ANESTHESIA EXPERT SYSTEM

by

Raynah Binti Musa

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
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CERTIFICATION OF APPROVAL

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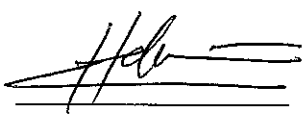
Approved by,



(Mr Helmi Md Rais)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
JUNE 2005

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

RAYNAH BINTI MUSA

ABSTRACT

This report is written as preliminary information on the Information Technology Final Year Project. The project selected for this purpose is Anesthesia Expert System. This project will focus on the general anesthetic and epidural anesthetic. The aim of the project is to support the decision-making process of administering anesthesia before the operation is done. The system will do this by automatically analyzing the different aspects of anesthesia and determining and suggesting the best and efficient anesthetic to be used for a particular medical procedure to be undergone by a patient. This system will take into consideration the different critical aspects about the patient, for example: blood pressure, age, weight and the type of procedure to be undergone. Because the system will be automated, it will thus improve and quicken the manual anesthesia decision-making process conducted by anesthesiologists in operating room settings. This system will be developed using tools that allow interactive graphical user interfaces for user-friendliness. The anesthesiologists can refer to the system at anytime, anywhere as they want to as it is a web based system.

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ABBREVIATION AND NOMENCLATURES

AES	Anesthesia Expert System
AI	Artificial Intelligence
ASA	American Association of Anesthesiology
CNS	Central Nervous System
CDSS	Clinical Decision Support Systems
DFD	Data Flow Diagram
DSS	Decision Support System
ES	Expert System
ESDLC	Expert System Development Life Cycle
HTML	HyperText Markup Language
HTTP	Hyper Text Transfer Protocol
ICT	Information and Communication Technology
IT	Information Technology
IV	Intravenous
PACU	Post-Anesthesia Care Unit
PDA	Personal Digital Assistant

CHAPTER 1

INTRODUCTION

The past decade has seen an impressive and incremental implementation of Information & Communication Technology (ICT) to support important processes of care in the health services. Currently, within the Ministry of Health, the Selayang and Putra Jaya Hospitals as well as Putra Jaya Health clinic are operating under a paperless environment. Another 13 Ministry of Health hospitals all over the country are being planned to have varying levels of hospital information system [12]. The private sector too is implementing varying levels of IT-assisted services in private hospitals as well as clinics, either to exchange clinical information or results.

Anesthesia, the general or localized insensitivity to pain or other sensation, revolutionized the practice of medicine more than a century ago. Both an art and a science, the purpose of administering general anesthesia during surgery is to render the patient unconscious, prevent pain and ensure a quiet surgical field with minimal movement during a surgical procedure.

1.1 BACKGROUND OF STUDY

Anesthesia is an important area of medicine that is crucial during major and minor medical procedures. Before the anesthesiologist decides on which type of anesthetic to administer to the patient before the surgery, there are a few factors, usually about the patient, to be considered concurrently. These factors can include the patient's age, allergy and blood pressure [2].

Making a decision while considering all these factors can be time-consuming and inefficient, thus there is a need for a reliable means to improve deciding on the type of anesthetic to use. This is where computers become relevant and useful as they can store large amounts of information (knowledge) and this knowledge can be manipulated and easily retrieved when needed. A system such as an expert system will be useful to help anesthesiologists in making decision before a patient undergo a surgery or operation.

This system allows the anesthesiologists to quickly build concise and complete anesthetic assessments, while supporting the workflow surrounding the pre-operative evaluation. The system will automate the pre-anesthetic evaluation and promotes optimum care by increasing the accessibility, clarity and quality of anesthesia data. Through automation of the diligent steps taken by anesthesiologists to ensure a successful and quality anesthetic event, this system will provide complete and detailed information on patient health and surgical readiness.

Expert systems are meant to solve real problems which normally would require a specialized human expert such as a doctor or a mineralogist. In this system, it requires the anesthesiologist expert itself. Building an expert system therefore first involves extracting the relevant knowledge from the human expert. Such knowledge is often heuristic in nature, based on useful ``rules of thumb'' rather than absolute certainties.

1.2 PROBLEM STATEMENT

Anesthesiologists face a demanding and time-consuming task of having to refer to medical literature before they can decide which type of anesthetic to administer to their patients before and after the surgery. Apart from the information gathered from the medical journals, the decision-making process

for administering anesthetics is solely dependent on the knowledge that the anesthesiologist has and this is insufficient to make a well-informed decision.

Anesthetic information needs to be readily available. Therefore, there is a need for an automated computer system to provide all-rounded information on anesthesia and to quickly assist in decision-making by suggesting and advising on the anesthetics and the dosage to be administered to a patient to undergo particular procedure.

This system will make use of stored knowledge and rules of "**if...and...then...**" relationships to suggest an anesthetic to be administered to a patient. This system will eliminate human errors as a misguided decision may result in the patient losing their life.

1.2.1 Problem Identification

Most hospitals in Malaysia are still using the conventional way deciding on which type of anesthetic to be used when a patient needs to undergo an operation. The decision making on which type of anesthetic to be used is mainly dependable on the anesthesiologist's knowledge and experiences. It is difficult for the anesthesiologist to decide on which anesthetic to use considering the factors required such as the patient' history, medical details and system review.

The current development of medical decision support system is still at the initial edge in this country. By encouraging automation in the hospital's basic operations, the mentioned problems would have to be reduced and this would lead to the efficiency in Malaysia's medical sector.

1.2.2 Significant of the project

The software was not meant to replace the specialist or anesthesiologist, yet it was developed to assist anesthesiologist in deciding the most suitable anesthetic to be given to the patient during an operation considering the required factors. Advancement in technology will form a platform for developing a better design of Anesthesia Expert System (AES).

This Anesthesia Expert System is expected to meet the minimal expectations of anesthesiologist in accepting the technology, and acting as a platform on which its features will be improved from time to time to suit the current needs, together with the evolution of the world around us.

1.3 OBJECTIVE AND SCOPE OF STUDY

The objectives of this project are to improve efficiency of anesthesiologists' daily tasks by:

- Providing a knowledge-base for anesthesia by gathering related data and compiling it into the knowledge-base.
- Developing an automated system for anesthesiologists that provide recommendations on which anesthetic to use for different situations.

The scope of study for this project will focus on gathering information related to general anesthesia and epidural anesthesia. The system will compile the information into a knowledge-base for this medical arena. The scope of the project will also be to provide anesthetic dosages and measurements of general anesthesia and epidural anesthesia, to be administered to patients for relevant operational procedures.

1.3.1 The Relevancy of the Project

The project is developed to give a basic idea on how an expert system could assist in deciding on which type of anesthetic suitable for the patient who needs to have a surgery while considering the related factors. By introducing some features which model the conventional way of deciding the suitable anesthesia, the project will assist anesthesiologists in utilizing automation in medical services. The system should provide the important quality such as accuracy, efficiency and effectiveness.

Data acquisition is done by interviews, reading related materials, use the technology information available in the World Wide Web using Internet Explorer. Document reviews are intensively done to give more concrete facts to the topic studied.

1.3.2 Feasibility of Project within the Scope and Time Frame

1.3.2.1 Scope Feasibility

The system will focus in automating the basic and main processes in deciding on which anesthesia should be used, while considering the related factors of the patient. The system will be able to give the suitable anesthetic based on the factors related to the patient with the suitable dosages of the anesthesia.

1.3.2.2 Schedule Feasibility

The system will be completed according to the budgeted time

1.3.2.3 Technical Feasibility

This system is developed using the Exsys CORVID application. Exsys CORVID provide practical delivery of complex decision-making knowledge on web sites and stand-alone applications. It emulates "always-available" one-on-one consultations with the experts. It can provide answers and recommendations that prospects, clients and staff need.

It will be combined with Macromedia Dreamweaver MX to build the HyperText Markup Language (HTML) pages. The Apache Hyper Text Transfer Protocol (HTTP) Server is used to act as the server for this project purposes since it is a web based system. Apache HTTP Server is an open source HTTP web server for Microsoft Windows and other platforms. HTTP is the primary method used to convey information on the World Wide Web. The original purpose was to provide a way to publish and receive HyperText Markup Language (HTML) pages. It is a request/response protocol between clients and servers. HTML is a markup language designed for the creation of web pages and other information viewable in a browser.

CHAPTER 2

LITERATURE REVIEW / THEORY

2.1 ANESTHESIA

2.1.1 Anesthesia

The word "anesthesia" refers to the inability to feel [1]. In a medical sense, anesthesia essentially refers to a broad range of medications used to make surgery possible. These drugs also make a person comfortable and pain-free during an operation.

Before the discovery of anesthesia, even relatively simple procedures, such as an appendectomy were painful and often fatal. With the discovery in the mid-1800s that nitrous oxide ("laughing gas") and ether made patients insensitive to pain, the practice of anesthesia was born, making surgery a viable option for many conditions. Today, a combination of anesthetic drugs accomplishes the needed results where the analgesic drugs provide pain relief; muscle relaxants ensure the patient doesn't move and hypnotic drugs make the patient unconscious. An estimated 20 million patients undergo surgery with general anesthesia every year in the U.S. alone.

Anesthesia is the process of blocking the perception of pain and other sensations. This allows patients to undergo surgery and other procedures without the distress and pain they would otherwise experience. There are various forms of anesthesia. The types of anesthesia the patient will receive

depend on the type of surgery and their medical condition. Usually, an anesthesiologist will administer a sedative in addition to the anesthetic.

In this project, this system will only focus on the pre-anesthetic suggestion with the suitable dosages for general anesthesia and epidural anesthesia.

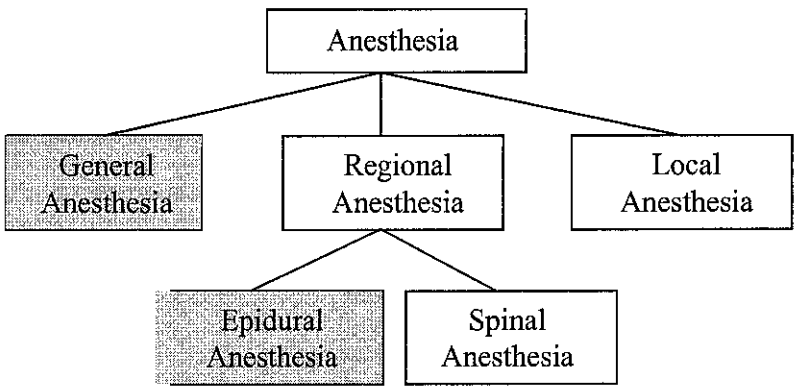

FIGURE 1: Types of Anesthesia

2.1.1.1 General Anesthesia

General anesthesia causes a patient to be unconscious during surgery. The medicine is either inhaled through a breathing mask or tube, or administered through an intravenous line, a thin plastic tube inserted into a vein (usually in the patient's forearm). A breathing tube may be inserted into the windpipe to maintain proper breathing during surgery. Once the surgery is complete, the anesthesiologist turns off the anesthetic and the patient wakes up in the recovery room.

Injection anesthetics are used for induction and maintenance of a state of unconsciousness. Anesthetists prefer to use intravenous injections as they are faster, less painful and more reliable than intramuscular or subcutaneous

injections. Among the most widely used anesthetic drugs are propofol and diazepam.

Propofol is a drug that reduces anxiety and tension, and promotes relaxation and sleep or loss of consciousness. Propofol provides loss of awareness for short diagnostic tests and surgical procedures.

Diazepam is in a class of drugs called benzodiazepines. Diazepam affects chemicals in the brain that may become unbalanced and cause anxiety, seizures, and muscle spasms. Diazepam is used to relieve anxiety, nervousness, and tension associated with anxiety disorders. It is also used to treat certain types of seizure disorders and muscle spasms.

More explanation of propofol and diazepam can be referred in **APPENDIX 2A** and **APPENDIX 2B** respectively.

The inability to directly measure the effect of anesthesia on each individual certainly presented some serious challenges. Cases of under-sedation and over-sedation can lead to adverse clinical and economic outcomes. In rare and extreme cases, patients who receive too little anesthesia might experience intra-operative awareness, which can have long-term emotional implications, including post-traumatic stress disorder.

More common is the problem of patients receiving more anesthetic than is needed because a patient requires fewer drugs than the standard dosage, which has been set at levels to prevent awareness in the majority of the population. Receiving too much drug can result in longer wake-up times, unnecessarily prolonged recoveries and, frequently, nauseous recoveries. No specific data have been published on the number of patients who receive

more anesthesia than they need, but estimates place this number in the millions.

2.1.1.2 Epidural Anesthesia

This type of anesthesia is similar to a spinal anesthetic and also is commonly used for surgery of the lower limbs and during labor and childbirth. This type of anesthesia involves continually infusing drugs through a thin catheter that has been placed into a space that surrounds the spinal cord in the lower back, causing numbness in the lower body.

An epidural anesthetic is a type of regional anesthesia that 'blocks' pain in a particular region of the body. This type of anesthesia is used for procedures on the lower abdomen, the lower extremities, for pain relief following many types of major surgery and usually done in labor and delivery. The goal of an epidural block for labor and delivery is to provide analgesia, or pain relief, rather than complete anesthesia, which is total lack of sensation. Having an epidural during labor allows the patient to be fully conscious and aware of the entire labor and delivery experience, with a minimal amount of discomfort.

Epidural medications fall into a class of drugs called local anesthetics, which block pain in a particular area of the body. Epidurals block the nerve impulses from the lower spinal segments resulting in decreased sensation in the lower half of the body. They are often delivered in combination with opioids, or narcotics. Narcotics, such as fentanyl and sufentanil, are often added in order to decrease the required dose of local anesthetic. This way pain relief is achieved with minimal effect on strength and movement of the lower extremities which is less weakness of the legs. They should not cause sleepiness or light-headedness in the mother.

Epidural anesthesia can also be used for cesarean section. Women who have an epidural during labor and later require a c-section can be given higher doses of anesthetic through the epidural catheter. This increased dose serves as excellent anesthesia for the operative procedure. The most widely used anesthetic drugs for epidural anesthesia are fentanyl and sufentanil.

Fentanyl (FEN-ta-nil) belongs to the group of medicines called narcotic analgesics. Fentanyl acts in the central nervous system (CNS) to relieve pain. Some of its side effects are also caused by actions in the CNS. When a narcotic is used for a long time, it may become habit-forming which cause the mental or physical dependence. Mental dependence or addiction is not likely to occur when narcotics are used for this purpose. Physical dependence may lead to withdrawal side effects if treatment is stopped suddenly.

Sufentanil is a drug that belongs to the class of drugs known as the opioid analgesic drugs. The main use of this medication is in operating suites and critical care where pain relief is required for a short period of time.

More explanation of fentanyl and sufentanil can be referred in **APPENDIX 2C D** and **APPENDIX 2D** respectively.

2.1.2 Anesthesia Considerations

Decision making in anesthesia field is very important. The correct anesthetics and the correct amount of dosage to be given to the patient are very crucial. The anesthesiologist need to make the right decision in a very short of time. The principle to remember when selecting an anesthetic or analgesic agent for use on a protocol is that there are many factors that can affect the activity of anesthetics and analgesics so they must be considered for their potential effects on activity and dose rate [2].

