

June 8, 1988

To: Joseph W. Vick Roy, M.D.
W. David Sperzel, M.D.

From: Paul Volberding, M.D. 

Re: AIDS Clinic Systems Analysis Report

Thanks a lot for giving me a copy of the AIDS Clinic Systems Analysis Report. I have looked it over and think it identifies quite nicely some of the information flow that happens on Ward 86. We are in the process of trying to implement some of the changes that we have been proposing for some time. If you are interested to see how this goes, feel free to get in touch with Kjeld or Dave.

Again, thanks for your involvement in our clinic.

c:\wpfiles\sper.roy

April 28, 1988

To: Dr. Dave Feigal
Mr. Kjeld Molvig
Ms. Peg Trezevant
Dr. Paul Volberding

Re: *AIDS Clinic Systems Analysis Report*

Attached is a copy of our report for the systems analysis project that we did in the AIDS clinic. We have revised the report to incorporate the comments of the professor who taught our course and to include some additional information that might be of value to you. The report refers to "Appendix II," but we did not attach a copy of it, since this appendix is only a compilation of forms used in the AIDS clinic.

We hope that you find this report useful. If you would like to meet with us to discuss the report, we would be happy to do so. We also wish to thank all of the people who were kind enough to give us their time and cooperation during the course of this project.

Dave

Dave Sperzel (476-8008)

Chip

Chip Vick Roy (476-8009)

AN ANALYSIS OF INFORMATION SYSTEM REQUIREMENTS FOR THE
AIDS CLINIC AT SAN FRANCISCO GENERAL HOSPITAL

MIS 222

Winter Quarter, 1988
Professor David Stimson

Joseph W. Vick Roy, M.D
W. David Sperzel, M.D.

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Appendix II

1. INTRODUCTION

The seriousness of the AIDS (Acquired Immune Deficiency Syndrome) epidemic in San Francisco has been widely publicized. Since the time this diagnosis was first recognized, San Francisco has ranked second in the world in terms of total case load (behind New York). (Arno, 1986) The task of providing medical care for this growing portion of the city's inhabitants has fallen largely on San Francisco General Hospital (SFGH), which has responded to the problem by initiating a variety of dedicated AIDS services. The outpatient AIDS clinic at SFGH (hereafter referred to as the AIDS clinic) is perhaps the most visible and vital component in this network of services. Due to the extremely large number of patients who have received care at the AIDS clinic, it has been recognized as a model treatment system with a worldwide reputation. (Abrams, 1986) Further background information concerning the AIDS problem can be found in Appendix I.A.

Given the unique position of the AIDS clinic, accurate information on the patients whom it serves is particularly important. Such information can help the clinic meet its goals in the areas of patient care, research, and internal administration. Some of the senior staff at the clinic perceive these goals as not being adequately supported by the the present means of collecting and retrieving information. This study was undertaken in order to analyze the requirements for a computer-based information management system that would better serve the goals of the AIDS clinic and its staff.

2. ENVIRONMENT

2.1. Relationship to the Hospital and the University

The City of San Francisco has a contract with the University of California, San Francisco (UCSF) to operate the AIDS clinic. Although the clinic is located at SFGH,

all clinic staff are UCSF employees. Further background on the AIDS clinic is given in Appendix I.B.

2.2. Funding

As a consequence of its contract with the city, the AIDS clinic is not allowed to bill for its services. It is the city's prerogative to recover revenue (e.g., from Medi-Cal) for the services provided by the clinic. The contract with the city provides over 90% of the funding for outpatient AIDS services at SFGH as shown in Figure 1. These funds are allocated almost entirely to salaries. Additional revenue is provided by State and Federal programs, grants for the conduct of clinical trials, and donations. The distribution of revenue to each major component of the clinic is shown in Figure 2.

2.3. Hospital Information System

The hospital information system (HIS) can be viewed as part of the environment of the clinic and as well as part of the system being studied. The HIS is part of the environment in the sense that the clinic has no control over the HIS and the clinic staff must provide it with the data required for registration and billing purposes. The HIS can be viewed as part of the system under study in the sense that it constitutes an information management resource for the clinic. During the period when this study was taking place, a new HIS (the "Independence" product from Shared Medical Systems) was installed. This development has important implications for the topic of this study, which will be elaborated on throughout this report.

3. GOALS

The goals which must be considered in order to carry out this project fall into two broad categories: system goals and subsystem goals. The terms themselves reflect the essential relationship between the items in each category.

The system goals for this project are shown in Table 1 and represent the overall goals of the AIDS clinic itself. These goals fall into the broad categories of patient care, research, and internal administration. The subsystem goals are specified in Table 2 and describe the more specific goals of an information management system which is designed to function within the AIDS clinic.

The purpose of identifying the system goals is to insure that a proposed solution to the subsystem problem will not violate any of the overall goals of the AIDS clinic. This task has been referred to as the "suboptimization problem". The purpose of specifying the subsystem goals is more apparent since these goals will lead directly to a set of criteria against which any proposed solution must be measured. We will return to this issue of criteria in section 8 of this paper.

4. PROBLEM STATEMENT

The problem under study can be stated as a lack of useful and easily retrievable information that supports the goals of the clinic and its staff.

5. METHODS

A variety of methods were used to carry out this systems analysis of the AIDS clinic:

1. Interviews were conducted with physicians, nurses and other staff members who were considered key people in the management hierarchy of the clinic. A list of the individuals who were interviewed (most on more than one occasion) is shown in Table 3.
2. Observation sessions were arranged at the clinic front desk to allow each of us to witness the activities which take place during routine clinic operation. This was considered a key step in the project since the front desk is the

gateway through which most information which is pertinent to the clinic must pass. The front desk, in many ways, is analogous to the control tower at an airport.

3. Samples of all of the important data forms used by the clinic were collected and analyzed. (See Appendix II.)
4. The information gathered in Steps 1 to 3 above was used to develop a model of the information flow within the clinic (section 6.1).
5. An effort was made to learn as much as possible about the new hospital information system which came on-line on March 7, 1988. Several people from the Data Processing Division were interviewed (Table 3), some of the documentation for the new system was reviewed (SMS, 1987) and a hands-on demonstration session was arranged to allow us to experience the user interface of the system first-hand.
6. A list of queries was prepared as an example of the types of questions which could potentially be answered by a database management system (see "data wish list"). This list was distributed to several members of the clinic staff who were asked to rate the importance of each query. This "data wish list" is discussed in further detail in section 7.
7. After all of the information described above was collected and studied, a set of criteria were drawn up which specify the requirements of an "idealized" information management system (section 8).
8. Alternative solutions were proposed and analyzed (section 9).

6. DESCRIPTION OF THE CURRENT SYSTEM

6.1. Model of Information Flow

Our next task was to propose a model of the clinic information system as it presently exists. Our model should be a simplified version of the real system which will allow us to focus our attention on the most relevant aspects of the system and to evaluate the impact of alternative solutions. The type of model which we selected is a flow chart which appears in Figures 3 and 4. Figure 3 depicts the flow of patients and information through the various areas within the AIDS clinic. Figure 4 describes the operations of the front desk, which is the focus of information flow within the clinic. Figures 3 and 4 are accompanied by a lengthy caption which explains them in detail. The forms referred to in these figures may be found in Appendix II.

6.2. The AIDS Registry

The AIDS registry is an important research effort to collect detailed clinical data that will be used to describe the natural history of the disease. The data is collected on a six-page form (see Appendix II), and then entered into a personal computer database (d-BaseIII). The information is uploaded from here to a VAX 780 where statistical analyses are performed. A considerable amount of effort has been devoted to the AIDS registry over the last several years. The registry is an attempt to utilize for research purposes the wealth of clinical information available from this large patient population. It is a major concern of the Director of AIDS Activities.

