A Model for System Users to Develop a Software Needs Specification and to Evaluate the Ability of Systems to Comply with the Specification

By

Kevin Patrick Saier

A THESIS

Presented to the Division of Medical Informatics and Outcomes Research and the Oregon Health & Science University School of Medicine in partial fulfillment of the requirements for the degree of Master of Science in Medical Informatics.

May 17, 2001

School of Medicine
Oregon Health & Science University

CERTIFICATE OF APPROVAL

This is to certify that the M.S. thesis of

Kevin Patrick Saier

has been approved

[redacted]
Joan Ash, Ph.D.

[redacted]
Judith R. Logan, M.D.

[redacted]
Dale Kraemer, Ph.D.

[redacted]
William Smith, Ph.D.

Associate Dean for Graduate Studies

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ACKNOWLEDGMENTS

I would like to acknowledge my advisor, Joan Ash, for her guidance in preparing this thesis, Warren Harrison for providing direction for my thesis, and Judy Logan for her meticulous proofreading skills and for providing tremendously helpful feedback. I would also like to thank Dale Kraemer for his analytical guidance, William Smith for stepping up at the last minute to fill in on my committee, and Bill Hersh for being who he is.

I would like to especially thank my wife Patricia for putting up with me during the two years that it took to complete this thesis.

ABSTRACT

In nearly every software project which fails to meet performance and cost goals, requirements inadequacies play a major and expensive role. Increasingly, the users of software systems are being asked to initiate the system requirements process with the generation of a *needs specification document*. This poses a challenge for the users, who are not traditionally familiar with system engineering techniques and procedures.

The science of "user centered design" (UCD) provides a foundation for developing a procedure which can be applied by users not only when a system must be designed or discovered, but also when it is necessary for users to evaluate the ability of existing products to meet their needs. Since UCD processes are based on the perspective of users, a UCD process can be developed which the users of a system apply to the problems themselves -- without the aid of engineers.

To generate a needs documentation methodology that all users could follow, a simplified, graphical model of the user centered design methodology was developed. The model was applied by system users in a working facility, and a successful needs document was generated. The model was then applied by users to evaluate the ability of existing systems to fulfill their needs.

The research question was: Can a user centered model be used as a tool both to develop the needs specification document and to evaluate the ability of systems to

fulfill those needs? The results demonstrate that the proposed user centered model can be used by system users to create a needs specification document, that the model can be used to evaluate the ability of proposed systems to meet the needs of the users, and that users find the model and procedure to be useful.

INTRODUCTION

In his article "No Silver Bullet: Essence and Accidents of Software Engineering", R. Brooks states that "the hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the requirements. No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later" (Brooks, 1987).

Defining the problem and documenting the results is the goal of the needs specification process. For many developers of large, complex computer systems, specification is their biggest software engineering problem. In cases where no systems engineers are present, the task of generating the need specification document may fall into the hands of the very people who have the problem and are in need of a solution. For this reason, a procedure is needed that allows non-technical computer system users to identify and document their own problems and needs. This procedure must be simple, and must be complete enough that it can accurately depict the needs of the user groups.

Once users have documented their system needs and begun the search for a solution, they are then faced with the challenge of deciding which system most appropriately addresses their needs. To address these two problems, a single procedure which allows users to not only identify their needs, but also to compare the ability of systems to meet their needs, would be ideal. The purpose of this research is to propose and test a model to meet these two needs of system users.

BACKGROUND

By definition, a need is a "stress or a state of tension or instability in the environment which tends to discharge in behavior aimed at relieving the tension or restoring stability" (Hall, 1989). A need may occur in any environmental factor or element, not only in humans, and its importance or urgency can be gauged by the good it can cause if satisfied, or by the damage or pain which may be caused if it is not satisfied. Thus, need can be measured by its incidence, intensity, duration, certainty or uncertainty, time of occurrence, fecundity, and number of persons affected (Hall, 1989).

When needs rise to a sufficient level of intensity, they may serve as a motive which is sufficiently pressing to direct the person or organization towards the goal of satisfying them. In their book *System and Software Requirements Engineering (1990)*, Thayer and Dorfman define a need as a capability required by a user to solve a problem or achieve an objective (Thayer, 1990). Specification of these needs commonly precedes design or purchase of software systems.

The specification of needs is a subset of the requirements specification process. A specification of needs differs from a specification of requirements in that the requirements specification provides a greater level of technical detail than does the needs specification (Thayer, 1990). A needs specification addresses what the general needs are that the system must address. The requirements specification includes not only the definition of but also the proper documentation of the functions, performance, internal and external interfaces, and quality attributes of the system under

development. In addition, it includes any valid constraints on the system design or on the development process (Thayer, 1990). Data about needs can be translated or mapped into goals, objectives, constraints, input-output requirements, and specifications for systems that will satisfy the needs.

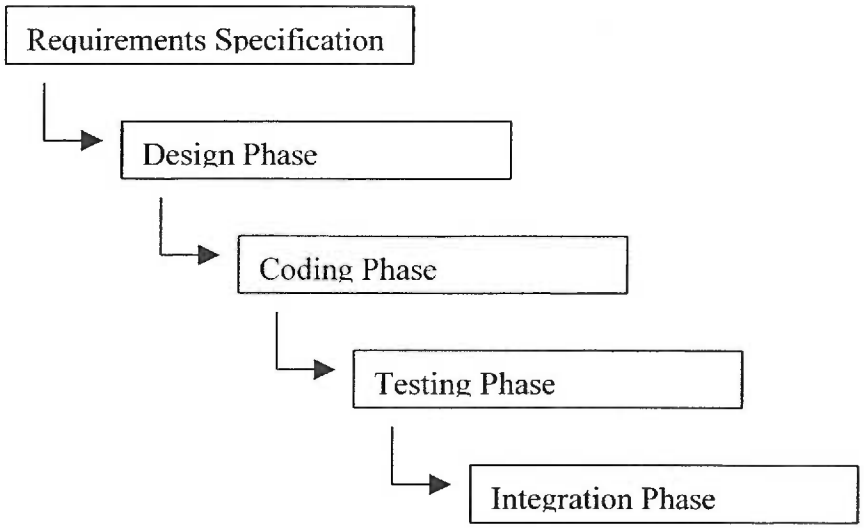
The concept of needs documentation originated from a subset of the systems engineering field known as software requirements engineering. Early software requirements engineering was summarized by five basic phases:

1. Software requirements elicitation – the process through which the customers and the developer of a software system discover, review, articulate, and understand the users' needs and constraints on the software and development activity.
2. Software requirements analysis – the process of reasoning about and analyzing the customers' and users' needs to arrive at a definition of software requirements.
3. Software requirements specification – the process of developing a document that clearly and precisely records each of the requirements of the software system.
4. Software requirements verification – the process of ensuring that the software requirements specification is in compliance with the system requirements, conforms to document standards of the requirements phase, and is an adequate basis for the architectural design phase.

5. Software requirements management – the process of planning and controlling the requirements elicitation, specification, analysis, and verification activities

The specification of the requirements for a system is the first of five phases in Royce's Standard Waterfall Development Model (Royce, 1987). (Figure 1)

Figure 1: Royce's Standard Waterfall Development Model



According to the Royce's Standard Waterfall Development Model, the requirements specification phase involves defining the requirements a new system must meet without defining how the system will meet them. This is done by first focusing on the needs of the user, not the process of meeting the user's needs. In Royce's model, the requirements phase is followed by the second phase, the design phase. The design phase involves the transformation of the needs specification into a plan for

implementing a solution. In the coding phase, the design is applied and the new system is built. The coding phase is followed by the testing phase, which involves verifying and validating the solution. The waterfall model concludes with the integration phase, in which the new system is integrated into the environment (Royce, 1987).

The needs specification document is the net output of the needs specification process, and acts as a representation of the requirements for a proposed system to all people who are involved with the system. Its purpose is to provide a methodical description of capabilities that must be met or possessed by a system or system component to satisfy any contracts, specifications, or standards. It is important to recognize that the needs document must specify the required properties of the system without specifying any details on how the properties will be achieved. The needs document allows readers to better understand the problem itself, without focusing on the solution. When the roles of the needs specification document are looked at in terms of the players in the design process, we see that the document serves a purpose for many different parties. For the customer, it typically documents what should be delivered and may provide the contractual basis for the development. For managers, the needs document may provide a yardstick for measuring progress. For designers, it provides a "design-to" specification. For programmers, it may define the range of acceptable implementation and is the final authority on the outputs that must be produced. And finally, for the quality assurance personnel, the needs document is the basis for validation, testing, and verification (Davis, 1988).

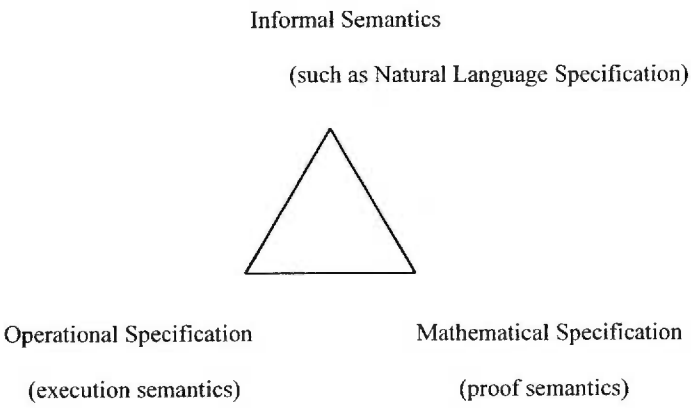
The benefits of a good needs specification document include: agreement among developers, customers, and users on the job to be done and acceptance of criteria for the system; a sound basis for resource estimation, including cost, personnel, equipment, and time; improved system usability, maintainability, and other quality attributes; and the achievement of goals with minimum resources (less rework and fewer omissions and misunderstandings).

System requirements and needs documentation are usually based on one or more of the following: interviews with customers and users, marketing surveys, statement of work documentation, concept of operations documents (CONOPS), and observations. In addition, measures of the current system, current system documentation, and current models and prototypes may be used.

NEEDS SPECIFICATION METHODOLOGIES

The tools and techniques for needs specification originated with software developers and were later modified to be used for specifying needs. The three basic techniques for preparing a requirements specification can be summarized by Zave's Triangle (Zave, 1982). (Figure 2)

Figure 2: Zave's Triangle



Zave's triangle represents the three cornerstones of requirements specifications. They are mathematical specification, operational specification, and informal semantics.

Informal specifications can be defined in natural language. Informal specifications require no special training to read or write, and can specify all required properties while imposing no inherent bias.

A mathematical specification has a semantic based on a mathematical proof system. Proofs can be used to derive consequences which are helpful for validation. Examples of mathematical specifications include decision trees, decision tables, finite state machines, state transition diagrams, and state transition matrices (Zave, 1982).

Operational specifications have semantics defined in terms of a logical execution model. Operational specifications tend to resemble logical programming language code blocks. Examples of operation specifications include Structured Analysis, Structured Analysis and System Specification (SASS), Program Design Language

(PDL), Problem Statement Language/Problem Statement Analyzer (PSL/PSA), Structured Analysis and Design Technique (SADT), Object-oriented Analysis, and Structured Requirements Definition (SRD) (Zave, 1982)

THE USER-REQUIREMENT PROBLEM

With increasing frequency, the users of software systems are being asked to generate the needs specification document for new systems. This creates problems for the users, who are not traditionally familiar with system engineering techniques and procedures. The challenges the users may face include:

- how to analyze the problem they want the new system to address
- how to decompose the problem into intellectually manageable pieces
- how to organize the problem so that it can be understood
- how to discover all the needs of the entire user community
- how to communicate the problem to all the parties involved
- how to qualify and quantify the requirements
- how to generate a requirement specification document that is unambiguous, consistent, and complete
- how to know when to stop

A system of any but the smallest size must be decomposed into the individual needs the system must meet in order to initiate the development process. For the user this challenge can be compounded by the fact that many specification methods require

previous training or familiarity, are non-friendly, and may be difficult for non-technical personnel to understand. In addition, some users may be unable to articulate what they want, others may not know what they want, and some may lack motivation altogether. Finally, there is little benefit to developing a thorough understanding of the problem if that understanding is not effectively communicated to customers, designers, implementers, testers, and maintainers.

The significance of the user-requirement problem is difficult to quantify and measure. Alford and Lawrence state that "in nearly every software project which fails to meet performance and cost goals, requirements inadequacies play a major and expensive role in the project failure" (Alford, 1979).