There are many factors to be considered before the anesthesiologist can decide in which type of anesthetic and dosages to be given to the patient. The factors include the strain, sex, age, physiologic status, relative body size, disposition/demeanor, presence of concurrent pain or distress, concurrent medication or other treatments are known to either increase or decrease the amount of a drug that is needed to produce a desired effect in a human being [2].

Dosage charts for anesthetic and analgesic agents usually state an amount that would be expected to produce a desired level of activity for the agent under average conditions. The duration of anesthesia produced by the agent should coincide with the expected duration of the experiment and the duration of analgesia produced by the analgesic should coincide with the expected level of pain generated.

Personal knowledge, experience, preference, and skill with available agents and equipment can affect the outcome of the use of anesthetics and analgesics. These factors must be taken into consideration before the anesthetics are used.

Before surgery, the anesthesiologist or nurse anesthetist will do a preanesthetic evaluation to determine which anesthesia including anesthetic dosages to be given to the patient. The preanesthetic evaluation is done by anesthesiologist who will ask the patient for the

1. Patient's history and details
2. Allergies
3. Previous surgical history
4. Patient's medical condition
5. Physical medical assessment
6. Review of body system

7. Current medication

The details of the factors that need to be considered in anesthesia decision making can be referred in **APPENDIX 2E.**

After consider all the factors, and then the next step is the administration of general anesthetic. A general anesthetic is an anesthetic drug that brings about a reversible loss of consciousness. These drugs are generally administered by an anesthesiologist in order to induce or maintain general anesthesia to facilitate surgery.

Anesthetic drugs given to induce or maintain general anesthesia is either given as gasses or vapors which is inhalation anesthetics or as injections which known as intravenous anesthetics. Most commonly these two forms are combined, although it is possible to deliver anesthesia solely by inhalation or injection. Inhalational anesthetic substances are either volatile liquids or gasses and are usually delivered using an anesthesia machine. An anesthesia machine allows composing a mixture of oxygen, anesthetics and ambient air, delivering it to the patient and monitoring patient and machine parameters. Liquid anesthetics are vaporized in the machine.

Many compounds have been used for inhalation anesthesia, but only a few are still in widespread use. Desflurane and sevoflurane are the most widely used volatile anesthetics today. They are often combined with nitrous oxide. Older, less popular, volatile anesthetics include isoflurane, halothane, enflurane, and methoxyflurane. Researchers are also actively exploring the use of xenon as an anesthetic.

2.1.3 Anesthesia Malpractice

When the patient has a surgery, they trust an anesthesiologist to properly administer anesthesia and monitor the consciousness throughout the operation. In cases of anesthesia malpractice, an anesthesiologist fails to do his or her job correctly, and the patient can suffer serious, sometimes fatal, injury [3].

For example, a hospital in Crewe has been criticized over mistakes made during an operation which led to the death of a patient. The Health Service Ombudsman, Ann Abraham, upheld a complaint against Leighton Hospital by the family of a man who has not been named [4]. The Parkinson's sufferer was admitted to hospital when he could not eat. Surgeons put a feeding tube in to wrong place which led to internal bleeding and peritonitis. He died the next day. The wrong type of anesthetic was also used. The man's family has lodged a complaint against the hospital.

2.2 EXPERT SYSTEM

2.2.1 Expert System

An expert system is regarded as the embodiment within a computer of a knowledge-based component from an expert skill in such a form that the system can offer intelligent advice or take an intelligent decision about a processing function [5]. A desirable additional characteristic, which many would consider fundamental, is the capability of the system, on demand, to justify its own line of reasoning in a manner directly intelligible to the enquirer.

Defining "intelligence" in a computer system can be problematic since intelligence can be defined as something that humans possess and computers

do not. In Artificial Intelligence (AI), however, an "intelligent system" is one that exhibits behaviors normally associated with human intelligence [6].

Systems that perform complex diagnostic procedures and pattern matching are considered intelligent. An expert system, which can be considered a subset of the DSS technology, is software that contains expert knowledge and attempts to solve problems at a level equivalent to or better than human experts. In general, expert systems provide decisions, whereas other DSS support the decision-making process of clinical experts.

2.2.2 Expert System Architecture

FIGURE 3 shows the most important modules that make up a rule-based expert system. The user interacts with the system through a user interface which may use menus, natural language or any other style of interaction. Then an inference engine is used to reason with both the expert knowledge, extracted from expert and data specific to the particular problem being solved. The expert knowledge will typically be in the form of a set of IF-THEN rules. The case specific data includes both data provided by the user and partial conclusions along with certainty measures based on this data. In a simple forward chaining rule-based system the case specific data will be the elements in working memory.

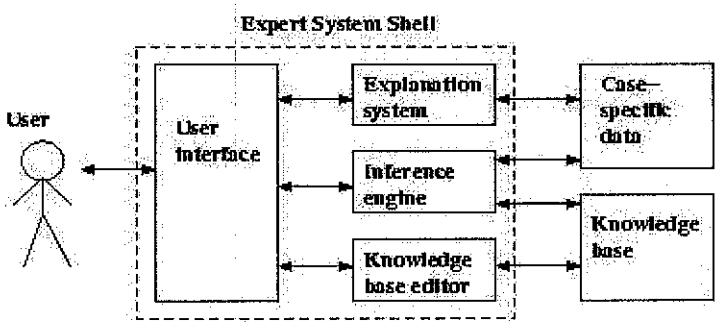

FIGURE: Expert System Shell

One important feature of expert systems is the way they separate domain specific knowledge from more general purpose reasoning and representation techniques. The general purpose bit which is indicated in the dotted box in the FIGURE is referred to as an expert system shell. The shell will provide the inference engine and knowledge representation scheme, a user interface, an explanation system and sometimes a knowledge base editor.

2.2.3 Rules and Expert Systems

Rule-based programming is one of the most commonly used techniques for developing expert systems [7]. In this programming paradigm, rules are used to represent heuristics, or "rules of thumb," which specify a set of actions to be performed for a given situation.

This expert system will be based on IF-AND-THEN rules work. The *if* portion of a rule is a series of patterns which specify the facts or data which cause the rule to be applicable. The process of matching facts to patterns is called pattern matching. The expert system tool provides a mechanism, called the inference engine, which automatically matches facts against patterns and determines which rules are applicable. The *if* portion of a rule can actually be thought of as the *whenever* portion of a rule since pattern matching always occurs whenever changes are made to facts. The *then* portion of a rule is the set of actions to be executed when the rule is applicable.

The actions of applicable rules are executed when the inference engine is instructed to begin execution. The inference engine selects a rule and then the actions of the selected rule are executed (which may affect the list of applicable rules by adding or removing facts). The inference engine then selects another rule and executes its actions. This process continues until no applicable rules remain

Rule-based systems can be either goal driven using backward chaining to test whether some hypothesis is true, *or* data driven, using forward chaining to draw new conclusions from existing data. In this system, it will be based on the goal driven/backward chaining strategy. It is an inference strategy in which the conclusion is already known, and the system works backwards to determine which known premises entail that conclusion.

The reason for this is that the expert system will collect information about the problem from the user by asking them questions. By using a goal driven strategy the questions asked are relevant to a hypothesized solution. Solving problems using backward chaining involves searching through all the possible ways of proving the hypothesis, systematically checking each of them.

2.3 ADDING INTELLIGENCE TO MEDICAL DEVICES

The medical industry is seeing an emergence of computer-based intelligent decision support systems (DSSs) and expert systems, the current success of which reflects a maturation of Artificial Intelligence (AI) technology [6]. The addition of intelligence to a medical device can be extremely successful.

In anesthesia field for example, a system may be embedded with the human intelligence so the system later on will help to decide on what treatment and procedures should be done to the patients. In anesthesia field, the expert system may decide and give solution on how much dosage of what kind of anesthesia to be given to the patients. The addition of intelligence to a medical device or system can be very helpful especially when there is a need for a quick decision making such as in the anesthesia field of medical industry.

2.4 DECISION TREES

2.4.1 Decision trees

Knowledge representation is the single most critical phase in building expert systems. Decision trees are used as knowledge representation schemes. They are hierarchically arranged semantic work and they are composed of nodes representing goals and links that represent decisions or outcomes. Decision trees are read from left to right with the root being on the left. Expert systems development is based on knowledge bases

This system will make use of stored knowledge and rules of "**if...then...else...**" relationships to suggest an anesthetic to be administered to a patient. This system will eliminate human errors as a misguided decision can result in the patient losing their life. For example, in this system, the decision tree will look like as shown below:

IF: Type of anesthesia to be used: General Anesthesia
AND: Procedure: Ophthalmic
AND: Gender: Male
AND: Patient Class: ASA1
AND: Patient's age: 0 - 3
AND: Blood type: A
AND: Blood pressure condition: Normal
AND: Blood glucose condition: Normal
AND: Patient's allergy: None
AND: Antibiotic medicine: None
AND: Antihypertensive medicine: None
AND: Tobacco Used: None
AND: Alcohol used: None
AND: Anemia: None
AND: Nutrition: Normal
AND: Diabetes None
AND: Hemophilia: None
AND: Hypothermia None
AND: Adrenalin: None-adrenalin

AND: Cardiovascular medical condition: Normal

AND: Respiratory Medical Condition: Normal

AND: Renal System: None

THEN:

Suggested anesthetic: Propofol

Dosage rate: 20 mg/ second.

Dosage analysis: 2.5 mg/kg

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 PROCEDURE

In developing the system, the Expert System Development Life Cycle (ESDLC) has been chosen rather than the conventional system life cycle. This is so since the system to be developed is based on the expert system nature, which deals with expert (anesthesiologist) and solving the problems of deciding the suitable anesthesia with appropriate. The phases in the life cycle slightly differ from the conventional system life cycle in several aspects:

1. A system analyst deals with data and information obtained from the user, while the knowledge engineer deals with knowledge acquired from the expert.
2. The main interface for the systems analyst is with the user, who knows the problem but not the solution. The main interface with the knowledge engineer is an expert, who knows the problem and the solution.
3. The conventional system development is primarily sequential; ESDLC is incremental and interactive.
4. Testing is done in at the end of the conventional information system; verification and validation are performed throughout the development of the expert system.

The similarity between the conventional system development and expert systems' development life cycle are also noted:

1. Both begin with a problem and end with a solution.
2. Both begin with information gathering to ensure a clear understanding of the user's requirement or the problem at hand.
3. Both involve testing the system.

The phases of ESDLC are as shown in **FIGURE 3.1**.

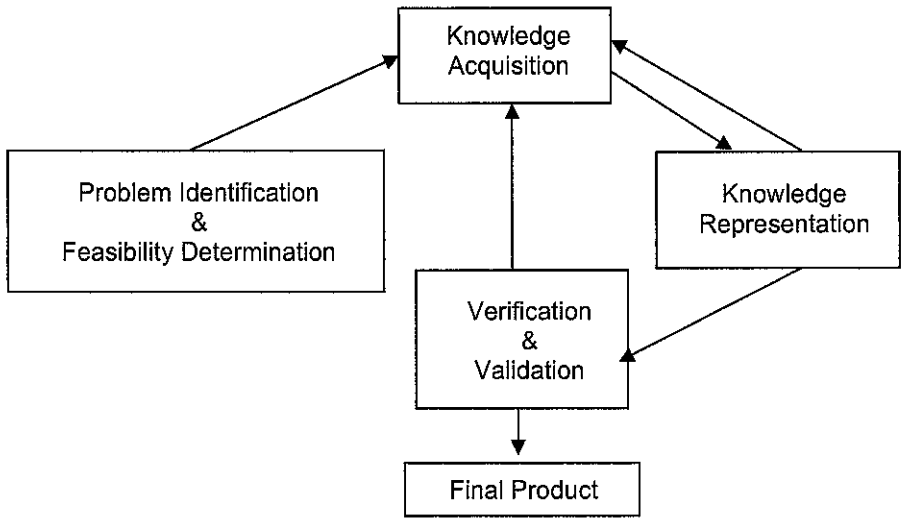

FIGURE 3.1: Phases in Expert System Development Life Cycle (ESDLC)

3.1.1 Problem Identification and Feasibility Determination (Requirement Analysis)

This is the stage of identifying problem potentially solved with this expert system. Application justification, scope definition and feasibility studies are done during the stage.

In this case, there is a need for an automated system that can assist anesthesiologists in the decision-making process to come up with an anesthesia plan. Anesthesiologists face a daunting task of deciding which

anesthetic to administer to the patient, after considering the different factors that influence their decision-making.

The relevancy of the project is studied against the current requirements of the system and on current issue arises. The functionality scope of the system has been defined to model the basic process of anesthesia decision making process while the feasibility is viewed from the scope, technical, operational and schedule aspects.

- Scope Feasibility - The system will focus in automating the basic and main processes in deciding on which anesthesia should be used, while considering the related factors of the patient. The system will be able to give the suitable anesthetic based on the factors related to the patient with the suitable dosages of the anesthesia.

- Technical feasibility - The system is technically feasible as the developer has the necessary skills and expertise in designing and developing this system. The tools used to develop the system are:

- Operational feasibility - The system will serve the users' requirements, to the degree that it will simplify their information-gathering process regarding which anesthetic chemicals to administer to a patient before surgery.

- Schedule feasibility – The system can be designed and implemented within the available time period, which is a whole semester period.

After identifying the problem, the next step is to gather and analyze the user requirements as well as the system requirements. The requirements are divided into the functional requirements as well as the non-functional requirements.

3.1.1.1 Functional Requirements

The functional requirements are the requirements that the system must provide to the users. They are the functionality or the services that the system must provide to the users.

- Inputs: The system will accept inputs from the user (anesthesiologist) which is the answer the user gives when the system prompt the questions regarding the factors that need to be considered before the system can suggest the anesthetic and its dosages.

- Processes: The system will process the information received from the user, by comparing it with the information in the knowledge base.

- Outputs: The system will suggest the suitable anesthetic to use with the suitable dosages after considering all the factors that have been answered by the user.

3.1.1.2 Non-functional requirements

The non-functional requirements of the system are descriptions of other features, characteristics and constraints that define the system.

- User friendliness – The system shall be user friendly and usage of a graphic user interface will ensure user-friendliness. The user interface will be the main point of communication between the system and the users and this will be in instances when the users enters patient details and when the system displays the suggested decisions in anesthesia.

- Quick processing- The system shall quickly process the information received from the user and quickly provide an accurate suggested solution.
- Reliability- The system shall provide accurate and reliable information.
- Accessibility- The system shall be accessible at all times from any point within the hospital.

- Security- For security purposes, the system shall be used only by authorized personnel. Authorization shall be through the user entering their details when logging into the system.

3.1.2 Knowledge Acquisition (Conceptualization)

This stage includes eliciting, analyzing and interpreting the knowledge that a human expert uses to solve and find the suitable anesthesia with appropriate dosages. Interviews with the expert who are the anesthesiologist are used to gather information and knowledge. Knowledge acquisition deals with determining feasibility, choosing the expert, tapping the expert's knowledge, re-tapping knowledge to plug gaps in the system for verification and validation of the rules, and correcting or updating the knowledge base after the system is delivered.