The AIDS registry forms are not shown in Figures 3 and 4 because they are not intended to be completed for all patient visits. The forms should be filled out when a new patient is seen at the clinic, if the patient gives informed consent to participate in the registry research project. In order to monitor the patient's progress at follow-up

visits, a subset of the forms should be completed by the physician every three to four months.

The first two pages of the registry form concern family and social history, and should be completed by the patient. The remaining four pages are used by the physician to record a detailed history and physical examination.

There are a number of significant problems with the registry. The most serious is that busy clinic physicians are often reluctant or unwilling to take the time to complete the lengthy forms. In addition, many patients who have been entered into the registry are subsequently lost to follow-up. A third problem concerns the difficulty of integrating relevant information from hospitalizations into this longitudinal outpatient database.

Various improvements to the registry program are currently under consideration. These include: hiring a special individual to collect most of the registry data, revising the forms to make them easier to fill out, and providing incentives for the physicians to complete the forms. Providing further detailed recommendations for improvement of the registry program is not the purpose of this study. Rather, our proposals are intended to complement the registry program in a variety of ways. The exact interaction between the registry and another AIDS clinic information system will depend on the nature of the system which is selected. For example, a new system which contains information related to patient visits might be used for identifying and tracking the patients who should have registry forms completed. Other ways of integrating the two systems are also possible.

6.3. Computing Resources Available

The AIDS clinic has a number of computer resources under its control, which could

potentially be used to implement a computer-based information system. These resources include a Digital VAX 11/780 minicomputer, which was purchased several years ago. The principal software on this machine (which runs the VMS operating system) is SAS (Statistical Analysis System). The VAX is presently used only for data analysis, and there is not a heavy load on the system. In addition, a number (approximately 10 to 20) of personal computers (PCs) are scattered throughout the AIDS Activities Division and are currently used for a variety of purposes. A precise count of these machines was not available, but many are older models with rather limited memory and disk capacity.

7. SURVEY OF INFORMATION DESIRED

7.1. Description of Survey

Our observations of the AIDS clinic in operation confirmed that a large body of information is captured by the present system in some form. This information is recorded on many different types of documents as well as in the HIS computer files. An attempt was made to evaluate the data content of each significant component in the model of information flow.

The results of these evaluations were used to generate a non-redundant list of all data items which are being recorded in some fashion by the current system. For practical considerations, groups of logically related data items (e.g., individual drug names), were identified as a single data type (e.g., medications), which is understood to represent the entire range of potential values.

This list of data items/types in the current system was in turn used to generate a list of potential queries which could be answered by an "idealized" data base management system (DBMS) running on an "ideal" database of AIDS clinic information. This

list of potential queries will hereafter be referred to as the "data wish list".

An arbitrary 7-point rating scale was applied to each query on the "data wish list", and the resulting form was distributed to several key members of the clinic staff as a questionnaire. (See Appendix II.) An attempt was made to select the most influential individuals from each of several levels within the clinic hierarchy. Participants were asked to rate each query as to the importance of knowing the correct answer.

7.2. Results of Survey

The results of the survey were tabulated and appear in Table 4. The ratings for each individual rater are shown, as well as the average among all raters and for the physician raters. The ratings were quite high overall, which indicates a strong desire for information in all of the categories listed on the form. It is of interest to note that no single item received a rating of less than 5 from all of the raters. In judging the importance of each query, the ratings from the Director of AIDS Activities were felt to carry particular weight due to his position as the top decision-maker within the clinic. The results were used to identify the data items and data relationships that a system would have to manage in order to answer the queries successfully.

8. CRITERIA

The following criteria were derived from analysis of the "data wish list" results, subsystem goals, and environmental constraints. Although it is unlikely that any system that is implemented will satisfy all of these criteria, they can be used to judge the relative merits of alternative solutions.

1. Data Content and Integration Criteria

The integration of many related data items is a major requirement if the types of queries deemed important in the "data wish list" are to be performed. One way to show these interrelationships is by means of an "entity-relationship diagram", (Korth, 1986) as shown in Figure 5. This diagram is not intended to represent a detailed database design. Rather, it is an attempt to show on a conceptual level how the most important data items are related to each other. Specifically, the following links or associations are desirable:

- a. Each patient should be related to one or more appointments/visits. This relationship is needed to answer basic questions such as the number of patients seen per month, the number of patients seen monthly by a given provider, or the number of no-shows per month.
- b. Each patient should be related to one or more diagnostic categories or AIDS risk categories.
- c. It should be possible to relate each patient to his participation in the AIDS registry or in one or more research protocols, to assist in tracking these projects.
- d. Each visit should be related to the tests ordered at that visit. This relationship is important for various queries concerning the costs of care.

Many other data items can be dealt with by making them attributes of the more basic entities mentioned above (i.e., patient, appointments/visit, diagnostic category, risk category, AIDS registry, research protocols, and tests). A more detailed explanation of the notation used in this diagram appears in the caption which accompanies Figure 5.

2. Other Criteria

- a. The system should be designed to allow for evolution over time as needs and resources change. This is a sound principle of software engineering, and it is particularly important given the uncertainty of funding for computer-related expenditures at SFGH.
- b. As much desired information as possible should be collected from pre-existing resources.
- c. The system should avoid the necessity for redundant data entry.
- d. Any data entry or retrieval operations performed during the hours of clinic operation should be simple and fast. Personnel at the front desk should not have to deal with two different computer systems.
- e. A new system should not require hiring a data processing professional on whom the clinic would become critically dependent.
- f. A new system should not require the purchase of extremely costly hardware or software.

The clinic is heavily dependent on city funds and has relatively little discretionary income. Thus, an effort should be made to keep the solutions considered within the bounds of existing resources, perhaps with the addition of relatively small purchases such as an additional personal computer.

9. ALTERNATIVES

The alternatives discussed in this section take into account two ongoing efforts at SFGH. One is the planned expansion of the hospital information system, which should result in increased functionality as new modules are installed and specialized requests are satisfied by the hospital data processing department. The second is an effort by a

programmer analyst within the Department of Medicine, working with a physician in charge of statistical activities for the AIDS clinic, to develop a computerized appointment book that will capture basic administrative information.

9.1. Rely Entirely on the HIS.

Overview

This first alternative is to use only those information resources which already exist in the clinic and its environment. Thus, the main source for answering queries would be the new HIS. The HIS is primarily designed to support hospital registration and billing functions; as such, it can only be queried in certain restricted ways. In addition, the report generation capabilities of the HIS will be limited, particularly in its early stages. That is, it will be difficult to generate useful reports concerning only those SFGH patients who are registered in the AIDS clinic. Although the new HIS could theoretically be adapted to generate such reports, this task would require a cooperative effort between data processing personnel and representatives from the AIDS clinic. Even if such cooperation was assured, it is not clear that the HIS will be capable of generating the necessary ad hoc reports. Due to these restrictions this alternative would severely limit the ability of the AIDS clinic to answer queries such as those on the "data wish list".

Criteria satisfaction

This alternative would satisfy the criteria concerning data content and integration in a theoretical sense only. While much of the proper data exists in the HIS database, it is presently difficult to access this data in the form of useful reports. Information concerning the population of patients followed by the AIDS clinic could only be examined by querying the system for one patient at a time. The information regarding

diagnoses for each patient can be entered into the HIS (at the discretion of each clinic) via a set of ICD-9 codes. The problem with this approach is that most physicians check off only a single box (corresponding to a diagnosis of AIDS) on the encounter forms which get entered into the HIS. This means that the other diagnoses on the patient's problem list will most likely not be in the database. There is no capability in the HIS to associate patients with risk categories, research protocols, or the AIDS registry. Other information which is not contained in the HIS database includes: the follow-up status of the patient, whether or not the patient consented to participate in the AIDS registry, and the disposition of the patient following his clinic visit.