A survey of large aerospace firms identified requirements as the most critical software development problem (Faulk, 1992). A study of problems in mission-critical defense systems identified requirements as a major problem source in two-thirds of the systems examined (Hall, 1989). Errors in the system requirement document are often not detected until after the product is delivered, and cost far more to fix the later they are detected (Boehm, 1976). Results of industry studies in the 1970s, and since repeated a number of times, showed that requirements errors are the most costly. The basic conclusion was that the earlier in the development process an error occurs and the later the error is detected, the more expensive it is to correct (Boehm, 1981) (see Figure 3).

Figure 3: Relative Cost of Error Discovered in Each Design Phase

Stage	Relative Repair Score	Relative Repair Cost
Requirements	1	$500
Design	5	$2,500
Coding	10	$5,000
Unit Test	20	$10,000
System Test	50	$25,000
Maintenance	200	$100,000

The most common types of error in needs documentation are incorrect facts, omissions, inconsistencies, and ambiguities (Basili, 1981). Sources of error in needs specification documents include the writer's failure to understand what was required of the software by the customer, end user, or other parties with a stake in the final product. Often, the writer does not completely and precisely capture the requirements or subsequently communicate the requirements effectively to other parties involved in the development (Basili, 1981).

According to Alan M. Davis, a good needs specification technique should be helpful and understandable to non-computer-oriented customers and users, as well as technically trained personnel. When the technique is properly used, the resulting document should be able to serve effectively as the basis for design and testing. The

technique should encourage the writer to think and write in terms of external product behavior, not internal product components. The technique should also effectively organize the information that will go into the document. Finally, the technique should reduce ambiguity, incompleteness, and inconsistency (Davis, 1988).

Richard E. Fairly and Richard H. Thayer state that the needs specification technique should communicate users' and buyers' needs to the system developers. More important, it should communicate the writer's understanding of user needs to the developer. The technique used should document the divergent needs and differing viewpoints of the various user groups. This is important because software systems frequently have many different user groups. Needs document techniques should document consensus on the system's characteristics among multiple users, user groups or multiple buyers. Techniques should provide a mechanism to document users' operational needs in a manner that can be verified by the user without requiring them to have any technical knowledge beyond what is required to perform their job functions. Finally, the technique should provide a place for users to state their desires, visions, and expectations without requiring them to provide quantified, testable specifications (Fairley, 1997).

Staurt R. Faulk contends that a needs documentation technique should provide the primary vehicle for agreement between the developer and customer on exactly what is to be built. It should be used as the basis for judging fulfillment of contractual obligations. In addition, the needs document technique should provide a basis for

estimating cost and act as a primary tool for tracking development progress and ascertaining what remains to be done (Faulk, 1997).

Robert J. Lano (1990) contends that any specification type document should be:

- complete
- concise
- clear
- simple
- understandable
- unambiguous
- specific
- consistent
- referenceable
- traceable
- implementation-free
- feasible
- maintainable
- manageable

One interesting approach to systems design which could be applied to the needs documentation process is user centered design (UCD). User centered design is so named because the system's users are always positioned at the center of the design and

development process. User centered design is different from data centered design in that UCD considers the skills that the users possess, along with other user characteristics, while data centered design focuses on information technology, including its data structures and formats (Allen, 1996).

In 1994, A. Dillon proposed a model for UCD consisting of five core elements: the identification of stakeholders, analysis of the users, analysis of tasks, generation of a specification, and prototype development (Dillion, 1994). At about the same time, D.E. Mahling proposed a model consisting of six core elements: analysis of the users' goals, analysis of the tasks, analysis of the user groups, formulation of models, design of the system, and performance usability testing (Mahling, 1994). Finally, in 1996, Bryce L. Allen proposed a five element model: analysis of the user's needs, analysis of the users' tasks, analysis of the resources involved, creation of user models, and performance usability testing (Allen, 1996).

Since user centered design processes are based on the perspectives of users, it seems possible that a user centered design process could be developed which the users of a system might be able to apply the process themselves -- without the aid of engineers. If this were true, then it might be possible that a simple UCD model could be developed allowing the users to create their own needs specification document.

While attempting to apply UCD design to allow users to create their own needs specification document, the researcher discovered that the same model could conceivably be applied to another user problem – the evaluation of the ability of

proposed systems to meet the needs of the users. With this in mind, it was decided to attempt to develop a user centered design model that could be used both to create a needs specification document and to evaluate the ability of software systems to meet the specified needs of the user.

METHDOLOGY OVERVIEW

The goal of this project was to describe and evaluate a model to be used by system users for the development of the preliminary needs specification document. This section consists of two parts.

Part I

- the proposal of a needs documentation model
- an example demonstrating the application of the model to a problem
- an evaluation of the resulting needs specification document

Part II

- proposal for use of the model to compare the ability of software systems to solve the original problem
- an example demonstrating the application of the model to compare the ability of two proposed software systems to fulfill the users' needs
- an evaluation of that comparison

PART I

PROPOSAL OF THE MODEL

Development of a needs document is often the first obstacle a user encounters when selecting a computer system to address a specific need. Generally, however, system users are not proficient in developing such documents, and have little or no training in the science of analyzing the existing problems which they wish to have addressed.

The user is faced with many questions:

- How does he discover everything he requires?
- How does he organize the problem so that it can be understood?
- How does he decompose the problem into intellectually manageable pieces?
- How does he communicate all the needs of the user community to all the parties involved?
- How does he effectively communicate the requirements to the system developer or the system sales team?
- Ultimately, how does he generate a requirements document that is unambiguous, consistent, and complete?

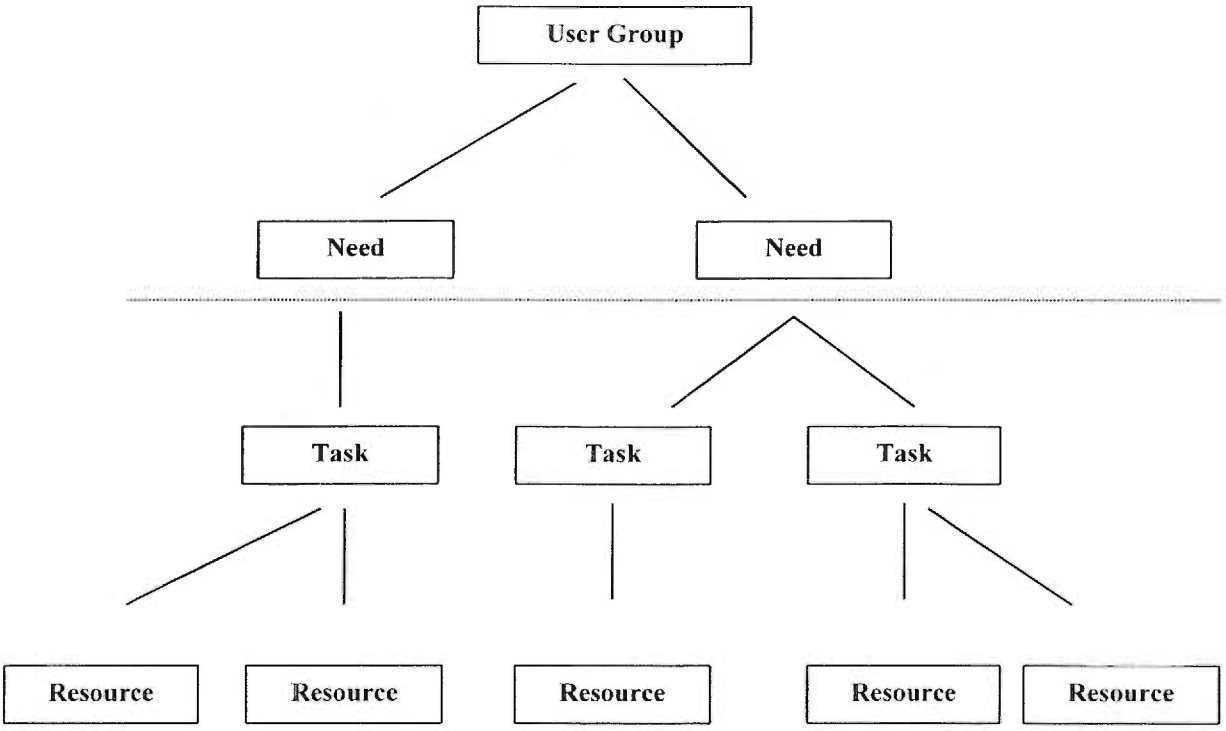
Based on user centered design principles and the researcher's personal experience, the proposed model includes four fundamental elements:

- the user groups
- the needs of each user group
- the tasks used by each user group to meet the need

- the resources used by each user group to accomplish the task

To represent these four components in a cognitively organized format, the hierarchical schema, commonly referred to as a "tree diagram" was selected. With each of the four components assigned a generational level of the tree, the visual representation in figure 4 is created.

Figure 4: Hierarchical Arrangement of Selected UCD Components



The graphical model is the basis for the procedure to elicit the needs specification. The procedure is performed as follows:

Step 1. Identify who the systems users are. Be aware that the "users of the system" can include many diverse and often unrelated groups of people.

Step 2. Gather together a survey group of current users of the system. The number of participants in the survey should be based on the complexity of the problem being addressed and the number of user groups involved. Recruit three to five survey participants from each user group which may have a unique perspective on the problem.

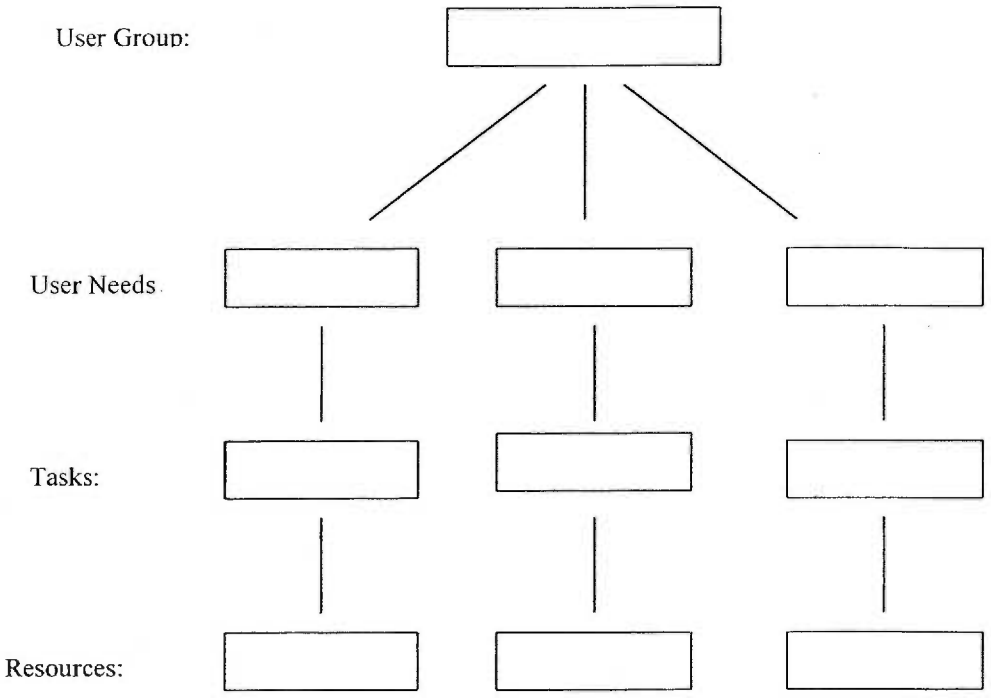
Step 3. Recruit any administrators, managers, or technical experts who are familiar with the current environment.

Step 4. Describe to the participants the logic behind the proposed hierarchical user centered design model: (see figure 5)

1. each system has users
2. every user has needs
3. every need requires tasks to meet those needs
4. every task requires resources in order to accomplish the task

Step 5. Provide the collected group of people with numerous copies of the empty diagram as shown in Figure 5.

Figure 5: Data Collection Diagram



Step 6. Ask the gathered group to sketch out their own tree diagrams using the following criteria:

1. Uniquely identify each **user group** and represent that group as an individual box on the tree.
2. Within each user group, list all of the **needs** that must be met for that user group by the new system. Represent these needs by boxes in the generation below the corresponding user group.
3. Within each user group's need, identify all the **tasks** the user group currently goes through to meet that need. Represent these tasks by boxes in the generation below the corresponding need.

4. Finally, within each user group's associated need-task, identify all **resources** that the user group currently must use to obtain the information necessary to fulfill the tasks which meets the need of that user. Represent each resource by a box in the generation below the corresponding need.

Ask participants to continue the process until they have included every user group, every user need, every task, and every resource used with which they are familiar. Be aware that this process can be lengthy and that each participant may require many large pieces of blank paper.

Step 7. Review the "user groups" identified by the study participants. If additional user groups are identified in the study, which are not represented in the survey process, recruit participants from these user groups and repeat Step 2 through Step 7 with them. This iterative process is known as snowballing.

