HOSPITAL EMERGENCY SERVICES:

MODELING A DYNAMIC SYSTEM

by

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and

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ABSTRACT

In the past decade visits to hospital emergency departments in the United States have increased dramatically. The rate of increase of emergency department usage has exceeded both the rate of increase of population growth and the rate of increase in hospital inpatient or outpatient clinic utilization. The increased use of hospital emergency departments has focused attention on the difficulties and shortcomings of emergency health care services. Complaints of overcrowded facilities, depleted staffs and criticisms of quality of care are expressed privately by patients and publicly by citizen groups and elected officials.

This thesis describes a systems dynamics model of an urban hospital emergency department. The authors have developed this mathematical simulation in the hope that it might facilitate planning and assist in the resolution of some of the complicated issues attendant to the provision of emergency health care.

The model is based on the integration of four major interactive components. These are: (1) the potential patient pool - patient load, (2) staffing of the emergency department, (3) capital investment in plant and facilities and (4) operational financial considerations.

Employing the basic model, one can simulate a variety of operating conditions in this "typical" emergency department. Singly or in combination, for example, one can alter the total patient load, vary the mix of true emergency and non-emergency patients, the relative attractiveness of alternate forms of care, and observe the effects of these changes on staffing requirements, costs and capital investment. The model also permits the simulation of staffing with full-time salaried physicians rather than with interns and residents, the increased use of physician assistants, the introduction of neighborhood health centers and health maintenance organizations,

and the advent of some form of universal entitlement.

Preliminary testing of the model demonstrates that the growth of the potential patient pool is the major driving force. Successes in improving quality of care, staffing levels, or the financial situation are relatively short-lived when steady growth of the patient pool continues.

The model, as presented here, is regarded by the authors as only a first approximation of what is possible. Experience with this model, however, offers promise that with further refinement a viable, working model of emergency health care services can be developed. Such a refined model would prove valuable as a planning instrument in attempting to solve some of the manifold problems of emergency health care planning and delivery.

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CHAPTER I INTRODUCTION

The problems that complicate the provision of health care in the United States today are sufficiently severe to constitute what has been described as a "health-care crisis". The "crisis" label may be disputed by some and variably defined by others. Agreement can be found, however, in two general areas. Large segments of our population do not have adequate health-care available to them at prices they can afford and, secondly, government at all levels has recognized that the rapidly rising health costs threaten to upset any fiscal stability that remains.

This study examines but one aspect of the complex health-care problem. In many ways, however, the area of emergency health-care services represents a microcosmic example of the larger problem. The choice of the systems dynamics simulation technique as a tool for examining these complex interrelationships was made because its implementation requires a fastidious description of the multiple interrelationships that comprise the hospital-based emergency care system. From this examination a logical model has been developed that, hopefully, will permit rational decisions to be made with a higher degree of predictable consequences than hitherto has been possible.

THE PROBLEM

The overcrowding of existing hospital emergency departments, the rise in visits to emergency departments by patients judged not to have emergency problems, the inadequacy in supply of emergency health-care facilities and the depleted supporting staffs for these facilities, the increasingly frequent complaints about the quality of emergency medical care -- all this laces today's lay and professional press. These expressions of concern, indeed, prompted President Nixon to call for, in his State of the Union message on January 20, 1972, "(development of) new systems of emergency health-care that could save thousands of lives annually". Significantly, this proposal was the principal new idea offered by the President in the health-care field. Public attention thus was focused further on the need for solution to our emergency health-care problems.

In the past decade visits to hospital emergency departments in the United States have increased one hundred twenty-two per cent. In the same time the nation's population has increased only nineteen per cent. Simultaneously, hospital inpatient admissions and outpatient clinic visits increased approximately thirty per cent each (4). The consequences of this disproportionately rapid growth in emergency service demand, often not accompanied by increase or improvement in physical facilities or in recruitment of increased professional staff, are multiple and undesirable. They include overcrowding, a perceived -- and probably real -- diminution in the quality of emergency health-care, and a growing, increasingly expressed, dissatisfaction on the part of the patients and families seeking relief at these facilities.

The causes of the disproportionate increase in the demand for emergency health-care and dissatisfaction with that provided are not known with certainty. Multiple explanations have been offered. Among them are the following:

(a) Expansion of emergency physical facilities has not kept pace with the population increase or its attendant increase in service demand. It seems fair to state that, in the past, hospitals generally have expanded their capacity for emergency services only after the demand became virtually critical. Additionally, hospital emergency departments usually have had a low priority in the allocation of capital funds within the hospital complex. Generally, inpatient services have had preference over emergency department facilities in modernization and expansion programs.

(b) Hospital emergency departments have become the doctor for the urban poor. While metropolitan areas have acquired increased concentration of low-income groups, practicing physicians have left these central city ghettos. The hospital emergency department frequently becomes the portal of entry into the medical system for the patients from these areas. The emergency facility proves to be the most convenient route to the outpatient clinic where, with the advent of Medicaid and other forms of assistance, the urban poor receive their only medical care.

One author, working at a large metropolitan children's hospital recently commented, "Not all families use the emergency clinic for the same reasons or with the same degree of consistency. Some use it for true emergencies, others as a source of ongoing care. This differential utilization has been associated with economic status, with high income families said to use the emergency clinic for true emergencies, while low income families use it as a source of ongoing care"(2).

(c) The mobility of the population is also cited as a causal factor leading to the increase in emergency department visits. An estimated twenty per cent of the American population changes residence annually (4). Living in a new location without established contacts, usually without a physician to call upon, the hospital emergency department becomes a seemingly logical source of medical care.

(d) The nature of private and governmental insurance programs also has led to increased use of hospital emergency facilities. True emergency visits to a hospital facility frequently are covered by insurance while treatment for the same problems in a private physician's office are not. Many patients with what might be termed "semi-emergencies" (sprains, sudden fever, minor lacerations) are motivated to use the emergency department rather than to visit their private physicians.

A recent review of emergency department visits made to a metropolitan general hospital by patients sixty-five years of age and older, before and after the introduction of Medicare, indicates that emergency department visits by this age group were more than four times as frequent following the advent of Medicare as preceding it (33). This experience, however, apparently is not uniform throughout the country (34).

(e) An absolute and relative decrease in the number of physicians no longer choose to deal with emergency visits in their offices (or, it should be noted, in the patient's home). The emergency department facilities afford a centralized location for complex and expensive equipment. Many physicians find it easier and, from their point of view, more efficient to treat their patients in the hospital emergency department.

(h) Another factor contributing to the growing emergency department burden is the physician's concern with professional liability. Few physicians will acknowledge openly that concern regarding possible litigation for malpractice is a factor in referring patients to the emergency department. It is the authors' opinion, however, based upon personal experience and interviews, that, increasingly, patients are referred to the emergency department because of the physician's desire to either divest or share possible legal liability.

What rank order should be applied to these explanations for the increase of emergency department use cannot be offered with confidence. What can be predicted with assurance, however, is that without some significant change in the medical care system, the striking influx of hospital emergency department patients noted in the last decade will not moderate in the foreseeable future.

Coupled with the increase in emergency department visits has been an emergency department professional staffing problem of sizable proportions. Hospital emergency departments, particularly in in general practice has resulted in the emergency department becoming, in many instances, the present day family doctor. One hospital emergency department director expresses this view: "By default we often become the Community Medical Center, the providers of care for the patient with non-emergent illness, who all the same has legitimate needs which the declining number of general practioners can (or will) no longer provide" (13). One result is that some two thirds of patients seeking care at a hospital emergency department do not have a true emergency (18).

(f) The hospital emergency department customarily offers twenty-four hour per day service. It does not seem by chance that peak patient loads in some emergency departments occur on weekends or on mid-week afternoons when private physicians may not be readily available. A Blue Cross survey conducted in Michigan revealed that approximately one-half of patients seen in an emergency department during the period of study first had tried to reach their physician. Half of these patients, one-quarter of the group, were unable to reach the physician; the remainder were told to seek care at the emergency department or instructed to meet their own physician at the emergency department (4).

(g) The suggestion immediately foregoing may be viewed as another factor contributing to the proliferation of emergency department visits. With increasing specialization and sophistication in the technology of medical care, many physicians metropolitan settings, traditionally have drawn their physician staff from interns and residents in training at that institution. Many of these hospitals, however, no longer are competing successfully in attraction of interns and residents. Fewer doctors are thus available to staff the urban hospital emergency departments. In part this is true because of the increase in the size and staffing patterns of some of the popular teaching hospitals. Another influence is that many specialties no longer require internship prior to the physician entering his specialty training. The result is that fewer graduating medical students enter the internship pool and the physician staffing pattern in the emergency department then is relatively leaner in the face of increasing demand for service.

In addition to this quantitative deficit can be added a qualitative failing. With the major exception of university hospitals or teaching hospitals affiliated with university teaching programs, many hospitals are obtaining foreign trained physicians as interns. While exceptions occur, the foreign trained physicians usually have less suitable professional qualifications. Occasionally a language communication difficulty arises between the foreign physician and the distressed emergency patient or family, leading to misunderstanding and a potential lowering of the quality of emergency department care.

For many interns and residents the emergency department experience has become a less attractive portion of their training period. When given a choice, a sizable sample of new interns choose the less frantic, more closely supervised teaching atmosphere of inpatient care, deleting the emergency department experience.

In order to cope with the shortage of physicians in the emergency department, and in an effort to improve the quality of care administered, many hospitals are developing a staff of full-time, salaried (or income guaranteed) physicians to provide care in the emergency department (22). The use of these salaried physicians in the emergency department then permits the hospitals to utilize their interns and residents chiefly in the inpatient service.

SCOPE OF STUDY

The purpose of this study is to develop a method for examining alternative policies for hospital emergency services. The technique of systems dynamics has been employed because of the complex nature of the problem. We have developed a computer program that permits examination of alternative solutions to the problems of rising demands for emergency services, the provision of professional care despite shortage of physicians, the impact of changing insurance programs and the changing cost of various levels of care.

The "true" emergency described in this report is that defined by Kluge et al (18). Two criteria must be fulfilled: (1) the patient must have a problem which, even if not deemed serious, requires prompt attention by a physician and (2) the problem, by its nature, is apt to need the facilities (x-ray, consultations, operating rooms) that are available in a hospital. Examples of the latter might be examinations following auto accidents, even if no injury is demonstrated subsequently, acute abdominal pain, even if later demonstrated to be only gastric distress, and the threat of myocardial infarction, even though this subsequently proves not to be the case.

The remainder of emergency department visits will be characterized as non-emergencies. As noted earlier, these visits account for up to two-thirds of the typical emergency department case load. By earlier definition (18) these include: (1) conditions which, by their nature, should be attended to within a twenty-four hour period but which do not need the immediate availability of hospital facilities (sudden high fever in a child, ligamentous sprains, minor abrasions or bruises) and (2) those conditions which do not require the advice of a physician, or conditions which could easily wait twenty-four hours or longer for attention. This latter category would include distress such as a lingering upper respiratory infection, a persistent headache or a request for prescription renewal.

The hospital emergency department described in this model will be that of a "typical" well-equipped urban hospital. It would include approximately 15,000 square feet of space, access to diagnostic x-ray and laboratory facilities and a patient load of between 50,000 and 100,000 visits annually (the same patient coming to the emergency department three times is counted as three visits). The staff varies between 10 and 20 doctors, of whom one or two will be senior supervising physicians and the remainder will be distributed between interns and residents in a ratio of approximately two to one, and also includes requisite nursing, paramedical and clerical personnel to support such a program. The description of such a hospital emergency department, we would emphasize, serves only as a starting point for the systems dynamics model.

An advantage of the systems dynamics model is the ability to alter its characteristics and readily examine the consequences. The use of this model, for example, permits the elimination of interns and residents from the emergency department, such as would be the case in a hospital that does not succeed in attracting them; it permits the use of full-time contract physicians in the emergency department; it further permits altering methods of reimbursement, changes in demographic influences, and varying the patient load within broad limits. The model is designed so that alterations do not affect internal logical consistency. So long as that is maintained, the quantitative measures of the component parts can be varied in the test situation, and the likely outcomes of these variations determined by computer simulation.

Several key features of hospital emergency department operations are examined. These include the following:

1) Physician staffing. The traditional method of providing physician care in urban hospital emergency departments has been to use interns and residents. Increasingly, hospitals have found it difficult to continue this method of staffing. Efforts to do so have resulted in an increase in the use of foreign trained physicians. Other hospitals have hired full-time salaried physicians to fill this function. The variations in such staffing patterns are numerous. The model has been constructed so that the impact of these various physician

staffing alternatives can be evaluated.