This alternative does not allow for evolution over time since the AIDS clinic has no control over the HIS (violates criterion 2.a). Criteria 2.b and 2.c would be fully satisfied since no new information processing elements would be introduced by this alternative. Data entry could presumably be done easily, and thus criterion 2.d would also be satisfied. The remaining criteria (2.e and 2.f), would also be satisfied since no additional personnel or computing equipment would be required. Thus, there would be no cost to the clinic if this alternative was chosen.

9.2. Rely Entirely on a Free-standing, Microcomputer (PC)-based System

Overview

This alternative would view the hospital information system only as a repository of information needed for hospital billing purposes and would rely on an independent system for all information needed to support the goals of the AIDS clinic. Since the clinic would maintain a separate database concerning only their own patients, this alternative would offer many advantages over alternative 9.1. The database could be created and altered to suit the specific needs of the clinic, without regard for the HIS or

the hospital data processing department. The main limitation of this approach is the need to re-enter data which is already contained in the HIS files.

A prototype of this free-standing system, which involves a computer-generated appointment book, has already been developed. New appointments would be written on the computer-generated sheets (Appendix II) during clinic hours, and the updates to the appointment book would be batch-entered into the computer in the evening. This updating process is estimated to take less than one hour per night. Data on visit type (Appendix II, key to clinic census sheet) could be entered into the "electronic appointment book" rather than onto the census sheet, which could therefore be eliminated. In addition, new types of reports (e.g., cards listing each physician's daily appointments) could potentially be generated.

Criteria satisfaction

This approach would meet several important criteria, but it would fall short on others. In its initial stage, this is primarily an appointment tracking system. It would partially satisfy criterion 1.a by relating patients to appointments and visits. Criterion 1.c would also be partially satisfied by cross-referencing the file to the AIDS registry, thus allowing the tracking of patients who should have registry forms completed. However, only a subset of the queries concerning administrative information (and none of the queries concerning demographics, resource use, and clinical information) could initially be answered using this approach.

This system could potentially be evolved over time (satisfies criterion 2.a) to satisfy all of the data content and integration criteria. This evolution would entail considerable redundant data entry (violates criterion 2.c). Most data could be easily collected from pre-existing resources such as the currently-used appointment book (satisfies criterion 2.b). In fact, this was one of the main motivating factors behind the

development of this "electronic appointment book." Since the data would be entered in the evening, this alternative would not disrupt the operations of the front desk (satisfies criterion 2.d). New equipment or personnel would not be needed (satisfies criteria 2.e and 2.f). In this sense, the cost of implementing this alternative would also be zero.

9.3. Download Data from the HIS to a Microcomputer-based System.

Overview

This alternative differs from 9.2 (above), in that it provides some integration with the new hospital information system. All of the advantages of having an independent AIDS clinic database are maintained, but without the need to re-enter some of the data which is already in the HIS. The HIS mainframe would download (i.e., transfer) information onto a PC's data storage disk. A variety of options are available to implement this file transfer capability, depending on the type of connections that exist on the mainframe computer. A special circuit board (e.g., an IRMA board from Digital Communications Associates) could be installed in the PC, or the data transfer could be accomplished at a slower rate by using PC software without a special circuit board. Additional equipment (modems) may be needed if the communication with the mainframe is to take place over telephone lines, as opposed to a direct communication link.

This alternative would require the hospital data processing department to formulate periodic reports from the HIS database, (as in alternative 9.1). However, the need for specialized reports would be eliminated since the data contained in standard HIS reports could be reformatted after it was downloaded to a PC in the AIDS clinic. Additional information of interest to the clinic could be added to the database directly by personnel in the clinic. In other words, neither the content or structure of the clinic

database would be limited by the information coming from the HIS.

Criteria satisfaction

This alternative could theoretically be implemented in a way that satisfies all of the data content and integration criteria. In phase 1 of the HIS implementation (registration only), the HIS database will contain most of the necessary information to satisfy criteria 1.a, 1.b, and 1.d. The main obstacle to utilizing this information will be the limited ad hoc reporting capabilities of the new HIS. These capabilities are expected to improve in the coming months. Unfortunately, it is too early to accurately predict how "cooperative" the HIS will ultimately be in aiding our quest to satisfy all of the criteria under data content and integration. The database will be expanded in phase 2 of the implementation (registration and scheduling systems), but many of the limitations on report generation will presumably still exist.

Once the HIS appointment scheduling module is implemented, the HIS will contain almost all of the information needed to satisfy criteria 1.a and 1.d. The information downloaded from the HIS could be supplemented with several additional data items in the PC database to fully satisfy criteria 1.a through 1.d. If diagnostic information stored as ICD-9 codes is downloaded from the HIS, this alternative may result in inaccurate data for the same reasons that were discussed in alternative number 1 above. On the other hand, accurate diagnoses could be stored in the database if this information was entered into the PC component of the system.

The PC component could be expanded incrementally to achieve greater levels of data capture and integration (satisfies criterion 2.a). This alternative also does an excellent job of satisfying criteria 2.b and 2.c because the HIS itself can be considered a pre-existing resource and downloading data from the HIS would avoid the need for redundant data entry. Data that is not in the HIS would be entered into a PC after

clinic hours, thus satisfying criterion 2.d. This alternative would not require hiring new personnel by the clinic since the HIS will be fully supported by the data processing division of SFGH (satisfies criterion 2.e). Additional hardware and/or software would be required to implement this alternative. A workable communications solution could probably be implemented for less than \$3000 in commercial hardware and software costs, if an existing personal computer is utilized; if a new personal computer must be purchased, the costs could increase by an estimated \$3000-7000.

A related but more ambitious project would be to build a PC-based "front end" to the HIS. This means that another computer system would be interposed between the user in the AIDS clinic and the HIS. All data of interest to the AIDS clinic would be entered into the "front end" rather than into HIS terminals, and the data needed by the HIS would subsequently be transmitted to the mainframe computer. The "front end" computer system would maintain an integrated database, which would be used to answer all queries and generate reports. This approach would require close cooperation between the hospital data processing department and the AIDS clinic, as well as a significant programming effort on both sides. In view of the technical and political barriers that would need to be overcome, such a project is probably not feasible at the present time.

9.4. Develop a Minicomputer-based system

Overview

This approach would involve the use of the VAX 780 minicomputer which is already owned by the AIDS Division. Since this hardware is presently underutilized, it could be devoted almost entirely to a new clinic information system. This alternative would also involve the establishment of an independent AIDS clinic database, and in

this sense, many of the advantages listed under alternatives 9.2 and 9.3 would still apply.

The implementation of this plan would require the purchase of a commercial database management system, (DBMS). After such a system was installed, a database such as that shown in the entity-relationship diagram of Figure 5 would have to be set up. (The diagram demonstrates how each of the desired data items could be interrelated in order to construct a relational database.) The data could then be typed into the system by data entry personnel. It would also be technically feasible to download information directly from the HIS as was discussed above, (alternative 9.3).

This alternative would probably require the hiring of a skilled database administrator or manager to help set up and maintain the system. The primary advantage of this alternative over 9.2 and 9.3 is the superior computing power of the VAX which would permit the use of more sophisticated data handling software. However, the overall cost of designing, implementing, and maintaining such a system would be relatively high.