Interviews are done to elicit mainly on the knowledge-base for the system requirement, besides focusing on the procedures of anesthesia decision making process for system flow modeling purpose. Besides, the technical aspects of the system in the realistic environment are also being highlighted.

The anesthesiologist for the system development is chosen based on credibility and availability criterion. Expert should posses a recognized position in any health institution, preferable in hospital, which related to the knowledge acquired.

This phase involves gathering data, information and knowledge, and representing and arranging it in such a way that an inference program will be able to use stored knowledge whenever needed to draw conclusions. The information acquired is about the 2 types of anesthesia that will be used as mentioned under the project scope. The project will only focus on the general and epidural anesthesia. It focuses on the 4 anesthetics which are the propofol and diazepam for the general anesthesia and sufentanil and fentanyl for the epidural anesthesia.

Further knowledge acquisition was carried out on different factors that need to be considered to give the suggestion of the anesthetics to be used for both general and epidural anesthesia. The factors that need to be considered are:

1. Patient's history and details
2. Allergies
3. Previous surgical history
4. Patient's medical condition
5. Physical medical assessment
6. Review of body system
7. Current medication

After acquiring all the required materials, the interpretation is done on the information gathered. From there, the analysis is turned into the logical model, followed by the physical design of the system. The designs of the data, process and interface are done in this stage.

3.1.2.1 Data Design

The data of the system will be arranged in the form of decision trees and they will hierarchically map the out the facts and their inter-relationships. The rules used in this system are "***if...then...else***" statements.

FIGURE 3.2 is all the variables that are included in the system. This is where the variables have been declared with all the value stated. For example, the variable patient_classification, all the related values contained in the variables are ASAI, ASAII, ASAIII, ASAIV, and ASAV.

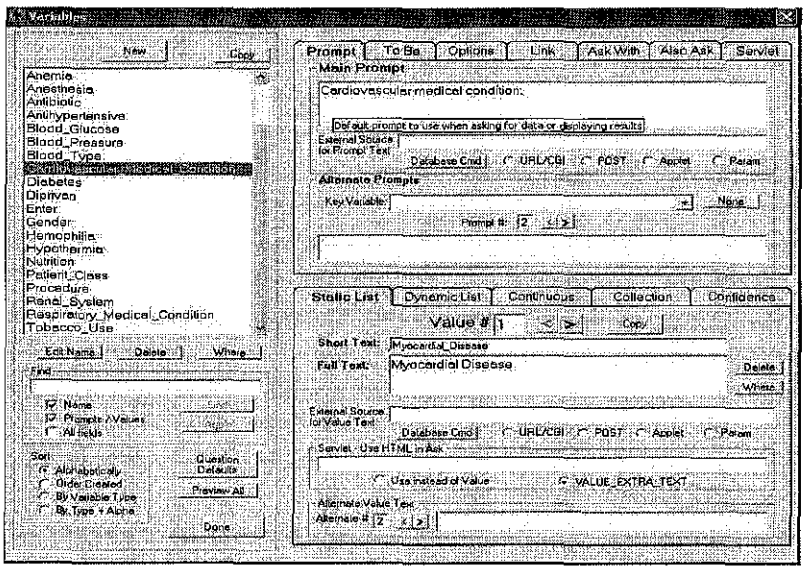

FIGURE 3.2: Variable Declaration

The entire variable will then be used to develop the logic block. The logic block is the decision tree of if...then relationship. It is as shown in FIGURE 11. This system will make use of stored knowledge and rules of "**if...then...**" relationships to suggest an anesthetic to be administered to a patient. This system will eliminate human errors as a misguided decision can result in the patient losing their life.

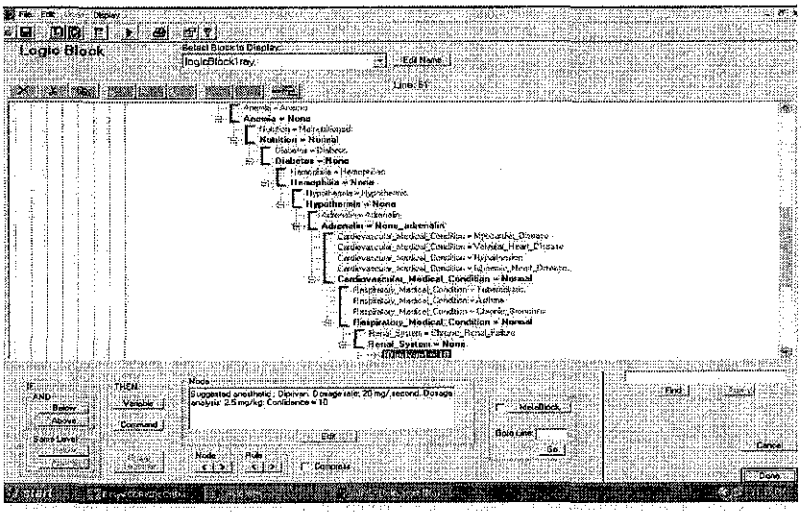

FIGURE 3.3: Logic Block

For example, in **FIGURE 3.3**, the logic block will look as shown below:

IF:

Type of anesthesia to be used: General Anesthesia

AND: Procedure: Ophthalmic

AND: Gender: Male

AND: Patient Class: ASA1

AND: Patient's age: 0 - 3

AND: Blood type: A

AND: Blood pressure condition: Normal

AND: Blood glucose condition: Normal

AND: Patient's allergy: None

AND: Antibiotic medicine: None

AND: Antihypertensive medicine: None

AND: Tobacco Used: None

AND: Alcohol used: None

AND: Anemia: None

AND: Nutrition: Normal

AND: Diabetes None

AND: Hemophilia: None

AND: Hypothermia None

AND: Adrenalin: None-adrenalin

AND: Cardiovascular medical condition: Normal

AND: Respiratory Medical Condition: Normal

AND: Renal System: None

THEN:

Suggested anesthetic: Propofol

Dosage rate: 20 mg/ second.

Dosage analysis: 2.5 mg/kg

3.1.2.2 Process Design

Use case diagram as shown in **FIGURE 3.4** is used to model the process. Use case diagram depicts the functions provided by the system to external entity (actor). In other words, use case diagram concerns about the specification on the function of the system that is built. In this situation, it is between the system and the anesthesiologist (actor).

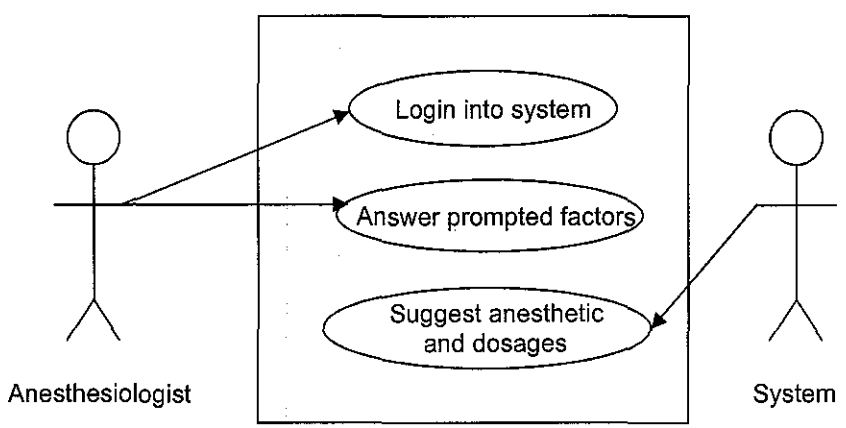

FIGURE 3.4: Use Case Diagram

As shown in **FIGURE 3.4**, the use case diagram shows the relationship between the anesthesiologist and the system. The anesthesiologist need to login into the system. After that, the anesthesiologist will answer the prompted factors according to the patient's condition. The prompted factors are the question regarding the required factors to be considered before the system can suggest the suitable anesthetic and its dosages. After finished, the system will summarize the answer given and suggest the suitable anesthetic and the dosages.

System flow depicts the flow of the system between the anesthesiologist and the system. It is as shown in **APPENDIX 3A**

3.1.2.3 Interface Design

The design of the interface touches on the system functionality.

FIGURE 3.5 is the login page for the system. The user, who is the anesthesiologist, has to provide username and password before the system access is enabled. The username and password will be referred to the database. The valid username and password will be directed and assigned to the session. The descriptions of the **FIGURE 3.5** are as below:

Title: Anesthesia Expert System
Label 1: Username
Label 2: Password
Text 1: Username filled by the user
Text 2: Password filled by the user
Button 1: Log in
Button 2: Cancel

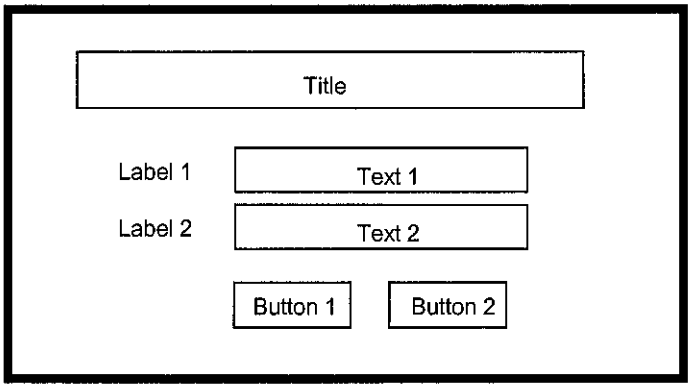

FIGURE 3.5: Login Page Design Interface

The anesthesiologist will be directed to the Anesthesia Expert System first page as shown in **FIGURE 3.6**. The anesthesiologist need to check all the

factors that need to be considered before the expert system can suggest the what type of anesthetic to be used with the suitable dosages. The expert system will prompt all the factors required, and the anesthesiologist will answer the prompted question based on the patient's condition. The descriptions of the **FIGURE 3.6** are as below:

Title: Anesthesia Expert System
Label 3: The prompt question that the expert system asks
Label 4: The static list of the factors attributes
Button 3: "OK" which will direct the user to the next question
Button 4: "Restart" to restart the question from the beginning.
Button 5" "Exit" to exit from the system

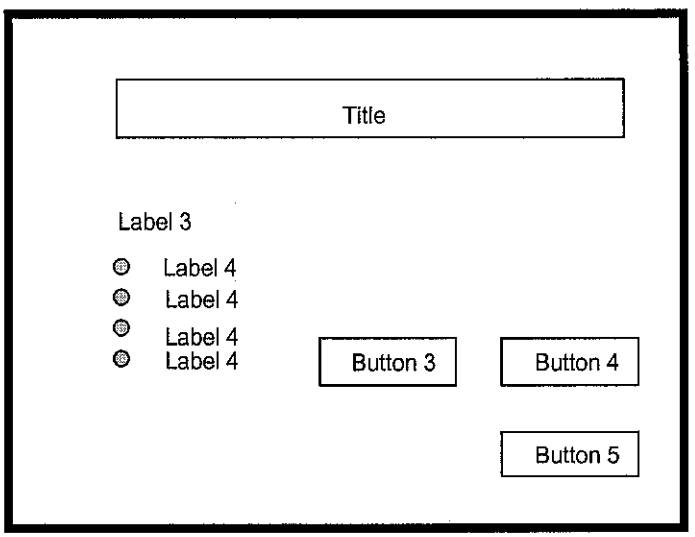

FIGURE 3.6: First Page Design Interface

The user will go through the entire questions, from page to page until the end of the factor has been determined. The middle questions page of the system, as shown in **FIGURE 3.7** will be added with one more button which is button 6. It is the "Back" button where the user will be directed to the previous page of the system. The arrangement of the buttons is also different from the first page.

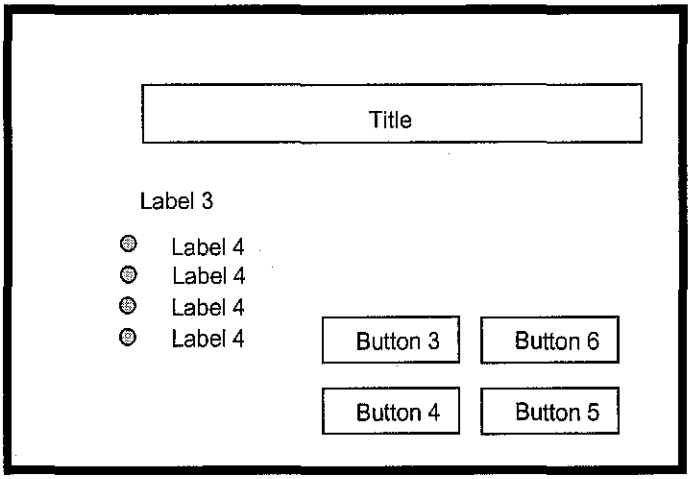

FIGURE 3.7: Middle Page Design Interface

The user will go through the entire question, from page to page until the end of the factor has been determined. If all the factors have been determined and answered, then the expert system will suggest the suitable anesthetic to be given to the patient with the suitable dosages. The result page is as shown in **FIGURE 3.8**. The descriptions of **FIGURE 3.8** are as below:

Title: Anesthesia Expert System

Label 5: The factors that has been determined

Label 6: The suggested anesthesia drugs with the suitable dosage

Button 3: "OK" which will direct the user to the next question

Button 4: "Restart" to restart the question from the beginning

Button 5: "Exit" to exit from the system

Button 6: "Back", direct ser to the previous page

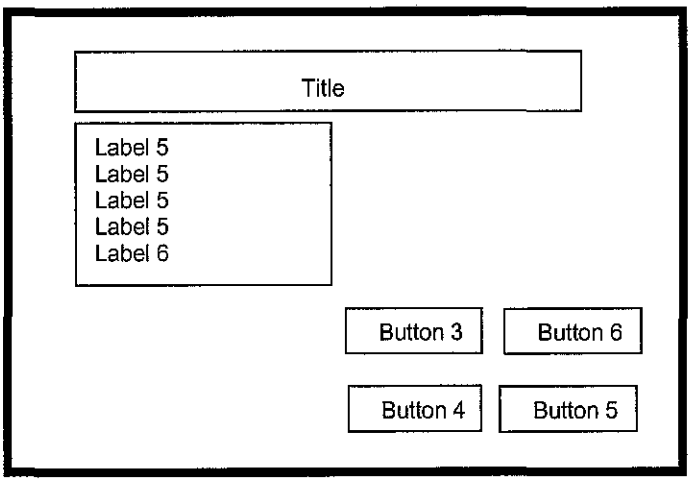

FIGURE 3.8: Result Page Design Interface

3.1.3 Knowledge Representation (System)

This stage deals with coding the knowledge and enables the inference program to use the stored knowledge to draw conclusions. This is where expert's heuristics are represented via the system. The resulted product of the system is presented in findings and discussion parts.

3.1.4 Verification and Validation (End Producer)

Verification and validation of this system are tantamount to the testing step in building a conventional information system. Verification intended to ensure that the system is right through a procedure, while validation involves testing the system to ensure it is the right system or meeting expectations.