2) Nurse and paramedical staffing. The role of the nurse in the function of the hospital emergency department is a central and critical one. Many excellent hospital emergency departments use nurses as triage officers. Other hospitals are expanding the role of the nurse by employing her in a yet more clinical fashion, as a "nurse-clinician". In this capacity she substitutes for the physician in other professional functions. A number of hospital emergency departments now are using specially trained technicians, comparable to the hospital corpsman of military service as "physician-expanders". This model can incorporate these alternatives and permits the exploration of variations in the mix on quality of care, recruitment, patient satisfaction and costs.

3) Patient load and variety. The number of patient visits and the nature of the patient problems are central to the planning for the hospital emergency department. This study examines the influences of demographic data, differences in dealing with the true emergency patient and the present majority of patients who are not considered true emergencies, the impact of various reimbursement methods, and the development of neighborhood health centers and/or health maintenance organizations. The model permits the prediction of changes in emergency department load induced by these factors. Indeed, the model reciprocally permits the prediction of the

impact of changes in the patient load on the other elements in the program.

4) Quality of care. The quality of medical care probably is the most elusive definition confronted in this effort. The report attempts to assess the quality of care from two points of view: (1) as perceived by the physician and (2) as perceived by the emergency patient, his family and his friends.

It is asserted that the physician will be most concerned with minimizing the prospects of error in diagnosis and in maximizing the prospects for cure and/or comfort. He will be concerned to a lesser extent with the amount of professional time expended, the length of the patient queue and the costs.

The patient, on the other hand, hopes for error free care and provision of maximum comfort and prospect for cure or relief. It is asserted that the patient is more concerned with waiting time, professional attitudes confronted and, to a lesser extent, cost.

Quality of care, as perceived by the patient, becomes an important factor in influencing the patient load in the emergency department. As perceived by the physician, quality of care is important in the attraction and maintenance of a skilled professional staff.

5) Reimbursement policies. Medicare and Medicaid have had important, even dramatic, impact on emergency department usage (32). This report, with the use of the model

described, explores the consequences of expansion of insurance coverage on emergency department services.

6) Cost. Each of the issues described above influences the cost of hospital emergency services. Further, the level and rate of capital investment, the size of clerical staff, costs transferred (or assigned) from the inpatient hospital operations, and bad debt experience, all will affect the cost of operating the emergency department. The systems dynamics model developed in this report explores the interactions of costs, staffing, patient-load, reimbursement policies and quality of care.

The model developed in this study simulates only the hospital emergency department, per se. Transportation systems, for example, are not considered, nor is patient care once the patient has been admitted to the hospital inpatient service. Other external factors are considered only as they affect the patient-load. The model can be enlarged in detail to incorporate many other features, but the scope of this report is deliberately limited as described.

METHOD OF ANALYSIS

The model developed for this study of hospital emergency services employs the systems dynamics technique described by Forrester (11) and first applied to health systems by Roberts. This analytical tool seemed particularly suitable to the study of hospital emergency services. The interrelationships of the hospital emergency services with inpatient care, the community at large, and with economic and social issues, provided a setting in which the systems dynamics method would serve well. Within the hospital emergency department we find striking examples of Professor Forrester's feedback systems. To quote from Forrester (11):

> A feedback system, which is sometimes called a "closed system", is influenced by its own past behavior. A feedback system has a closed loop structure that brings results from past action of the system back to control future action. One class of feedback -- negative feedback -- seeks a goal and responds as a consequence of failing to achieve that goal. A second class of feedback system -- positive feedback -- generates processes wherein action builds a result that generates still greater action.

An illustration of the negative feedback, or "goal seeking" feedback, at work in the hospital emergency department is not difficult to demonstrate. Patients with serious problems are seen as rapidly as possible in the emergency setting. Patients with less obvious emergency problems are obliged to wait for attention when the system is overloaded and a queue exists. An increase in total patient load has, as one of its consequences, an increase in waiting time, before service, for the non-emergency patient. An increase in the patient waiting time, in turn, decreases the perceived attractiveness of the emergency department to the patient, or his family. It then can be argued that non-emergency patients will use the hospital emergency department somewhat less frequently as the waiting time increases, in turn dampening the rate of increase of total patient emergency department visits. These phenomena then constitute, in Professor Forrester's terms, a negative feedback loop.

An illustration of the positive feedback loop also is easy to establish. As a hospital increases in size it becomes more "complete" in terms of the services that it offers. A large hospital, for example, might include a specialized care unit for patients severely burned, or a special respiratory care unit as part of its inpatient services. A small hospital is less likely to have these facilities. The more complete a hospital is in this sense, the larger the patient pool that it potentially serves. With a larger patient pool, one can expect more emergency department visits per unit time. This, in turn, leads to an increased number of hospital admissions (some 10 or 11 per cent of hospital emergency department visits result in hospital inpatient admissions). The rate of patient admissions ultimately affects the use of the hospital facilities, creating the potential for further specialized development, enhancing the hospital "completeness", expanding its attractiveness to a larger patient pool, and resulting in increasing growth. Growth processes feed back positively to result in still greater growth.

The complete description of any integrated system, industrial, social, or biological, involves both types of feedback loops. They interconnect with one another, but may act with differing delays in time and with different magnitudes of response. A matrix of feedback loops describing even simple systems rapidly becomes complex.

The technique of modeling with systems dynamics requires mathematical representation of the various relationships. With the aid of the computer these quantitative relationships, and their influences upon one another, can be followed through time. The system, or matrix, that quickly becomes too complex for the mind to follow is manageable by the computer. Thus, while one can mentally visualize the two loops described earlier, a system of ten, or many more, feedback loops, all interrelated to one another, is impossible for the mind to follow. The computer, however, can trace these actions and influences, synthesize the information generated, and provide descriptions of the ultimate effects.

Employing the technique of systems dynamics, we have constructed a mathematical representation of an urban hospital emergency department. A limited number of hypotheses have been tested. The hypotheses have been tested singly and in various combinations that will be described subsequently. The hypotheses initially tested have been deliberately kept simple and relatively non-controversial. This has been done so that the logic of the model can be validated and then expanded.

SAMPLES OF HYPOTHESES TESTED

1. Employing physicians with greater experience in the emergency department will lead to improved quality of care, faster patient processing rate, increased patient satisfaction and reduced costs per patient visit.

2. Increased use of nurse clinicians and paramedical personnel in the hospital emergency department will increase patient processing rates, improve patient satisfaction and will reduce costs.

3. Expansion of insurance programs will overload existing emergency facilities.

4. Development of expanded insurance programs that pay professional fees in private physicians' offices will decrease hospital emergency department use.

The results and interpretations are discussed in subsequent chapters.

CHAPTER II DESCRIPTION OF THE EMERGENCY DEPARTMENT

This section describes the physical plant and facilities, its organization, administration and staffing, and a description of the services offered. Details are limited to those that offer insight into the complexity of emergency department operations and assist in the understanding of the model. The description is idealized. It is not typical in the sense that few emergency departments contain all the features and facilities described. On the other hand, the description is realistic in the sense that nothing described is beyond present economic, technologic, social or professional practices or capabilities.

PHYSICAL PLANT AND FACILITIES

The model developed in this program envisions an annual patient load ranging between fifty thousand and one hundred thousand visits per year. The space required to provide service to this volume of patient traffic is not precisely known. Our research suggests that a minimum floor space of fifteen thousand square feet be considered.

The location of the emergency department within the hospital complex is of great importance. The emergency department should be placed so that the patient flow and attendant traffic arrives directly at the emergency department from outside the hospital without having to traverse other hospital facilities. The majority of patients seeking help in the hospital emergency department are ambulatory, arriving by private vehicle or public transportation. The ambulatory patient entrance should be designed and constructed so that no stairs need be climbed or descended to enter the emergency department.

A registration and control area should be established at the entrance of the emergency department. A small area with comfortable seating should be supplied so that the distressed patient and relatives can be more comfortably positioned while the often misunderstood, but necessary, information can be gathered.

A resuscitation room should be placed immediately adjacent to a separate ambulance entry. This should be out of sight and sound of the ambulant patient entry and its waiting room.

The remainder of patient area within the emergency department can be divided in design for two general functions, those serving the true emergency patients and those areas serving the non-emergency patients. It is important that separate areas be established for pediatric patients, psychiatric patients, patients suffering from drug ingestion, and patients requiring special forms of intensive care.

An emergency operating room equipped to initiate care for auto accident victims, gun-shot wounds, open fractures, crushing chest injuries and central nervous system trauma must be provided. When properly used, this area can spare the use of larger more expensive facilities in the hospital's principal operating suite.

Laboratory facilities can be limited to support of those procedures commonly required, urinalysis and routine hematology. More elaborate tests, such as those of blood chemistry, can better be accomplished in the central hospital laboratory.

Diagnostic x-ray facilities also should be present within the emergency department. X-ray studies requiring the use of contrast media can be done more expeditiously in the hospital's central diagnostic x-ray facilities.

Because of the turbulent social patterns and disruptions caused by illness, it proves meritorious to have a division of the hospital social service program established in the emergency department area.

Patient care facilities for the non-emergency group should include pediatric rooms, private offices for psychiatric interviewing, examining rooms for obstetrical, gynecologic and urological patients, as well as interview and examining areas for adult medical and surgical patients. Multiple purpose conference rooms should be provided within this area for discussion of complicated patients and for staff meeting and teaching functions. A small library can be adjacent to this area for the use of professional personnel.

ORGANIZATION AND ADMINISTRATION

The multiple demands placed upon the hospital emergency department and the complex relationships necessary for responding to these demands create a difficult organizational problem. The functional structure more closely corresponds to a matrix organization but, as described below, it would appear to represent a more traditional pattern.

The organization is directed by a full-time physician who operates under a director of ambulatory services. In a smaller hospital, the physician director of the emergency department also can serve as director of ambulatory services. The director of ambulatory services (or the director of the emergency department if they are the same person) should be equally placed in the hospital organization with directors of individual clinical and clinical support services. The director of the emergency department has reporting to him the nursing supervisor for emergency services and an administrator. The former also is a member of the hospital nursing hierarchy; the latter also is a member of the hospital administrative structure. Reporting to the emergency department director of nursing are the staff nurses and nursing assistants, as well as certain of the technical, paraprofessional personnel such as surgical technicians. The emergency department administrator has reporting to him record, financial, insurance, and non-professional laboratory and x-ray personnel.

The social service representatives in the emergency department work with the nursing department but are not responsible to them. They are jointly responsible to the administrator for the emergency department and their own supervisors within the hospital social service structure.

All physicians working within the emergency department are professionally and administratively responsible to the physician director for emergency services. While interns and residents normally are members of the clinical specialty departments, while working in the emergency department they are under the direction of the director for emergency services.

THE PROBLEMS OF STAFFING

Hospitals initially were created as agencies to house the indigent when they took sick. The well-to-do, when ailing, were cared for at home. On this basis, the large urban hospitals developed as instruments for care of the poor. When advances such as anesthesia occurred in mid-19th century, and the principles of asepsis developed in parallel, surgery as a practical remedy became established. With this development hospitals then expanded their function to serve as agencies for patients from other socio-economic groups. The care of the indigent patients was left largely to newly graduated physicians as a vehicle for gaining experience. At the same time these young physicians cost the hospital the least as they were unsalaried or poorly salaried. The new physicians were eager to have the experience and responsibility, and were willing to forego significant financial reward at the same time.

In recent years this has changed. More hospitals offer opportunities for interns and residents than there are U. S. graduates to fill them. At the same time, the newly graduated physicians and those in their postgraduate training period expect and receive a salary nearly commensurate with their experience and responsibilities.

The dilemma of the emergency department today is that of the hospital at large: How to provide the optimal care that every professional wants to supply and every patient understandably desires, while keeping the costs at a level low enough so that individuals will neither deny themselves care because of fear of higher charges, nor be devastated by those charges when care is imperative. Costs also must be kept within the abilities of insurance carriers to meet them without constantly escalating the policy premiums, and low enough so that the emergency department does not create a crisis in cost allocations within the hospital, possibly denying other hospital areas of less visible but equally important stature, their share of the hospital dollar.

The central determinant and the ultimate solution to this dilemma of services and costs lies with the staff of the emergency department. On the one hand it is the staff that establishes the level of care provided in the department. Their attitudes, their skills and their numbers determine the quality of care. On the other hand, it is their composition, their resourcefulness, and their ability to work together that largely determine the costs of providing emergency care. Without proper leadership and development of motivation toward common goals, important coordination of effort is lost and individual and institutional harm can result.

Clearly, recruitment of the best personnel, their organization into a cohesive instrument with recognition of common goals, training and continuous upgrading of all skills, and effective utilization of all personnel are the most important managerial efforts within the hospital emergency department. These lofty aims, however, frequently are difficult to achieve because of a number of problems.