Criteria satisfaction

This approach would satisfy all of the criteria under data content and integration since a relational database could be specifically tailored to fit the needs of the AIDS clinic. A VAX-based system could not be implemented incrementally, but it would allow for some evolution over time since most relational systems can be modified to accommodate changing requirements (satisfies criterion 2.a). Such a system would utilize the data which has already been collected on pre-existing sources (satisfies criterion 2.b), but it would necessitate the entry of much duplicate data (violates criterion 2.c), unless an automatic downloading process could be implemented. Data entry and retrieval could be done entirely after clinic hours (satisfies criterion 2.d). However,

criterion 2.e would be violated since this approach would require the hiring or assignment of a computer-trained individual to design and manage the database. It would also involve the purchase of a commercial DBMS for the VAX (estimated cost of \$8,000 for INGRES from Relational Technology at university discount, \$40,000 without discount), and increased maintenance costs to support the system (conflicts with criterion 2.f).

10. MEASUREMENTS

One of the important concepts of systems analysis is that measures of performance should be defined for a system, so that we can assess the degree to which the goals of the system are being met. If one of the alternatives discussed above was implemented, a scheme to measure its effectiveness could be devised by using the "data wish list." The simplest approach would be to add up the number of queries on the "wish list" that the implemented system could successfully perform. This approach could be supplemented by assigning weights to the queries to reflect their relative values, based on the survey results (Table 4).

11. RECOMMENDATIONS

The management of the AIDS clinic should seriously consider implementing some form of computer-based information system to satisfy their desire for information that can support the goals of the clinic. Of the alternatives discussed in this report, alternative 9.3 (download data from the HIS to a PC-based system) appears to offer the best long-term solution. Three major advantages of this solution become apparent when comparing it to the other three proposals.

1. The AIDS clinic would maintain its own independent database and therefore, not be limited by the content or structure of the HIS.

2. Some integration with the HIS would be provided to capitalize on the information which is already available and help eliminate the burden of duplicate data entry.
3. The cost would be relatively low.

In one sense, this alternative offers "the best of both worlds" by utilizing the sophisticated capabilities of the new HIS and simultaneously providing the clinic with its own locally-controlled database on a personal computer. If this alternative is implemented, an effort should be made to keep in close contact with people in the data processing area of the hospital in order to stay abreast with developments regarding the HIS.

Since uncertainties still exist regarding the new HIS (e.g., implementation of the appointment scheduling module and ease of interfacing to PCs), alternative 9.2 should be pursued in the short-term. This relatively inexpensive alternative (a free-standing, PC-based system) will be able to provide an immediate solution to certain long-standing information problems, such as counting the total number of patients seen by the clinic. Compatibility between the two solutions (9.2 and 9.3), is high since the automatic downloading system could be phased-in after the free-standing component was already functioning. It is important to note that a purely free-standing system (alternative 9.2), would eliminate any dependence on the HIS. This feature may be viewed as an advantage by some members of the clinic staff.

The solutions proposed above are not intended to replace the valuable information which is already being managed by the AIDS registry. Rather, our goal was to complement the registry by handling information which is not presently managed by this system. One of the advantages of these alternatives is that they will permit better tracking of the extent to which registry data are being collected, and this knowledge will be of value in the effort to improve the completeness of the AIDS registry database.

Overall Sources of Support for AIDS Outpatient Services at SFGH
(\$ 1,140,724)

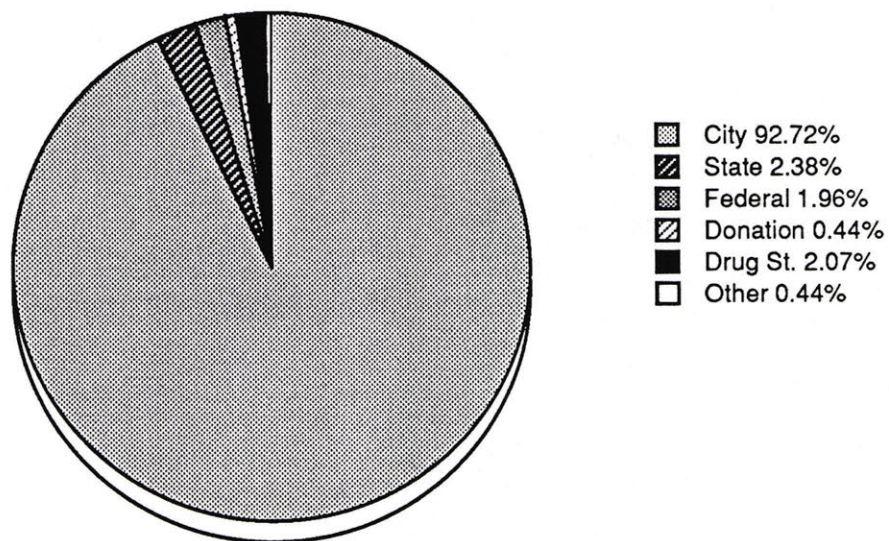


Figure 1

Fund Allocation to Functions of the SFGH AIDS Division
(\$ 3,709,440)