Step 8. Once all the participants have concluded filling out the diagrams, gather all the users' diagrams together and begin grouping all the responses from the first two levels of the users' hierarchies (User Groups and Needs) into one master diagram. To avoid including user needs that are perceived to be valid needs by only a few individuals, it may be necessary to include some exclusion criteria or perform periodic member checks before tabulating the results. The net result of this process should be a series of large diagrams including all the valid needs for each possible user group. This will become the foundation for the users' "Needs Document". (See appendix A)

Step 9.

Transfer the large tree diagrams into outline form using the format below. This will become the Needs Document.

Figure 6: Outline Format of Needs Document

1. **User Group**
    - **1.1. Need**
    - **1.2. Need**
    - **1.3. .....**
2. **User Group 2**
    - **2.1. Need**
    - **2.2. Need**
    - **2.3. .....**
3. **.....**
    - **3.1. ....**
    - **3.2.**

Once the needs document has been created, the users and their needs will have been identified. These two components constitute the critical portion of the needs document, yet constitute only the first two levels of the proposed hierarchical model. At this point the bottom two levels of the hierarchy (current tasks and resources – see Figure 4) are useful to have, but do not constitute an important part of the needs specification. Instead, these two levels of detail will be useful later, when it becomes necessary to evaluate of the ability of systems to fulfill the needs of the needs specification document.

APPLICATION OF THE MODEL

The demonstration of the use of the new model to create a needs document was performed by applying the model to an actual ongoing scenario at Providence St. Vincent Hospital and Medical Center (PSVMC) in Portland, Oregon. In the Fall of 1999, the surgical staff at St. Vincent Hospital began the task of searching for an information system to provide the surgical services facilities with accurate, real-time patient location and status information. As no such systems were readily available, the staff decided to take on the challenge of designing a needs specification based on their own requirements. A review of systems engineering processes revealed that there were no needs specification models readily available which would be simple enough for the system users to apply.

At that time, Providence St. Vincent Hospital had four separate surgery units located throughout its facilities. The four surgical units included main surgery, day surgery, eye surgery, and cardiac surgery. Together, these four surgical units utilized 29 operating rooms, 52 preoperative/postoperative beds, and eight overflow holding beds. On a daily basis, there were usually 90-100 surgeries performed. During perioperative surgical visits, patients could move through any combination of the surgical locations. This created an extraordinary problem in the tracking of the location of surgical patients.

Each day numerous parties would request information pertaining to the location of patients, but there was no established method for tracking surgery patients throughout their perioperative stay. Numerous phone calls were made daily among the perioperative units and within the units themselves to determine the location of the patients. Tracking such a large number of patients over the phone became a tedious and labor-intensive task. Each phone call took a staff member away from other important patient care duties. Hospital volunteers and patient families had no way of determining the status or location of their family member except through phone calls; surgeons had no sure way of identifying the current location of each patient; and ancillary members of the patient care team did not know the location of patients when responding to laboratory, electrocardiography, or radiology orders.

The model proposed by this study was applied to the situation at Providence St. Vincent Hospital. The survey group consisted of three surgical nurses, two Operating Room (OR) control nurses, two Surgical Prep Unit (SPU) nurses, two Post Anesthetic Care Unit (PACU) nurses, two surgeons, and two anesthesiologists. All were selected based on their willingness to take part in the survey. In addition, the survey group included several managers and administrators. The survey participants were each given a unique identifier number to label their survey results. A single master list of the unique identifier numbers and the corresponding participants' name was kept in a password protected file on a computer stored in a secure location.

The results of the surveys were tabulated into one master hierarchical diagram for each user type. These master hierarchical diagrams became the basis for the user needs document.

EVALUATION OF THE NEEDS DOCUMENT

The needs document that resulted from the application of the model was evaluated using a survey (see Appendix B) including a compilation of the criteria specified by various systems engineering specialists as being critical to effective needs documentation. The criteria selected, while not inclusive of all specification criteria published, were felt to adequately represent the range of criteria that are published, as well as represent the goals of the author in proposing this method for needs documentation generation.

Three systems analysts from the Providence Health System were selected to participate in the survey based on their past familiarity with requirement specification documents. Each of the survey participants was asked to rank each of the selected criteria on a Likert scale of 1 to 5, with 1 representing "Strongly Disagree" and 5 representing "Strongly Agree".

PART II

THE MODEL AS A TOOL TO EVALUATE THE EFFICIENCY OF PROPOSED SYSTEMS TO MEET THE NEEDS OF THE USER

The first portion of the model lists the users and their needs as identified by the users themselves. It is important that the users and users' needs be represented independent of the tasks and resources used to meet those needs, in order to prevent the needs from being understood only in the context of how they are presently met. The second part of the project involves using the data collected in Part I to help compare and evaluate the ability of proposed systems to meet the needs of the user.

To do this, all the users' diagrams from the previous exercise were again gathered together and accumulated into one master diagram. This time, however, all four levels of the hierarchy (user groups, needs, tasks, and resources) were accumulated into one master diagram. The result was a large, detailed diagram including all possible needs, tasks, and resources for each user group (see appendix D).

Once the users' tasks and resources had been added to the listing of users and needs, a complete understanding of how users *currently* meet their identified needs was available.

To compare and evaluate the effectiveness of a new system to meet those same needs, the user now needs to identify the *tasks* and *resources* required for the new system to meet those needs. To do this, the user will need literature, documentation, or an expert

source on the new or proposed system. The user can then take the top two lines from the output of the model in Part I (listing user groups and needs) and complete the model using the *tasks* and *resources* necessary for the new system to meet those needs.

By applying this process repeatedly to each available new or proposed system, a new set of hierarchical diagrams is created identifying the tasks and resources required by each system to meet the needs of each user group. Once this has been completed, the *tasks* and *resources* from each system can be accumulated into a master 'comparison diagram', sorted by user group (See appendix E). The comparison model can now be used to easily compare the ability of the different systems to meet the needs of the users.

APPLICATION OF THE MODEL TO COMPARE TWO SYSTEMS

To demonstrate how the model is used to compare the ability of various new or proposed information system solutions to meet the original needs of the users, the model was applied to two new systems being reviewed by the Providence St. Vincent Hospital staff.

EVALUATION OF THE COMPARISON STUDY

To confirm the usefulness of this model in evaluating the efficiency of systems to meet the needs of the users, a 'member check' was performed using the original members of the study group charged with evaluating different systems to meet the patient tracking needs of the surgical staff. A 'member check' is a method used in qualitative research in which a product is brought back to and reviewed by the original members of a study group to collect feedback and assess the success of the study.

Four participants randomly selected from the original survey process were gathered together and asked to review the model and results. The participants were asked whether the model "produced results that were useful to them in comparing the ability of the new systems to meet their needs?"

RESULTS

EXAMPLE DEMONSTRATION OF THE SYSTEM

The application of the new UCD model to the PSVMC scenario produced a comprehensive listing of user needs as identified by the PSVMC users themselves. The resulting needs document is listed in Appendix C.

The application of the model appeared to be straight forward and understandable to the study participants. The participants each spent anywhere from five to forty-five minutes completing the data collection sheets. The sheets were collected and compiled by the user group. Several participants expressed having enjoyed contributing their perspective in the needs elicitation process.

EVALUATION OF THE NEEDS DOCUMENT

The results of the evaluation of the needs document are summarized in Table 1.

None of the survey criteria received the same score from all three of the respondents. There were, however, several criteria that were scored with all three of the scores within a two point range (e.g., "4, 5, and 5"). Items focusing on whether the document was concise, clear, simple, understandable, and understandable to non-computer oriented users, all received scores of "Agree" or higher. This supports the relative simplicity of the model. In addition, it supports the ability of the model to be understood and applied by non-computer oriented users – one of the initial goals of the model.

Table 1: Results of Evaluation of the Needs Document

(1 = Strongly Disagree ..... 5 = Strongly Agree)

Criteria	Reviewer 1	Reviewer 2	Reviewer 3
1. The needs document is concise.	4	5	5
2. The needs document is clear.	4	4	5
3. The needs document is simple and understandable.	5	4	5
4. The needs document is unambiguous.	5	2	5
5. The needs document is understandable to non-computer oriented user.	5	4	5
6. The needs document communicates the author's understanding of the user needs to the developers.	4	4	5
7. The needs document provides a place for users to state their desires and expectations without requiring them to provide quantified, testable specifications.	4	3	5
8. The needs document documents the divergent needs and differing view points of different user groups.	4	3	5
9. The information in the document could be verified by users without requiring them to have any technical knowledge beyond what is required to perform their job functions	4	3	5
10. The needs document format encourages the author to think and write in terms of external product behavior, not internal product components.	4	5	4
11. The needs document could serve as a basis for design and testing.	4	2	5
12. The needs document will reduce ambiguity, incompleteness and inconsistencies in a new software product's design.	4	2	4
13. The technique provides a vehicle for agreement between the user and the developer on what is to be built.	4	3	4
14. The needs document can be used as a basis for judging fulfillment of contractual obligations.	4	2	5
15. The needs document provides a basis for estimating cost.	4	1	3
16. The needs document can act as a primary tool for tracking the development progress of a new system.	4	2	5
17. The needs document provides a basis for test plan development.	4	3	5

Two criteria which were not related to the ease of use of the model also had scores of "Agree" and higher. They were:

- the needs document communicates the author's understanding of the users' needs to the developers.
- the needs document format encourages the author to think and write in terms of external product behavior, not internal product components.

The first criterion is important because the author is the system user. Thus, the model allows the system's users to communicate their understanding of their needs to the system developer. The favorable response on the latter criteria is more readily achieved since system users rarely think of terms of internal product components. Rather, they are most concerned with the external product behavior.

The criterion with the lowest scores was associated with estimating cost. This indicates that the needs methodology may not be specific and detailed enough to identify and estimate costs. The low score could also indicate that the generation of the needs document may fall too early in the system development process to be able to identify costs.

In addition to the criterion associated with cost, it was not clear that the needs methodology was adequate for producing a needs document that was effective for serving as a basis for system design and testing; that the needs document would reduce ambiguity, incompleteness and design inconsistencies; that the document could be used as a basis for judging fulfillment of contractual obligations; and that the needs

document could act as a primary tool for tracking the development progress of a new system.

Criteria in which the ratings were all between "Neutral" and "Strongly Agree" include the following:

- The document provides a place for users to state their desires and expectations without requiring them to provide quantified testable specifications.
- The needs document documents the divergent needs and differing view points of different user groups.
- The information in the document could be verified by users without requiring them to have any technical knowledge beyond what is required to perform their job functions.
- The technique provides a vehicle for agreement between the user and the developer on what is to be built.
- The needs document provides a basis for test plan development.

Further testing and a larger survey sample size would be required to better understand the ability of the needs document to fulfill these criteria.

EXAMPLE APPLICATION OF THE MODEL TO EVALUATE THE EFFICIENCY OF PROPOSED SYSTEMS TO MEET THE NEEDS OF THE USER

Appendix E lists the results of applying the model to identify the ability of alternative systems to meet the users' patient tracking needs. The examples compare using a variation of an information system called STAR from HBOC, versus using a third party patient tracking system offered by the company Versus Technology.

The application of the model was successfully completed as specified in the methodology.

EVALUATION OF THE RESULTS OF THE METHODOLOGY FOR COMPARING THE EFFICIENCY OF VARIOUS SYSTEMS TO MEET THE NEEDS OF THE USERS

The member check of the study subjects revealed that the users felt the model was extremely useful for comparing the efficiency of various systems to meet the needs of the various user groups. In addition, they felt that the results of the model would be effective for presenting and using as a medium for discussion at team meetings. Finally, the participants felt that the results would be useful for presenting to administrative personnel in explaining and justifying decisions regarding new software development and purchases.

DISCUSSION

The model was intended to be simple enough to be applied by a variety of different system users, regardless of their skill levels, thus resulting in a comprehensive listing of all possible user needs. The advantage to this approach is that it provides a medium for brainstorming which allows the users to put all of their perceived needs on paper. Through repetition of the brainstorming-documentation process with many different users, the likelihood of overlooking a user need diminishes. While this was a fundamental intent in the development of this needs specification model, the process also introduces the potential for irrelevant or invalid user needs to be introduced by some individuals. The result is that the process requires an unbiased method to sort through the users' input and determine which of the perceived needs are actually valid user needs (which will be included in the tabulated results), and which are merely needs that are perceived to be valid by a few individuals.