The personnel working in the hospital emergency department represent multiple functional units within the hospital. However loyalties may be directed toward common emergency goals, if they ever have been delineated, responsibilities and rewards are determined elsewhere by persons not usually primarily concerned with the emergency department.

Determinations of physician staffing are made, in part, by viewing the experience as a learning one, yet operating under the financial constraints imposed by the administration of the emergency department. Patient care is, for most, a governing principle but it necessarily operates within certain limits.

Nursing assignments are made, on the other hand, largely from the standpoint of service to the patient. Financial constraints operate here as well. Nursing staff and schedules are under the direction of the nursing office, however, and do not always coordinate optimally with physician assignments.

The shortage of physicians and nurses has led to the suggestion that technical specialists be trained who can serve to reduce the burden on the more highly trained professionals. Experience suggests that such persons can be effectively trained and do serve creditably as postulated. At the present time legal constraints limit the role that the new physician assistants can play. Their administrative and professional direction also is not clear at this time. Many emergency departments have record room functions, house-keeping functions, and other technical support areas separately administered. This creates staffing and service problems which can be diminished by centralizing the authority in a single emergency department administrative unit. The model described operates with this in mind.

In summary, traditional emergency department staffing has suffered on several bases. Too little coordination has been evident in staffing decisions so that optimal team approaches to patient care could be accomplished. Secondly, staffing decisions have been empirically based and the data to support them have been scant. To these, also, can be added the problems of rising salaries and the difficulty of recruitment of personnel. The model described permits examination of alternatives that take these problems into consideration.

SERVICES PROVIDED

The history of the development of hospital emergency departments is that of initially providing care for patients accidently injured. As medical knowledge improved the hospital emergency department became the point at which, in the cases of illness developing acutely, distinctions could be made and initial treatment supplied. Social issues, however, rather than medical issues, have played a larger role in shaping the evolution of the hospital emergency department into the complex organization it represents today.

The poor who did not have acute illnesses were cared for in large, out-patient clinics that developed in urban hospitals. These were modeled after the clinics developed in the hospitals in western

Europe from which most of our medical traditions have come. When these clinic patients became ill at times outside of clinic hours they were brought to the hospitals for care. As surgical techniques improved activities in the emergency department increased. The development of the automobile increased the amount of trauma seen in hospital emergency departments.

An exponential growth of activities in hospital emergency departments has taken place during the past twenty years. It is in this time that great social dislocations have occurred in this country. Many rural families have moved to the city. The total population has increased but we have not had a proportionate increase in the number of physicians entering practice. Our political and social consciousness has developed to the point where health care has been recognized as a fundamental human right. Insurance programs that permit the care of those who previously could not afford it have been created. All of this has resulted in demand for health care that could not be supplied within the previous structure of the system. The hospital emergency department has evolved as the most elastic facility for relieving some of the burden on the total system.

Scientific discovery and technological development also have added to the growth of the hospital emergency department. Surgical techniques that permit repair of injuries to major blood vessels and even to the heart, itself, the use of roentgenographic techniques to demonstrate illness and injury, the development of new bacteriologic and serologic methods for rapid diagnosis of certain infectious illnesses -- all these have contributed to increasing patient traffic.

Improvement in transportation systems also has played a part in increasing the activities in the hospital emergency department. In major metropolitan areas public transportation, while not free of fault, facilitates transit to the hospital. The development of high speed roadways for the use of rural populations, coupled with the rapid growth of the automodile in our cities, also has increased emergency department activities. Interestingly, there has been no proportionate growth in per cent of patients arriving by ambulance. Over a several year period in one community studied, the patient arrival by ambulance has remained at a relatively constant ten to eleven per cent. During this same period emergency department visits grew at a rate of eight to ten per cent per year (18).

Today not only the poor seek medical care in the hospital emergency department. The middle-class and well-to-do also use the emergency department as their physician on occasion. In the case of the indigent, they either have no other access to care or require it at a time when the clinic is not open. In the case of the middle-class or well-to-do, it may be that care is required at a time when their own physician is not available or, most interestingly, at a time when they do not wish to bother their private physician.

Preliminary data suggest that the nature of insurance coverage also has resulted in a disproportionate use of emergency department facilities. Certain insurance programs will pay for services rendered in an emergency department but will not pay for them when the same services are performed in a doctor's private office or in a private laboratory. Understandably, there is some tendency for the patient to seek his care where he does not have to pay for it.

The model developed in this study represents an emergency department that can provide a wide range of services. The model makes only general distinctions between true emergencies and non-emergencies. In the category of true emergency would be services supplied because of injury that might be life-threatening, such as head injury or severe chest or abdominal injury. Acute illnesses such as myocardial infarction ("coronaries"), pulmonary embolism and infarction, pneumonia, bleeding esophageal varicies or bleeding peptic ulcer, all these represent examples of acute illness that are considered true emergencies. Psychiatric problems represent a significant portion of true emergencies. Obstetrical complications can represent ture emergencies. Some dental problems also can be so considered.

Problems that are classified as non-emergencies represent a heterogeneous group. Most are genuine medical problems and the classification depends upon the urgency. Others are more social than medical, and yet others can be considered public health problems rather than emergency problems. Examples include unexplained headache that has lasted for a day or two, unexplained temperature elevation of a smiliar duration, recurrent abdominal discomfort that is troublesome but not disabling, and upper respiratory symptoms. Referrals of aged patients by family who no longer feel able to care for them at home, and similar referrals from nursing homes when the patient interrupts the routine of care, also serve as a source of referral. Increasingly, patients with venereal infections seek their care in what they view as the anonymity of the hospital emergency department, rather than seeking care privately or, in the case of students, at the institutions where they are enrolled. Some patients who normally are seen in the hospital clinics will seek prescription renewals at times when the clinics are not open. Toothache that somehow can be tolerated during the day often becomes intolerable at night and patients seek relief in the emergency department for this. It probably is fair to state that there exists virtually no complaint of medical or social sort where comfort or redress is not thought possible in the hospital emergency department! While the model developed does not deal with all the specifics, it is important to bear in mind the diverse demands that are made on the emergency department while it tries to cope humanely and efficiently with the problems brought to it.

CHAPTER III THE UTILIZATION OF THE HOSPITAL EMERGENCY DEPARTMENT

This description of emergency department utilization is based in large part upon data derived from studies conducted in Rochester and Monroe County, New York. The data and impressions are derived from published studies conducted by the Genesee Regional Health Planning Council, departments of the University of Rochester School of Medicine, the Neighborhood Health Center, Inc. of Monroe County and from interviews, personal observations and experience of the authors of this report.

POTENTIAL PATIENT POOL

Although numerous studies have been made of individual hospital emergency departments, studies of emergency department utilization of entire communities are notably uncommon. Such studies have been conducted during the past several years in Monroe County, New York, and many of the data used to help characterize this model have been derived from those studies.

A key consideration in this model is what we call the potential patient pool. The 1970 federal census figures indicate a population of approximately 712,000 in Monroe County. This figure represents a compounded rate of growth of approximately 2.1 per cent per year over the previous decade. Cumulative data for emergency department utilization do not exist for the same ten year period. In a single hospital (The Rochester General Hospital), the rate of increase of emergency department utilization for this 1960-1970 period was approximately eleven per cent per year. For the entire Monroe County area in the two year period 1968-70, the annual rate of increase in emergency department utilization was approximately 8.6 per cent.

DEMOGRAPHIC INFLUENCES

Demographic data are of particular importance in any effort at policy planning in the health care area. Not unexpectedly, the urban population utilized emergency department services at a greater rate than did the suburban areas. The communities surrounding, but not including, the city of Rochester contributed 165 patient visits per year per 1,000 population in 1970. During that same year, the population of the city of Rochester utilized emergency department services at the rate of 453 patient visits per 1,000 population. The consolidated urban and suburban utilization rate for 1970 was 285 visits per 1,000 population. For the city of Rochester, the annual growth rate in utilization for the two years, 1968-70, corrected for population growth, was just over 3 per cent per year. For the suburban areas, the annual growth rate of utilization, corrected for population, was approximately 2.5 per cent.

When one looks at smaller divisions within the city one finds equally interesting data. Certain areas of the city have been designated as major poverty areas. The population within these areas declined in the two years mentioned, as did the absolute number of emergency department visits. Nonetheless, the utilization rate of emergency services still increased. The rate in 1968 was 964 visits per 1,000 population and in 1970 the rate was 972 per 1,000 population. These figures represent rates six times that for suburban areas, and more than twice that for the city at large. In 1970, 15.5 per cent of the urban population lived in the two lowest socio-economic areas. Some 40 per cent, however, of all emergency visits from the city came from these two areas. The emergency visits were not a consequence of more accidents or more "true emergencies". The 1968 data suggested that 72 per cent of the visits from these areas could have been treated in a physician's office.

REFERRAL PATTERNS

The overwhelming majority of visits to the emergency department are stimulated by the patient or the family. In 1968 two-thirds of the patients were so referred; two years later these self-referred patients represented three-fourths of all the patient visits. A socio-economic point not to be overlooked is that patients representing the highest socio-economic areas were six times more frequently referred by private physicians than were the poorest patients (16.8 per cent for the former to 2.8 per cent for the latter) in 1968. In 1970 the ratio for frequency of referrals by private physician for the richest was four times that for the poorest patients (9.3 per cent for the former to 2.3 per cent for the latter). A sizable drop occurred in the physician referrals in the highest socio-economic group, but the already low rate of referral by physicians among the poor dropped even further, possibly reflecting diminished access to private care.

The ratio of patients transported to the emergency department by ambulance has remained relatively stable at about 11 per cent of total patient visits over the past several years. A generous scatter about the 11 per cent figure is noted for various hospitals in this study as well as variation in the same hospital figures over a period of time. Most patients (approximately 86 per cent) arrived at the emergency department having been transported by public transportation or private automobile. One inference that might be drawn from this relates to the greater incidence of medical problems, rather than accidents and disabling injuries.

TYPE AND SEVERITY OF CLINICAL PROBLEMS

Other information held to be important in developing the model is the nature of the problem suffered by the patient and some assessment of its severity. A classification designed by Kluge et al (18) was employed. Three definitions were used. The first was that of no emergency condition present. This described those conditions which either did not require the advice of a physician, or that could have waited twenty-four hours or more before the patient sought attention. The second was considered an emergency in that the patient should be seen prior to the elapse of a twenty-four hour period, but did not need immediate availability of emergency facilities. The third classification was that of a true emergency. These patients had problems that, even if later not serious, required prompt attention by a physician and, by their very nature, were apt to require facilities such as x-ray, operating rooms and the consultation of other physicians.

Data from two separate studies were analyzed. The studies were not perfectly comparable so that rigid comparison is inappropriate. Nonetheless, helpful information has been derived from them (36). A 1968 study concluded that 35 per cent of patients seen in one hospital in Monroe County were true emergencies and 65 per cent were seen for problems that could have been dealt with in the physician's office at a later time. A 1970 study which included all hospital emergency departments within Monroe County, concluded that 55 per cent of patients seen could be considered true emergencies. This latter figure was derived from reviews of the same records made independently by an experienced nurse and an experienced physician. The nurse concluded that some forty-nine per cent were true emergencies; the physician concluded that something over thirty per cent were true emergencies. Either, or both, voted some fifty-five per cent true emergencies. These data conservatively suggest that as many as one-half the patients seeking emergency department care could be well served in some other facility.

When one examines emergency department visits by diagnostic classification some constancy over a several year period is observed. Injuries or adverse effects from chemicals or other external causes (burns) represented forty-six per cent of patients visits in 1968 and forty-four per cent in 1970. Respiratory illnesses represented eleven per cent in both studies; other infectious illnesses represented four per cent in both studies. An apparent increase in psychiatric diagnoses occurred between 1968 and 1970, going from three per cent to five per cent of the total. If one views all of these in the aggregate, medical rather than surgical, problems represented some forty-five per cent of all problems in 1968, and forty-five per cent of all problems in 1970. A more careful examination of accidents and injuries reveals that problems related to falls, or to piercing or cutting injuries, represented forty-three per cent of all visits in 1968, and forty-three per cent in 1970. Vehicular accidents constituted nine per cent in 1968 and eight per cent in 1970. Injuries inflicted by one person upon another represented four per cent in both of the two study periods; animal bites represented four per cent of all accidents in 1968, and four per cent in 1970.