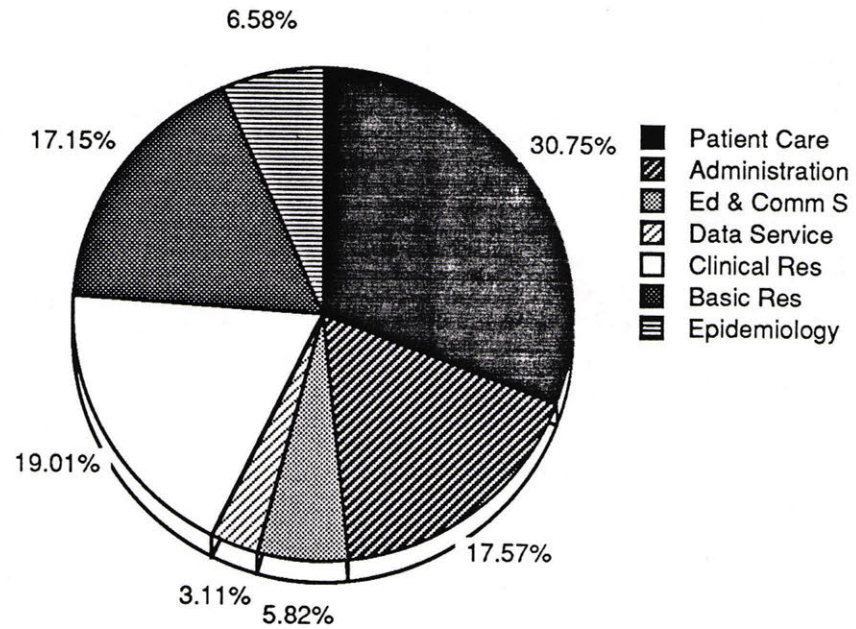


Figure 2

Figure_3

PATIENT AND INFORMATION FLOW

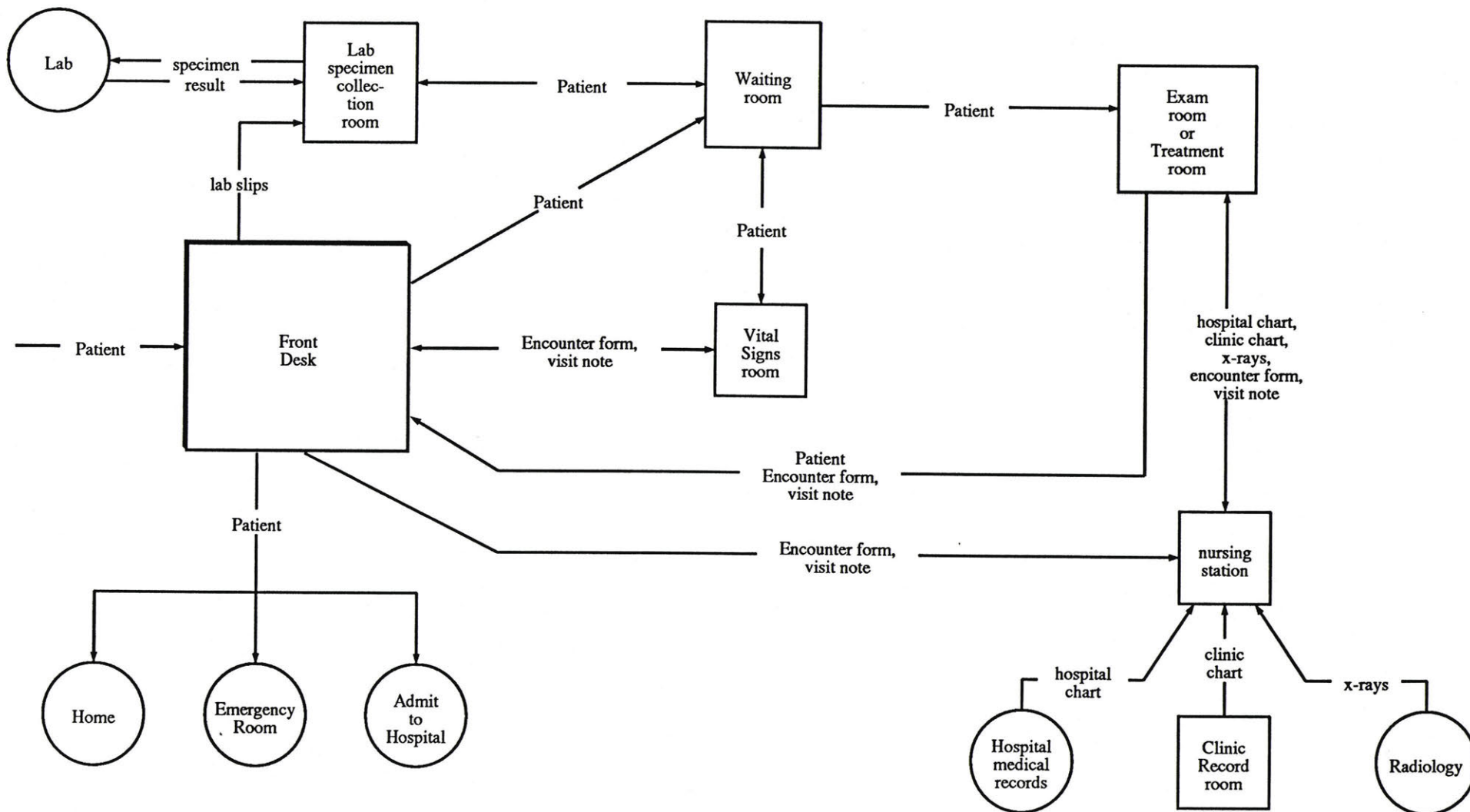


Figure 3

Figure_4

FRONT DESK OPERATIONS

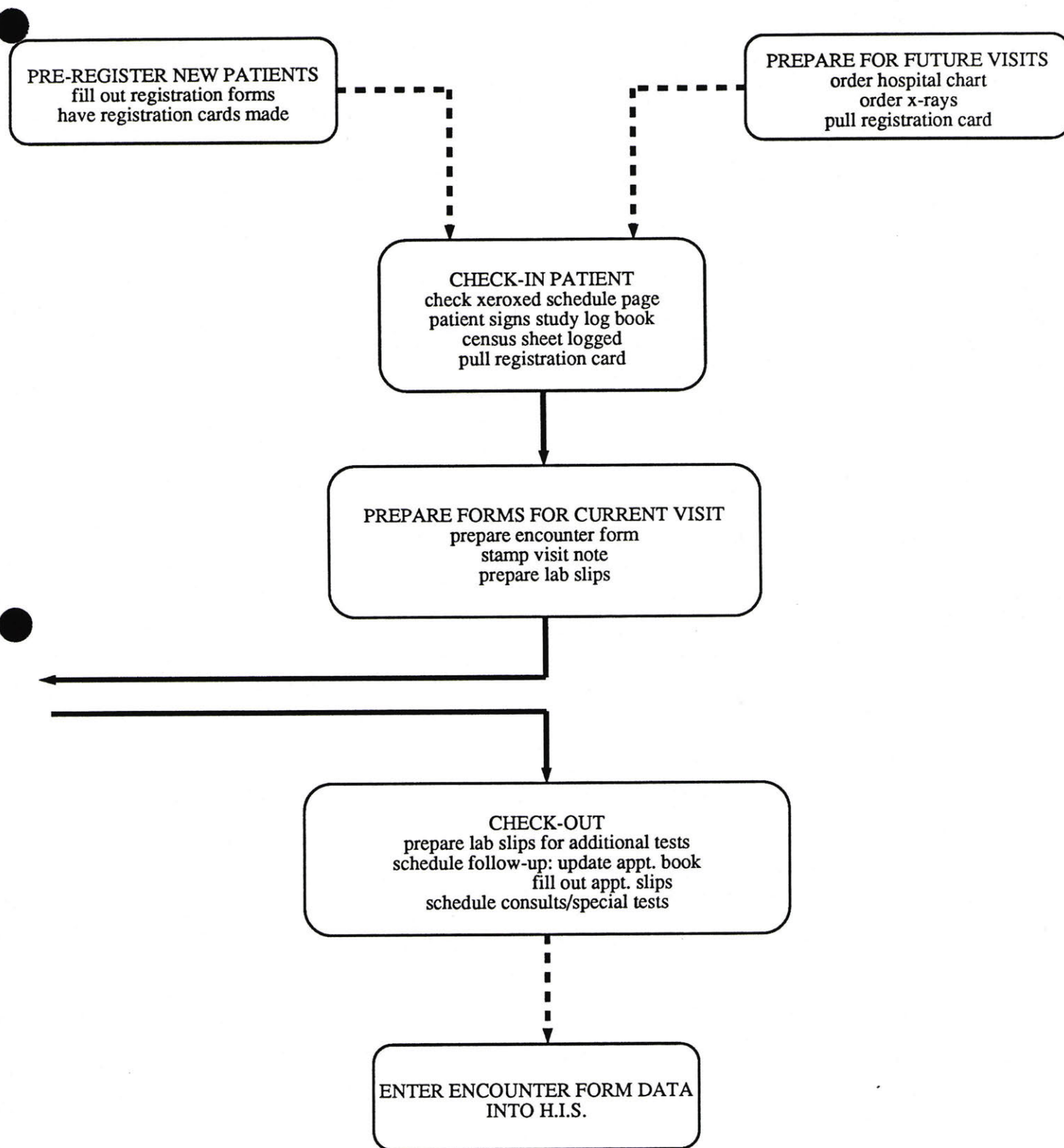


Figure 4

Caption
Figures 3 and 4

When patients arrive at the front desk, they are checked in. This involves verifying that the patient is listed in the appointment book, having the patient sign a log book if he is participating in a research study, pulling the patient's plastic registration card from the daily card file, and stamping a census sheet on which the type of visit (e.g., new patient visit, visit for chemotherapy only, etc.) is to be indicated by circling a letter. The forms for the current visit (encounter form, visit note, and laboratory slips) are then prepared by stamping them with the patient's plastic card.

The patient goes to the waiting room, and is called to the appropriate areas to have his laboratory specimens drawn and vital signs taken. After these tasks are completed, the patient is called to the examination or treatment room.

For the patients to be seen during a clinic session, the hospital chart, clinic chart (containing the medical record for the AIDS clinic only), and any X-rays requested are brought to the nursing station before the clinic session begins. The encounter form and visit note are sent to the nursing station after the vital signs are taken. All of these documents are made available to the provider in the examination or treatment room.