The solution chosen for the St. Vincent Hospital application of the model was that a user need was required to appear in at least 40% of that user groups' surveys before it was considered to be a valid need that was included in the results. Needs that appeared on fewer than 40% percent of the user groups' surveys were excluded as needs that were merely "perceived" by a few individuals to be valid. The decision to use 40% as the cut off for a valid need was based on the sample size in the example demonstration. Since there were approximately three survey participants from each

user group, a score of 40% would eliminate all needs that were identified by only one of the three participants.

An alternate solution to this problem would be to perform periodic member checks, in which the accumulated listing of group needs are brought back before the user group for review and consensus on which needs are valid.

A final method might be to have a designated, unbiased system analyst review all of the survey results and determine which specified needs are valid for inclusion in the needs specification and which are not. This method would require a system analyst who has not only a thorough understanding of needs specification practices but also of the environment from which the need specification is being generated. Involving a system analyst would defeat one of the initial purposes of the model – to develop a process that can be completed by the user.

PROPOSAL OF THE MODEL TO EVALUATE THE ABILITY OF OTHER SYSTEMS TO MEET THE NEEDS OF THE USERS

The original hope in developing this model was that it could be applied to quantitatively evaluate the efficiency of systems to meet the needs of users. By dissecting the needs process into the individual tasks and resources, it was anticipated that it would be possible to assign a quantitative value to each task and/or resource. When the dissection process was actually completed, it was realized that the level of specificity of the results would not actually allow for the individual components to be

quantified. A quantified analysis would require a level of detail that allowed qualitative values to be assigned to each task and resource. Tasks such as "the surgeon is required to walk from surgical prep unit to the main OR to obtain information" are difficult to quantify. One could attempt to quantify the time required, but would have to assign a value to the surgeon's time. How is the surgeon's time compared to the nurse's or other staff member's time?

The issue of the value of different tasks then comes in to play. If it takes 5 minutes for a doctor to walk somewhere to get information, should that be assigned a higher or lower quantitative value than if it takes the doctor 5 minutes on the phone to obtain the information?

A final issue that arises is the discrepancy between task values and resource values. How to go about comparing the value of a surgeon's five minute phone call to the value of three computer monitors can be a difficult task. Therefore, it was decided to leave these 'value' decisions up to the person who is reviewing the results of the comparison model. The model places the information in a simple graphical format that allows users to then make their own value decisions based on the output.

CONFIRMATION OF THE RESULTS OF THE METHODOLOGY FOR EVALUATING THE ABILITY OF VARIOUS SYSTEMS TO MEET THE NEEDS OF THE USERS

The researcher became concerned with the lack of detail in the individual components of the model when completing the application of the model to the St. Vincent Hospital example scenario. The researcher felt that this lack of detail might jeopardize the ability of the model to adequately allow the user to apply the model to evaluate the ability of various systems to meet their needs. Fortunately, this did not appear to play as large a factor as anticipated. The users of the system confirmed that the model provided useful output for comparing the efficiency of various systems to meet the needs of the users.

FUTURE RESEARCH

Future research could identify the reliability of this model. A reliability study could be accomplished by dividing a large group of study participants into two or three smaller groups and have each group go through the needs documentation process separately. The disparity between the results from each group of participants could be measured to identify the reliability.

A study to identify the user group for whom the model is most appropriate could be performed using a tool that would measure the effectiveness of the model's results. Such a tool could be applied to the results of the application of the model from a variety of different user groups. Comparing the effectiveness of the model's results with different types of user groups might reveal that the model is more suitable for some user groups than for others.

CONCLUSION

Software system users no longer play a passive role in the discovery and design of new software systems. As the system users are asked to play a more active, new methods will be needed which allow the user to accomplish the often complex tasks of system engineers.

User Centered Design concepts place the user as the central point in the design process. Since system users are generally not familiar with systems engineering, User Centered Design methods allow the user to approach the problem from their perspective. To generate a needs documentation methodology that all users could follow, a simplified, graphical model of the User Centered Design methodology was developed.

During development of the model, it was discovered that the model could also be used to compare the ability of new or proposed systems to meet the needs of the user. Thus, the methodology was expanded to include this purpose and the model was applied as such in a working environment.

The new model was successfully applied in a production environment and a needs specification document was produced. The needs specification document lacked the level of detail that might have been generated had the document been prepared by professional system analysts, yet it contained enough detail to be useful to both system users and developers. The model was then applied to help the users compare the

ability of various systems to meet their needs. The users reported that the model proved helpful in evaluating the ability of systems to meet their needs. Further research should be performed to determine the reliability and effectiveness of this model.

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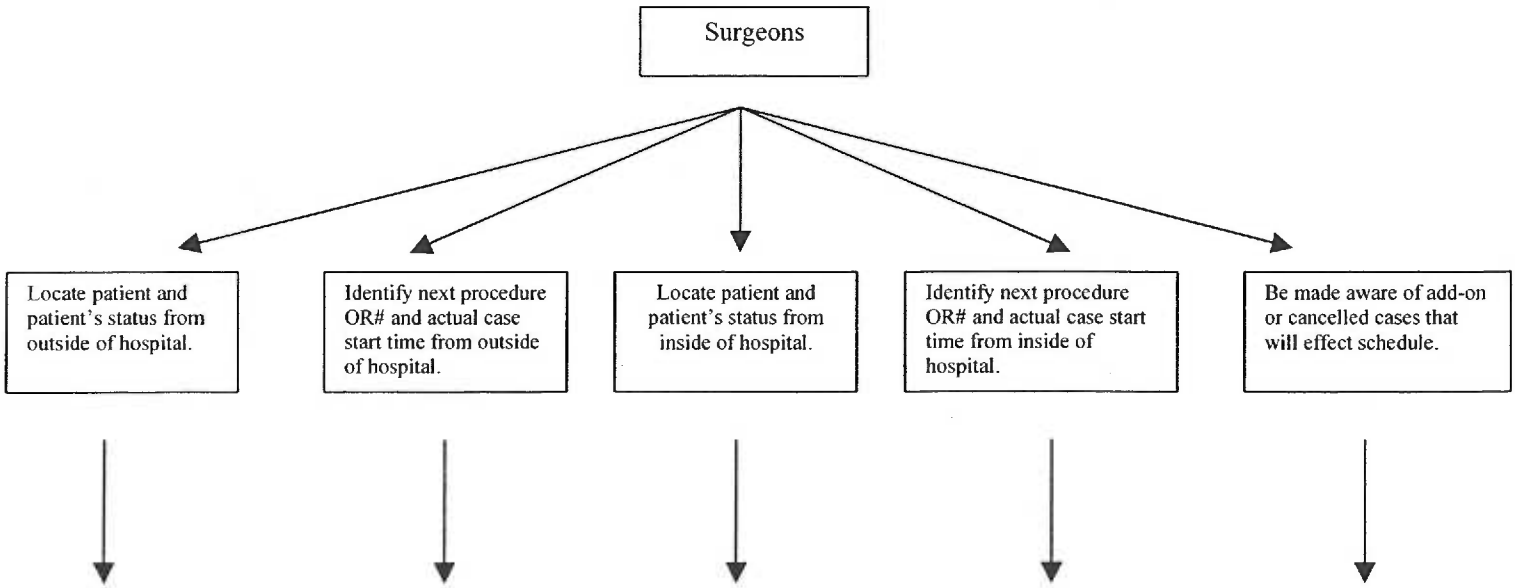
APPENDICES

APPENDIX A: Example Hierarchical Representation of User Group and Needs



APPENDIX B: Needs Document Survey

NEEDS DOCUMENT EVALUATION

Please use the likert scale below to evaluate the Needs Document Methodology on each of the criteria listed. Score the criteria from (1) Strongly Disagree, to (5) Strongly Agree. Circle your selections.

	Strongly Disagree				Strongly Agree
The Needs Document is concise	1	2	3	4	5
The Needs Document is clear	1	2	3	4	5
The Needs Document is simple and understandable	1	2	3	4	5
The Needs Document is unambiguous	1	2	3	4	5
The Needs Document is understandable to non-computer oriented users	1	2	3	4	5
The Needs Document communicates the author's understanding of the user needs to the developers	1	2	3	4	5
This Needs Document provides a place for users to state their desires and expectations without requirement them to provide quantified, testable specifications	1	2	3	4	5
The Needs Document documents the divergent needs and differing viewpoints of different user groups	1	2	3	4	5
The information in the document could be verified by users without requiring them to have any technical knowledge beyond what is required to perform their job functions	1	2	3	4	5
The Needs Document format encourages the author to think and write in terms of external product behavior, not internal product components	1	2	3	4	5
The Needs Document could serve as a basis for design and testing	1	2	3	4	5

This Needs Document will reduce ambiguity, incompleteness and inconsistencies in a new software product's design	1 2 3 4 5
This technique provides a vehicle for agreement between the user and the developer on what is to be built	1 2 3 4 5
The Needs Document can be used as a basis for judging fulfillment of contractual obligations	1 2 3 4 5
This Needs Document provides a basis for estimating cost	1 2 3 4 5
This Needs Document can act as a primary tool for tracking the development progress of a new system	1 2 3 4 5
This Needs Document provides a basis for test plan development	1 2 3 4 5

THANK YOU

APPENDIX C: Needs Document

1. **Surgeons**
   1.1. From outside the hospital, the surgeon needs to be able to identify the location of his or her next surgical patient and the patient's current status.
   1.2. From outside the hospital, the surgeon needs to be able to identify the operating suite number for his or her next surgical procedure and identify what the actual surgical start time will be.
   1.3. From inside the hospital, the surgeon needs to be able to identify the location of his or her next surgical patient and the patient's current status.
   1.4. From inside the hospital, the surgeon needs to be able to identify the operating suite number for his or her next surgical procedure and identify what the actual surgical start time will be.
   1.5. The surgeon needs to receive immediate notification of "add-on" or cancelled surgeries which will effect the surgeon's schedule for that day.
2. **Anesthesiologists**
   2.1. From outside the hospital, the anesthesiologist needs to be able to identify the location of his or her next surgical patient and the patient's current status.
   2.2. From outside the hospital, the anesthesiologist needs to be able to identify the operating suite number for his or her next anesthetic procedure and identify what the actual surgical start time will be.
   2.3. From inside the hospital, the anesthesiologist needs to be able to identify the location of his or her next surgical patient and the patient's current status.
   2.4. From inside the hospital, the anesthesiologist needs to be able to identify the operating suite number for his or her next anesthetic procedure and identify what the actual surgical start time will be.
   2.5. The anesthesiologist needs to receive immediate notification of "add-on" or cancelled surgeries which will effect the anesthesiologist's schedule for that day.

3. **Surgical Prep Unit (SPU) staff**
   3.1. From within the SPU, the SPU staff needs to be able to identify the current location of today's surgical patients
   3.2. From within the SPU, the SPU staff needs to be able to identify the number of patients currently in the POP room and whether the POP room has reached capacity.
   3.3. From within the SPU, the SPU staff needs to be able to identify the current location of a surgical patient who is presently in surgery.
   3.4. From within the SPU, the SPU staff needs to be able to identify where a current surgical patient will be going after surgery.
   3.5. From within the SPU, the SPU staff needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.
4. **Operating Room (OR) Charge Nurse - Control Desk**
   4.1. From the OR Control Desk, the Charge Nurse needs to be able to identify the number of patients currently in the POP room and whether the POP room has reached capacity
   4.2. From the OR Control Desk, the Charge Nurse needs to be able to identify the current location and status of today's surgical patients who have not yet entered surgery.
   4.3. From the OR Control Desk, the Charge Nurse needs to be able to identify the current location and status of today's surgical patients who are anywhere within the surgical department.
   4.4. From the OR Control Desk, the Charge Nurse needs to be able to identify the location and status of surgical patients who have left the surgical unit to go to a diagnostic unit (i.e. X-Ray, MRI, etc.)
5. **OR Circulating Nursing Staff**
   5.1. From any OR surgical suite, the circulating Nurse needs to be able to identify the location of his or her next surgical patient and the patient's current status.

5.2. From any OR surgical suite, the circulating Nurse needs to be able to identify the number of patients currently in the POP room and whether the POP room has reached capacity

5.3. The circulating Nurse needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the Nurse's surgical schedule for that day.

6. Post Anesthetic Care Unit (PACU) staff

6.1. From inside the PACU, the PACU staff needs to be able to identify the current location and status of any of that day's surgical patients.

6.2. From inside the PACU, the PACU staff needs to be able to identify that day's remaining volume of surgical patients coming to the PACU.

6.3. From the inside PACU, the PACU staff needs to be able to identify the approximate hourly volume of patients coming to PACU for the remainder of that day.

6.4. From the inside PACU, the PACU staff needs to be notified immediately when a surgical patient is currently on the way to the PACU

6.5. The PACU staff needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the timing and volume of surgical patients going to the PACU that day.