As noted earlier, the fraction of emergency department visits that led to patient hospitalization was very similar in 1968 and 1970, 10.6 per cent in 1968, and 10.9 per cent in 1970. In 1968, 74.8 per cent of patients were either sent home or referred to their own physician following treatment. In 1970, 72.1 per cent were similarly handled. In 1968, 8.3 per cent of patients' visits led to an outpatient clinic referral. In 1970, 7.8 per cent of patients were similarly referred. A point that we will return to later is that, in 1968, 1.4 per cent of patients returned to the emergency department again with a problem (presumably) related to the first visit, while 1.9 per cent of visits could be so related in 1970. Patients pronounced dead on arrival at the emergency department represented 0.4 per cent in both study years.

AGE DISTRIBUTION

The age distribution of patients seen in the emergency depardment appeared to change little between 1968 and 1970. A decrease of approximately five per cent in visits by children under ten years of age was noted in this time span. This modest, but probably significant, decrease has been attributed to the development of a neighborhood health center in a low socio-economic area within the city of Rochester (36). A surprisingly constant relationship for the two separate studies was observed in virtually all other age classifications. The distribution by gender also stayed the same, with some 55 per cent of visits being by males and 45 per cent by females; this despite the fact that the distribution by sex throughout the county reveals that some 48 per cent of residents are males and 52 per cent female. Thus, some seven percentage points greater visits by males are noted than would be proportionate to their representation in the population.

INFLUENCE OF INSURANCE

A separate inquiry, questioning influence of insurance programs on age distribution of patients seeking emergency department care, was carried out at the Rochester General Hospital. This revealed that when emergency department visits by patients sixty-five years of age or greater was compared for January, 1965 -- eighteen months prior to the implementation of Medicare -- with January, 1970, after three and a half years experience with Medicare, the total patient visits in the emergency department had increased 72 per cent, but the increase in patients over age sixty five was more than double that, at 146 per cent.

Consideration of the source of payment for emergency department visits revealed differences difficult to interpret. In 1968, 51 per cent of visits were paid for by Blue Cross, whereas in 1970 43 per cent were similarly covered. This decline would appear to be significant but is difficult to interpret for several reasons. Principal among these is the change in the economic situation in the area during that time. Unemployment increased sharply between those two dates and it is possible that a significantly smaller fraction of the patient pool was covered by insurance. This is conjectural as these data are not available. In 1968, 15 per cent of emergency department visits were paid for by Medicaid, whereas in 1970, 20 per cent were so covered. This would be in keeping with the increase in unemployment in the community. The percentage of patients who paid for their visits themselves, without insurance, stayed nearly constant at about 11 per cent. Medicare changed from some five per cent of the visit payments in 1968 to 3.5 per cent in 1970. This is quite different from the data gathered at the Rochester General Hospital. No obvious explanations are at hand.

Cumulative data about the costs of operating the emergency departments are not available. In fact, few precise data of the costs of operation of the emergency department in individual hospitals are available. Despite uniform accounting procedures required in hospitals in the state of New York, allocation of costs within the hospital to the emergency department presently do not permit rational analysis.

CHAPTER IV THE SYSTEMS DYNAMICS MODEL

Introduction

A model is viewed popularly as a representation of an object or a structure. The model may be precise in detail, exquisite in its execution and may describe reality in every sense. The model may be constructed on a diminutive scale as, for example, in the case of bridges or dams, on a scale equal to the object or structure it represents, or it may be on a vastly expanded scale such as models designed to illustrate the structure of chemical substances at the molecular level.

A model can be viewed in other ways, however. It serves as an abstraction of reality and, in a functional sense, substitutes for reality. Few who have seen a young boy flying his airplane constructed of clothes pins, or observed a young girl lavishing affection on her Raggedy Ann doll - neither of which models represents the real world objects of excitement or love in more than the simplest sense -- will have difficulty in accepting the utility of physical models.

Models of processes probably are a good deal more common than models of objects. These process abstractions, most commonly mental images, govern much of our thinking. Our imagery permits us to identify and relate the components of the model and to restructure it in ways that permit increased understanding and utility.

The utility of the mental model may take a number of forms. Complex phenomena may be understood through integration of simple processes. Psychological stability may be enhanced by clarification or simplification of previously complicated events. The point to be made here, however, is that virtually all of our thought processes employ models.

The success achieved by employing a model depends upon many factors. Prominent among these are the degree to which the problem or process can be modeled by building its whole from simple components, the degree to which the model bears fidelity to the real structure or process being modeled, and the ability to express the relationships of the component parts of the model in quantificable terms. When the latter can be achieved, ambiguity diminishes. Descriptive weaknesses in the model are minimized when the model can express relationships in mathematical terms.

A goal common to most model design is that the process improves our understanding of the real phenomenon being modeled. The model often represents a simplification of the real problem. In this way the essential structure of the problem can be clarified or emphasized. This simplification in the model structure often is challenged because the model no longer perfectly resembles the real structure or problem it describes. Forrester defends against such criticism by suggesting that models should be judged, not on an absolute scale that condemns them for failure to be perfect, but rather on a scale that approves them if they succeed in clarifying knowledge and insights into systems (11).

DEFINITIONS

A system can be defined as an organized or connected group of objects, or a set of principles or ideas, that are related by some common function or belief. The term, system, is used in this report to represent a grouping of personnel, practices and programs that work toward a common goal.

A dynamic system is one that varies with time. The behavior of the system is influenced by the passage of time.

The systems dynamics model described in this report is an example of a simulation model. To model by simulation requires a detailed description of the process being modeled. The various factors and events that cumulatively constitute the process being modeled must be identified. Relationships between the component parts must be established and the results of the interactions evaluated.

The systems dynamics simulation, however, requires more than that. This special type of simulation further subsumes that the component parts of the system being modeled influence one another over a period of time. They have a dynamic, rather than a static, relationship.

The essential characteristic, indeed, the sine qua non, of the systems dynamics relationship is the "feedback". This states that the function of the system is influenced by its own past behavior. A popular illustration of the feedback system is described by the relationship between the furnace of a home and the thermostat which controls the temperature in the home. The heat generated by the furnace is controlled through the action of the thermostat influenced by the heat previously generated by the furnace. When sufficient heat has been produced so that the room temperature reaches a desired level the thermostat functions to turn off the furnace so that no more heat is generated. If insufficient heat has been generated so that the temperature of the home has not reached the desired level, the thermostat permits the furnace to generate more heat. This is defined as a "goal-seeking" or "negative" feedback system.

An example of a complex, biological, negative (or goal seeking) feedback system is that which helps govern the oxygen carrying capacity of blood in man. When the hemoglobin level in blood falls, the kidney responds by producing a precursor of a hormone that stimulates the development in the bone marror of the hemoglobin containing red blood cells. The oxygen carrying capacity of the blood is then increased by the newly produced red blood cells. When the hemoglobin level is at or above the level necessary to transport oxygen normally, production of the hormone precursor by the kidney is diminished and fewer new red blood cells are delivered to the circulation.

Positive feedback systems also exist. Systems governed by positive feedback are those in which an action or process results in yet more action or more product. A simple example of positive feedback is offered in the area of personal finance, that of the bank savings account. Interest paid on a deposit, if not withdrawn, enlarges the sum on deposit so that interest subsequently paid is yet larger and when added to the savings generates yet larger earnings when interest next is paid.

An example of positive feedback in human biology can be drawn from a disease, acute leukemia. The proliferation of leukemic cells results in the production of more acute leukemic cells so that they generate in a logarithmic growth fashion. Normal white blood cell production is characterized by a negative, or goal-seeking feedback system where the goal is a stable level of white blood cells.

Most social systems are complex; they are described best by a large number of related feedback systems. The feedback systems, in summation, constitute an integrated structure with characteristic behavior.

The conceptualization of a program or process so that it can be modeled as a dynamic system requires that the components of the system be described or classified in one of two fundamental ways. These two types or classes of descriptors are <u>levels</u> and <u>rates</u>.

A <u>level</u> represents an accumulation of whatever is being described. A level can be the amount of money in a savings account, if the system being described is one of personal finance; a level can be the volume of packed red blood cells in the circulation if the system being described is that of normal physiology; a level can also be the number of physicians working in a hospital emergency department if that is the system being described. A level is the state of one component of the system. All of the levels in a system cumulatively describe the state of the total system.

A <u>rate</u> is a description or statement about how a level is changing. It is a statement of behavior, a depiction of an action.

A rate is measured over a period of time and is given as an average. Rates of speed can be measured as miles per hour or feet per second, rate expressions of changes in financial levels can be described in dollars per year and rates of energy expenditure may be stated in terms of calories per hour. The interval of time over which a rate is measured can be vanishingly small; the rate calculation thus becomes increasingly accurate but it is, nonetheless, measured over a period of time. Accordingly, the rate must be considered an estimate. The estimate may be very precise when the time interval is very small, but the time period is never zero.

In the mathematical sense, levels are integrations. The levels integrate the results of change in the system. The levels in the system do not change instantaneously. They are a function of the accumulation of changes in the rates and these occur only over a period of time, however small.

Rates, in turn, depend upon levels. Changes in levels determine the rates and the rates, in turn, determine the levels. This, in essence, describes the closed feedback loop.

A concept of value in the design and clarification of a systems dynamics model is that of the auxiliary function. The auxiliary is a statement (equation) that assists in the development of the statement (equation) of the <u>rate</u> that immediately follows the auxiliary statement. It is an algebraic subdivision of the rate equation. It can be united with the rate equation or eliminated altogether, without fundamentally changing the structure of the system. The auxiliary serves, however, to clarify the system and can be an advantage in the model.

In summary, a system can be classified as open or closed. The latter is known as a feedback system. The closed system is influenced by its own past behavior. The past performance governs future results. The closed, or feedback, system can be subdivided into negative or positive feedback systems. The negative, or self-correcting, feedback system is considered a goal-seeking system. It responds and modifies its future performance based upon knowledge of its past performance. The positive feedback system is a growth generating system. Past action produces results that in turn produce still greater results. Logarithmic increase is the characteristic of the unspoiled, positive feedback system.

The necessary components of a feedback system are levels and rates. The levels integrate (accumulate) the results of past levels and past rates (actions) and are changed only by the rates. The rates describe how a level is changing.

Designing a model by describing a process step by step is called simulation. The description of levels, rates and feedback processes characterizes the systems dynamics type of simulation.

Employment of the computer in simulation modeling permits the building of complex models that otherwise would not be possible. The use of the computer also permits repeated change, modification and evaluation of the model. The model can be refined as perceptions into the workings of the system improve. The validity of the information generated depends upon the accuracy of the model description. The computer offers the opportunity for repeated iterations so that theory and assumptions about the model behavior can be challenged repeatedly. The understanding of the process or program being modeled thus inevitably improves.

THE MODEL: ITS RATIONAL BASIS, SAMPLE EQUATIONS, CONSTRUCTION AND ILLUSTRATIVE RESULTS

This model, which describes an urban hospital emergency department, is viewed as consisting of four major components. These, in turn, have smaller subsystems. All of these interact with one another in the functioning of the model. The major divisions of the model are:

I. The potential patient pool and the patient load that develops from that patient pool;

II. The staff necessary to provide care in the emergency department;

III. The capital investment in the emergency department facilities, including plant and equipment;

IV. The financial aspects of the emergency department operation.

The following paragraphs illustrate the development of equations used in the construction of the model.

The potential patient pool (PATPOOL) proves to be the most important factor in determining the degree of hospital emergency department activity. PATPOOL has been defined, in this model, as the number of individuals potentially served by the hospital emergency department. This can be considered a catchment area but it should be viewed abstractly rather than in a geographical sense. Many patients who select a hospital for their emergency department care do not do so because of geographical convenience but for other reasons that will be discussed subsequently.

The patient pool for this model is stated to be 150,000 individuals. The growth rate constant of this population (PGC) is stated to be 1.5 per cent per year, compounded. The equations describing this are as follows:

PATPOOL = PATIENT POOL (INDIVIDUALS)

PATPOOL.K = 150000*EXP(PGC*TIME.K) 22, A

These expressions indicate that the patient pool at any time, K, is equal to 150,000 people multiplied by the exponential growth rate constant (1.5 per cent per year) at the time K.

Our research data suggest that about 40 per cent of the potential patients of an urban hospital emergency department will annually experience an incident that will result in a visit to the hospital emergency department. This has been defined as the POPULATION PERCEIVED EMERGENCY (PPEMER), defined in equation 22.2, C:

PPEMER = .4(DIMENSIONLESS)

The population perceived emergency equals .4. This is a dimensionless number, representing the per cent of the potential patient pool that will demand emergency services. As the initial value for the potential patient pool is 150,000, the modeled emergency department has an initial patient load of approximately 60,000 visits per year.