Iterative testing and verification are done throughout the development of the system. This is so as to test the prototype to functioning as in requirements by running different data according to different situations given.

3.2 TOOLS

3.2.1 Project Management

Microsoft Project will be used for managing project.

3.2.2 Modeling

Microsoft Visio will be used for modeling purposes.

3.2.3 Analysis

Microsoft Excel will be used for statistical analysis and presenting results of studies.

3.2.4 Development

The Exsys CORVID application will be the main tool to develop the system. The Macromedia Dreamweaver MX will be the tool to create and design the page for the system's front end. The Apache HTTP server will be server in developing this web based expert system.

3.2.5 Documentation

Microsoft Word is used for composing most project documentation.

3.2.6 Hardware

These are the hardware that will be used in developing the system:

- Intel Pentium 4 2.0 GHz
- MSI 845E Max motherboard
- Kingston 256MB DDR RAM

- Acer Monitor 17”
- Acer Optical Mouse
- 40x12x48x Yamaha CD-Rewritable Drive
- Sony 1.44MB Floppy Disk Drive

CHAPTER 4

RESULTS AND DISCUSSION

4.1 RESULT

4.1.1 POSITION OF ANESTHESIOLOGY IN MODERN CLINICAL MANAGEMENT

Today there exists a constant demand for more information more rapidly. New, ever-increasing demands from the market and the medical field, along with new and more complex forms of treatment with new controls and regulations are a part of our daily life. Especially in public health, the customers expect better service [13].

The vision of this information management is to optimal structures of information to internal and external customers, knowledge management, and modern methods of guiding the staff. Leading doctors are coordinators and not solvers of problems in a team.

Many countries are focusing on developing its medical information system (MICIS), in order to keep pace with the progress made in other aspects of national and international development. America, Australia and Europe have been actively developing their MICIS. The Good European Health Model (GEHR), later known as the Good Electronic Health Model, started in the early nineties is one such example. In Australia, Malaysia and New Zealand

medical specialists and information systems researchers are actively working on health informatics to advance the quality of life of their people [15].

New Zealand though a small nation, follows closely with other developed countries in health informatics. Since the early eighties, its Ministry of Health has embarked on certain national health strategies in a structured manner. Information management and technology is vital for providing the ability to exchange high-quality information between partners in health care processes, focusing on achieving better health outcomes. Clinical Decision Support Systems (CDSS) is a natural choice of information system tool.

Malaysia develops its health care system in its own way. In various parts of the country, there is an integration of western medical science and the traditional health values (alternative medicine) during the last decade. However CDSS has not gained grounds among the doctors, as in some western countries by the late nineties. The research project initiated in Malaysia in 1999 by Lee Philip and Loo Grace, highlights the associated issues and proposes some solutions for consideration by clinicians and researchers. It investigates the attitudes of doctors, socio-technical issues and past implementation efforts and offers suggestions to improve adoption of CDSS for MICIS.

The survey found that generally Malaysian doctors have attitudes ranging from unfavourable to neutral towards CDSS. Many had misconceptions that CDSS would replace them and pose a threat to them and patients. The analysis showed they had low awareness and were willing to be exposed to this technology.

Doctors intuitively employ complex decision making strategies based on common sense, instead of fixed organisational and medical guidelines. While the doctor would still be able to decide on the course of action to be

undertaken, CDSS would present the standard decision approved by the organisation. Among tangible economic benefits of CDSS would be the savings achieved by using less medical resources and time to arrive at a diagnosis, as CDSS produced a tested fixed procedure to arrive at the optimum decision on a range of cases.

4.1.2 SYSTEM PROTOTYPE

The user (anesthesiologist) has to provide username and password before the system access is enabled. The username will be referred to the database. The username and ID will be assigned to the session. The login page is as shown in **FIGURE 4.1.**

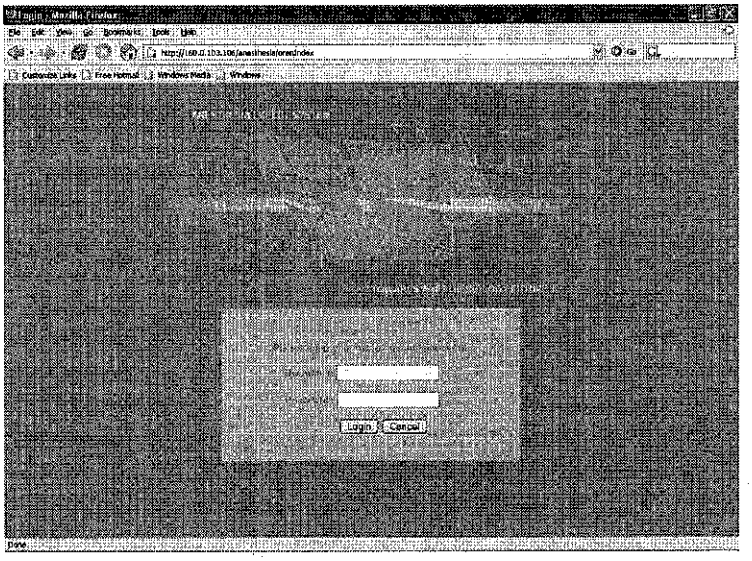

FIGURE 4.1: Login Page

If there is incorrect username or password, a message will be prompted to the user. It is as shown in **FIGURE 4.2**. The user needs to give the correct information in order to able to go to the intended session or page.

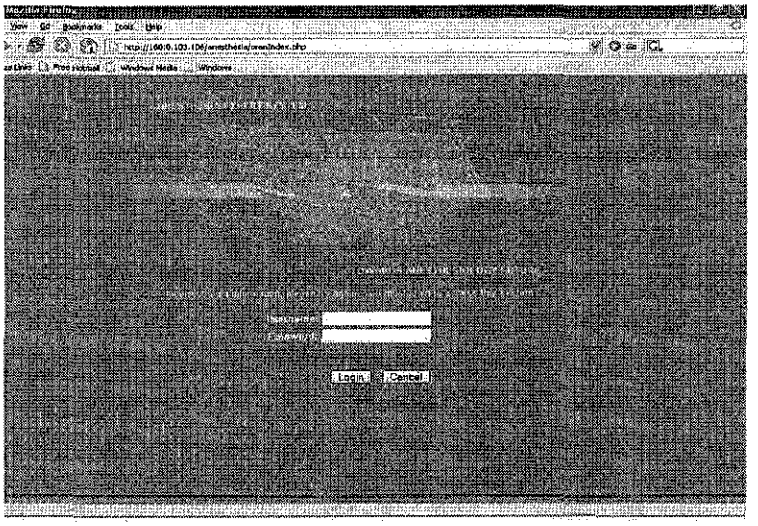

FIGURE 4.2: Incorrect Login Information Page

After successful login, the user will be directed to the welcome page of the expert system as shown in **FIGURE 4.3.**

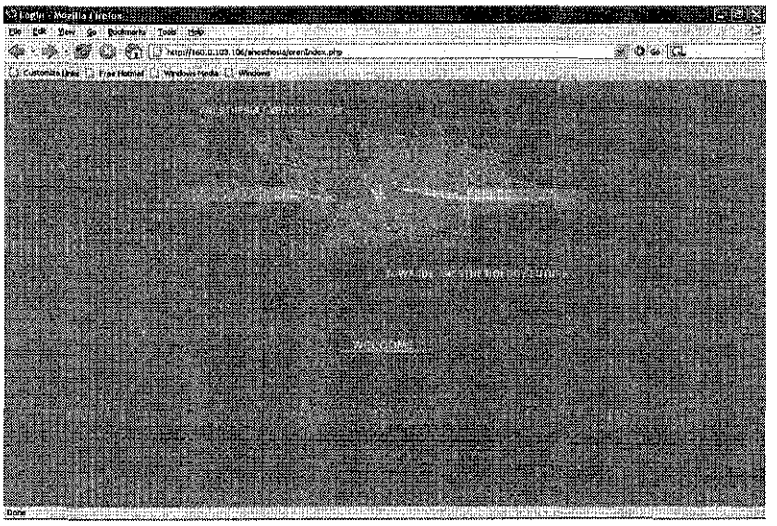

FIGURE 4.3: Welcome Page

The user click the welcome menu, the system will go to the main menu of the system as shown in **FIGURE 4.4.** In the main menu page, the user may choose from the options available which are 'administer anesthesia' or to see the 'anesthesia information'. Basically, the expert system is in the 'administer anesthesia' menu.

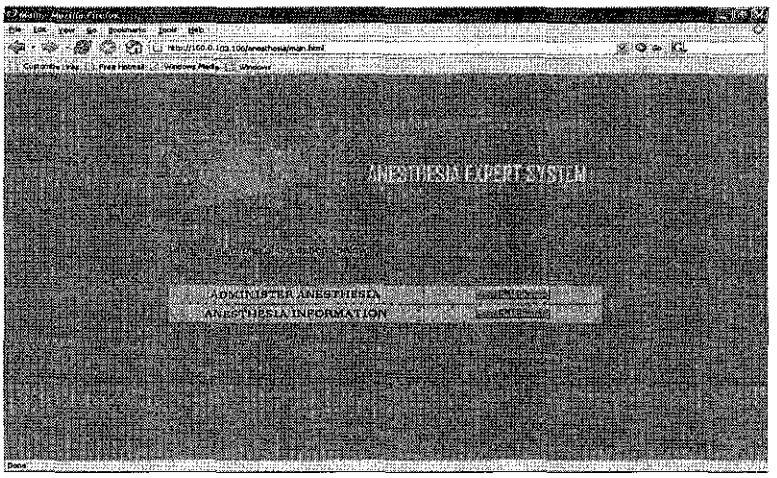

FIGURE 4.4: Main Menu Page

In the 'administer anesthesia' menu, he system will prompt the required factors to be identified before giving the suitable anesthetic and dosages. The user will need to check and verify the patient condition and give the answer to the system. As shown in **FIGURE 4.5**, the anesthesiologist needs to identify what type of anesthesia to be used to the patient. The anesthesiologist may select one of the available choices, either general or epidural anesthesia.

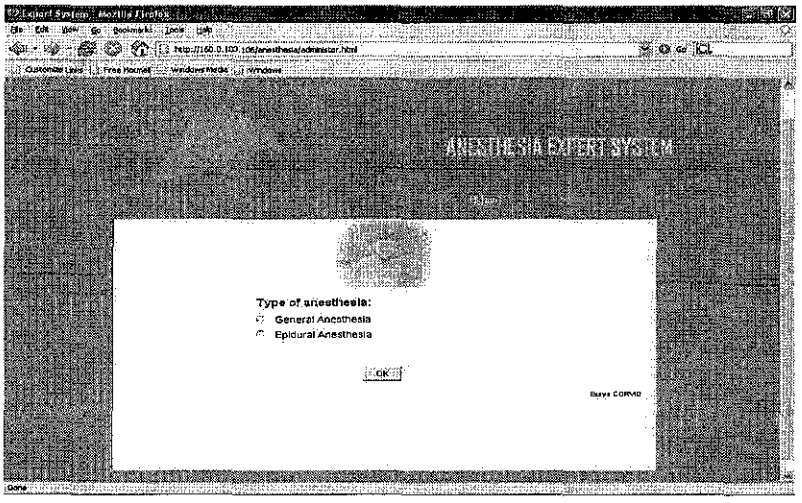

FIGURE 4.5: First Prompt Factor (Type of Anesthesia)

The anesthesiologist need to identify all the prompted factors until the end of the factor that need to be considered before the system can compile the information and give the suitable anesthetic with the right amount of dosages. **FIGURE 4.6** shows another factor that need to identify by the anesthesiologist. It is about the patient's class, ASAI, ASAII, ASAIII, ASAIV or ASAV.

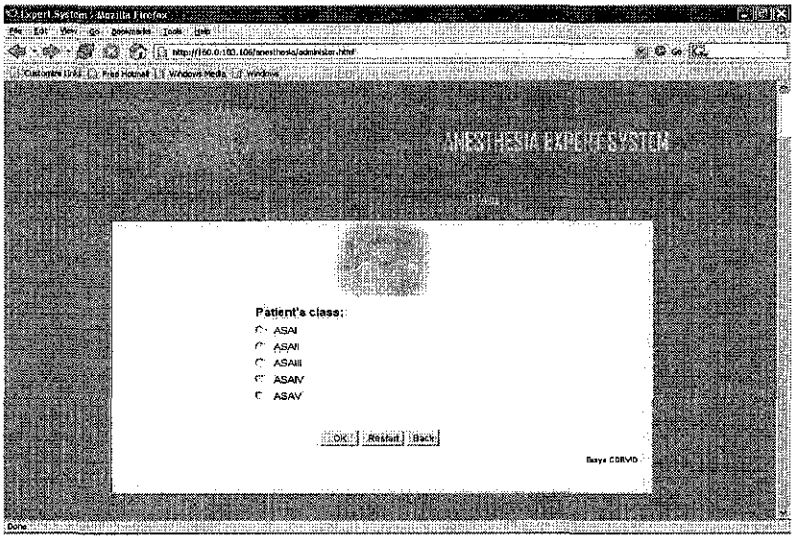

FIGURE 4.6: Another Prompt Factor (Patient's Class)

The suggested anesthetic with the suitable dosage will be given in the result page as shown in **FIGURE 4.7**. The system state all the factors that has been choose previously and state the result.

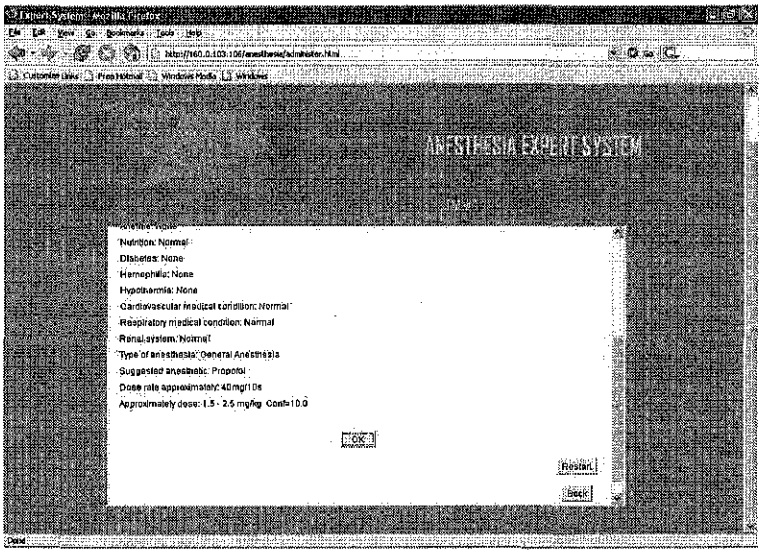

FIGURE 4.7: Result Page

In 'anesthesia information' menu, the user may select either to view the general or epidural anesthesia. It is as shown in **FIGURE 4.8**.