After the encounter, the patient returns to the front desk. Laboratory slips are prepared if the provider has ordered any additional tests to be done before the patient leaves. Follow-up appointments, consults for other clinics, and special tests are scheduled. An appointment slip is completed for the patient's next visit to the AIDS clinic. The patient is then sent home, unless his condition is so serious that he needs to be admitted to the hospital or sent to the emergency room.

Several other activities take place at the front desk but do not relate to the flow of a specific patient through the clinic. Pre-registration of new patients involves taking

the necessary patient identification information over the telephone and having a registration card made before the patient comes to the clinic for the first time. Preparing for future visits involves the retrieval of appointment slips for patients who are scheduled to be seen on a particular date and ordering the hospital chart and X-rays (three days in advance). It also involves pulling of the plastic registration cards from a file for patients to be seen the next day. Encounter form data are entered into the HIS after the patient has left the clinic.

The model presented in Figures 3 and 4 applied to the operations of the front desk prior to the installation of the new HIS. With the new HIS, the need to enter encounter form data after the patient leaves the clinic is eliminated. The check-in procedure is also changed in that a patient visit record is entered into the system immediately upon the patient's arrival at the clinic.

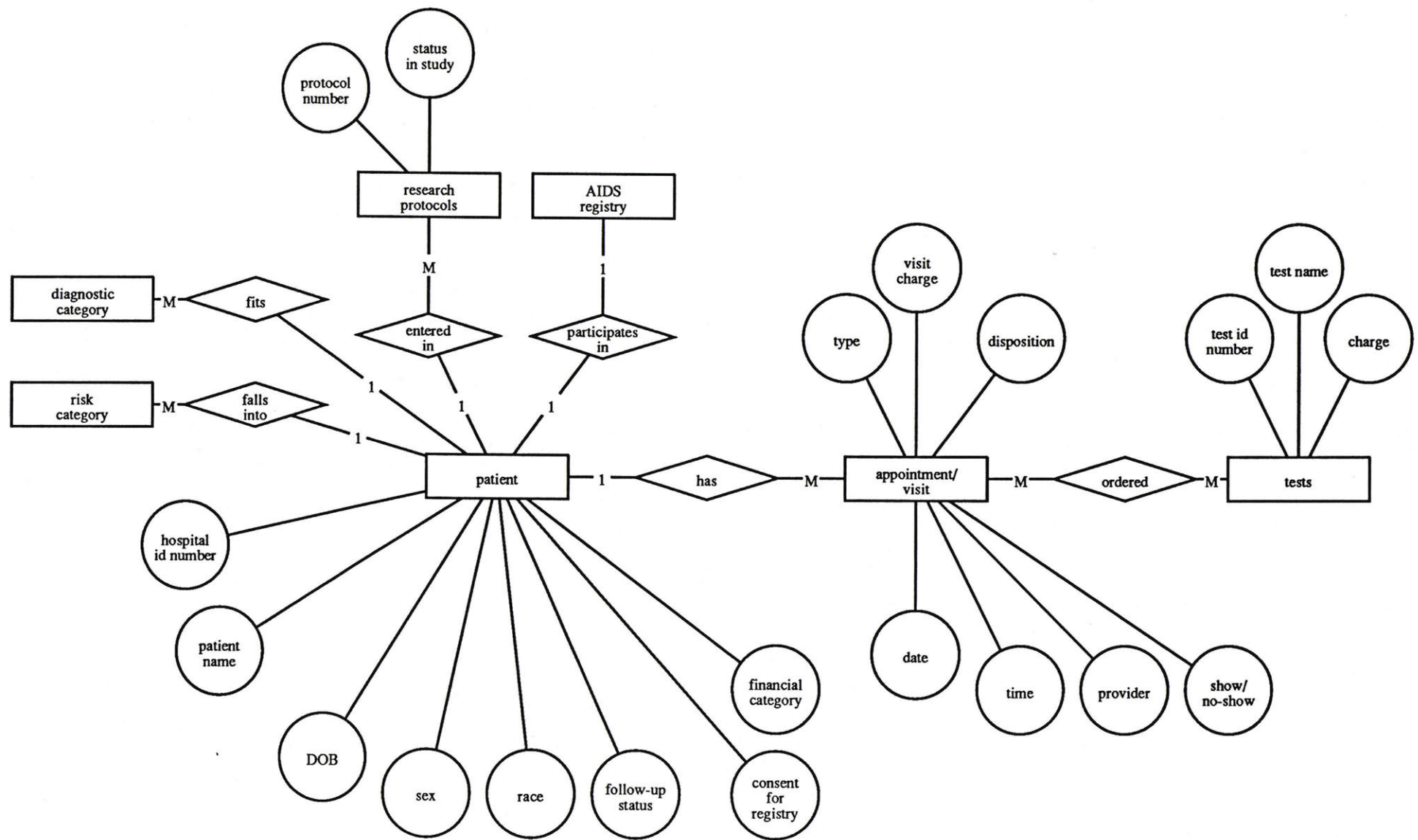


Figure 5

Figure 5

Entity Relationship Diagram

Rectangles represent entities, which are objects of interest. Entities have attributes, which are characteristics that describe them. Circles are used to depict attributes. The diamond shapes represent relationships between entities. Relationships between entities can be one-to-one, one-to-many, or many-to-many, as denoted by the "1" or "M" on a line connecting an entity and a relationship. Further information can be found in the reference by Korth.

SFGH AIDS Outpatient Clinic Encounters

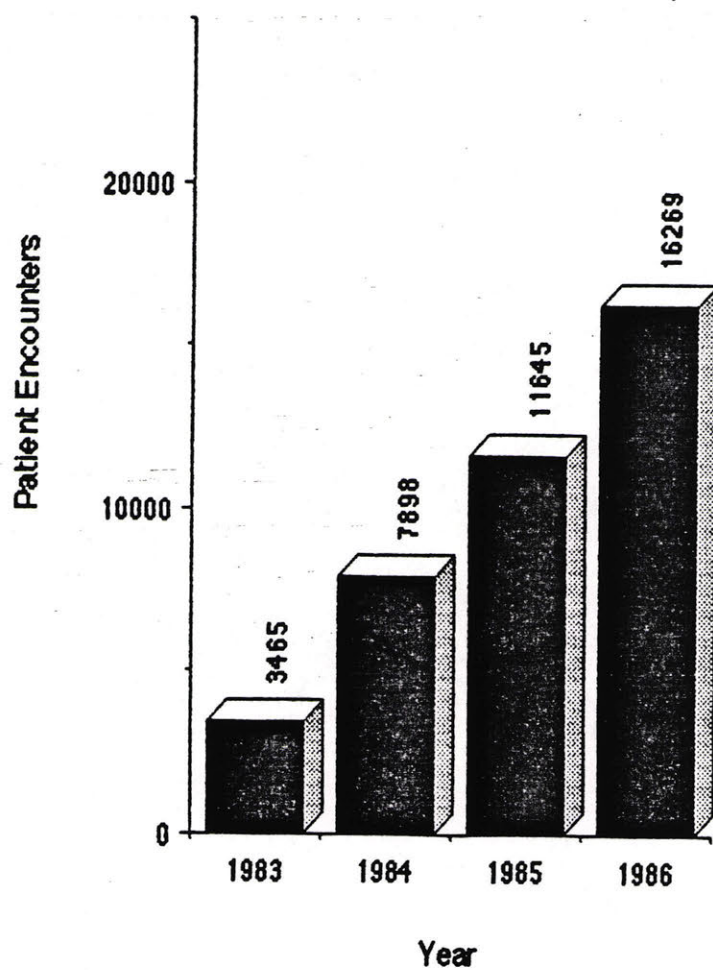


Figure 6

Table 1

SYSTEM GOALS

Patient Care

To provide high quality care for patients with AIDS

To help prevent the further spread of AIDS
by educating patients and the community