A somewhat more complicated statement dealing with patient visits to the emergency department is illustrated by equation 21, R. This equation defines the CHANGE IN PATIENT LOAD (CPL) which is expressed in visits per year. The equation is:

CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER

This states that the rate of change in patient load between two points in time K and L is equal to the perceived attractiveness of the emergency department to patients at time K (PAEDTP.K), times the patient pool at time K (PATPOOL.K), times the ratio of population perceived emergencies per year (PPEMER).

The perceived attractiveness of the emergency department to patients has been defined as a third order information delay function. This relates the actual attractiveness of the emergency department to patients (AEDTP) and an information delay time to patients (IDTTP) (see page 109, Appendix II). The latter definition asserts that it takes four years for approximately 60 per cent of the patient pool to perceive changes in the emergency department operation that would change their estimate as to its desirability as a haven for care. The graph illustrating the third order delay function is included in Appendix II.

The actual attractiveness of the emergency department to patients (AEDTP) is defined in detail in Appendix II. We have reasoned that the attractiveness of the emergency department to patients is a function of the speed of service and the patients' perception of professional skills. The expressions dealing with the attractiveness in terms of waiting time are determined by the ratio of the patient load in visits per year to the planned capacity of the emergency department, divided by the normal overload of facilities in the area. The normal overload has been arbitrarily defined as 1.2. We have asserted that a 20 per cent excess of patients beyond the planned capacity of the emergency department will not have an adverse effect on the attractiveness of the facility. That is to say, the operation of the emergency department is not significantly impaired by that increase over planned capacity. When overload exceeds that, however, attractiveness as perceived by the patient will fall.

Detailed descriptions of the equations used in this model are presented in Appendix II. These include definitions describing the staff, capital investments, finances as well as the considerations of patient pool and patient load.

OPERATION OF THE MODEL

The functioning of the model can be illustrated by referring to the next page which is the graphic output of the base model. This simulation displays the changes of seven important variables through fifty years of time. These are: the number of interns (I), residents (R), capital investment (C), patients (P), overload of the emergency department (O), quality of care in the emergency department (Q), and profit or loss of the emergency department operation (S). The values for each of these initially are as follows: interns = 6.3, residents = 4.8, capital investment $2.63 million, patient load 60,700 per year, emergency department overload (a ratio of actual patient-load per year over a planned capacity)=1.2, quality of care (which is expressed on a scale from 0 through 1, with 0 being the worst care and 1 the finest possible care) = 0.6, and the financial loss of operating the emergency department just less than $200,000 per year.

The initial values and constants used in the "base" simulation of the hospital emergency department were derived by a three step process. First, the model was programmed using values obtained by research, or the authors' best estimates for these initial values (e.g. the normal annual rate of hiring interns-NHRI) and constants (e.g. the time it takes an intern to treat an emergency patient - IMPE). Next, the simulation was run until the outputs stabilized in equilibrium. The third step was to replace the initial values used in step one with the values of these variables recorded at equilibrium. Finally, the program was rerun to prove the equilibrium condition. The equilibrium state assumed a static patient pool. The print out of the system in stability is included as page 145 in Appendix III.

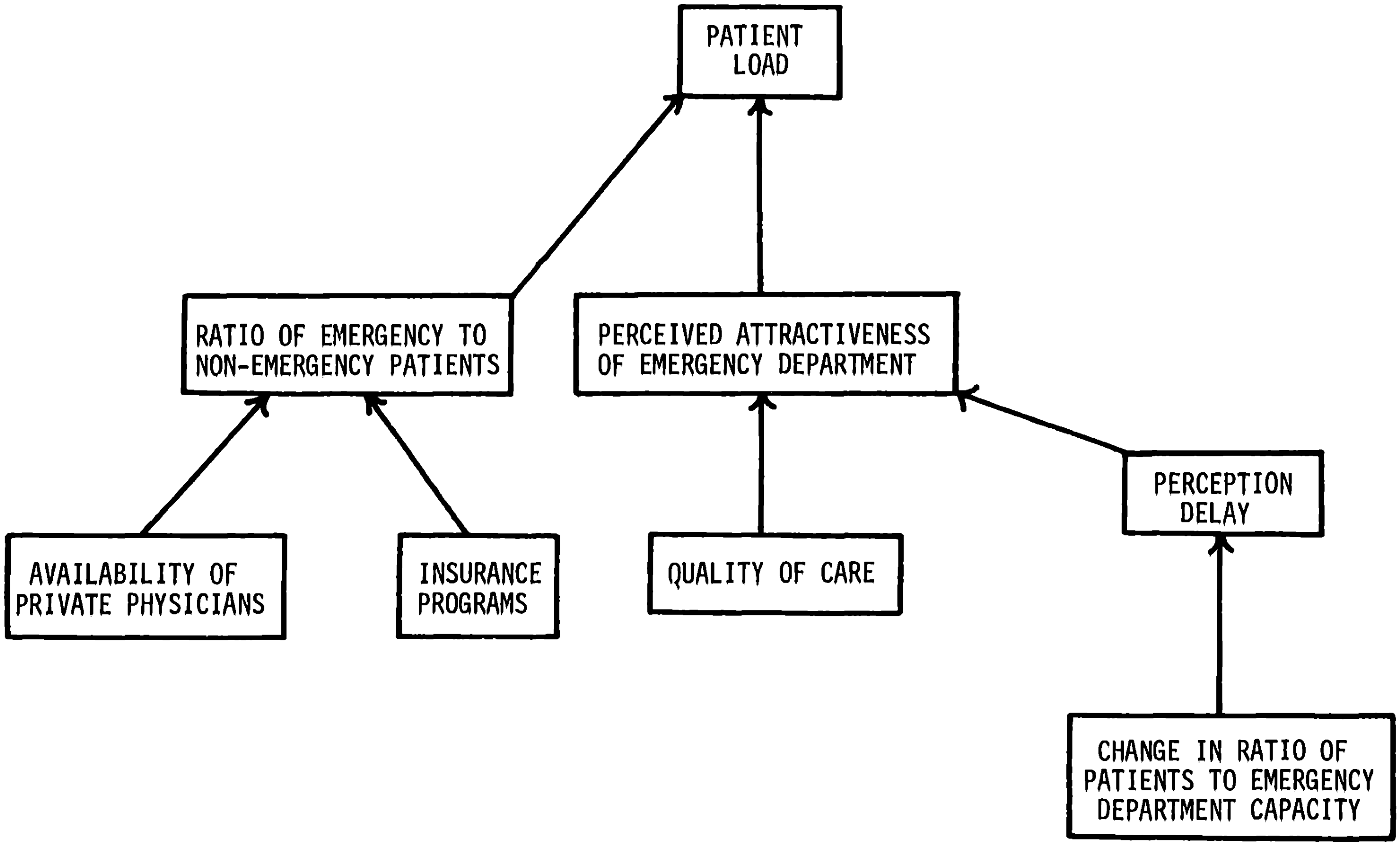
The equilibrium condition is achieved by running the model with the patient pool growth constant (PGC) at 0 rather than at its normal value of 1.5 per cent per year. The equilibrium values for these seven variables then are selected as the initial values of the base model run (page149, Appendix III). The base model run then is made with the potential patient pool growth constant at 1.5 per cent per year.

The base model demonstrates several points of interest. The patient load begins to rise after the first year of operation, reflecting the steady increase in the potential patient pool. The emergency department overload increases approximately in parallel, reflecting its dependent nature on the patient load. The interns and residents necessary to staff the emergency department rise slowly and in a slightly delayed fashion when compared to the rise in patient load. The quality of care slowly but steadily decreases as the overload in the emergency department rises. This reflects the necessarily shorter period of time that the staff has to devote per patient and the lengthening stay in the emergency department for the patient waiting to be seen. Capital investment changes most slowly of all, not rising significantly until about twenty years. This reflects the assertions made (to be found in Appendix II) which describe the delay prior to recognition of need for implementation of capital improvements. A fairly steady negative financial operation is evident during the course of the run, largely reflecting the increased cost of staffing the emergency department as the patient load increases.

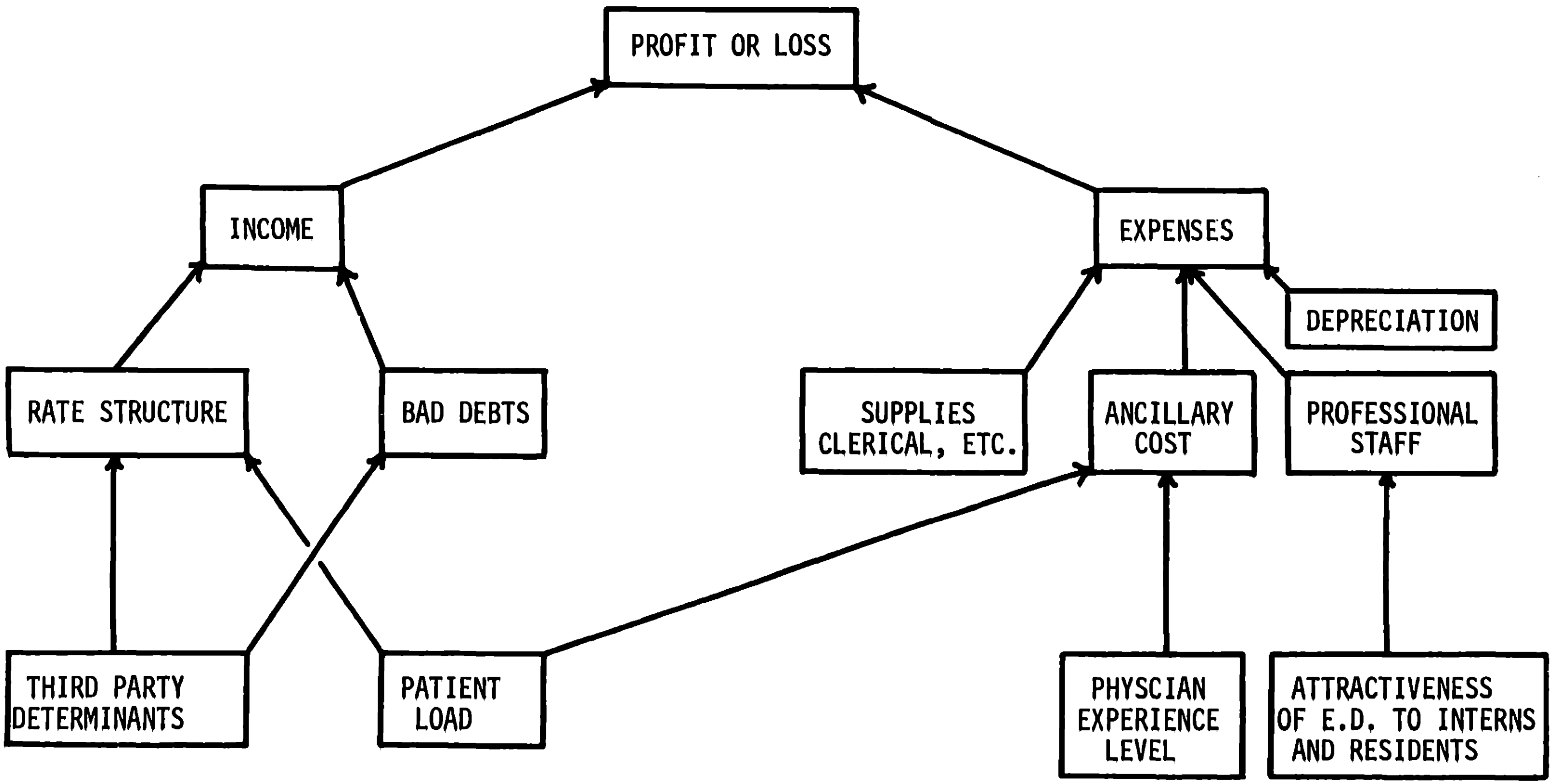
The base simulation displays little information that is surprising. This is true particularly for the patient load and the staffing by interns and residents. The steady erosion of quality of care deserves comment. While the units of measurement have been arbitrarily established it is evident that by year ten the quality has dropped by one-third of its initial value. As defined in the model seven-tenths of the quality function is determined by the ratio of the patient load to the planned capacity. This might not be viewed by some as a matter of concern. The other side of the coin, however, is that three-tenths of this deterioration in quality reflects diminished time of physician spent with patient and this must be a matter of concern. Subsequent testing of the model and addition of other external variables should be examined with a view of this parameter in mind.

A final note regarding the base model relates to the financial aspects. Although progressive financiai loss worsens over the period of time graphed, the magnitude is not great. Even after fifty years an additional loss of less than $80,000 annually is incurred. While the curve is impressive, the actual financial loss is less so.

On the following two pages we have graphically displayed some of the more important interrelationships that influence the base simulation.