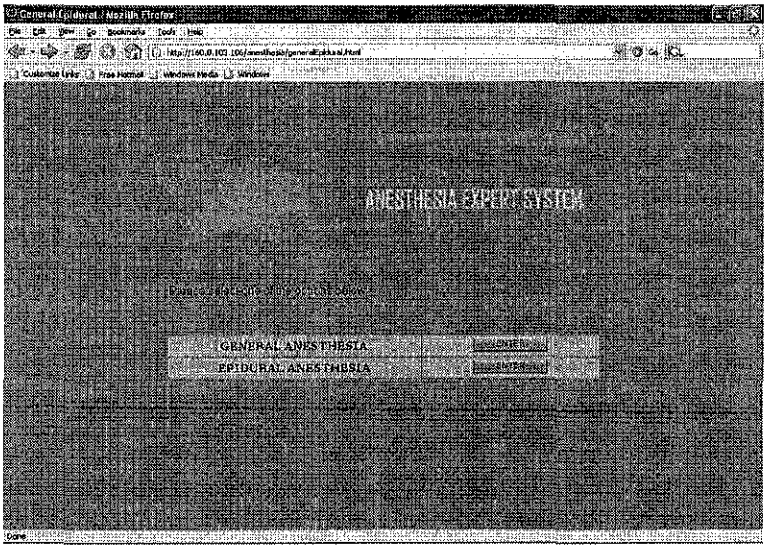

FIGURE 4.8: Anesthesia Information Page

If the user clicks the general anesthesia, the user will be directed to the selection of anesthetics page as shown in **FIGURE 4.9**. In this system, it only focuses propofol and diazepam. So, the user may choose one of them.

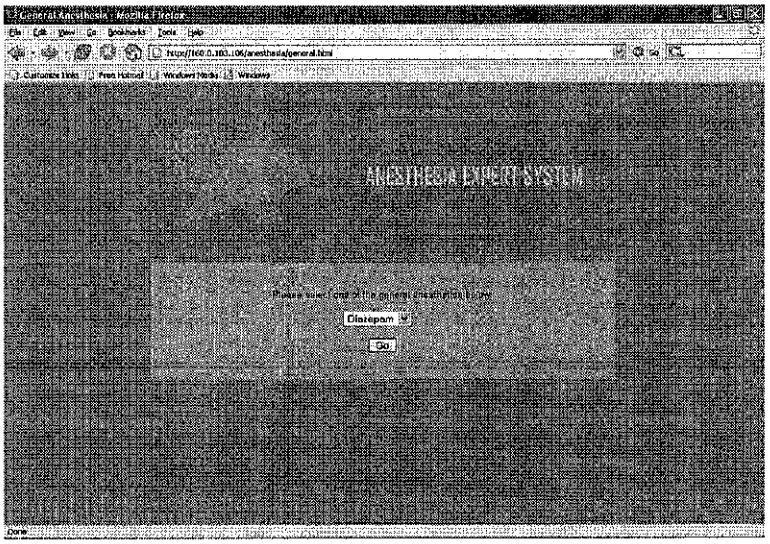

FIGURE 4.9: Anesthetic Selection Page

The user may select one of the anesthetic. The user will be directed to the intended page. Each of the anesthetic, both for general and epidural anesthesia will have its properties, precautions and side effects from the used of the anesthetic. For example the diazepam, its properties is shown in **FIGURE 4.10**, precautions that need to be considered in anesthetic decision making is shown in **FIGURE 4.11** and its side effects is shown in **FIGURE 4.12**.

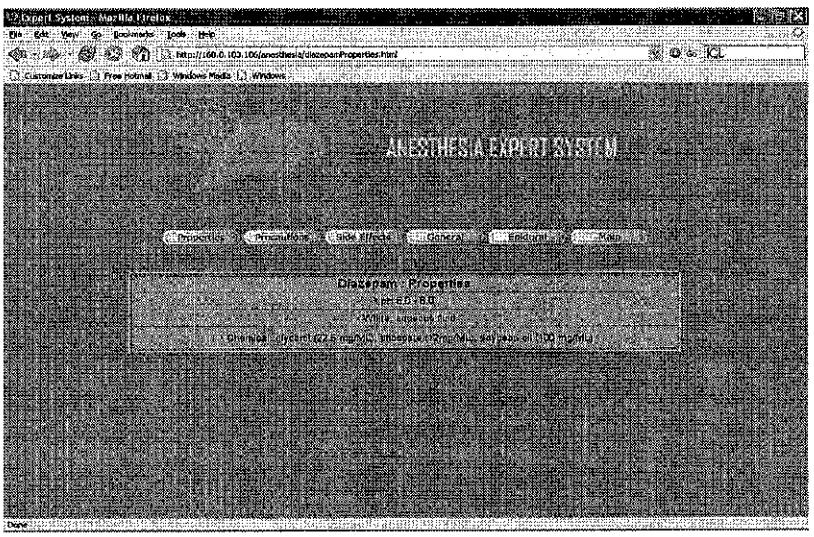

FIGURE 4.10: Diazepam Properties Page

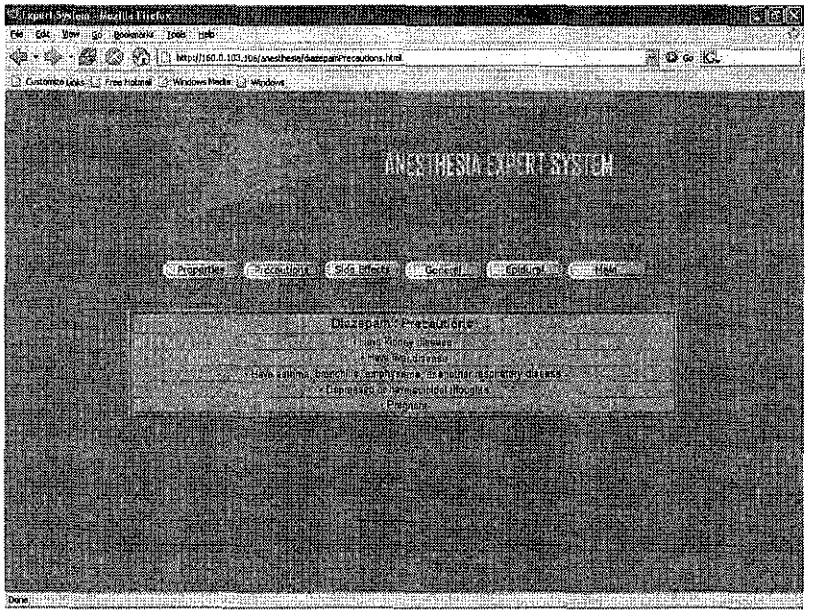

FIGURE 4.11: Diazepam Precautions Page

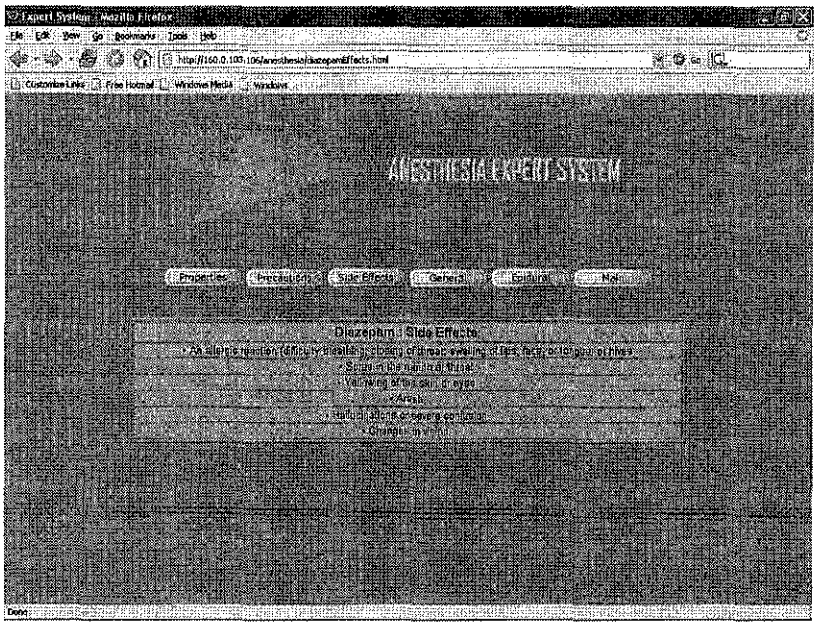

FIGURE 4.12: Diazepam Side Effects Page

4.1.3 COMPARISON OF INTERFERENCE ENGINE TO TRADITIONAL PROGRAMING

The Exsys CORVID backward chaining Inference Engine makes system development and maintenance much easier. When first exposed to IF/THEN rule logic, it is easy to confuse it with the simple IF/THEN statements of computer languages such as C++ and BASIC. However, the Inference Engine is fundamentally very different and much more powerful. In a typical programming language, there can be nested IF/THEN blocks, but if a deeply nested IF/THEN relationship is needed by another section of the code, it can only be called by duplicating the code, or making a function that can be called from several places. A standard program will not simply and automatically "call" the necessary section of computer code just because it exists in the system, yet this is exactly what the Inference Engine does.

In backward chaining, if any rule assigns a value to variable X, that rule will automatically be used whenever another rule being tested needs to know the value of X. Rules can be anywhere in the system, and there does not need to be any explicit linking of rules. Having 2 rules that use the same variable is all that is needed to link them. This rather "free-form" nature of the rules in a CORVID system makes development very simple. The user provides the IF/THEN rules needed to make a decision, tell the system what to derive and the Inference Engine does the rest. Questions are automatically asked in a focused manner and, only relevant questions that cannot be derived from other rules, are asked.

Frequently, a programmer will look at the IF/THEN rules in a simple system, such as those used to demonstrate concepts, and say "I could just program that in a few lines of Visual Basic". For very simple systems, that is true. However, if the system grows even a modest amount, the problem can rapidly become very complex to program by traditional techniques. It requires far more than just nested IF/THEN statements to handle cases where there can be multiple sources to derive a fact, multiple uses of the same rules, or many levels of derivation that may depend dynamically on user input. Traditional

code can rapidly become very complicated in order to handle all the situations. It becomes even more complex dealing with the issues of adding new rules and maintaining the system.

Adding even a single new rule with traditional programming could be quite difficult, and if not added correctly, could have ripple effects that would be difficult to detect and fix. With CORVID adding a new rule is easy and it will automatically be used where it is needed.

For systems of any significant level of complexity, the only approach that works is to handle the rules as "data", rather than incorporating them in the actual code of the system. Then, writing a program to process the rules as "data". This is what the Exsys CORVID Inference Engine does for you. Attempting to build robust expert systems by traditional programming techniques will usually be much more expensive and far less likely to be successful or maintainable.

4.1.4 ANESTHETICS AND DOSAGES

The findings for every anesthetic and dosage have been summarized in the table below. **TABLE 4.1** shows the Propofol Properties and Dosages, **TABLE 4.2** Diazepam Properties and Dosages, **TABLE 4.3** Fentanyl Properties and Dosages and **TABLE 4.4** Sufentanil Properties and Dosages

4.1.4.1 Propofol

Generic Name:	Propofol
Trade Name:	Diprivan ®
Action:	General Anesthetic and sedation in patients mechanical ventilated
Indications:	An alternative to first line agents for short term sedation during mechanical ventilation
Administration Guidelines:	

Usual dosage Range and Route:	• Starting Dose: 25 - 75 mg/hr • Maintenance Dose: Titrate by 25 mg increments every 15 minutes until desired response is achieved up to a maximum of 300 mg/hr • Bolus Dose: 10-50mg
Standard Concentrations:	• Single use ampules/vials 200mg/20ml in fat emulsion (do not dilute) • Single use infusion bottles 10mg/ml-100ml infusion bottle in fat emulsion (do not dilute)
Special Considerations:	• Sulfite Warnings. Propofol injectable emulsion contains sodium metabisulfite, a sulfite that may cause allergic-type reactions including anaphylactic symptoms and life-threatening or less severe asthmatic episodes in certain susceptible people. The overall prevalence of sulfite sensitivity in the general population is unknown and probably low. Sulfite sensitivity is seen more frequently in asthmatic than in non-asthmatic people. • There are no preservative in either brand of propofol, vial and ampules are for single use only. • Propofol is diluted in 10% fat emulsion. • Patient must be on mechanical ventilation • Propofol should not be administered in the same IV line as other medications • Monitor for signs and symptoms of drug withdrawal from previous sedative. • A label should be affixed to the syringe or infusion bottle and must include date and time prepared/spiked. • For Ampules or vials: Wipe neck of ampule with alcohol swab prior to drawing up drug. Drug must be withdrawn from the ampule or vial into a

	syringe immediately after opening, with ampules, use a 5 micron filter needle. Syringes and tubing must be changed every six hours and unused drug discarded. • For Infusion Bottle: Wipe port of infusion bottle with alcohol swab prior to spiking bottle. Infusion bottles are restricted to use in patients requiring an infusion rate >100mg/hour. Infusion bottles and tubing must be changed every 12 hours and unused drug discarded. • During Propofol infusions, the delivery system should not be manipulated or violated in any way. • At end of infusion, flush IV line to remove any residual Propofol.
Precautions and Side Effects	• Hypotension • Headache, Dizziness • Nausea, Vomiting • Rash • Pain at the site of injection • Discard any unused portion of drug six hours after ampules have been opened. • Use with caution in patients with documented egg allergy • Ileus • Rapid IV doses are associated with histamine release

TABLE 4.1: Propofol Properties and Dosages

4.1.4.2 Diazepam

Generic Name:	Diazepam
Trade Name:	Valium
Action:	• Sedative/Hypnotic • Anxiolytic
Indications:	• Restlessness / Anxiety /Agitation • Alcohol Withdrawal • Conscious Sedation • Status Epilepticus
Administration Guidelines:	
Usual Dosage Range and Route:	• Anxiety / Agitation: 2.5 to 10 mg IV at 5 mg / min • Status Epilepticus: 10 to 30 mg at 5 mg / min
Special Considerations:	• Valium: Burning sensation may result at site of injection if administered through peripheral access. • Dosage adjustments may be required in: o geriatric patients o renal failure o hepatic failure • Cumulative effect may be observed, dosage adjustment may be required • Caution: will potentiate actions and side effects of narcotics and other CNS depressants
Precautions and Side Effects:	• Hypotension • Bradycardia • Respiratory depression

TABLE 4.2: Diazepam Properties and Dosages

4.1.4.3 Fentanyl

Generic Name:	Fentanyl / Midazolam
Trade Name:	Fentanyl / Versed
Action:	Opiate Analgesic / Sedative Hypnotic
Indications:	Sedation
Administration Guidelines:	
Usual Dosage Range and Route:	5 - 10 ml / hour via syringe based, variable flow, continuous microinfusion pump as titrated to patient response
Standard Concentration:	Microinfusion: 2 mg of fentanyl (40ml of 0.05 mg/ml) with 10 mg midazolam (10 ml of 1 mg/ml). Total = 50 ml
Special Considerations:	• For sedation purposes, fentanyl must be administered in the presence of a physician trained in airway management • Drug tolerance may result in need for frequent evaluation of patient response • Rapid injection will result in increased incidence of side effects up to and including respiratory arrest • For patients maintained on fentanyl for analgesia, monitoring of untoward respiratory effects should be observed during dose titration. Consideration of an alternative agent should be explored as other medications provide superior analgesia.
Precautions and Side Effects:	• When used as an analgesic, fentanyl should not be abruptly withdrawn and alternative agents should be considered for pain management. • Hypotension • Respiratory Depression • With drawal symptoms after 48 to 72 hours of use • Paralytic ileus • Bradycardia

	• Hallucinations

TABLE 4.3: Fentanyl Properties and Dosages

4.1.4.4 Sufentanil

Generic Name:	Sufentanil
Trade Name:	Sufenta
Action:	Opiate analgesic
Indications:	Short term analgesia and sedation
Administration Guidelines:	
Standard Concentration:	Microinfusion: 500mcg/50mL (10mcg/mL)
Usual Dosage Range and Route:	Loading Dose: 0.1-0.5 mcg/kg by slow IV injection Maintenance Dose: 0.1-1mcg/kg/hr IV titrated to patients' response
Special Considerations:	• Patient must be ventilated except when induction doses for intubation are being given. Sufentanil must be administered in the presence of a physician trained in airway management • Drug tolerance may result in need for frequent evaluation of patient response • Rapid injection will result in increased incidence of side effects up to and including respiratory arrest
Precautions and Side Effects:	• Skeletal Muscle/Chest wall rigidity • Respiratory depression, bronchospasm • Bradycardia/Tachycardia • Hyper/Hypotension • CNS Depression • Paralytic Ileus • Pruritus

	• Hallucinations

TABLE 4.4: Sufentanil Properties and Dosages

4.2 DISCUSSION

This Anesthesia Expert System allows the anesthesiologists to quickly build concise and complete anesthetic assessments. The system will automate the pre-anesthetic evaluation and promotes the suitable anesthetic and its dosages to be given to the patient before the operation. It is to ensure the surgery operate successfully while the patient feel no pain while the surgery is done.