6.6. From within the PACU, the PACU staff needs to be able to obtain orders from an anesthesiologist or surgeon

7. Waiting Area Volunteers

7.1. From within any surgical area, the waiting area volunteers need to be able to identify the location of a patient who is currently in the surgery department.

7.2. From within any surgical area, the waiting area volunteers need to be able to identify the approximate length of time a patient who is currently in the surgery department will be in surgery.

7.3. From within any surgical area, the waiting area volunteers need to be able to identify the location of the belongings of a patient who is currently in the surgery department.

7.4. From within any surgical area, the waiting area volunteers need to be able to determine a current surgical patient's final destination within the hospital.

7.5. From within any surgical area, the waiting area volunteers need to be able to determine whether a patient's surgeon will be coming out to speak with the family.

7.6. From within any surgical area, the waiting area volunteers need to be able to determine when and where the patient's family will be able to see the patient next.

7.7. From within any surgical area, the waiting area volunteers need to receive timely notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.

8. Sterile Processing and Distribution (SPD) Staff

8.1. From within SPD, the SPD staff need to receive immediate notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.

9. Medical Records Staff

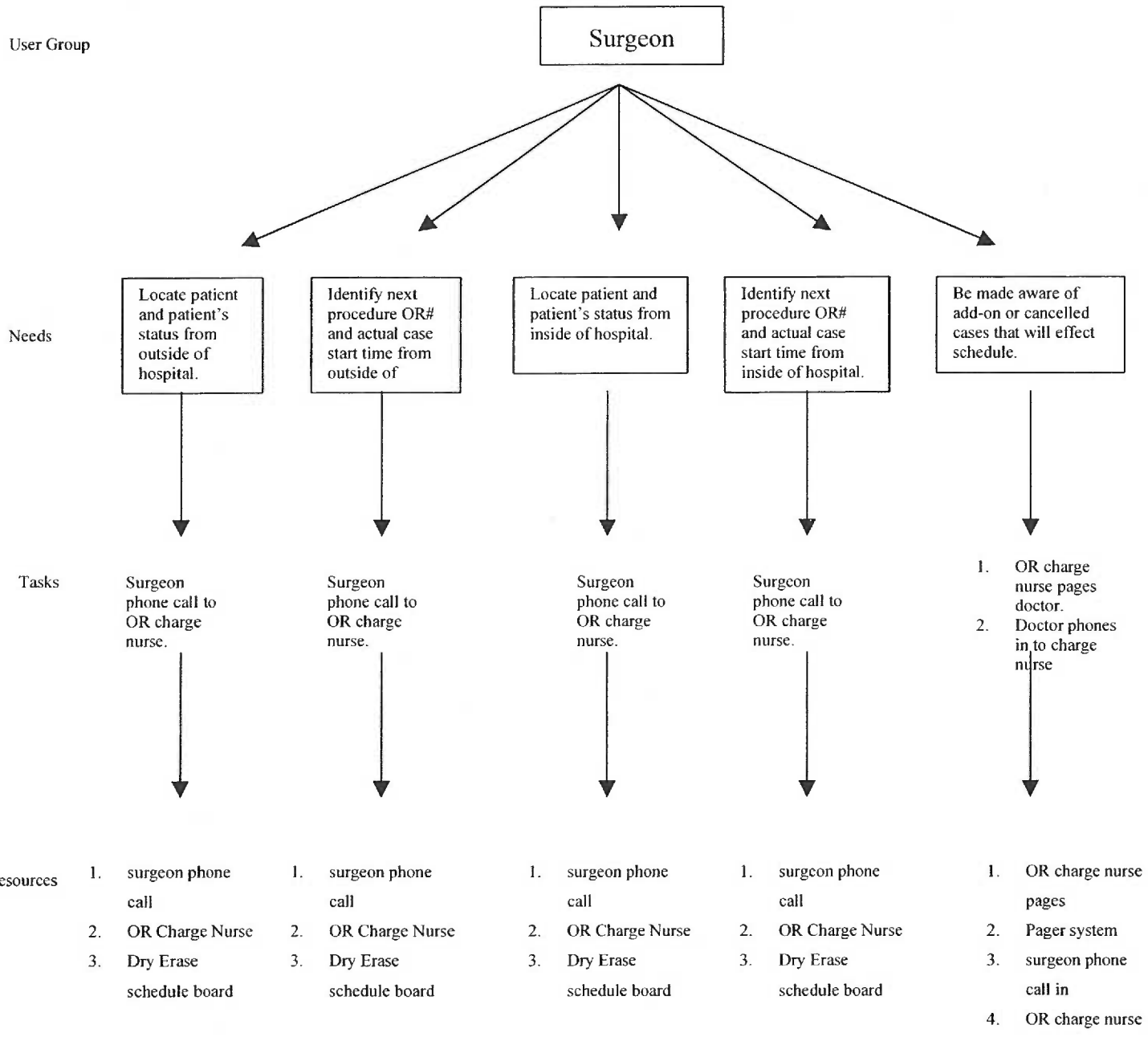
9.1. From within Medical Records, the Medical Records staff need to be able to identify the location of any patient who is currently in the surgery department.

10. Access Services (Admitting) Staff

10.1. From within Admitting, the Admitting staff need to receive timely notification of new patients that need to be admitted that day.

10.2. From within Admitting, the Admitting staff need to receive timely notification of the day's "add-on" or cancelled surgeries.

APPENDIX D: Example Hierarchy



APPENDIX E: Outline of Users, Needs, Tasks, and Resources

1. Surgeons

1.1. From outside the hospital, the surgeon needs to be able to identify the location of his or her next surgical patient and the patient's current status.

1.1.1. Surgeon places phone call to OR charge nurse. Charge nurse references dry erase board.

1.1.1.1. surgeon phone call

1.1.1.2. OR charge nurse on receive phone

1.1.1.3. master dry erase board

1.2. From outside the hospital, the surgeon needs to be able to identify the operating suite number for his or her next surgical procedure and identify what the actual surgical start time will be.

1.2.1. Surgeon places phone call to OR charge nurse. Charge nurse references dry erase board.

1.2.1.1. surgeon phone call

1.2.1.2. OR charge nurse receive phone call

1.2.1.3. master dry erase board

1.3. From inside the hospital, the surgeon needs to be able to identify the location of his or her next surgical patient and the patient's current status.

1.3.1. Surgeon places phone call to OR charge nurse. Charge nurse references dry erase board.

1.3.1.1. surgeon phone call

1.3.1.2. OR charge nurse receive call

1.3.1.3. master dry erase board

1.4. From inside the hospital, the surgeon needs to be able to identify the operating suite number for his or her next surgical procedure and identify what the actual surgical start time will be.

1.4.1. Surgeon places phone call to OR charge nurse. Charge nurse references dry erase board.

1.4.1.1. surgeon phone call

1.4.1.2. OR charge nurse receive call

1.4.1.3. master dry erase board

1.5. The surgeon needs to receive immediate notification of "add-on" or cancelled surgeries which will effect the surgeon's schedule for that day.

1.5.1. OR charge nurse pages surgeon, surgeon calls back charge nurse

1.5.1.1. OR charge nurse pages

1.5.1.2. pager system

1.5.1.3. surgeon phone call

1.5.1.4. OR charge nurse receive call

1.5.1.5. master dry erase board

2. Anesthesiologists

2.1. From outside the hospital, the anesthesiologist needs to be able to identify the location of his or her next surgical patient and the patient's current status.

2.1.1. Anes. places phone call to SPU secretary. Secretary references dry erase board.

2.1.1.1. Anesthesiologist phone call

2.1.1.2. SPU secretary

2.1.1.3. SPU dry erase board

2.2. From outside the hospital, the anesthesiologist needs to be able to identify the operating suite number for his or her next surgical procedure and identify what the actual start time will be.

2.2.1. Anesthesiologist places phone call to OR charge nurse. Charge nurse references dry erase board.

2.2.1.1. anes phone call

2.2.1.2. OR charge nurse receive phone call

2.2.1.3. master dry erase board

2.3. From inside the hospital, the anesthesiologist needs to be able to identify the location of his or her next surgical patient and the patient's current status.

2.3.1. Anes. places phone call to SPU secretary. Secretary references dry erase board.

2.3.1.1. Anesthesiologist phone call

2.3.1.2. SPU secretary

2.3.1.3. SPU dry erase board

2.4. From inside the hospital, the anesthesiologist needs to be able to identify the operating suite number for his or her next anesthetic procedure and identify what the actual surgical start time will be.

2.4.1. Anesthesiologist places phone call to OR charge nurse. Charge nurse references dry erase board.

2.4.1.1. anes phone call

2.4.1.2. OR charge nurse receive phone call

2.4.1.3. master dry erase board

2.5. The anesthesiologist needs to receive immediate notification of "add-on" or cancelled surgeries which will effect the anesthesiologist's schedule for that day.

2.5.1. OR charge nurse pages anesthesiologist, anesthesiologist calls back charge nurse

2.5.1.1. pager system

2.5.1.2. anes phone call

2.5.1.3. OR charge nurse

2.5.1.4. master dry erase board

3. SPU staff

3.1. From within the SPU, the SPU staff needs to be able to identify the current location of today's surgical patients

3.1.1. look on the SPU dry erase board

3.1.1.1. SPU dry erase board

3.1.1.2. SPU secretary

3.2. From within the SPU, the SPU staff needs to be able to identify the number of patients currently in the Pre-Operative Holding Room (POP room) and whether the POP room has reached capacity.

3.2.1. Phone call to POP room

3.2.1.1. nurse phone call

3.2.1.2. POP room nurse

3.3. From within the SPU, the SPU staff needs to be able to identify the current location of a surgical patient who is presently in surgery.

3.3.1. SPU staff call to OR charge nurse. OR charge nurse references dry erase board.

3.3.1.1. nurse phone call

3.3.1.2. OR charge nurse

3.3.1.3. OR dry erase board

3.4. From within the SPU, the SPU staff needs to be able to identify where a current surgical patient will be going after surgery.

3.4.1. SPU staff phone call to OR circulating nurse

3.4.1.1. SPU staff phone call

3.4.1.2. OR circulating nurse

3.5. The SPU staff needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.

3.5.1. OR charge nurse calls or faxes SPU secretary

3.5.1.1. OR charge nurse

3.5.1.2. phone call or fax

3.5.1.3. SPU secretary

4. OR Charge Nurse (Control Desk)

4.1. From the OR Control Desk, the Charge Nurse needs to be able to identify the number of patients currently in the POP room and whether the POP room has reached capacity

4.1.1. Charge nurse phone call to POP room

4.1.1.1. charge nurse phone call

4.1.1.2. POP room nurse

4.2. From the OR Control Desk, the Charge Nurse needs to be able to identify the current location and status of today's surgical patients who have not yet entered surgery.

4.2.1. OR Charge Nurse phone call to SPU secretary

4.2.1.1. charge nurse phone call

4.2.1.2. SPU secretary

4.2.1.3. SPU dry erase board

4.3. From the OR Control Desk, the Charge Nurse needs to be able to identify the current location and status of today's surgical patients who are anywhere within the surgical department.

4.3.1. Check OR camera system or place phone call to SPU or PACU

4.3.1.1. camera system

4.3.1.2. charge nurse phone call

4.3.1.3. SPU or PACU staff

4.3.1.4. SPU dry erase board

4.4. From the OR Control Desk, the Charge Nurse needs to be able to identify the location and status of surgical patients who have left the surgical unit to go to a diagnostic unit (i.e. X-Ray, MRI, etc.)

4.4.1. OR charge nurse phone call to diagnostic unit

4.4.1.1. charge nurse phone call

4.4.1.2. diagnostic unit staff member

5. OR Circulating Nursing Staff

5.1. From any OR surgical suite, the circulating Nurse needs to be able to identify the location of his or her next surgical patient and the patient's current status.

5.1.1. Circulating Nurse phone call to SPU

5.1.1.1. nurse phone call

5.1.1.2. SPU secretary

5.1.1.3. SPU dry erase board

5.2. From any OR surgical suite, the circulating Nurse needs to be able to identify the number of patients currently in the POP room and whether the POP room has reached capacity

5.2.1. Circulating nurse phone call to POP Holding room nurse

5.2.1.1. nurse phone call

5.2.1.2. POP room nurse

5.3. The circulating Nurse needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the Nurse's surgical schedule for that day.

5.3.1. OR charge nurse calls OR circulating nurse

5.3.1.1. OR charge nurse

5.3.1.2. nurse phone call

5.3.1.3. OR master dry erase board

6. PACU staff

6.1. From inside the PACU, the PACU staff needs to be able to identify the current location and status of any of that day's surgical patients.