PATIENT LOAD: SELECTED BASIC RELATIONSHIPS



FINANCIAL CONSIDERATIONS:

SELECTED BASIC RELATIONSHIPS

CHAPTER V USING THE MODEL

Sensitivity Tests

In testing the sensitivity of the model to changes in values of the key variables, we have selected alternate ranges of values that represent reasonable extremes of each major variable. The initial values used in the base model represent our best figures for the urban emergency department. The graphic outputs following the equilibrium run in Appendix III display the reaction of seven major model variables - interns (I), residents (R), capital investment (C), patients (P), overload (O), quality of care (Q), profit or loss (S) - to the changes madein the constant values. Note the scales of the graphs in Appendix III differ slightly.

Many other variables could be graphed. It is our opinion that those tested in the sensitivity analysis are central to the understanding of the simulation. In introducing the sensitivity tests, each variable - for example, the increase in the amount of time it takes staff members to treat patients - has been changed independently. This has been done so that the reaction of the model to this variable alone could be studied. In the real world, values of many variables may change simultaneously. Efforts beyond this thesis are planned to effect these more complex, but more real simulations.

In the following pages we discuss the response of the base simulation to changes in single variables.

Case 1 - Decreased physician--patient time (page 147)

In this modification we have reduced the average time which physicians spend with patients. Times for interns have been more than halved, from 45 to 20 minutes for a true emergency, from 25 to 10 minutes for a non-emergency patient. Resident-patient times have been reduced from 30 minutes per true emergency and 20 minutes per non-emergency to 15 and 10 minutes, respectively. The ten minute times for both classes of patient for supervising physicians represent an estimate of the minimum time required by them to evaluate a patient in the emergency department.

The behavior of the intern and resident levels is predictable. From the initial equilibrium levels, the numbers of residents and interns rapidly drops to about 2 and 2.7 men respectively, and then increase in proportion to the growth in the patient pool.

The patient load increases in a delayed fashion as the shorter processing times have a favorable impact on the attractiveness of the emergency department to patients, i.e. as the ratio of patients to planned capacity is temporarily reduced. This influx of patients then increases the overload ratio, thereby decreasing the emergency department's attractiveness. The patient load decreases in about six years to initial levels. From this point the exponential growth of the patient pool dominates. The increase in patient load and the rising overload then track one another in a manner similar to the base model.

The "stabilized", or equilibrium, quality of care in this variation is still below the optimal level of 1., but is slightly better than the quality level in the base model. As the overload rises slowly after year 10, this small improvement in quality results from the relatively smaller number of interns present as a portion of the total staff. Since the residents have a higher level of experience than the interns, and the ratio of supervising physicians to interns also is greater, that portion of the quality of care function attributed to experience (QOCE), exerts a favorable influence on the quality of care.

Because of lower staff levels, thus reduced staff costs, the absolute amount of emergency department financial loss is reduced. Initial financial improvement quickly gives way to steady deterioration as the patient load, and attendant costs, increase.

It is worth noting that sharply decreasing physician-patient time gives only a short term benefit to quality of care and only moderately decreases the financial loss.

Case 2 - Lengthened physician-patient time (page 148)

Lengthening patient processing times to more than double the base time does not produce effects strikingly different from the base model.

As expected, intern and resident levels rise rapidly. Patients, though initially discourage because of an increased waiting time (reflected by the increased overload ratio) and thus decreased attractiveness, return to the emergency department as the new, higher staff levels are reached. The patient load does not grow quite as rapidly as in the base model. The quality of care is little affected by this change.

The financial loss is substantially higher per patient, and increases more rapidly in this variation, due to two factors: (1) higher staff levels and (2) increased ancillary costs. The latter (x-rays, lab tests, pharmacy charges) are related inversely, by table function 6, to the experience level of the physicians. As the number of interns and residents grows - the number of supervisory physicians is assumed static at one - the average experience level of the staff declines and ancillary costs secondarily rise.

In both cases varying patient processing times, the level and requirement of capital investment is little affected for some 25 years.

Case 3 - Decrease in staff hours (page 149)

This change tests the effect of a 40 hour week for interns and residents and a fifty per cent reduction in supervising physician time. It is likely that in the near future interns and residents will be successful in significantly reducing the current long work week, much as they have had success in obtaining a near "living wage" while in training.

Interestingly enough, after small fluctuations in the first two or three years of operation, this change has little effect on the major variables except to increase the operating loss. Intern and resident levels rise to meet the demands of the patient load and stabilize at a level roughly 5 interns and 3 residents higher than in the base model.

The quality of care is little affected after the initial transient adjustment. The financial loss increases rapidly, with higher staff costs and a lower aggregate experience level (high ancillary costs). The annual loss in this simulation runs about $70,000 a year higher than under the base conditions.

Case 4 - Increase in staff hours (page 150)

In an attempt to overcome staff shortages attendant to increasing overload in the hospital emergency department we have increased the intern and resident working hours. In this simulation interns and residents work 70 hours per week. Supervising physicians time is increased by 50 per cent to 30 hours per week.

Again, the effects on the emergency department are not striking. Intern and resident levels fall by about one person each, but their level is almost immediately affected by the relentless exponential increase in the patient load. Quality of care increases minimally from years 2 to 7, but, again, the overload caused by increasing numbers of patients drives the quality level downward.

With fewer staff working for the same money, the fiscal loss is reduced by about $20,000 annually. This "saving" is doubtlessly illusory considering the almost certain staff demands for more pay.

Thus, modifications of staff working hours, either plus or minus, have no significant effect on factors of major concern - cost and quality of care. Those changes that are brought about by altering the working hours are short term and seemingly of minor consequence.

Case 5 - Decreased patient pool growth rate (page 151)

In the base run, (page 146) the patient pool (PATPOOL) was defined as 150,000 people, growing at an exponential rate of 1 1/2 per cent per year. The annual population growth rate in Monroe County, New York over the past decade has been about 2 per cent. To test the sensitivity of this factor we have tested growth rates of one per cent and two per cent (Cases 5 and 6, respectively). We also have illustrated, in Case 7, an "exploding" population growth rate of six per cent per annum.

The growth rate of one per cent illustrated in this case dampens the increase in patient load as contrasted with the base simulation. Starting from a level of 60,700 patients per year, a 50 year growth of one per cent will yield a patient population of just under 80,000 visits annually. This compares with roughly 92,000 visits under the base 1.5 per cent population growth rate constant. Staffing levels are affected proportionately, as is the overload factor - all being somewhat lower than in the base simulation. Financial losses are also somewhat less. The quality of care does not diminish to quite as low a level.

In total, however, the effects of change in this simulation are marginal.

Case 6 - Increased patient pool growth rate (page 152)

Increasing the growth rate to two per cent per year has evident effects, short run as well as long. The financial loss increases significantly after the first ten years, closely tracking the increase in patient visits. Quality of care degenerates more rapidly as the overload increases. Resident and intern levels grow in attempt to cope with the increasing patient visits, but fall short of desired levels.

Thus, while a decrease of 0.5 per cent in the patient growth constant has minimal effects, an increase of the same magnitude would appear to have serious long term consequences for the emergency department. Obvious corrective action, such as higher prices, infusion of additional staff - perhaps contracted physicians - or accelerated construction of new facilities, have not been introduced in this simulation.

Case 7 - Exploding patient pool (page 153)

This simulation is included to illustrate the dramatic effects of a high exponential growth rate of the patient pool. Within a short period of time the quality of care falls significantly; the annual operating loss reaches $250,000 per annum by year 10. Both the staffing and capital requirements are large. Although the system as designed generates interns and residents to man the emergency department facility, it is unlikely that many hospitals could recruit these doctors. Nor is it likely that financing would be readily available for the capital facilities needed. The overload factor beyond year 10 might well be unacceptable to both patients and staff.

In this situation, which is perhaps, not atypical of some communities in Florida or Southern California in the past decade, drastic remedial action would be necessary if the emergency department were to be able to continue to function.

Case 8 - Decrease in the percentage of perceived emergencies (page 154)

In estimating the patient load for the hospital emergency department we have concentrated on three factors: (1) the size of the potential patient pool -- initially 150,000 people and growing exponentially at 1.5 per cent per year (2) the perceived attractiveness of the emergency department to the patients -- primarily a function of the emergency department overload in relation to the overload or availability of all ambulatory care facilities in the area, and (3) the perceived emergencies in the catchment area (PPEMER).

This last variable is the proportion of the patient pool, in aggregate, who perceive a health emergency during the year. The value of this variable for the base simulation is 0.4, i.e., 40 per cent of the catchment area population are estimated to perceive an emergency in any one year, generating about 60,000 annual patient visits to the emergency department. This figure is in accordance with research data described in Chapter III.

For this sensitivity test we have halved this factor, estimating that only 20 per cent of the patient population perceived an emergency in one year. The effect of this change on the intern and resident levels is immediate and predictable. With fewer emergency department visits these levels fall quickly, but in about year four they begin to rise again as the steady increase in the patient pool generates the requirement for additional staff.

Due to the reduced PPEMER factor, the patient load initially falls from 60,700 visits to a level of about 42,000 annual visits. Despite a halving of the percentage of perceived emergency visits, the patient load does not fall in half. This is due to the fact that with fewer visits the attractiveness factor (PAEDTP) rises, causing an increase in the rate of change in patient load (CPL).

With fewer patients and a more favorable staff experience factor (proportionately fewer interns) the financial loss also improves temporarily. But the relentless growth in the patient pool adversely affects this variable as well and the loss eventually increases to initial levels.

The reduced overload and relatively increased level of staff experience have a marked early impact on the quality of care. The overload runs above the norm until year seven; it degrades somewhat more slowly than in the base simulation, because the patient load is lower relative to the physical facilities available.

The capital investment behaves in an expected manner in this combination of circumstances. Due to the time delay in ordering and in construction of capital facilities (CAPITC), the capital investment continues to grow - based on previous demands - despite the initially sharp decline in patient load. Capital investment already in the pipeline cannot be turned off. Additions are made at a rate faster than current circumstances warrant. Eventually, the slowdown in patient growth has a visible impact on the rate of capital investment increase. The capital investment rate then over-reacts in the opposite direction and decreases (as a result of depreciation with fewer additions) at a time when the exponential growth of the patient pool is once again the controlling factor. It should be noted that the fluctuations of capital investment in this simulation take place in a relatively narrow dollar band ($\pm$ \$30,000).

<u>Case 9 - Increase in the percentage of perceived emergencies (page 155)</u>

In this simulation the ratio of the patient population perceiving emergencies has been increased from the base of 40 per cent to 70 per cent annually. The reaction of the model to this change is predictable. The patient load grows rapidly in the initial year or two. A delay in hiring additional staff and adding additional physical facilities occurs; the resultant overload quickly makes the emergency department an unattractive place from the patient's viewpoint (and the intern's and resident's as well), and the number of visits declines.

As additional capital facilities are developed and staff members are added, the overload falls and the dynamics of the model again resemble the base simulation. The patient load grows; the losses increase; the quality of care declines. An almost exponential growth in capital investment is required after a pause at the ten year level, and total investment necessary reaches $3.5 million at year thirty.

In this case, as with the exploding patient pool, remedial action relative to staff, pricing and capacity would undoubtedly take place. One logical solution to the increased patient load, for example, would be the establishment of neighborhood health clinics (see below).

<u>Case 10 - Increased costs without an increase in prices (page 156)</u>

Costs of operations have been increased moderately in this representation. The assumed average cost per perceived emergency (AVCPE) has been increased from $15 per visit to $20 per visit. The similar figure for non-emergencies (AVCPNE) has been increased from $8 to $12 per visit. Staff salaries have been raised from $10,000 per year for interns, $10,500 per year for residents and $30,000 per year for the supervising physician, to $12,500, $13,500 and

and $36,000 per annum, respectively.

The sole effect of these changes on the model is to increase the loss by some $40,000 per year. The increased financial loss follows the same pattern through time as in the base simulation. The differential between this simulation and the base model, at year fifty, is still $40,000. This fiscal change has no effect on the attractiveness of the emergency department to patient (and, hence, patient load), as staff costs in this simulation are separate and distinct from the prices charged the patients (BCTEP and BCTNEP).

Case 11 - Increased prices without an increase in costs (page 157)

In this simulation the charges to both emergency and non-emergency patients have been increased. BCTEP has been raised from $25 per visit to $40 per visit; BCTNEP has been increased from $15 per visit to $25 per visit. These base charges represent the costs of the professional and staff services and are separate from charges for ancillary services.

The changes made in this simulation are sufficient to reverse the emergency department's fiscal loss. The emergency department moves from an annual loss of $200,000 per year to a profit of $250,000 per annum in the first year. Subsequently the increase in profit tracks the rise in the patient load.