This system is developed using the Exsys CORVID application. Exsys CORVID provide practical delivery of complex decision-making knowledge on web sites and stand-alone applications. It emulates "always-available" one-on-one consultations with the experts. It can provide answers and recommendations that prospects, clients and staff need. It will be combined with Macromedia Dreamweaver MX to build the HyperText Markup Language (HTML) pages, since it is web based application.

The system need to be tested before it can be widely used. The system enhancement should be made to make it more interactive and more user friendly since the interface is the main point of communication between the system and the users and this will be in instances when the users enters patient details and when the system displays the suggested decisions in anesthesia.

The software was not meant to replace the specialist or anesthesiologist, yet it was developed to assist anesthesiologist in deciding the most suitable anesthetic to be given to the patient during an operation considering the required factors. This Anesthesia Expert System is expected to meet the minimal expectations of anesthesiologist in accepting the technology, and

acting as a platform on which its features will be improved from time to time to suit the current needs, together with the evolution of the world around us.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

An expert system is able to do the work of a professional. Moreover, a computer system can be trained quickly. Has virtually no operating cost, never forgets what it learns, never calls in sick, retires, or goes on vacation. Beyond those, intelligent computers can consider a large amount of information that may not be considered as humans.

The medical profession is one of the professions that need to utilize the efficiency and simplicity of computers, especially the anesthesiology section of medical arena. There is a need for an expert system to provide readily-available information about anesthesia to medical staff. Different types of medical procedures require different amounts and varieties of chemicals to produce the desired effects of anesthesia.

But to what extent should these systems replace human experts? Or, should they at all? In some fields such as forecasting weather or finding bugs in computer software, expert systems are sometimes more accurate than humans. But for other fields, such as medicine, computers aiding doctors will be beneficial, but the human doctor should not be replaced. Expert systems have the power and range to aid to benefit, and in some cases replace humans, and computer experts, if used with discretion, will benefit human kind.

5.2 RELEVANCY TO THE OBJECTIVES

The medical profession is one of the professions that need to utilize the efficiency and simplicity of computers, especially the anesthesiology section of medicine. There is a need for an expert system to provide readily-available information about anesthesia to medical staff. Different types of medical procedures require different amounts and varieties of chemicals to produce the desired effects of anesthesia.

5.3 SUGGESTED FUTURE WORK FOR EXPANSION AND CONTINUATION

5.3.1 Enhance functionality and interface

The functionality of the system can be enhanced to not only include the pre-operative medication, but to also encompass the post-surgery monitoring and medication. Post-operative care is as important as pre-operative assessment and lack of it (post-operative care) can also result in detrimental and severe complexities with the patient.

5.3.2 Integrating Sub-Systems

This prototype models only the basic functionality of anesthesia system. In order to give the anesthetic, patient records and other test results plus imaging, are also contributing to the anesthesia decision making process for better and more accurate results. It is suggested to build the system, which can manage the test results, imaging and other functions, which are then to be linked to this prototype for making decision on resulted anesthetic to be used.

5.3.3 Mobile Anesthesia System

As the technology of telecommunication is getting more advanced from day to day, the future is seen to move towards the wireless environment. Therefore, the anesthesia application can be made wireless, by utilizing the tools such as wireless programming on Personal Digital assistant (PDA) one day, and enable the availability of health information and consultation facilities at a bigger scale compared to the current days.

5.3.4 Inclusion of Medical Procedures and More Anesthetic

As mentioned already, the anesthesia field is a broad field and it comprises of a lot more anesthetics for epidural, local and general anesthesia. These anesthetics can be included into the system to cover a broader scope of anesthesia. The medical procedures may also be included in the system so the anesthesiologist the best way to take care of the patient.

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APPENDICES

APPENDIX 1A

PROJECT TIMELINE

No.	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	**Introductin**																	
	Preliminary report																	
	Submit preliminary report																	
2	**Preliminary research**																	
	Gather data																	
	Modeling data																	
3.	**Project work**																	
	Design																	
	Prototype																	
	System																	
	Progress report																	
	Modify system																	
	Dissertation																	
	Oral presentation																	

APPENDIX 2A

PROPOFOL

Consideration:	Special concern need to be done if the patient has any of these conditions: o arrhythmia (rapid, slow, or irregular heart beat) o blood vessel disease, head injury, heart disease, high cholesterol, pancreatitis o seizures (convulsions), an unusual or allergic reaction to propofol, anesthetics, other medicines, foods, dyes, or preservatives o pregnant or trying to get pregnant, breast-feeding
Drugs interaction:	The drug(s) that may interact with propofol: o alcohol, barbiturate medicines for inducing sleep or treating seizures (convulsions) o herbal products, medicines for anxiety or sleeping problems, such as diazepam or temazepam o medicines for colds, breathing difficulties, or weight loss, medicines for mental problems and psychotic disturbances, medicines for pain
Side effects:	The side effects may include: o difficulty breathing, wheezing, swelling of the throat o fast heartbeat, palpitations o lightheadedness or fainting spells, numbness or tingling in the hands or feet o seizure (convulsion), skin rash, flushing (redness), or itching, swelling or extreme pain at the injection site o uncontrollable muscle spasm, dizziness, pain or irritation at the injection site.
Complication:	There are some potential complications after the general anesthesia procedure. The most feared complication of general anesthesia is death. This occurs in roughly 1 out of every 10,000 people. It is not possible to predict who will have this type of severe reaction. Therefore the anesthesiologist must pay attention to some situations that may arise from the anesthetic

APPENDIX 2B

DIAZEPAM

Considerations:	Special concern need to be done if the patient has any of these conditions: o have kidney disease, have liver disease o have asthma, bronchitis, emphysema, or another respiratory disease, depressed or have suicidal thoughts o pregnant
Side effects:	The side effects using diazepam may include: o an allergic reaction, difficulty breathing, closing of the throat, swelling of lips, face, tongue or hives o sores in the mouth or throat, yellowing of the skin or eyes, a rash o hallucinations or severe confusion, changes in vision.

APPENDIX 2C

FENTANYL

Considerations:	**1. Allergies** The patient must tell the doctor if they have ever had any unusual or allergic reaction to fentanyl, including the stick-on patch. The allergies may also include to any other substances, such as foods, preservatives, or dyes. **2. Breast-feeding** Fentanyl passes into breast milk. Nursing babies whose mothers are using this medicine regularly may receive enough of it to cause unwanted effects such as drowsiness or breathing problems. A mother who wishes to breast-feed and who needs treatment for continuing pain should discuss the risks and benefits of different pain treatments with her health care professional. **3. Older adults** Elderly people may be especially sensitive to the effects of narcotic analgesics. This may increase the chance of side effects during treatment. **4. Other medicines** Although certain medicines should not be used together at all, in other cases two different medicines may be used together even if an interaction might occur. When patients are using transmucosal fentanyl, it is especially important that the health care professional know if the patient are taking any other dosage form of fentanyl for example injection or patch, nonprescription medicine or any of the following: o Alcohol o Central nervous system (CNS) depressants, the medicines that cause drowsiness including other narcotics, Erythromycin for example the E-Mycin o Itraconazole for example the Diflucan, Ketoconazole o Ritonavir where these medicines may add to the effects of transmucosal fentanyl. This may increase the chance of serious side effects. **5. Other medical problems** o Alcohol abuse or history of o Drug dependence, especially narcotic abuse or

	dependence, history of o Kidney disease, Liver disease where the chance of side effects may be increased o Emphysema or other chronic lung disease, Head injuries o Slow heartbeat because the sufentanil may cause this become worse
Side effects:	o an allergic reaction and difficulty breathing, closing of the throat; swelling the lips, tongue, face or hives o slow, weak breathing, seizure, cold, clammy skin o severe weakness or dizziness, unconsciousness, constipation, dry mouth, nausea, vomiting, or decreased appetite o dizziness or lightheadedness, drowsiness or fatigue, muscle twitches, sweating, itching

APPENDIX 2D

SUFENTANIL

Considerations:	o patient's medical history, especially of drug allergies o heart problems, liver problems, kidney problems o lung diseases or breathing disorders o head injury o drug or alcohol dependency
Drugs interactions:	The sufentanil may interact and cause complications with other drugs such as: o beta-blockers for example the propranolol o blood pressure drugs, other narcotic pain relievers o tranquilizers, sleeping pills, sedatives o certain antihistamines, anti- anxiety drugs, anti-seizure drugs, muscle relaxants, cimetidine
Side effects:	o upset stomach, vomiting o drowsiness, unsteadiness, confusion and hallucinations, constipation, difficulty breathing, difficulty being roused o seizures

APPENDIX 2E

ANESTHESIA CONSIDERATIONS

Factors	Explanation
1. Patient's history and details	
1.1 Gender	The gender of a patient has some influence on the anesthesia plan. It is anatomical fact that the structures of female bodies are different from male bodies. They also react differently to the different stressed induced on them and thus they also react differently to the chemicals administered.
1.2 Age	The patient's age is an important consideration factor for pre-operative assessment. The very young and the very old (pediatric and geriatric patients) require special attention. The dose of anesthetic is affected by this factor. Geriatric patients have slow circulation and they require carefully toned-down dosages of anesthetic. Although pediatrics may have a quicker circulation, they also require lower dosages of anesthetic chemicals.
1.3 Weight	The patient's body composition (weight) affects the effectiveness of the anesthetics chemicals. The heavier people require larger doses for the anesthetics to become effective.
2. Allergies	Some patients may have allergies towards the different chemicals such as latex. This factor also needs to be taken into account in administering the anesthesia plan. Combination of these allergies with the anesthesia chemicals may cause complication during surgery, thus it is vital to take these into consideration.
3. Previous Surgical History	It is important to review the previous surgical histories of the patients and to look closely at the complications that may have arisen during those past procedures. This is such that the medical professionals can be aware and alert for similar emergencies if they are to resurface again.
4. Patient's medical condition	
4.1 Cardiovascular diseases	
• Ischemic heart diseases	Patients with ischemic heart disease who need anesthesia and surgery have a greater-than-average risk of complications, caused by narrowed coronary arteries.
• Myocardial infarct (heart attack)	These diseases are characterized by damages to the myocardial tissue, and may affect muscular performance. Anesthesia and surgery are then

	extremely hazardous and besides emergency cases, these patients should be referred for full cardiac assessment.
• Valvular heart diseases	Patients with valvular heart disease have impaired cardiac function. They pose a risk such that they may develop bacterial endocarditis as a result of transient bacteraemia from instrumentation.
4.1.2 Hypertension	Anesthesia is contra-indicated in any patient with sustained hypertension and blood pressure exceeding 180mmHg systolic or 110mmHG diastolic.
4.2 Respiratory diseases	Respiratory diseases present complications during surgery and thus are to be taken into consideration before the patient undergoes surgery. Example of respiratory diseases: o Tuberculosis o Asthma o Chronic bronchitis
4.3 Diabetes	Patients with diabetes require the medical professionals to have substitution regime required insulin. These patients face a risk of undetected hypoglycemia during anesthesia.
4.4 Renal failure	Patients suffering from renal failure may be suffering from a variety of related medical problems including diabetes, anemia and others. The anesthesiologists need to pay special attention to the anesthetics used as those excreted by the kidneys will have an abnormally marked and prolonged action.
4.5 Anemia	Anemia interferes with the body's oxygen transport system by reducing the amount of oxygen that can be carried by the blood. This means that the heart is placed under stressed as it has to pump more blood to supply tissues with oxygen. Anesthesia may interfere with oxygen transport by the blood and thus causes a risk.
4.6 Hemophilia	Patients with hemophilia have a bleeding tendency and thus extra care should be taken when administering anesthesia.
4.7 Hypothermia	Patients with hypothermia may go into cardiac arrest and respiratory failure during anesthesia thus the medics should prepare such emergency.
4.8 Malnutrition	Patients with malnutrition require special care and should ideally be allowed a period of intensive feeding beginning before surgery. It enables them to withstand the metabolic demands of surgery and be capable of the process of healing.
5. Physical medical assessment	
5.1 Patient classification	
• ASA I	• Patient's health: excellent, with no systemic