To treat as many patients with AIDS as possible

To treat patients regardless of their financial resources

To improve communications between caregivers

Research

To advance basic and clinical knowledge about AIDS

Internal Administration

To facilitate the operational efficiency and
effectiveness of the clinic

Table 2

SUBSYSTEM GOALS

To provide senior clinic staff with data to facilitate decisions regarding patient care, research, administration and resource planning

To collect data in a way that reflects its relative usefulness

To utilize data from pre-existing resources as much as possible

To avoid interference with routine clinic operations

To avoid additional training requirements for clinic staff

Table 3
List of Persons Interviewed

Position	Relevant Responsibilities
Director, Aids Activities	The physician in charge of AIDS related activities at SFGH, and the highest ranking person interviewed.
Assistant Professor, Medicine	The physician in charge of data-related, epidemiological, and statistical activities within the AIDS clinic; served as our primary contact.
Programmer Analyst, Medicine	Works within the Department of Medicine and has designed an "electronic appointment book" for the AIDS clinic, working with the above-mentioned epidemiologist; would be the person primarily responsible for designing and implementing a computer-based solution within the AIDS clinic.
Head Nurse	The highest-ranking nurse within the AIDS clinic; only recently joined the clinic.
Management Services Officer	The person responsible for administrative and financial activities concerning the AIDS clinic; works with the Director.
Administrative Assistant	Supervises the operations of the front desk at the AIDS clinic.
Former Head Nurse	Left the head nurse position only recently to assume a newly created position concerning AIDS inpatients at SFGH.
Consultant, Medical Information Systems	A physician consultant who is overseeing the installation of the new hospital information system at SFGH.
Hospital Programmer Analyst	Works with above-mentioned consultant in implementing the new hospital information system.
Hospital Outpatient Coordinator	Member of the hospital administration who is in charge of implementation of the new HIS in the outpatient clinics.

Table 4							
RATINGS FOR ADMINISTRATIVE INFORMATION							
Item	Dir. M.D.	M.D. Epi.	M.S.O.	H. Nurse	Admin. A	M.D. Avg.	Ov. Avg.
total number of patients seen monthly in the AIDS clinic	7	7	7	7	7	7	7
total number of patients seen monthly by any given provider	7	7	7	4	3	7	5.6
average annual number of visits for any given subgroup of patients	7	5	7	7	4	7	6
total number of no-shows in any given month	5	7	7	6	2	6	5.4
number of no-shows categorized by day of the week	2	5	7	3	2	3.5	4.4
number of no-shows categorized by provider	6	4	7	3	2	5	4.4
number of patients lost to follow-up	7	6	7	NR	1	6.5	5.25
number of patients who leave the AIDS clinic to receive care by another known provider	7	5	7	3	3	6	5
percent of patients who agree to participate in the registry	7	7	7	7	6	7	6.8
percent of new patients with registry forms properly completed	7	7	7	6	4	7	6.2
percent of follow-up patients with registry forms properly completed	7	6	7	6	4	6.5	6
percent of patients with registry forms properly completed by any given provider	6	7	7	5	7	6.5	6.4
percent of patients who agree to participate in research protocols	7	4	7	5	4	5.5	5.4
number of active and completed patients in each ongoing research protocol	7	6	7	7	4	6.5	6.2
total number of visits per month subdivided by category (new patient, follow-up, treatment only, lab test only, refill clinic, or walk-in)	6	7	7	7	7	6.5	6.8
percent of patients by financial category (private insurance, Medi-Cal, or indigent)	7	7	7	7	4	7	6.4

Table 4 (continued)							
RATINGS FOR DEMOGRAPHIC INFORMATION							
Item	Dir. M.D.	M.D. Epi.	M.S.O.	H. Nurse	Admin. A	M.D. Avg.	Ov. Avg.
number of patients seen, categorized by age range	4	3	6	7	4	3.5	4.8
number of patients seen, categorized by sex	6	1	6	7	5	3.5	5
number of patients seen, categorized by race	7	5	7	7	4	6	6.2
number of patients seen, categorized by occupation	2	1	5	4	1	1.5	2.6
number of patients in any given high-risk category for AIDS	7	5	5	7	6	6	6
number of patients in no known risk category	7	5	5	7	6	6	6
number of clinic patients who die in any given month	7	7	7	6	4	7	6.2
average number of clinic visits per month for patients in any given diagnostic category (e.g., Kaposi's sarcoma)	7	6	6	7	4	6.5	6
percent of patients from outside San Francisco	7	7	6	4	3	7	5.4

Table 4 (continued)							
RATINGS FOR RESOURCE USE INFORMATION							
Item	Dir. M.D.	M.D. Epi.	M.S.O.	H. Nurse	Admin. A	M.D. Avg.	Ov. Avg.
total number of patients on which a given laboratory test (or x-ray) was ordered	6	5	6	5	5	5.5	5.4
percent of patients for whom the given test (above) was positive	5	6	6	1	7	5.5	5
average number or cost of tests ordered per patient	6	3	6	7	7	4.5	5.8
average annual cost of clinic care per patient	7	4	6	7	7	5.5	6.2
average annual cost of clinic care per patient, categorized by diagnosis	7	4	6	7	4	5.5	5.6
average annual number of hospitalizations per patient	4	5	6	7	6	4.5	5.6
average annual number of hospitalizations per patient for any given diagnostic category	7	5	6	7	7	6	6.4
average annual number of emergency room visits per patient	6	5	5	4	7	5.5	5.4
average annual number of emergency room visits per patient for any given diagnostic category	4	5	5	2	3	4.5	3.8
total monthly number of patients admitted to the hospital directly from an AIDS clinic visit	7	3	6	3	7	5	5.2
total monthly number of patients sent to the emergency room directly from an AIDS clinic visit	5	3	6	1	3	4	3.6

Table 4 (continued)							
RATINGS FOR CLINICAL INFORMATION							
Item	Dir. M.D.	M.D. Epi.	M.S.O.	H. Nurse	Admin. A	M.D. Avg.	Ov. Avg.
total number of patients seen with a given physical exam finding	NR	2	5	NR	4	2	3.67
total number of patients seen who report a given historical finding (e.g., hematuria, dyspnea, family history of diabetes)	4	2	5	NR	7	3	4.5
percent of patients with AIDS vs. ARC	7	7	6	NR	6	7	6.5
number of patients in any given diagnostic category	7	7	6	NR	3	7	5.75
identification of patients who have been hospitalized since their last clinic visit	6	7	6	NR	6	6.5	6.25
identification of patients who have been seen in the emergency room since their last clinic visit	6	1	5	NR	6	3.5	4.5
identification of patients who have been seen by outside clinics since their last visit to the AIDS clinic	6	1	6	NR	6	3.5	4.75
total number of patients on any given medication	4	5	5	NR	3	4.5	4.25

Legend	
Dir. M.D.	Director of AIDS Activities
M.D. Epi.	Physician (in charge of AIDS Epidemiology)
M.S.O.	Management Services Officer
H. Nurse	Head Nurse
Admin. A	Administrative Assistant in charge of Front Desk
NR	Not Rated
M.D. Avg.	Average of Physician Ratings
Ov. Avg	Overall Average Rating

APPENDIX I

A. Background on the AIDS Problem

The first cases of AIDS were diagnosed in the United States in 1981 and since that time the number has increased at an alarming rate. As of April 1986 there were 20,000 reported cases of AIDS with a doubling time of 11 months. (Morgan, 1986) The most current statistics (1/4/88), show that the prevalence in the U.S. has now surpassed 50,000. (Volberding, 1988)

Fortunately, the rate of growth is slowing down and no longer appears to be exponential. (Morgan, 1986) However, in terms of economic consequences, the AIDS epidemic has already reached massive proportions. The total annual cost of goods and services directly related to the health needs of AIDS patients was an estimated 0.9 billion dollars in 1985. This amount is projected to rise to 10.8 billion in 1991. (Scitovsky, 1987) This figure does not reflect the even larger economic impact caused by loss of productivity which will cost the nation an estimated 55.6 billion in 1991.