6.1.1. Estimate from daily printed surgery schedule

6.1.1.1. Daily printed surgery schedule

6.1.2. Call OR charge nurse

6.1.2.1. OR charge nurse

6.1.2.2. nurse phone call

6.1.2.3. OR master dry erase board

6.2. From inside the PACU, the PACU staff needs to be able to identify that day's remaining volume of surgical patients coming to the PACU.

6.2.1. Estimate from daily printed surgery schedule

6.2.1.1. Daily printed surgery schedule

6.3. From inside the PACU, the PACU staff needs to be able to identify the approximate hourly volume of patients coming to PACU for the remainder of that day.

6.3.1. Estimate from daily printed surgery schedule

6.3.1.1. Daily printed surgery schedule

6.4. From the inside PACU, the PACU staff needs to be notified immediately when a surgical patient is currently on the way to the PACU

6.4.1. Phone call from OR circulating nurse or anesthesiologist

6.4.1.1. circulating nurse or anesthesiologist phone call

6.4.1.2. PACU nurse

6.5. From within the PACU, the PACU staff needs to be able to obtain orders from an anesthesiologist or surgeon

6.5.1. PACU staff pages doctor. Doctor phones back with orders

6.5.1.1. PACU staff pages

6.5.1.2. paging system

6.5.1.3. doctor phone call

6.6. The PACU staff needs to receive timely notification of today's "add-on" or cancelled surgeries which will effect the timing and volume of surgical patients going to the PACU that day.

6.6.1. OR charge nurse calls or faxes PACU secretary

6.6.1.1. OR charge nurse

6.6.1.2. nurse phone call or fax

6.6.1.3. PACU secretary

7. Waiting Area Volunteers

7.1. From within any surgical area, the waiting area volunteers need to be able to identify the location of a patient who is currently in the surgery department.

7.1.1. Volunteer asks PACU secretary

7.1.1.1. PACU secretary

7.1.2. Volunteer asks OR charge nurse

7.1.2.1. OR Charge nurse

7.1.2.2. OR master dry erase board

7.2. From within any surgical area, the waiting area volunteers need to be able to identify the approximate length of time a patient who is currently in the surgery department will be in surgery.

7.2.1. Ask PACU secretary

7.2.1.1. PACU secretary

7.2.2. Ask OR charge nurse. OR charge nurse checks dry erase board and camera system.

7.2.2.1. OR Charge nurse

7.2.2.2. OR master dry erase board

7.2.2.3. camera system

7.3. From within any surgical area, the waiting area volunteers need to be able to identify the location of the belongings of a patient who is currently in the surgery department.

7.3.1. Ask PACU secretary

7.3.1.1. PACU secretary

7.3.1.2. secretary phone call to SPU

7.3.1.3. SPU secretary

7.3.2. Ask OR charge nurse

7.3.2.1. OR charge nurse

7.3.2.2. nurse phone call to SPU

7.3.2.3. SPU secretary

7.4. From within any surgical area, the waiting area volunteers need to be able to determine a current surgical patient's final destination within the hospital.

7.4.1. Ask PACU secretary, who may ask PACU nurse.

7.4.1.1. PACU secretary

7.4.1.2. PACU nurse

7.5. From within any surgical area, the waiting area volunteers need to be able to determine whether a patient's surgeon will be coming out to speak with the family.

7.5.1. Ask PACU secretary. Secretary pages doctor

7.5.1.1. PACU secretary

7.5.1.2. paging system

7.5.1.3. doctor phone call

7.6. From within any surgical area, the waiting area volunteers need to be able to determine when and where the patient's family will be able to see the patient next.

7.6.1. Ask PACU secretary. Secretary may ask nurse

7.6.1.1. PACU secretary

7.6.1.2. PACU nurse

7.7. From within any surgical area, the waiting area volunteers need to receive timely notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.

7.7.1. Ask OR charge nurse

7.7.1.1. OR charge nurse

7.7.1.2. OR master dry erase board

7.7.2. Ask PACU secretary

7.7.2.1. PACU secretary

7.7.2.2. PACU schedule

8. Sterile Processing and Distribution Staff

8.1. From within SPD, the SPD staff need to receive immediate notification of today's "add-on" or cancelled surgeries which will effect the surgical schedule for that day.

8.1.1. Phone call or Fax from OR charge nurse

8.1.1.1. OR charge nurse

8.1.1.2. nurse fax or phone call

8.1.1.3. SPD staff

9. Medical Records Staff

9.1. From within Medical Records, the Medical Records staff needs to be able to identify the location of any patient who is currently in the surgery department.

9.1.1. Phone call to OR charge nurse

9.1.1.1. staff phone call

9.1.1.2. OR charge nurse

9.1.1.3. OR master dry erase board

10. Access Services (Admitting) Staff

10.1. From within Admitting, the Admitting staff needs to receive timely notification of new patients that need to be admitted that day.

10.1.1. Phone call from OR or SPU

10.1.1.1. OR charge nurse or SPU secretary

10.1.1.2. nurse or staff phone call

10.1.1.3. admitting staff

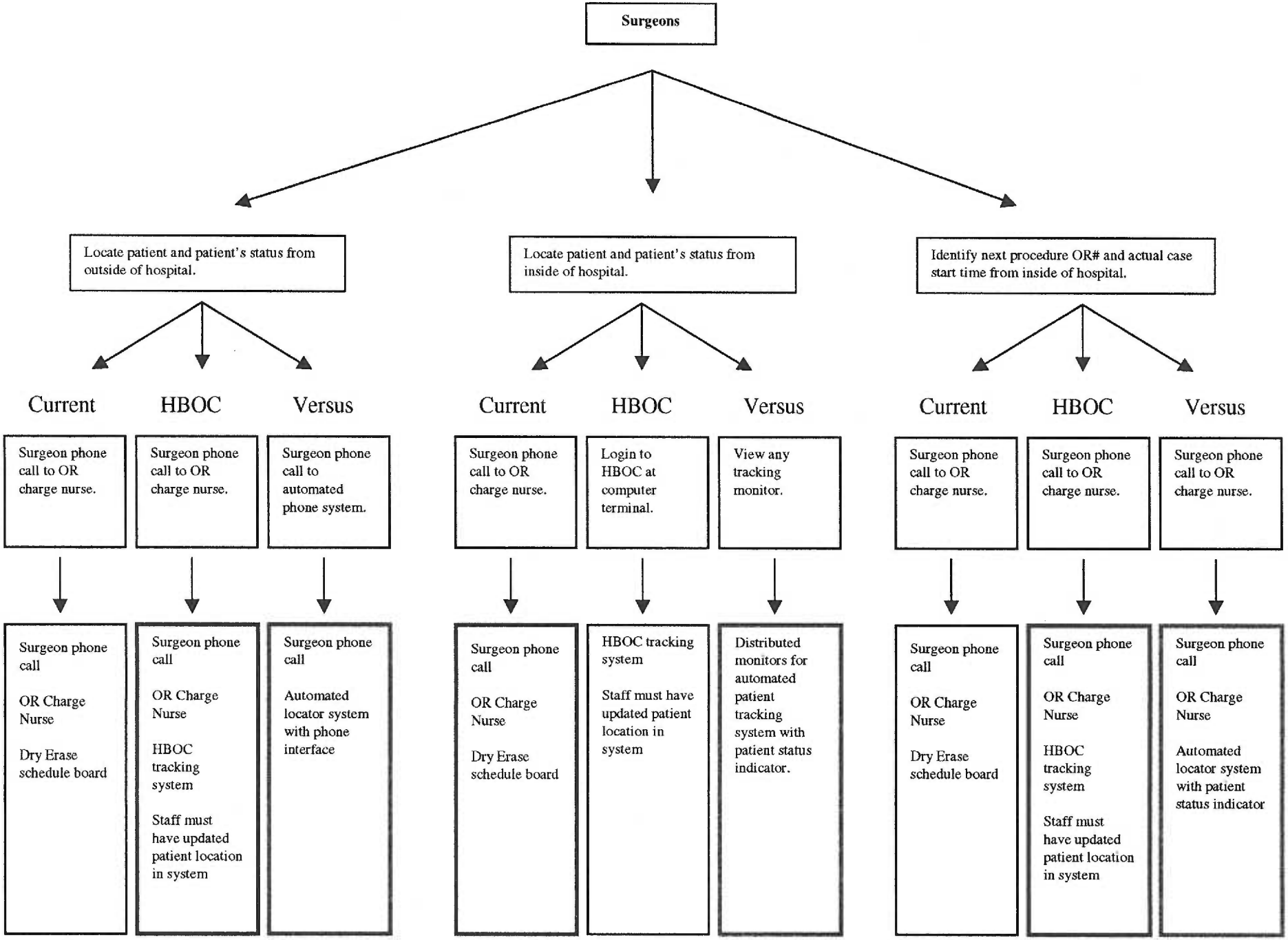
10.2. From within Admitting, the Admitting staff need to receive timely notification of the day's "add-on" or cancelled surgeries.

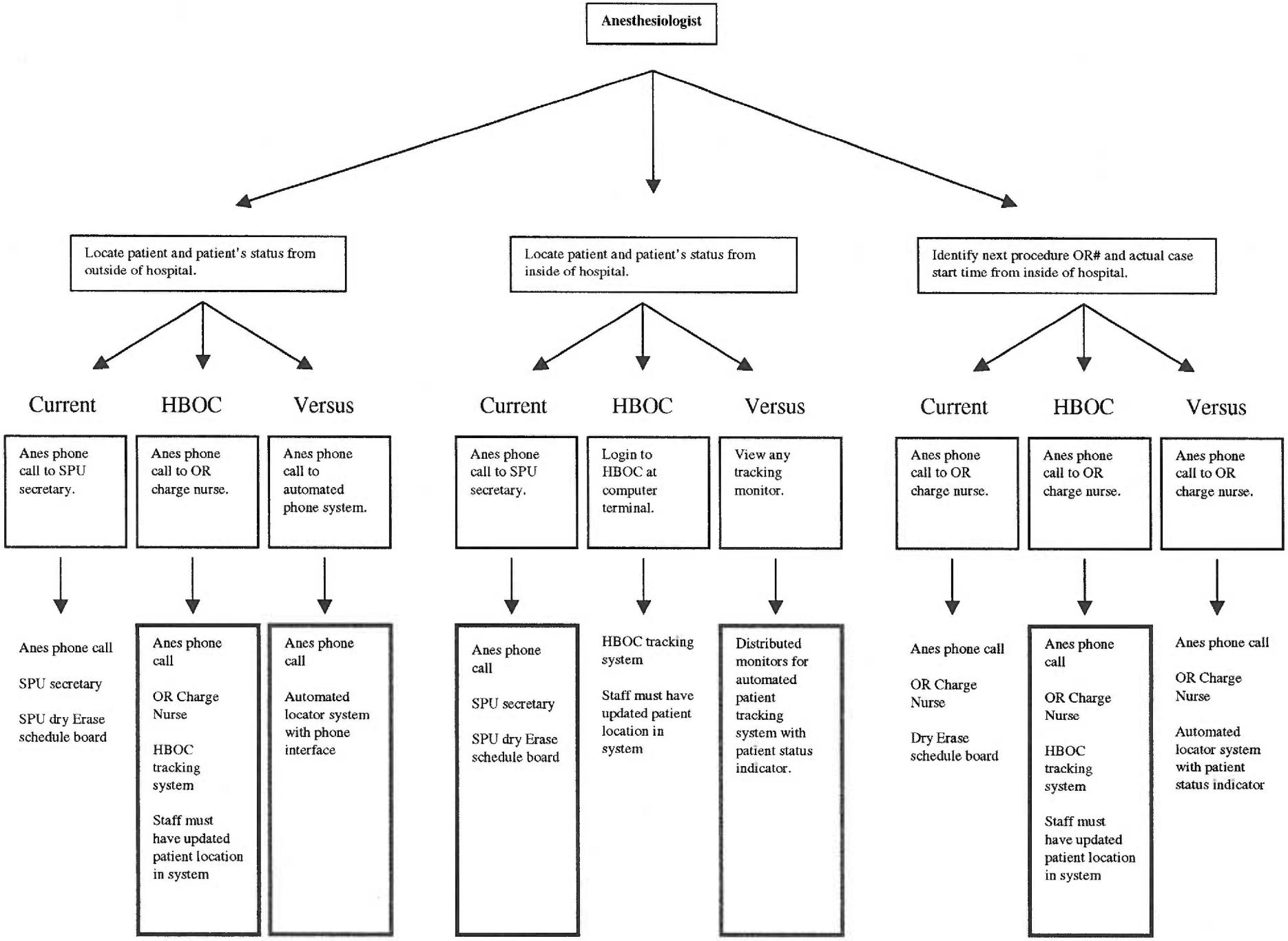
10.2.1. Phone call or fax from OR charge nurse