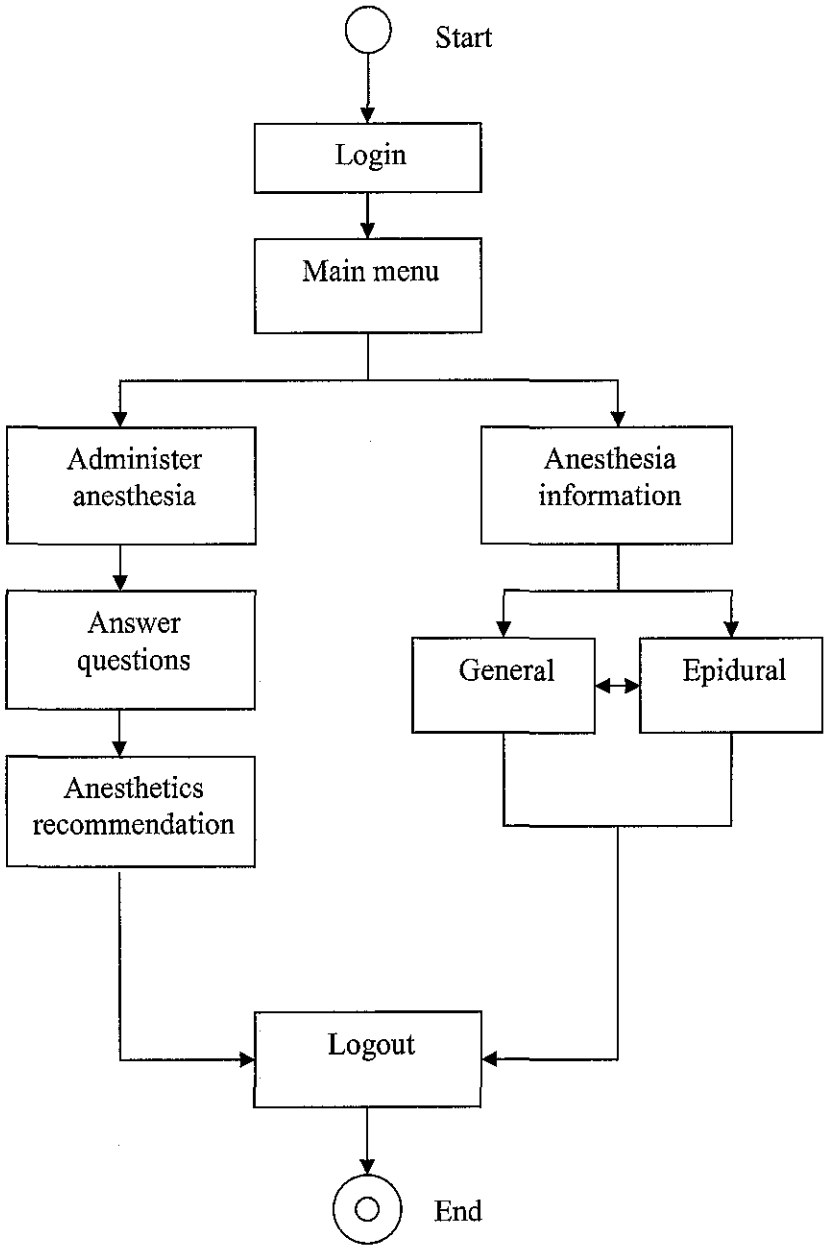
	disease • Limitations on activity: none • Danger of death: none • Excluded: persons at extremes of age (very young, very old)
• ASA II	• Patient's health: disease of one body system • Status of underlying disease: well controlled • Limitations on activity: none • Danger of death: none
• ASA III	• Patient's health: disease of more than one body system or one major system • Status of underlying disease: controlled • Limitations on activity: present but not incapacitated • Danger of death: no immediate danger
• ASA IV	• Patient's health: poor, with at least one severe disease • Status of underlying disease: poorly controlled or end-stage • Limitations on activity: incapacitated • Danger of death: possible
• ASA V	• Patient's health: very poor, moribund • Limitations on activity: incapacitated • Danger of death: imminent
5.2 Blood pressure and blood glucose	The patient's blood pressure must be constantly monitored and stabilized before the operation. Usually, the diabetic patients require special attention and complications may arise during surgery, thus it is also important to monitor the blood glucose.
5.3 Blood type	Medical professionals (surgeons and anesthesiologists) need to know what blood group the patient belongs to, in order to have the bloody type ready for in case of a transfusion need during surgery.
5.4 Types of surgery	
• Ophthalmic surgery	Ophthalmic surgery relates to the eye and the procedure is either intraocular or extraocular. Intraocular surgical procedures occur inside the eye and they are considered to be specialized because of the detrimental effect of anesthetic techniques and agents that have effect on the intraocular pressure. Extraocular surgical procedures occur outside the eye and they can be managed as any other operation on the surface of the body.
• Ear, nose, throat	For an operation in the ear, a potent chemical (anti-emetic) should be included in the pre-anesthetic

	medication to prevent nausea or vomiting, which could lead to a strain, which would in turn affect the blood vessels and give a pressure rise to the middle ear, resulting in technical difficulties during the procedure or resulting in post-operative ear complications. A tonsillectomy operation falls under throat surgery and this surgery requires certain particular chemicals. Overall, for this type of surgery (ear, nose and throat) chemicals which are used are those that would not affect the spontaneous respiration.
• Obstetrical	Obstetrical surgeries are almost all emergency procedures to deliver babies. This surgery requires care as it involves 2 lives, the mother's and the baby's. The chemicals administered to the mother intravenously also pass to the fetus in varying concentrations. The stress of surgery also affects the baby thus the chemicals used for this surgery are carefully selected and mixed.
• Cardiovascular	Cardiovascular surgery is usually conducted because of a cardiac defect that results in myocardial limitation in function or leading to myocardial damage. Cardiac patients require efficient sedation and tranquilization in the pre-anesthetic medication and extra oxygenation during the procedure and adequate analgesia on emergence from anesthesia.
• Neurosurgery	Neurosurgery encompasses the evaluation and treatment of a wide variety of diseases of the nervous system and its coverings but mainly addresses the brain, the spinal cord, peripheral nerves, spinal bones, inter-vertebral disks, cranial nerves, spinal fluid, and the blood vessels supplying the brain. This surgery deals with the treatment of brain tumors, head injuries, spinal injuries, herniated discs, spinal tumors, intractable pain, movement disorders, epilepsy, and certain psychiatric illnesses, chronic infections of the nervous system, peripheral nerve problems, and other neurological diseases.
• Orthopedic surgery	Orthopedic surgery is carried out on the patient's limbs and this surgery requires adequate anesthesia as the patient might be in deep pain. The pre-medication for this surgery should also include narcotic analgesia (such as morphine) because of possible pre-operative pain, painful procedure and the immediate post-operative pain.
6. Review of body system	
6.1 Cardiovascular system	The cardiovascular system includes the heart and the blood vessels. The cardiovascular system

	(together with the respiratory system) is basic to life and breathing, like the beat of one's heart, is an automatic function which is controlled by the brain. Before a medical procedure, it is thus important to ensure that this system is under normal condition and that there are no abnormalities which could lead to emergencies during the procedure.
6.2 Respiratory system	The respiratory system contains those organs which are responsible for carrying oxygen from the air to the blood stream and expelling the waste product of carbon dioxide.
6.3 Nervous system	The nervous system comprises the brain and various types of nerves, including nerves which carry sensory impulses from all parts of the body to the brain and efferent nerves through which "messages" are conducted from the brain to the muscles and all of the organs of the body.
6.4 Circulatory system	The circulatory system carries blood and oxygen to all the different organs of the body and also removes carbon dioxide. It is also important for this body system to also be under normal conditions before a medical procedure is carried out.
6.5 Tobacco use	Tobacco contains the chemical nicotine, which might affect or react with the chemicals used as anesthesia.
6.6 Alcohol use	Patients under the influence of alcohol and other drugs may respond variably and differently to anesthetics and may even regurgitate. Also, patients with a history of alcohol usage may already have liver damage thus it is important to note the alcohol use.
7. Current Medication	
7.1 Antibiotics	If the patient is on antibiotics before undergoing a medical surgery, this could result in prolonged states of anesthesia due to the reaction of the antibiotics with the anesthesia used.
7.2 Antihypertensive	Antihypertensive medication could cause severe hypotension when it reacts with the different anesthesia chemicals such as droperidol, halothane, opiates and thiopentone.
7.3 Adrenalin	Adrenalin can cause the patient to go into cardiac arrest if it comes into reaction with the anesthesia chemicals such as halothane, ethyl chloride and methoxyflurane.