This change does not affect the attractiveness of the emergency department to potential patients (although it may alter the attractiveness of private care). It has been assumed in this simulation that all emergency departments in the area raise their rates concurrently. This is the practice in the community studied.

A possible effect of this change, not considered here, might be a reduction of overall demands for hospital emergency services through a shift of patient visits to private physicians. If such a shift took place the loss would decrease proportionate to the decline in patient load.

Case 12 - Increased costs and increased prices (page 158)

For this sensitivity test, costs have been increased as in Case 10, but the charges for basic professional and staff services have not been raised to as high a level as in Case 11. The basic charge to emergency patients has been increased from $25 to $30 per visit and the basic charge to non-emergency patients has been increased 20 per cent, from $15 to $18 per visit.

In this simulation the increase in prices offsets the rise in costs and covers the present operating loss. By year 14 the emergency department has reached the breakeven point. Despite a hefty increase in costs - though these increases are quite possible in the near future - a more modest increase in emergency visit charges allows the emergency department to become financially self-sustaining. The sensitivity of the modeled emergency department's fiscal position to a relatively modest increase in prices is an important one to monitor in hospital financial planning.

Case 13 - Increase in the desired intern to resident ratio (page 159)

As described in equation 7, the desired number of interns is directly related to the number of desired residents (DI.K=DITRR*DR.K).

The initial desired ratio of two interns to one resident is based on the assumption that each resident can assist and teach this number of emergency department interns while providing optimal care.

The results of modifying this ratio to 2.5 to 1 are three-fold: (1) although the ratio of intern to resident increases, the continuing patient overload and its negative effect on attractiveness of the emergency department limits the ability of the hospital to hire personnel they desire; (2) the modest increase in staff does have some favorable effect on the ratio of patient load to planned staff capacity, i.e., overload. The overload does not grow quite as rapidly, or reach quite as high a level, as in the base simulation; (3) the decrease in the absolute value of the overload dampens the decrease in the quality of care (QOCO), although this influence is partially offset by a decrease in the overall staff experience level (SEXP)--due to a proportionately greater number of interns with a low experience factor.

Case 14 - Increase in local attractiveness (page 160)

In determining the attractiveness of the hospital emergency department to current and potential staff, the relationship between external and internal (local) attractiveness is a key factor. We have initially stated that the modeled emergency department is three times as attractive to interns as any competive outside job opportunities (LAWF=3, EATS=1). This relationship affects both the attrition rate of interns (AOI) and the rate of residents hired from the local intern staff (INTRES).

In this simulation we have increased the attractiveness ratio from three to one to five to one. Since the modeled department already has an advantage in attractiveness, the effect of this change is marginal at best. Perhaps one additional resident can be hired as a result of the positive influence this change has in INTRES; a fraction of an an additional intern can also be added to the resident staff. The only other effects are negligible improvement in the quality of care and a very small dampening of the overload factor.

Case 15 - Shortened information delay(page 161)

In the base simulation the information delay time to patients (IDTTP) was set at four years. That is, if the emergency department becomes overcrowded, or gives such poor service that it is no longer as attractive as alternative sources of health care, it takes four years for roughly 60 per cent of the patient pool to perceive this fact. In this simulation we have reduced IDTTP to one year.

Because the patients react faster in this simulation to the change in emergency department care, the number of patient visits (PAT) responds more quickly to increases in overload and reductions in the quality. Changes in PAT, however, are almost imperceptable. The exponential growth of the patient pool remains the controlling factor. Faster information flow to prospective patients has little quantitative effect on the number of patients visiting the emergency department.

Exogenous Variables

In addition to testing the sensitivity of the model to changes in constants and initial values, we have introduced several exogenous variables that represent changes underway in the health care field. These changes are: (1) the establishment of neighborhood health centers, which are expected to siphon off a portion of the non-emergency patients coming to the emergency department; (2) hiring additional paramedical personnel to assist the staff in treating patients, possibly at a reduced cost per visit; (3) the use of salaried physicians to staff the hospital emergency department; and (4) the advent of universal health care entitlement, with its impact on the health care system. The impact of each of these changes on the base simulation model has been examined.

Neighborhood Health Centers

One of the proposed solutions to the problems of the urban hospital emergency department is the introduction of neighborhood health centers into the total community health care system. These clinics would be located in those census tracts which generate the most emergencies per capita.

The revised model, illustrating the introduction of one neighborhood health center is included as page 181 in Appendix IV. The clinic has been added to the system in year ten. We have estimated that this center has the capacity to handle the visits generated by 15 per cent of the patient pool, and that the center will reach this capacity five years after its inception. The growth of the center's patient load has been introduced as a smoothed function overtime.

The results are clear. Even allowing for the delay in perception of the health center's attractiveness to the patient pool, the effect on the hospital emergency department is rapid. Its patient load drops; the overload falls with the decline in patient visits; the quality of care rises to 0.6. In addition, the number of required interns and residents falls and with reduced staffing and reduced load, the financial loss drops quickly to about $90,000 per year.

These improvements peak in about ten years (i.e., by year 20). At that point the health center has reached <u>its</u> capacity and the exponential growth of the patient pool again causes an increasing overload of the hospital emergency department facilities and staff. While the levels of interns and residents increase, they do not keep pace with the increase in patient load. Quality of care again declines.

Due to the removal of a significant proportion of non-emergency patients*, however, the fiscal loss remains fairly stable for many years. At year sixty, the loss again begins to increase, though not at the rate experienced in the base simulation. The capital investment required remains almost constant until year sixty, when it returns to the delayed exponential growth exhibited in the base model.

As introduced, the neighborhood health center appears to be a viable, <u>short-term</u> solution to some of the hospital emergency

* These patients are the most "uneconomic" for the emergency department. The fees for the services rendered them recover proportionately less cost than do the fees charged true emergency patients.

department problems. In the longer term, additional health clinics could be added or the capacity of the existing clinics expanded. Whether this solution is cost effective is a matter for separate consideration. In addition, while the financial loss of the emergency department is stabilized, the deterioration of quality of care is not. Other remedies must be sought to solve the "quality of care" problem.

Paramedical Personnel

As another simulation test, paramedical personnel have been added as a level: additions and deletions to their pool are handled in the model in the same manner as for interns and residents. We have assumed that each intern can effectively work with one paramedical assistant, each resident with two and that the supervising physician can work with three assistants. Thus, as the intern and resident levels vary, so will the level of paramedical personnel. Paramedical salaries are $12,000 per year, higher than either interns or residents, and their experience level, 2.5, is set slightly higher than that of the intern. It is further assumed that the physician assistants treat both emergency and non-emergency patients in the same time in which residents handle these visits.

The addition of paramedical personnel to the emergency department staff has little effect except to reduce the number of interns and residents required to handle a given patient load. Because the physician assistants treat slightly more patients per hour than the

<u>average</u> of interns and residents, the staff cost per visit is reduced slightly, despite the higher annual wage cost for paramedical personnel. The total loss is reduced approximately $10,000 per year during the term of this model. Quality of care is unaffected, as is the overload factor.

Physicians assistants are an alternative in the staffing problem but contribute little to the improvement of emergency department costs or quality of care as simulated by this model.

<u>Full-time Salaried Physicians</u>

One alternative to interns and residents in staffing the hospital emergency department is the use of full-time salaried physicians. This option now is in use in many hospitals in this country Such physicians have been added to the model as a level. At the same time, interns, residents and supervising physicians have been dropped from the simulation. Contracted physicians work a 50 hour week in this simulation, are paid a $40,000 annual salary, and take the same time to treat emergencies and non-emergencies as did the supervising physician in the base model. Their experience level is set at 9.0.

As illustrated on page 220, Appendix IV, the number of contracted physicians required is less than the previous total of interns and residents (8.5 versus 11.0, plus a supervising physician). Through time, the level of doctors closely tracks the growth in patient pool. The overload is unaffected during the time span plotted, as is the capital investment.

Quality of care is most favorably affected. At year zero it starts as .95, close to the optimum of 1.0 sought for the emergency department. Because of the high level of physician experience (SEXP), the increasing overload does not drive the quality of care much below 0.7 during the simulation.

A dramatic effect of the introduction of this variable in the system is the sharply increased cost of operation. The loss is initially increased by $150,000 to $350,000 per year. The increment is due to the higher salaries received by the contracted physicians.

This loss, however, does not take into consideration revenues which may be generated by the physicians, who may charge fees for personnel professional services rendered in their treatment of emergency department patients. These fees would be in addition to those charged by the hospital for emergency visits. If the former amounted to $10 per visit, and were wholly returned to the hospital, the initial financial position would be an annual profit of about $230,000.

While this alternative seems to be viable in the area of improving the quality of care, the cost may be a deterrent to the widespread introduction of such a plan if additional fees are not, or cannot, be charged.

Universal Entitlement

To simulate the advent of universal entitlement, we have modified two constants in the base hospital emergency department model. The percentage of the population in the potential patient pool who perceive an emergency each year (PPEMER) has been increased from 40 per cent to 65 per cent. Presumably, if medical care is prepaid, or if it is "free" to the patient, the individual will be more prone to use the emergency department facilities - less apt to feel that his illness, or that of a member of his family, need await treatment by a family physician, if they have one.

As a corollary to the first change, we have decreased the proportion of patients who arrive at the emergency department with actual emergencies (AE) from one third to 20 per cent. With an increased propensity to use the hospital emergency facilities, it is likely that the portion of the visits which are non-emergency cases will increase. Page 222 in Appendix IV illustrates the behavior of the model with these changes made.

The initial effect of such a change is a surge in the patient load. Concomitant with this increase in patient visits is a sharp rise in the overload factor. This, in turn, reduces the emergency department's attractiveness, and the number of patient visits then fall rapidly. By year ten, however, the system has stabilized into its normal pattern; the exponential growth of the patient pool again controls the system; the overload rises to more and more unacceptable levels, and the quality of care eventually falls below 0.2. The financial loss, although temporarily stable at $350,000 from years five to ten, soon begins to increase.

Clearly, unless remedial steps are taken prior to the introduction of universal entitlement, the emergency health care system in our modeled urban community will quickly deteriorate to a point unacceptable to both patients and staff.

Combining the Exogenous Variables

In the preceding discussion of changes originating outside the simulated emergency department, we again have looked at their effects in isolation from one another. It is likely that each of the four changes outlined above could occur simultaneously, or at least within a short time span. In an attempt to solve the emergency department problems of overcrowding, understaffing, and financial loss, it is likely that the hospital will simultaneously increase the use of para-medical personnel, hire contracted physicians to ease the staff load, and introduce neighborhood health clinics.

The interactive effects of such changes have not been examined in the present study. The basic model presented, however, readily lends itself - with only minor modifications - to such inquiry.

CHAPTER VI SUMMARY AND CONCLUSION

Summary of Results

The principal goal of this thesis research effort has been to develop a model of a hospital emergency department. We have demonstrated that, by employing systems dynamics simulation, it is possible to create a functioning model of a typical urban hospital emergency facility. The method requires characterization of the individual elements and influences and permits description of the numerous complex relationships integral to emergency health care delivery. Our research, accomplished by interview, observation and reading of the literature, has generated data that have enabled statements of the more fundamental relationships in the necessary quantitative manner.

In describing this model of hospital emergency services we have distinguished four aspects of emergency department operations. All interact closely with one another, participating in various related feedback systems. Sufficient differences exist, however, so that classification of issues into the following categories has been possible.

(1) Potential patient pool and subsequent emergency department patient load;

(2) Recruitment and retention of qualified professional personnel;

(3) Capital investment in plant and equipment;

(4) Financial aspects of emergency department operations.

The model has been tested on the computer and it runs, yielding information of equilibrium conditions. Sensitivity testing of variables judged to be of particular importance has been accomplished and are summarized briefly below. External variables, not included as a part of the basic model, have been introduced and tested. These include the use of specially trained physician assistants in the emergency department, the use of full-time salaried contract physicians in the emergency department, the introduction of a neighborhood health center and the simulation of the introduction of a national health insurance program granting universal entitlement to care.

Conclusions

Sensitivity testing of the model demonstrates that the driving force is the growth rate of the potential patient pool. This, in turn, governs the patient load presented to the emergency department. While wide fluctuations in other variables (e.g. patient perceived emergencies, attractiveness factors, cost and prices) may alter the character of the system for relatively short time periods, the increase in the patient load eventually and relentlessly dominates the system.

The introduction to the model of a neighborhood health center temporarily relieves the patient overload but the introduction of this variable alone does not address nor solve the problems of cost or quality of care. The introduction of physician assistants in the emergency department alleviates the professional staffing problem for a time but the quality of care may decline somewhat more rapidly than in the base simulation. The use of salaried physicians as an alternative to the current practice of using interns and residents appears to improve the quality of care somewhat for a significant period of time but introduces problems of cost that may be prohibitive.

