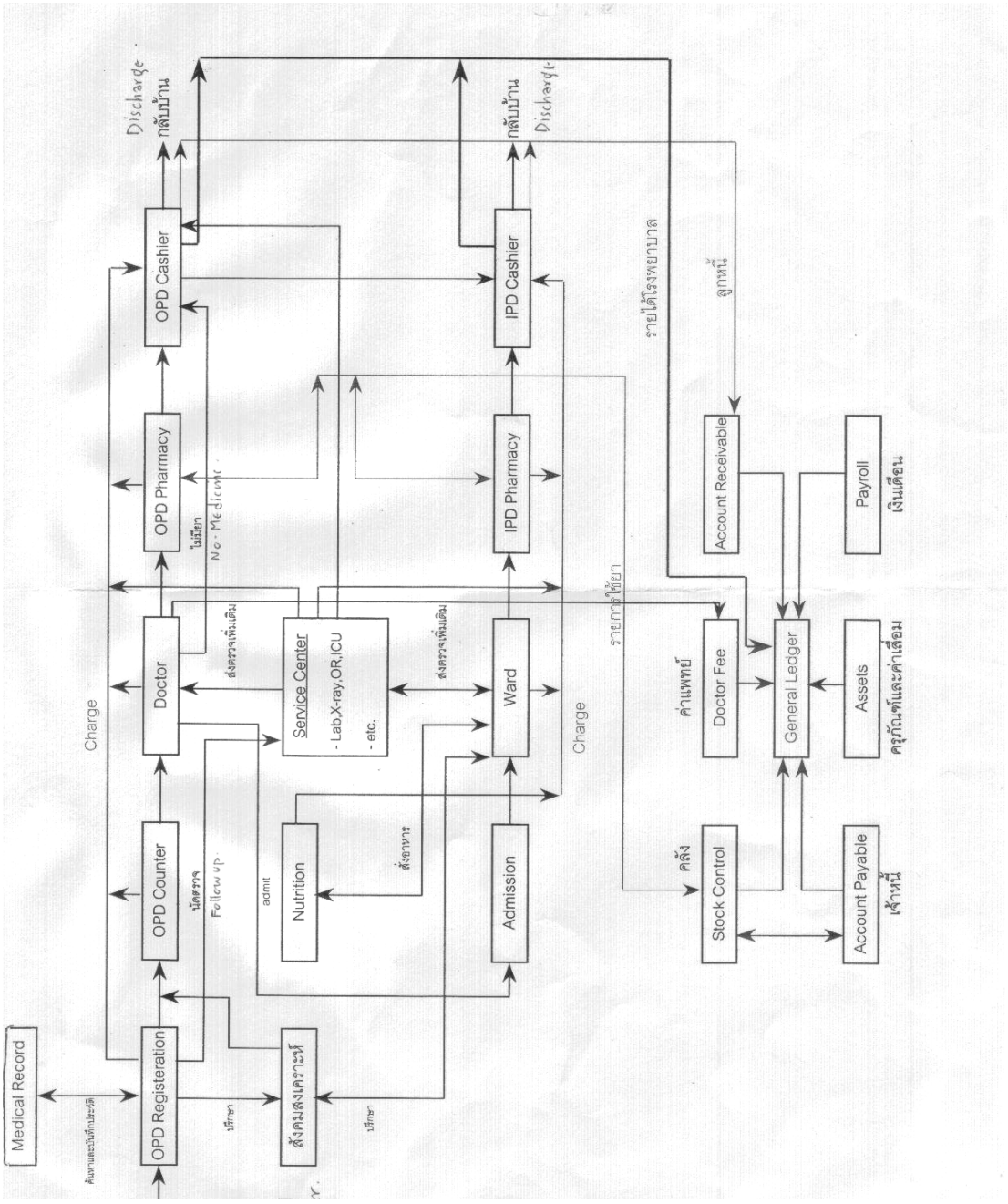
VII Network indicators

Date	Hospital / Province	Subspecialty / lecturer	Lecture (title)	Demonstration (title)

A7: Internet Journal Database – PubMed



A8: Nakornping Hospital Flow Chart



A9: Lerdsin Hospital – Hospital Evaluation

Tour of Orthopedic Department OPD, General OPD, Emergency Room, File Room
Monday, January 23rd, 2006

Attendees:
Pat Canny
Esteban Paez
Dr. Thavat

Types of Patients

30 baht scheme	300+
Civil Servant	300+
Social Security	500+
Self Paid	200+
Insurance	approx
Total	1600-1700
Total IPD	45
Total Orthopedic OPD	200

Orthopedics Interacts with
- Emergency Room
- Operating Room
- IPD
- OPD
- Laboratory
- X rays
- Pharmacy

1. ID Copy, Fill out form
2. Confirm
    a. Name
    b. Telephone
    c. Address
3. Nurse Screening
    a. Blood pressure
    b. Heart beat
    c. Etc
4. Determine Department
    a. OPD
    b. OBGYN
    c. Dental
    d. Pediatrics

    e. Etc.
5. Hospital #
    a. Clinical Record #
6. Department

- Dr. Thavat noted that certain employees may no longer have jobs once a new SSB system is put in place
- He also mentioned that the current paper management system was very disorganized, and illustrated to us by showing us stacks and stacks of patient files waiting to be sorted
    - We ask if this leads to lost files, and Dr. Thavat said it might
- When touring Emergency Room, Dr. Thavat mentioned how some of the patient file is filled out there and is completed later if the patient is admitted
    - Not all of the file is completed if the patient is discharged after receiving minor treatment
- We were not able to see the file room because we were not "cleared" to enter, but Dr. Thavat allowed us to view it from the outside.
    - We noticed how it was organized by shelves
    - We were told there was a book for residents to sign when they checked out documents and returned documents
- We were also shown around the General Outpatient Department
    - Dr. Thavat showed us the entire process of a patient's flow through the OPD, starting with screening
        - Screening
        - Insurance check
            - If uninsured, patient pays out of pocket
        - Admission to OPD
            - Receives appropriate numbers
            - Referral to appropriate department
        - Patient carries file with them
- We then proceeded to the Orthopedic Department's OPD
    - We were shown the registration desk and treatment rooms
    - We were also shown some of the registration process, including patient file storage