The epidemiologic trends have been similar in San Francisco where an estimated 11% of all AIDS cases in the U.S. have originated. (Morgan, 1986) The AIDS clinic at SFGH was opened in 1983 with a staff of one physician, two nurses, and one administrative secretary. This is the same year that the AIDS Activity Office was established at the San Francisco Department of Public Health to coordinate funding and activities among various AIDS related community services such as the Shanti project and the San Francisco AIDS Foundation. (Arno, 1986)

As the number of AIDS cases in San Francisco grew, the AIDS clinic expanded and struggled to keep up with the ever-growing demand for services. This steady increase is reflected in the total number of outpatient encounters per year as shown in Figure 6.

In mid-1985 the average census reached 1200 patients per month, and at the same time more than 2 new cases of AIDS were diagnosed each day in San Francisco. In early 1985 the death rate from AIDS in the city was 1 person per day, and by early 1986 the death toll in the city passed the 1000 mark. SFGH played the largest role of any health care facility in the city, with the AIDS clinic providing outpatient care to an estimated 35 to 40% of all AIDS patients in San Francisco. (Abrams, 1986)

In order to adequately assess the benefits of an information management system for the AIDS clinic, we need to have some estimate of the amount of money and other resources which are consumed by the average AIDS patient cared for at SFGH. The best source of data for these costs comes from an analysis by Scitovsky which was published in the Journal of the American Medical Association and summarizes the situation at SFGH in 1984. (Scitovsky, 1986) In that span of 12 months there was a total of 445 AIDS related admissions to SFGH with a mean length of stay of 11.7 days. The mean charges were \$773 per day or \$9024 per hospital stay.

AIDS patients were also divided into subgroups by the study in order to calculate the mean annual total charges for outpatient care. These charges came to \$3621 for the subgroup who were diagnosed with AIDS prior to 1984 and were alive for all 12 months of the year. These charges nearly equaled the average total inpatient charges for the same group of patients over the same 12 months. The mean annual number of hospital admissions for patients in this group was 0.6. (Scitovsky, 1986)

The subgroup of AIDS patients who died during 1984 were also looked at in the study by Scitovsky and it was determined that the average time from diagnosis to death among the patients cared for at SFGH was 224 days. The average total charges for each of these patients from the time of diagnosis to death was \$27,571. (Scitovsky, 1986) This figure is contrasted with much higher estimates from studies which were

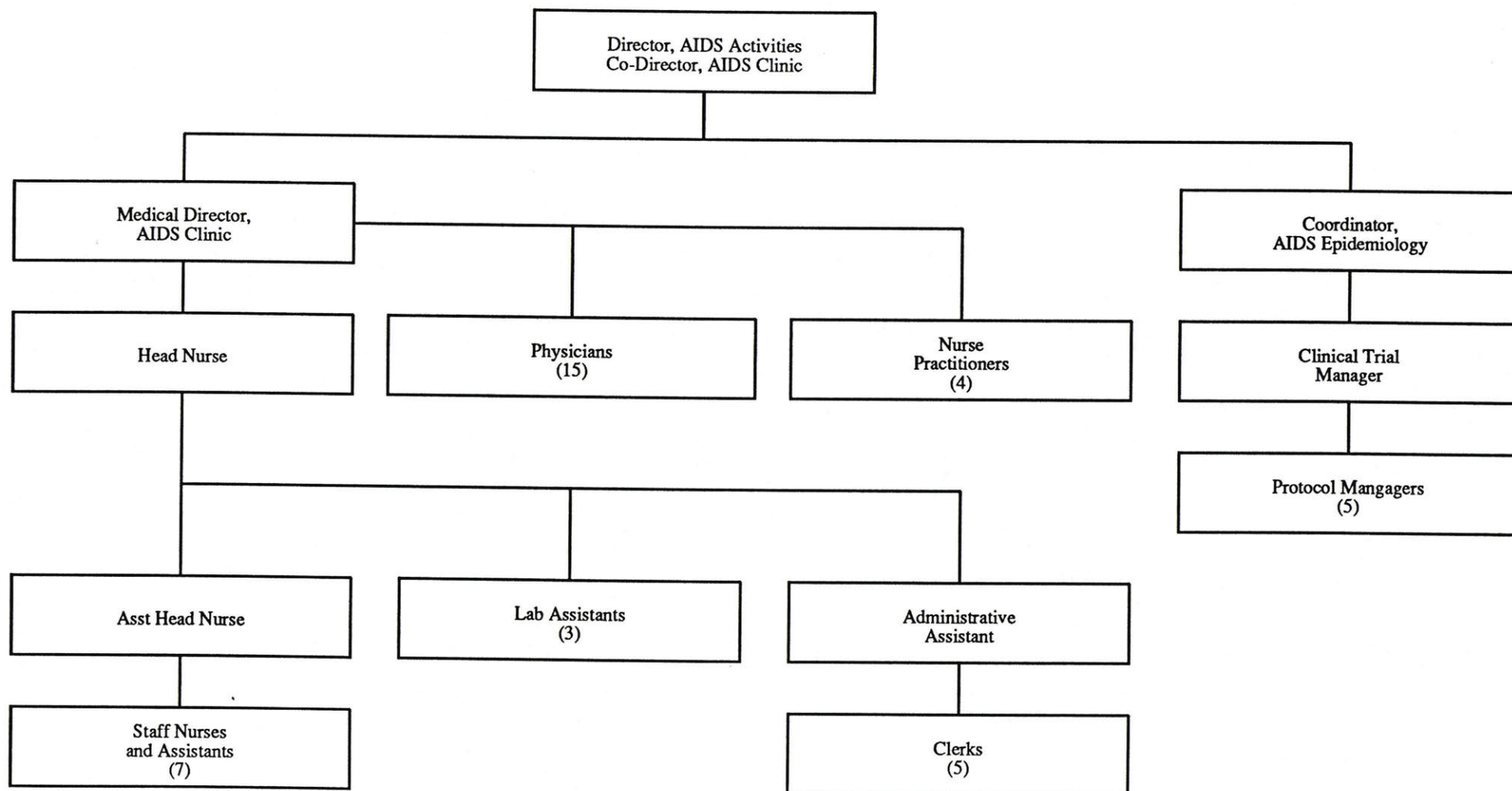
done in other parts of the country. (Hardy, 1986)

B. Background on the AIDS Clinic at SFGH

The AIDS clinic at SFGH is part of the AIDS Activities Division, which includes personnel at both UCSF and SFGH. The division has approximately 100 employees overall. There are approximately 15 physicians who see patients in the AIDS clinic. Physicians do not rotate through the clinic, and patients generally receive continuity of care from a single clinic physician. The AIDS clinic shares physical space (Ward 86) with the hematology and oncology clinics, which meet when the AIDS clinic is not in session.

An abbreviated organization chart is shown on the next page. Although a formal and complete organization chart was not available, this abbreviated chart is an attempt to show the major reporting relationships within the clinic.

Abbreviated Organization Chart
AIDS Clinic at SFGH



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