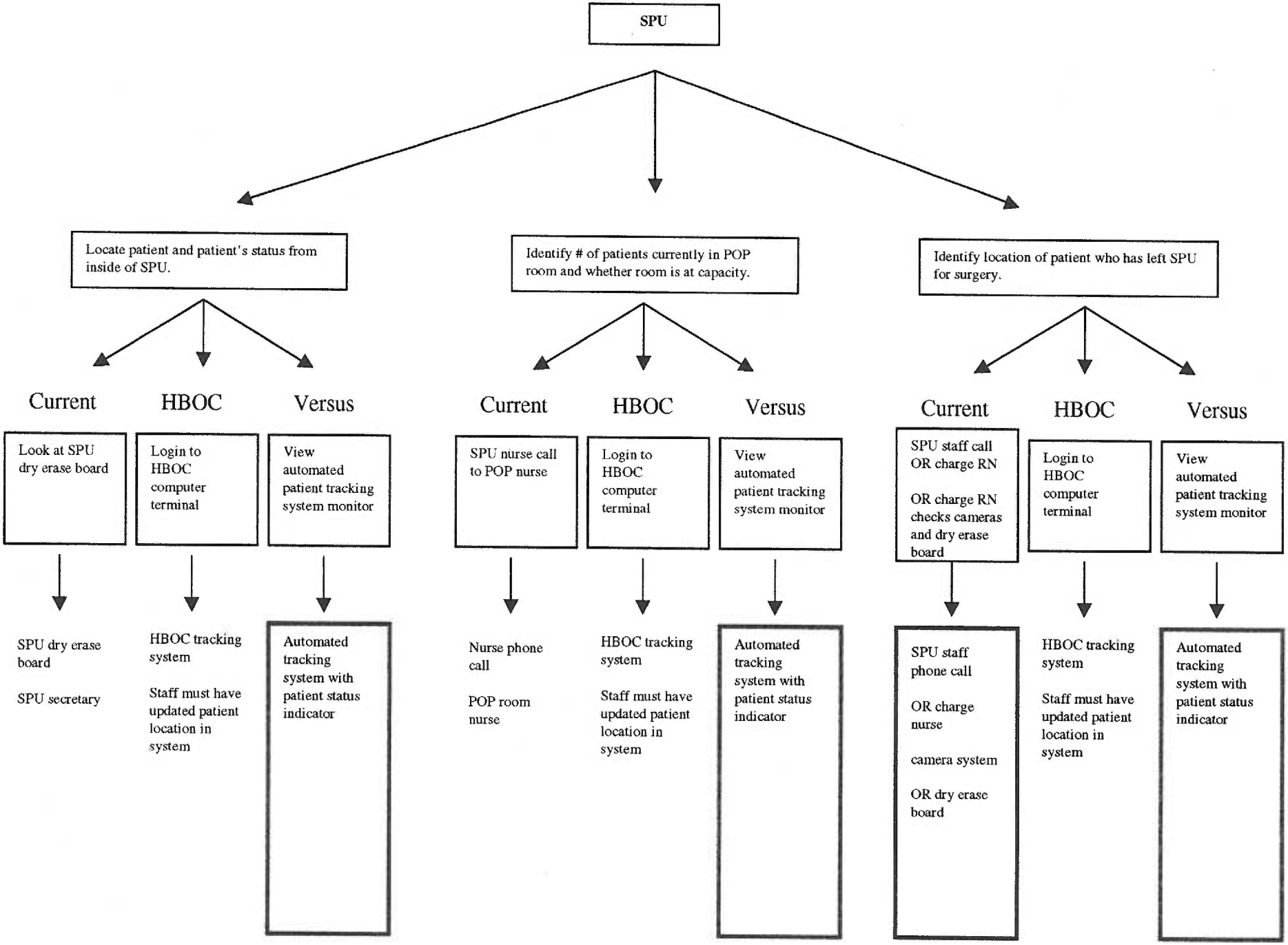
10.2.1.1. OR charge nurse

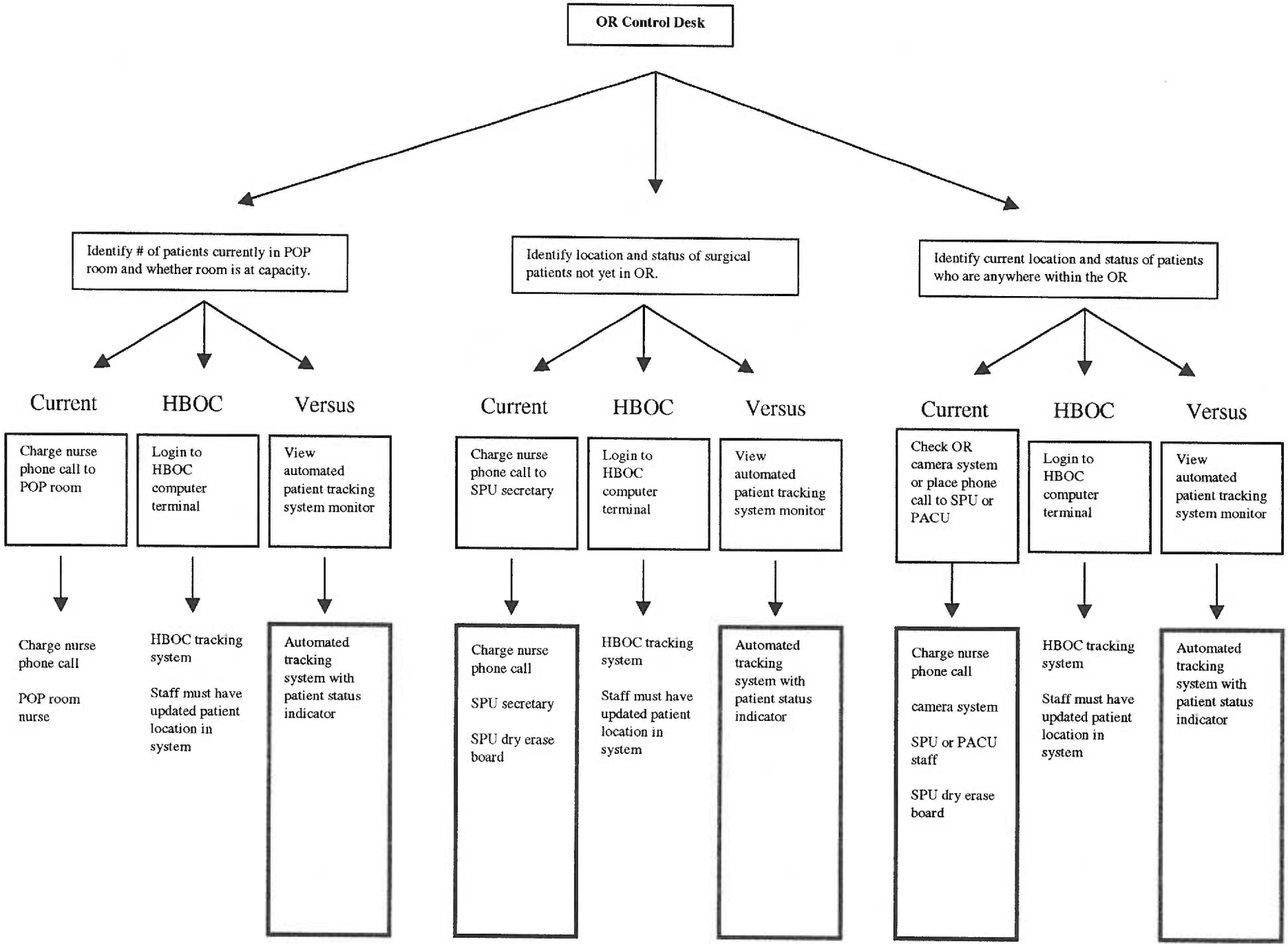
10.2.1.2. nurse phone call or fax

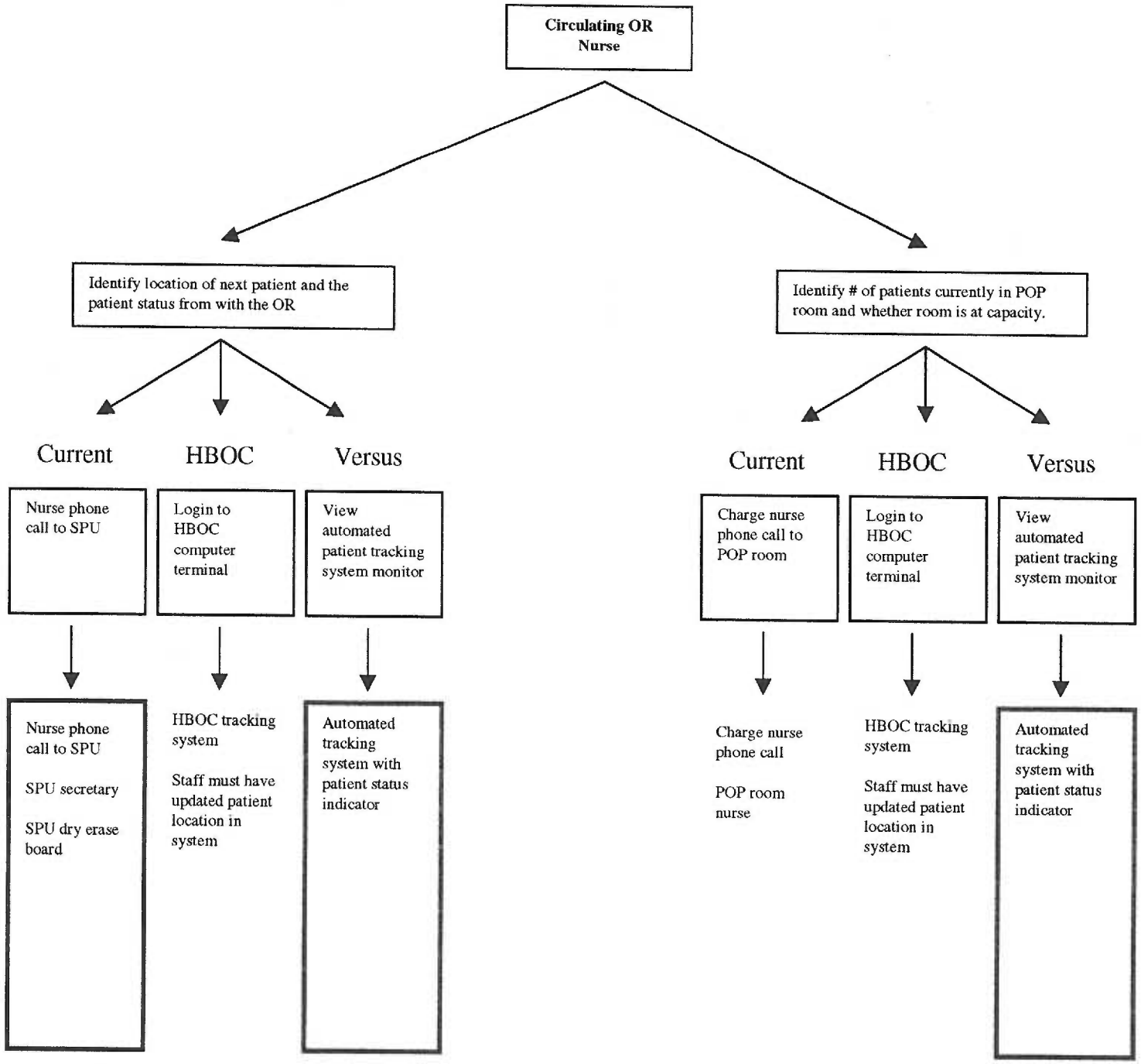
APPENDIX F: Hierarchical Comparison Diagrams