APPENDIX 3A

SYSTEM FLOW



APPENDIX 6A

CODING

```
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?>
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<?
session_start(); // start session.
?>
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marginwidth="0" text="#ffffff" vlink="#ffffff">
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    ANESTHESIA EXPERT SYSTEM -</font></strong></font></td>
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height="193"><img src="midright.gif" width="173" height="189"></td> </tr> <tr> <td
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sans-
serif"><strong>             &nbs
p;        Password</strong>
        <strong>:</strong>          <input name="password" type="password" id="password">
        </font><font size="2" face="Geneva, Arial, Helvetica, sans-serif">
        </font></p>          </div>          <p><font size="2" face="Geneva, Arial, Helvetica, sans-serif">
                
;            
                  
       <input name="login3" type="submit" id="login3" value="Login">
       <input name="cancel23" type="submit" id="cancel22" value="Cancel">
       </font></p>     <p> </p></td>   </tr> </table></form></body></html><?exit();}
// If all is well so far.
session_register("username");
session_register("password"); // register username and password as session variables.
// Here you would check the supplied username and password against your database to see if they exist.
// For example, a MySQL Query, your method may differ.
$db = @mysql_connect('localhost', 'admin', 'raynah');
mysql_select_db('anesthesia', $db);
$sql = mysql_query("SELECT password FROM user WHERE username = '$username'",$db);
$fetch_em = mysql_fetch_array($sql);
$numrows = mysql_num_rows($sql);
if($numrows != "0" & $password == $fetch_em["password"]) {
$valid_user = 1;
?><br /><a href="main.html"><p> </p>  <div align="center">  <strong><font color="#FFFF00" size="3"
face="Geneva, Arial, Helvetica, sans-serif">:: WELCOME ::</font>   </div><p> </p></a><?php}else
{$valid_user = 0;}
// If the username exists and pass is correct, don't pop up the login code again.// If info can't be found or verified....

if (!($valid_user)){
session_unset();  // Unset session variables.session_destroy(); // End Session we created earlier.// escape from php
mode.
?><form
action=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/<?=$PHP_SELF?><?if($QUERY_STRING){
echo"?". $QUERY_STRING;}?>" method="POST">
<p align="center"><font size="2" face="Geneva, Arial, Helvetica, sans-serif">Incorrect login information, please
try again. You must login to access this system</font></p>
<table align="center" border="0"> <tr>
 <th><font size="2" face="Geneva, Arial, Helvetica, sans-serif">Username:</font>  </th>  <th><input type="text"
name="username">    </th>  </tr>  <tr>    <th><font  size="2"  face="Geneva,  Arial,  Helvetica,  sans-
serif">Password:</font>  </th>
 <th><input    type="password"    name="password">        </th>    </tr>    <tr>    <th    colspan="2"
align="right"><p> </p><input type="submit" value="Login">  <input name="cancel" type="submit"
id="cancel"  value="Cancel"></form>    </th>    </tr></table></body></html><?exit();}  <link  rel="stylesheet"
type="text/css" href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css"></head>
<body  topmargin="0"  leftmargin="0"  alink="#999999"  bgcolor="#ff9900"  link="#ffffff"  marginheight="0"
marginwidth="0"                         text="#ffffff"vlink="#ffffff"><p>     
nbsp;               
                
;                            
</p><table border="0" align="center" cellpadding="0" cellspacing="0" bordercolor="#FFFF00">  <tbody>   <tr>
<td  width="588"  height="18"  background=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/top.gif">
<font                                                                                    color="#FFFF00"
size="2">            <strong><font
face="Geneva, Arial, Helvetica, sans-serif"> -
     ANESTHESIA  EXPERT  SYSTEM  -</font></strong></font></td>     </tr>      <tr>        <td><img
src="midleft.gif"    width="182"    height="195"><img    src="mid.gif"    width="233"    height="193"><img
src="midright.gif" width="173" height="189"></td>
   </tr>  <tr>
    <td  background=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/top.gif"  height="18">  <p><font
color="#FFFF00"
size="2">              &n
bsp;               &
nbsp;               
                
; </font></p>
     <p><font                                                                          color="#FFFF00"
size="2">              &n
bsp;               &
nbsp;               
                
;               &nbs
```

```
p;             <strong> &
nbsp;   <font face="Geneva, Arial, Helvetica, sans-serif">-
    TOWARDS ANESTHESIOLOGY FUTURE -</font></strong></font></p></td>    </tr>    <!--tr><td
valign=top colspan=3><P><BR><table border=0 cellpadding=0 cellspacing=0 width=588><tr><td><img
src="images/space.gif" width=10 height=1></td>//<td><P class="mash">Headline</p>//d fgk jdgf pogfdg dgf
gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod <P><a
href="page.html">details</a></td><td><img src="images/space.gif" width=10 height=1></td>//<td><P
class="mash">Headline</p>//dg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg
dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod <P><a
href="page.html">details</a></td><td><img src="images/space.gif" width=10 height=1></td>//<td><P
class="mash">Headline</p>//<P>kod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf
gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod fgk jdgf pogfdg dgf gfjkod
<P><a href="page.html">details</a></td></tr></table><P></td></tr--> </tbody></table><p> <?
if(!isset($username) | !isset($password)) {// escape from php mode.?></p><form
action="<?=$PHP_SELF?><?if($QUERY_STRING){ echo"?". $QUERY_STRING;}?>" method="POST"
name="" id="">
<form action="<?=$PHP_SELF?><?if($QUERY_STRING){ echo"?". $QUERY_STRING;}?>" method="POST"
name="" id="">
 <table width="41%" border="0" align="center">  <tr>   <td bgcolor="#FFCC66"><div align="center">
<pre> </pre>   <p><font size="2" face="Geneva, Arial, Helvetica, sans-serif"><strong><font
color="#FF9900">Please
    enter your username and password</font></strong></font></p>   </div>   <div align="center"></div>
<div align="left">   <p><font color="#FF9900"><strong><font size="2" face="Geneva, Arial, Helvetica, sans-
serif">

                
;      Username:     <strong><font size="2" face="Geneva, Arial,
Helvetica, sans-serif">
    <input name="username" type="text" id="username24">
</font></strong></font></strong></font></p>
  </div>   <div align="left">  <p><font color="#FF9900" size="2" face="Geneva, Arial, Helvetica, sans-
serif"><strong>             &nbs
p;        Password</strong>     <strong>:</strong>
<input name="password" type="password" id="password">    </font><font size="2" face="Geneva, Arial,
Helvetica, sans-serif">
    </font></p>    </div>    <p><font size="2" face="Geneva, Arial, Helvetica, sans-serif">
                
;                 
         
   <input name="login3" type="submit" id="login3" value="Login">    <input name="cancel23"
type="submit" id="cancel22" value="Cancel">    </font></p>    <p> </p></td>   </tr>
</table></form></body></html><?exit();}
// If all is well so far.
session_register("username");session_register("password"); // register username and password as session variables.
// Here you would check the supplied username and password against your database to see if they exist.
// For example, a MySQL Query, your method may differ.$db = @mysql_connect('localhost', 'admin', 'raynah');
mysql_select_db('anesthesia', $db);$sql = mysql_query("SELECT password FROM user WHERE username =
'$username'",$db);
$fetch_em = mysql_fetch_array($sql);$numrows = mysql_num_rows($sql);if($numrows != "0" & $password ==
$fetch_em["password"]) {$valid_user = 1;?><br /><a href="main.html"><p> </p> <div align="center">
 <strong><font color="#FFFF00" size="3" face="Geneva, Arial, Helvetica, sans-serif">:: WELCOME ::</font>
</div><p> </p></a><?php}else {$valid_user = 0;}// If the username exists and pass is correct, don't pop up
the login code again.// If info can't be found or verified....if (!($valid_user)){
session_unset();  // Unset session variables.session_destroy(); // End Session we created earlier.// escape from php
mode.
?><form
action=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/<?=$PHP_SELF?><?if($QUERY_STRING){
echo"?". $QUERY_STRING;}?>" method="POST"><p align="center"><font size="2" face="Geneva, Arial,
Helvetica, sans-serif">Incorrect login information, please try again. You must login to access this
system</font></p><table align="center" border="0"><tr>
 <th><font size="2" face="Geneva, Arial, Helvetica, sans-serif">Username:</font> </th> <th><input type="text"
name="username">  </th>  </tr>  <tr>   <th><font size="2" face="Geneva, Arial, Helvetica, sans-
serif">Password:</font> </th> <th>
<input type="password" name="password"> </th> </tr> <tr> <th colspan="2" align="right"><p> </p><input
type="submit" value="Login">  <input name="cancel" type="submit" id="cancel" value="Cancel"></form>
</th> </tr></table></body></html><?exit();}
//main
<html><head><title>Main</title>     <link rel="stylesheet" type="text/css"
href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css"></head>
<body topmargin="0" leftmargin="0" alink="#999999" bgcolor="#ff9900" link="#ffffff" marginheight="0"
marginwidth="0" text="#ffffff" vlink="#ffffff"><p> </p><p> </p><table align="center" border="0"
cellpadding="0" cellspacing="0">
 <tbody>    <tr>    <td background=""file:///c|/program%20files/yellowtip/htdocs/anesthesia/top.gif"
height="18"><img src="top.gif" width="706" height="18"></td>   </tr>   <tr>   <td><table width="100%"
border="0">    <tr>     <td width="39%" height="153">    <img
src="page_margin.gif" width="241" height="147"></td>     <td width="61%"><div align="left"><font
```

```
color="#FFFF66" size="4">                             
<object                                      classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="295"
height="34">
        <param name="movie" value="tajuk.swf">
        <param name="quality" value="high">
        <param name="bgcolor" value="#FF9900">
        <param name="scale" value="exactfit">
        <embed                          src="tajuk.swf"                          quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" scale="exactfit" width="295" height="34" bgcolor="#FF9900"></embed>
      </object>       </font></div></td>      </tr>      </table></td>  </tr>  <tr>     <td height="53"
valign="top"><p> </p><p><font     color="#000000"     face="Geneva,     Arial,     Helvetica,     sans-
serif">               
; Please
   select one of the options below:</font></p>      <p> </p></td>   </tr>   <tr>      <td height="86"
align="center"><table width="83%" border="0" align="center">      <tr bgcolor="#FFCC66">
      <td width="59%" height="24"><div align="center"><font color="#000000" face="Georgia, Times New
Roman, Times, serif"><strong>ADMINISTER    ANESTHESIA</strong></font></div></td>          <td><div
align="center"><font color="#000000">
      <object                                   classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="100"
height="22">
        <param name="BASE" value=".">
        <param name="movie" value="button66.swf">
        <param name="quality" value="high">
        <param name="bgcolor" value="#FF9900">
        <embed       src="button66.swf"       width="100"       height="22"       quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash"  bgcolor="#FF9900"  base="."></embed>                    </object>
</font></div></td>      </tr>      <tr bgcolor="#FFCC66">      <td height="24"><div align="center"><font
color="#000000"     face="Georgia,     Times     New     Roman,     Times,     serif"><strong>ANESTHESIA
INFORMATION</strong></font></div></td>
     <td><div align="center"><font color="#000000">  <object classid="clsid:D27CDB6E-AE6D-11cf-96B8-
444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="100"
height="22">
        <param name="BASE" value=".">
        <param name="movie" value="button67.swf">
        <param name="quality" value="high">
        <param name="bgcolor" value="#FF9900">
        <embed       src="button67.swf"       width="100"       height="22"       quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" bgcolor="#FF9900" base="."></embed>    </object>   </font></div></td>
</tr>    </table>
      </td>   </tr> </tbody></table></body></html>//administer<html><head><title>Expert System</title>
  <link                                rel="stylesheet"                                type="text/css"
href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css"><meta     http-equiv="Content-Type"
content="text/html; charset=iso-8859-1"></head>
<body topmargin="0" leftmargin="0" alink="#999999" bgcolor="#ff9900" link="#FFFF00" marginheight="0"
marginwidth="0" text="#ffffff" vlink="#ffffff"><table align="center" border="0" cellpadding="0" cellspacing="0">
<tbody>
  <tr>        <td  colspan="5"  background=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/top.gif"
height="18"><img src="top.gif" width="691" height="18"></td>
  </tr>  <tr>    <td colspan="5"><table width="100%" border="0">
     <tr>                         <td   width="39%"   height="153">     <img
src="page_margin.gif" width="241" height="147"></td>        <td width="61%"><div align="left">
        <pre><font color="#FFFF66" size="4">     
 </font><font  color="#FFFF66"  size="4">   <object  classid="clsid:D27CDB6E-AE6D-
11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="295"
height="34">
          <param name="movie" value="tajuk.swf">
          <param name="quality" value="high">
          <param name="bgcolor" value="#FF9900">
          <param name="scale" value="exactfit">
          <embed                          src="tajuk.swf"                          quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" scale="exactfit" width="295" height="34" bgcolor="#FF9900"></embed>
        </object>                      </font></pre>  <p  align="center"><font  color="#FFFF00"><a
href="main.html">[Main]</a></font></p>         </div></td>      </tr>      </table></td>   </tr>   <tr>
    <td width="1" valign="top"> </td>
    <td width="1" valign="top"> </td>
    <td width="1" valign="top"> </td>
    <td width="704" valign="top"><p>
      <APPLET
```

```
CODEBASE = "./"
CODE = "Corvid.Runtime.class"
NAME = "CorvidRuntime"
ARCHIVE = "ExsysCorvid.jar"
WIDTH = 706
HEIGHT = 400
HSPACE = 0
VSPACE = 0
ALIGN = middle
>
        <PARAM NAME = "KBBASE" VALUE = "" >
        <PARAM NAME = "KBNAME" VALUE = "anesthesia.CVR">
        <PARAM NAME = "KBWIDTH" VALUE = "700">
        The expert system would be running here but your browser has Java
        Applets disabled or does not support Java Applets.
      </APPLET>
    </p>              <img src=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/space.gif" height="1"
width="10"></td>
   <td width="1">  </td>  </tr>  <tr>    <td colspan="5" align="center"><p><br>     </p></td>  </tr>
</tbody></table></body></html>

//generalEpidural
<html><head><title>General Epidural</title>
 <link                                rel="stylesheet"                                type="text/css"
href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css"></head>
<body topmargin="0" leftmargin="0" alink="#999999" bgcolor="#ff9900" link="#ffffff" marginheight="0"
marginwidth="0" text="#ffffff" vlink="#ffffff"><p> </p><p> </p><table align="center" border="0"
cellpadding="0" cellspacing="0">
 <tbody>      <tr>          <td background=""file:///c|/program%20files/yellowtip/htdocs/anesthesia/top.gif"
height="18"><img src="top.gif" width="706" height="18"></td>  </tr>  <tr>      <td><table width="100%"
border="0">
     <tr>                    <td width="39%" height="153">     <img
src="page_margin.gif" width="241" height="147"></td>                <td width="61%"><div align="left"><font
color="#FFFF66" size="4">
                 
        <object                                classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="295"
height="34">
          <param name="movie" value="tajuk.swf">
          <param name="quality" value="high">
          <param name="bgcolor" value="#FF9900">
          <param name="scale" value="exactfit">
          <embed                              src="tajuk.swf"                              quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" scale="exactfit" width="295" height="34" bgcolor="#FF9900"></embed>
        </object>      </font></div></td>      </tr>    </table></td>  </tr>  <tr>    <td height="53"
valign="top"><p> </p>          <p><font color="#000000" face="Geneva, Arial, Helvetica, sans-
serif">                      Please
    select one of the options below:</font></p>      <p> </p>      <table width="83%" border="0"
align="center">
    <tr bgcolor="#FFCC66">      <td width="59%" height="24"><div align="center"><font color="#000000"
face="Georgia, Times New Roman, Times, serif"><strong>GENERAL ANESTHESIA</strong></font></div></td>
<td><div  align="center"><font  color="#000000">    <object  classid="clsid:D27CDB6E-AE6D-11cf-96B8-
444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="100"
height="22">
          <param name="BASE" value=".">
          <param name="movie" value="button68.swf">
          <param name="quality" value="high">
          <param name="bgcolor" value="#FF9900">
          <embed      src="button68.swf"      width="100"      height="22"      quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" bgcolor="#FF9900" base="."></embed>
        </object> </font></div></td> </tr> <tr bgcolor="#FFCC66">
      <td height="24"><div align="center"><font color="#000000" face="Georgia, Times New Roman, Times,
serif"><strong>EPIDURAL ANESTHESIA </strong></font></div></td>          <td><div align="center"><font
color="#000000">
        <object                                classid="clsid:D27CDB6E-AE6D-11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="100"
height="22">
          <param name="BASE" value=".">
          <param name="movie" value="button69.swf">
          <param name="quality" value="high">
          <param name="bgcolor" value="#FF9900">
```

```
<embed src="button69.swf" width="100" height="22" quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" bgcolor="#FF9900" base="."></embed>
</object></font></div></td></tr></table> <p> </p></td> </tr> </tbody></table></body></html>

//general
<html><head><title>General Anesthesia</title> <link rel="stylesheet" type="text/css"
href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css"><script language="JavaScript"
type="text/JavaScript">
<!--
function MM_jumpMenu(targ,selObj,restore){ //v3.0
eval(targ+".location='"+selObj.options[selObj.selectedIndex].value+"'");
 if (restore) selObj.selectedIndex=0;}
function MM_findObj(n, d) { //v4.01 var p,i,x; if(!d) d=document;
if((p=n.indexOf("?"))>0&&parent.frames.length) {
  d=parent.frames[n.substring(p+1)].document; n=n.substring(0,p);} if(!(x=d[n])&&d.all) x=d.all[n]; for
(i=0;!x&&i<d.forms.length;i++) x=d.forms[i][n];for(i=0;!x&&d.layers&&i<d.layers.length;i++)
x=MM_findObj(n,d.layers[i].document); if(!x && d.getElementById) x=d.getElementById(n); return x;
}function MM_jumpMenuGo(selName,targ,restore){ //v3.0
 var selObj = MM_findObj(selName); if (selObj) MM_jumpMenu(targ,selObj,restore);}//--
></script></head><body topmargin="0" leftmargin="0" alink="#999999" bgcolor="#ff9900" link="#ffffff"
marginheight="0" marginwidth="0" text="#ffffff" vlink="#ffffff">
<p> </p><table align="center" border="0" cellpadding="0" cellspacing="0"> <tbody> <tr>
  <td background=""file:///c|/program%20files/yellowtip/htdocs/anesthesia/top.gif" height="18"><img
src="top.gif" width="706" height="18"></td> </tr> <tr> <td><table width="100%" border="0"> <tr>
<td width="39%" height="153">     <img src="page_margin.gif" width="241"
height="157"></td>
      <td width="61%"><div align="left"><font color="#FFFF66" size="4">
          <object classid="clsid:D27CDB6E-
AE6D-11cf-96B8-444553540000"
codebase="http://download.macromedia.com/pub/shockwave/cabs/flash/swflash.cab#version=5,0,0,0" width="295"
height="34">
          <param name="movie" value="tajuk.swf">
          <param name="quality" value="high">
          <param name="bgcolor" value="#FF9900">
          <param name="scale" value="exactfit">
          <embed src="tajuk.swf" quality="high"
pluginspage="http://www.macromedia.com/shockwave/download/index.cgi?P1_Prod_Version=ShockwaveFlash"
type="application/x-shockwave-flash" scale="exactfit" width="295" height="34" bgcolor="#FF9900"></embed>
</object> </font></div></td> </tr> </table></td> </tr> <tr> <td height="53"
valign="top"><p> </p> <table width="89%" border="0" align="center"> <tr> <td
height="31" bgcolor="#FFCC00"><p align="center"> </p>
        <p align="center"><font color="#000000" size="2" face="Geneva, Arial, Helvetica, sans-serif">Please
select one of the general anesthetics below:</font> </p> <form name="form1"> <div align="center"> <p> <font
color="#000000"> <select name="anesthesia" onChange="MM_jumpMenu('parent',this,0)"> <option
value="diazepamProperties.html" selected>Diazepam</option> <option
value="propofolProperties.html">Propofol</option></select>   </font></p>
        <p> <font color="#000000"> <input type="button" name="Button1" value="Go"
onClick="MM_jumpMenuGo('anesthesia','parent',0)"> </font></p> </div> </form><p> </p></td>
</tr></table>
  </td> </tr> </tbody></table></body></html>
//epidural
<html><head><title>Epidural Anesthesia</title> <link rel="stylesheet" type="text/css"
href=""file:///C|/Program%20Files/YellowTip/Htdocs/anesthesia/default.css">
<script language="JavaScript" type="text/JavaScript"><!--
function MM_jumpMenu(targ,selObj,restore){ //v3.0
 eval(targ+".location='"+selObj.options[selObj.selectedIndex].value+"'");
 if (restore) selObj.selectedIndex=0;
}
function MM_findObj(n, d) { //v4.01 var p,i,x; if(!d) d=document;
if((p=n.indexOf("?"))>0&&parent.frames.length) {
  d=parent.frames[n.substring(p+1)].document; n=n.substring(0,p);} if(!(x=d[n])&&d.all) x=d.all[n]; for
(i=0;!x&&i<d.forms.length;i++) x=d.forms[i][n]; for(i=0;!x&&d.layers&&i<d.layers.length;i++)
x=MM_findObj(n,d.layers[i].document); if(!x && d.getElementById) x=d.getElementById(n); return x;}
function MM_jumpMenuGo(selName,targ,restore){ //v3.0 var selObj = MM_findObj(selName); if (selObj)
MM_jumpMenu(targ,selObj,restore);
}
//-->
</script>
</head><body topmargin="0" leftmargin="0" alink="#999999" bgcolor="#ff9900" link="#ffffff" marginheight="0"
marginwidth="0" text="#ffffff" vlink="#ffffff">
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Belongs to the group of medicines called narcotic analgesics</font></div></td> </tr>
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: Side Effects </td>
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throat; swelling of your lips, tongue, or face; or hives) </td>
</tr> <tr> <td bgcolor="#FFCC00"> • Slow, weak breathing </td> </tr> <tr>
<td bgcolor="#FFCC00"> • Seizure, cold, clammy skin </td> </tr>
<tr> <td height="19" bgcolor="#FFCC00"> •
Severe weakness or dizziness or unconsciousness </td> </tr> <tr>
<td bgcolor="#FFCC00"> •
Constipation </td> </tr> <tr> <td bgcolor="#FFCC00"> • Dry mouth, nausea, vomiting, or decreased appetite </td> </tr>
<tr>
<td bgcolor="#FFCC00"> • Dizziness or lightheadedness </td> </tr>
<tr>
<td bgcolor="#FFCC00"> • Drowsiness or fatigue </td> </tr> <tr>
<td bgcolor="#FFCC00"> •
Muscle twitches, sweating, itching </td> </tr> </table></td> </tr>
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