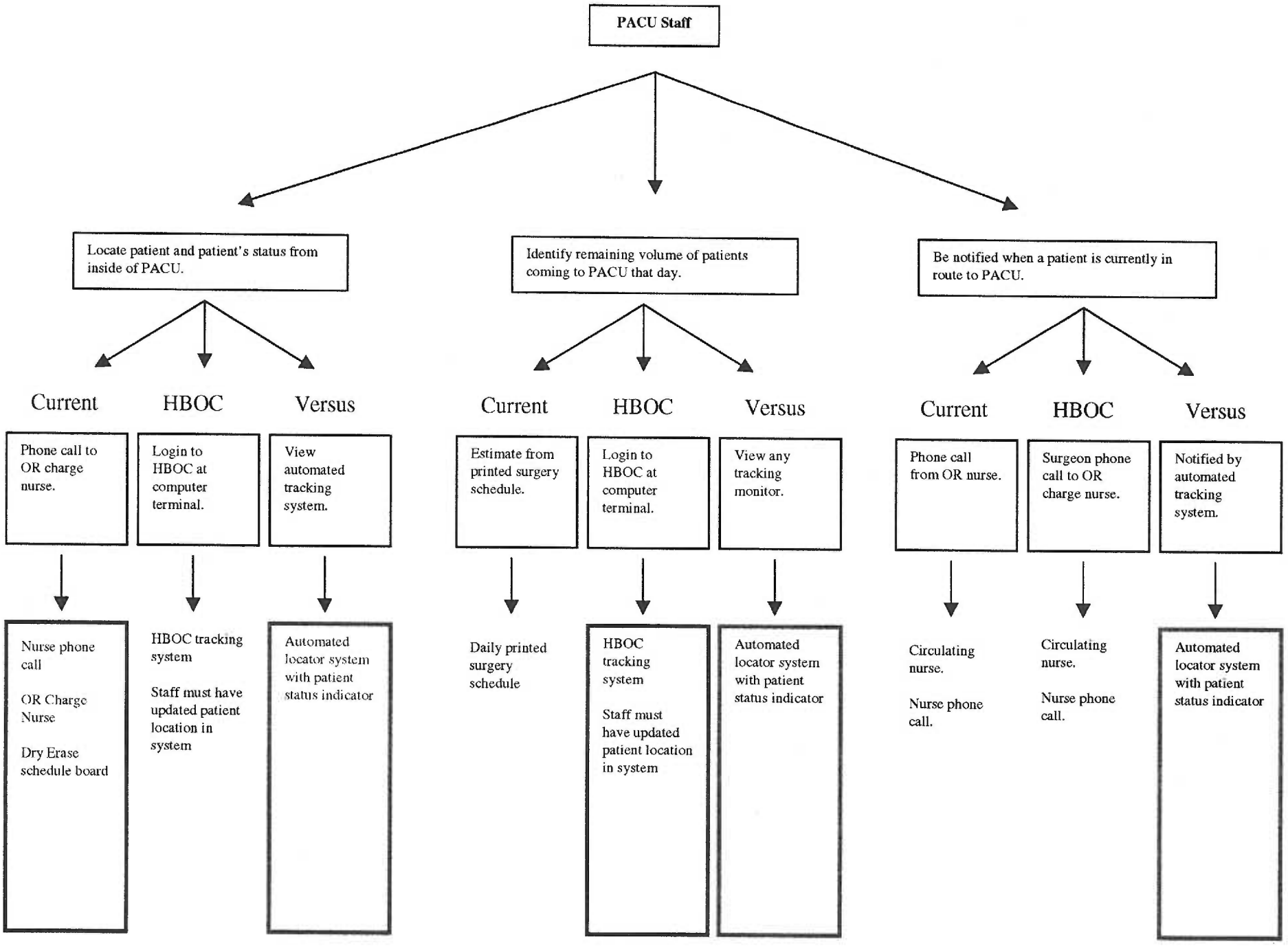

Surgeons
Locate patient and patient's status from outside of hospital.
Locate patient and patient's status from inside of hospital.
Identify next procedure OR# and actual case start time from inside of hospital.
Current
HBOC
Versus
Current
HBOC
Versus
Current
HBOC
Versus
Surgeon phone call to OR charge nurse.
Surgeon phone call to OR charge nurse.
Surgeon phone call to automated phone system.
Surgeon phone call to OR charge nurse.
Login to HBOC at computer terminal.
View any tracking monitor.
Surgeon phone call to OR charge nurse.
Surgeon phone call to OR charge nurse.
Surgeon phone call to OR charge nurse.
Surgeon phone call
OR Charge Nurse
Dry Erase schedule board
Surgeon phone call
OR Charge Nurse
HBOC tracking system
Staff must have updated patient location in system
Surgeon phone call
Automated locator system with phone interface
Surgeon phone call
OR Charge Nurse
Dry Erase schedule board
HBOC tracking system
Staff must have updated patient location in system
Distributed monitors for automated patient tracking system with patient status indicator.
Surgeon phone call
OR Charge Nurse
Dry Erase schedule board
Surgeon phone call
OR Charge Nurse
HBOC tracking system
Staff must have updated patient location in system
Surgeon phone call
OR Charge Nurse
Automated locator system with patient status indicator

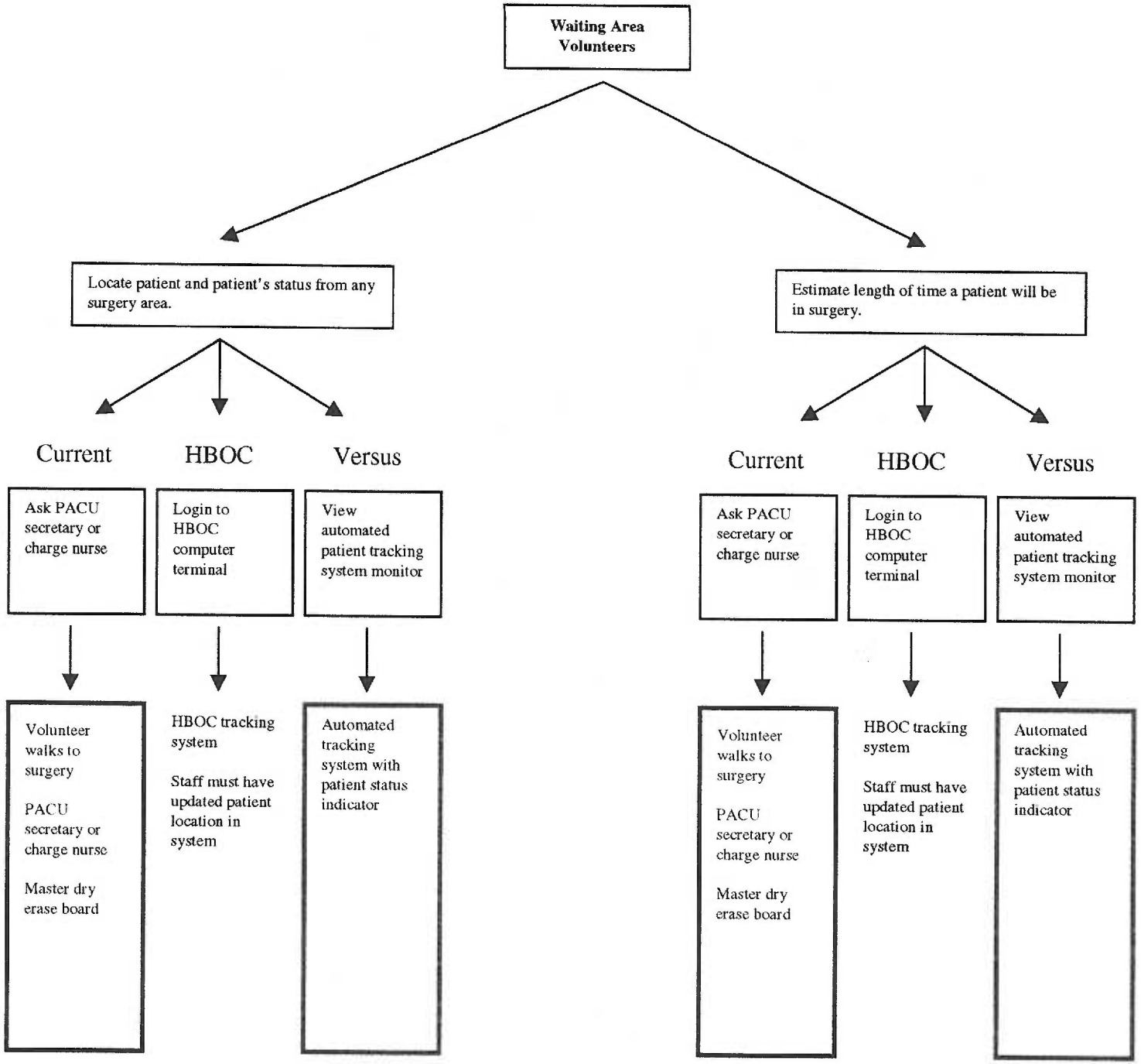

Anesthesiologist
Locate patient and patient's status from outside of hospital.
Locate patient and patient's status from inside of hospital.
Identify next procedure OR# and actual case start time from inside of hospital.
Current
HBOC
Versus
Current
HBOC
Versus
Current
HBOC
Versus
Anes phone call to SPU secretary.
Anes phone call to OR charge nurse.
Anes phone call to automated phone system.
Anes phone call to SPU secretary.
Login to HBOC at computer terminal.
View any tracking monitor.
Anes phone call to OR charge nurse.
Anes phone call to OR charge nurse.
Anes phone call to OR charge nurse.
Anes phone call
SPU secretary
SPU dry Erase schedule board
Anes phone call
OR Charge Nurse
HBOC tracking system
Staff must have updated patient location in system
Anes phone call
Automated locator system with phone interface
Anes phone call
SPU secretary
SPU dry Erase schedule board
HBOC tracking system
Staff must have updated patient location in system
Distributed monitors for automated patient tracking system with patient status indicator.
Anes phone call
OR Charge Nurse
Dry Erase schedule board
Anes phone call
OR Charge Nurse
HBOC tracking system
Staff must have updated patient location in system
Anes phone call
OR Charge Nurse
Automated locator system with patient status indicator


SPU
Locate patient and patient's status from inside of SPU.
Identify # of patients currently in POP room and whether room is at capacity.
Identify location of patient who has left SPU for surgery.
Current
HBOC
Versus
Look at SPU dry erase board
Login to HBOC computer terminal
View automated patient tracking system monitor
SPU dry erase board
SPU secretary
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
SPU nurse call to POP nurse
Login to HBOC computer terminal
View automated patient tracking system monitor
Nurse phone call
POP room nurse
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
SPU staff call OR charge RN
OR charge RN checks cameras and dry erase board
Login to HBOC computer terminal
View automated patient tracking system monitor
SPU staff phone call
OR charge nurse
camera system
OR dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator


OR Control Desk
Identify # of patients currently in POP room and whether room is at capacity.
Identify location and status of surgical patients not yet in OR.
Identify current location and status of patients who are anywhere within the OR
Current
HBOC
Versus
Charge nurse phone call to POP room
Login to HBOC computer terminal
View automated patient tracking system monitor
Charge nurse phone call
POP room nurse
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
Charge nurse phone call to SPU secretary
Login to HBOC computer terminal
View automated patient tracking system monitor
Charge nurse phone call
SPU secretary
SPU dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
Check OR camera system or place phone call to SPU or PACU
Login to HBOC computer terminal
View automated patient tracking system monitor
Charge nurse phone call
camera system
SPU or PACU staff
SPU dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator


Circulating OR Nurse
Identify location of next patient and the patient status from with the OR
Identify # of patients currently in POP room and whether room is at capacity.
Current
HBOC
Versus
Current
HBOC
Versus
Nurse phone call to SPU
Login to HBOC computer terminal
View automated patient tracking system monitor
Charge nurse phone call to POP room
Login to HBOC computer terminal
View automated patient tracking system monitor
Nurse phone call to SPU
SPU secretary
SPU dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
Charge nurse phone call
POP room nurse
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator


PACU Staff
Locate patient and patient's status from inside of PACU.
Identify remaining volume of patients coming to PACU that day.
Be notified when a patient is currently in route to PACU.
Current
HBOC
Versus
Phone call to OR charge nurse.
Login to HBOC at computer terminal.
View automated tracking system.
Nurse phone call
OR Charge Nurse
Dry Erase schedule board
HBOC tracking system
Staff must have updated patient location in system
Automated locator system with patient status indicator
Current
HBOC
Versus
Estimate from printed surgery schedule.
Login to HBOC at computer terminal.
View any tracking monitor.
Daily printed surgery schedule
HBOC tracking system
Staff must have updated patient location in system
Automated locator system with patient status indicator
Current
HBOC
Versus
Phone call from OR nurse.
Surgeon phone call to OR charge nurse.
Notified by automated tracking system.
Circulating nurse.
Nurse phone call.
Circulating nurse.
Nurse phone call.
Automated locator system with patient status indicator


Waiting Area Volunteers
Locate patient and patient's status from any surgery area.
Estimate length of time a patient will be in surgery.
Current
HBOC
Versus
Current
HBOC
Versus
Ask PACU secretary or charge nurse
Login to HBOC computer terminal
View automated patient tracking system monitor
Ask PACU secretary or charge nurse
Login to HBOC computer terminal
View automated patient tracking system monitor
Volunteer walks to surgery
PACU secretary or charge nurse
Master dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator
Volunteer walks to surgery
PACU secretary or charge nurse
Master dry erase board
HBOC tracking system
Staff must have updated patient location in system
Automated tracking system with patient status indicator