Possible simulative solutions to the problems of the hospital emergency department lie beyond the scope of the present study. Most notably these include the introduction of combinations of external variables, including those briefly noted above. The simultaneous introduction to the model of neighborhood health centers, increased utilization of physician assistants and the use of at least some contracted physicians in the emergency department might well interact in a manner that would yield improvement in at least some of the major areas of concern, staffing, costs and quality of care. By modeling reinforcement of some of these changes periodically, the simulated emergency department might cope more effectively with the continuing increase in patient visits.

Present and Prospective Use of the Model

The model described in this report is viewed by the authors as a rudimentary beginning. Despite its relatively primitive state, however, we believe that if offers a firm but flexible framework upon which alternative solutions to emergency health services can be developed. Many of the important variables in the present model have been described in an aggregate sense; subsequent studies should disaggregate some of these so that effects of more isolated components may be simulated. As more data become available as a result of the increasing interest in emergency health services, certain of the values applied to constants and table functions in this model can be altered to reflect these newer observations.

It is our conclusion that a sufficiently realistic systems dynamics simulation of emergency health services can be constructed so that subsequent policy planning and decisions within this area may be made with the aid of reliable, simulated, alternative effects at hand in advance of final decisions.

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Mr. Edward Smith, Unit Manager, Emergency Department
Mrs. Vera Umpleby, Insurance Coordinator
Mr. David Watt, Assistant Administrator for Ambulatory Services

University of Rochester Medical Center, Rochester, New York

Mr. David Fanning, Assistant Director for Finance
J. William Gavett, Ph. D, Professor of Management, Associate Professor of Medicine, University of Rochester School of Medicine and Dentistry
Dr. Milton N. Luria, Professor of Medicine, University of Rochester School of Medicine and Dentistry, Emergency Department Director for Medicine
Dr. John H. Morton, Professor of Surgery, University of Rochester School of Medicine and Dentistry, Emergency Department Director for Surgery.
Mr. Frank Platino, Assistant Administrator, Strong Memorial Hospital

APPENDIX I

THE BASE MODEL

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          MACRO DELAY3P(IN,DEL,PIPE)
          A      DELAY3P.K=$LV3.K/$DL.K
          L      $LV3.K=$LV3.J+DT*($RT2.JK-DELAY3P.J)
          N      $LV3=$DL*IN
          R      $RT2.KL=$LV2.K/$DL.K
          L      $LV2.K=$LV2.J+DT*($RT1.JK-$RT2.JK)
          N      $LV2=$LV3
          R      $RT1.KL=$LV1.K/$DL.K
          L      $LV1.K=$LV1.J+DT*(IN.JK-$RT1.JK)
          N      $LV1=$LV3
          A      $DL.K=DEL/3
          A      PIPE.K=$LV1.K+$LV2.K+$LV3.K
          MEND
1         L      INT.K=INT.J+(DT)(PHI.JK-AOI.JK-INTRES.JK) (MEN)
1.1       N      INT=INTN (MEN)
1.2       C      INTN=6.315 (MEN)
2         L      HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-ACR.JK) (MEN)
2.1       N      HRES=HRESN (MEN)
2.2       C      HRESN=4.7488 (MEN)
3         A      RES.K=1*HRES.K (MEN)
4         R      RHI.KL=NRHI.K*DIM.K*ATPS.K (MEN/YEAR)
5         A      NRHI.K=SMOOTH(RHI.JK,SMTI) (MEN/YEAR)
5.1       N      NRHI=6.3152
5.2       C      SMTI=2 (YEARS)
6         A      DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2) (DIMENSIONLESS)
6.1       T      TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2 (TABLE)
7         A      DI.K=DITRR*DR.K (MEN)
7.1       C      DITRR=2 (DIMENSIONLESS)
8         A      ATPS.K=DLINF3(ATCS.K,ATTDEL)
8.1       C      ATTDEL=5 (YEARS)
9         R      AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K) (MEN/YEAR)
9.1       C      AVSPI=1 (YEARS)
10        A      IDM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+EATS)) (DIMENSIONLESS)
10.1      C      LAWF=3 (DIMENSIONLESS)
10.2      C      EATS=1 (DIMENSIONLESS)
11        R      INTRES.KL=(1/AVSPI)(INT.K)(IDM.K) (MEN/YEAR)
12        R      RHR.KL=NHRR.K*DRM.K*ATPS.K (MEN/YEAR)
13        A      NHRR.K=SMOOTH(RHR.JK,SMTR) (MEN/YEAR)
13.1      N      NHRR=0 (MEN/YEAR)
13.2      C      SMTR=2 (YEARS)
14        A      DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2) (DIMENSIONLESS)
15        A      DR.K=(NEP.K-SUPHY*(1/((PR.K/SPEC)+(1/SPNC))))/
          X      ((1/((PR.K/REC)+(1/RNC)))+(DITRR/((PR.K/IEC)+(1/INC)))) (MEN)
16        R      AOR.KL=(1/AVSPR)(RES.K) (MEN/YEAR)
16.1      C      AVSPR=1 (YEARS)
17        A      ATCS.K=TABLE(TABLE7,(PAT.K/FLCAP.K)/INNORM,0,3,.3) (DIMENSIONLESS)
17.1      C      INNORM=1.2 (DIMENSIONLESS)
17.2      T      TABLE7=1.2/1.18/1.15/1.05/.85/.7/.52/.4/.3/.22/.2 (TABLE)
17.3      N      IEC=1/ITPE (VISITS/YEAR)
17.4      N      ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)
17.5      C      IMPE=45 (MINUTES)
17.6      C      IHPW=60 (HOURS/WEEK)
17.7      N      INC=1/ITPNE (VISITS/YEAR)
17.8      N      ITPNE=(IMPNE/60)/(IHPW*50) (YEARS/VISIT)
17.9      C      IMPNE=25 (MINUTES)
18        N      REC=1/RTPE (VISITS/YEAR)
18.1      N      RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)
18.2      C      RMPE=30 (MINUTES)
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```
18.3    C    RHPW=60 (HOURS/WEEK)
18.4    N    RNC=1/RTPNE (VISITS/YEAR)
18.5    N    RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)
18.6    C    RMPNE=20 (MINUTES)
18.7    N    SPEC=1/SPTPE (VISITS/YEAR)
18.8    N    SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)
18.9    C    SPMPE=25 (MINUTES)
19      C    SPHPW=20 (HOURS/WEEK)
19.1    N    SPNC=1/SPTPNE (VISITS/YEAR)
19.2    N    SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)
19.3    C    SPMPNE=20 (MINUTES)
20      L    PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J) (VISITS/YEAR)
20.1    N    PAT=PATN (VISITS/YEAR)
20.2    C    PATN=60707 (VISITS/YEAR)
20.3    C    TTCH=1 (YEAR)
21      R    CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER (VISITS/YEAR)
22      A    PATPOOL.K=150000*EXP(PGC*TIME.K) (PEOPLE)
22.1    C    PGC=0.015 (1/YEAR)
22.2    C    PPEMER=.4 (DIMENSIONLESS)
23      A    PAEDTP.K=CLINF3(AEDTP.K,IDTTP) (DIMENSIONLESS)
23.1    C    IDTTP=4 (YEARS)
24      A    AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/ARNORM,0,2,.2) (DIM.)
24.1    C    ARNORM=1.2 (DIMENSIONLESS)
25      L    CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK) (DOLLARS)
25.1    N    CAPINV=CAPINVN (DOLLARS)
25.2    C    CAPINVN=2627800 (DOLLARS)
26      R    DCI.KL=CAPINV.K/DEPT.K (DOLLARS/YEAR)
27      A    DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT) (YEARS)
28      A    DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3) (DIMENSIONLESS)
28.1    T    TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/.525/.5 (TABLE)
28.2    C    NORDT=30 (YEARS)
28.3    C    DEPDT=10 (YEARS)
29      R    RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K) (DOLLARS/YEAR)
29.1    C    CAPITC=4 (YEARS)
29.2    N    CIOO=CICON (DOLLARS)
29.3    C    CIOON=320020 (DOLLARS)
30      R    CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*EXFUND.K
        X    +SDCI.K (DOLLARS/YEAR)
31      A    EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2) (DIMENSIONLESS)
31.1    T    TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)
32      A    DCAPINV.K=DCIPP*PAT.K (DOLLARS)
32.1    C    DCIPP=60 (DOLLARS/VISIT/YEAR)
33      A    SDCI.K=SMOOTH(DCI.JK,TSDCI) (YEARS)
33.1    C    TSDCI=1 (YEARS)
34      A    SEXP.K=(IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/(STAFF.K) (DIM.)
35      A    STAFF.K=INT.K+RES.K+SUPHY (MEN)
35.1    N    IEXP=2 (DIMENSIONLESS)
35.2    N    REXP=3.5 (DIMENSIONLESS)
35.3    N    SPEXP=9 (DIMENSIONLESS)
35.4    C    SUPHY=1 (MEN)
36      A    PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) (VISITS/YEAR)
36.1    T    TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5 (TABLE)
37      A    OLOAD.K=PAT.K/PLCAP.K (DIMENSIONLESS)
38      S    QOC.K=.7*QOCO.K+.3*QOCE.K (DIMENSIONLESS)
39      A    QOCO.K=TABLE(TABLE1,OLOAD.K,0,2,.2) (DIMENSIONLESS)
39.1    T    TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 (TABLE)
40      A    QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9) (DIMENSIONLESS)
41      A    SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY (VISITS/YEAR)
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42      A     RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE) (VISITS/YEAR)
43      A     ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE) (VISITS/YEAR)
44      A     SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE) (VISITS/YEAR)
45      A     PCAP.K=CAPINV.K/DCIPP (VISITS/YEAR)
46      A     PEREMER.K=AE+SE*(1-AE) (DIMENSIONLESS)
47      A     PERNEM.K=1-PEREMER.K (DIMENSIONLESS)
48      A     NEP.K=PAT.K*PERNEM.K (VISITS/YEAR)
49      A     PR.K=(PAT.K-NEP.K)/NEP.K (DIMENSIONLESS)
49.1    C     SE=.1 (DIMENSIONLESS)
49.2    C     AE=.33 (DIMENSIONLESS)
50      A     ANCOST.K=EANCST.K+NEANCST.K (DOLLARS/YEAR)
51      A     EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K (DOLLARS/YEAR)
52      A     NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K (DOLLARS/YEAR)
53      A     ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9) (DIMENSIONLESS)
53.1    C     AVCPE=15 (DOLLARS/VISIT)
53.2    C     AVCPNE=8 (DOLLARS/VISIT)
53.3    T     TABLE6=1.5/1.43/1.32/1.1/.8/.7/.61/.57/.52/.51/.5 (TABLE)
54      A     OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K (DOLLARS/YEAR)
55      A     SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY (DOLLARS/YEAR)
55.1    C     ISAL=10000 (DOLLARS/YEAR/MAN)
55.2    C     RSAL=10500 (DOLLARS/YEAR/MAN)
55.3    C     SPSAL=30000 (DOLLARS/YEAR/MAN)
56      A     PHSAL.K=PHCPV*PAT.K (DOLLARS/YEAR)
56.1    C     PHCPV=18.33 (DOLLARS/VISIT)
57      A     INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*PERNEM.K) ($/YR)
58      A     CPE.K=BCTEP+AVCPE*ANCT.K (DOLLARS/VISIT)
58.1    C     BCTEP=25 (DOLLARS/VISIT)
59      A     CPNE.K=BCTNEP+AVCPNE*ANCT.K (DOLLARS/VISIT)
59.1    C     BCTNEP=15 (DOLLARS/VISIT)
59.2    C     BDEBT=.01 (DIMENSIONLESS)
60      A     PRFLSS.K=INCOME.K-OPEXP.K (DOLLARS/YEAR)
        PLOT  INT=I,RES=R/CAPINV=C/PAT=P/CLOAD=C/COC=Q/PRFLSS=S
60.2    C     DT=.1 (YEARS)
60.3    C     PLTPER=1 (YEARS)
60.4    C     LENGTH=50 (YEARS)
        RUN   BASE RUN
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```
INT.K=INT.J+(DT)(RHI.JK-AOI.JK-INTRES.JK)              1, L
INT=INTN (MEN)                                         1.1, N
INTN=6.315 (MEN)                                       1.2, C
    INT     - INTERNS (MEN)
    DT      - INCREMENT IN TIME (YEARS)
    RHI     - RATE OF HIRING INTERNS (MEN/YEAR)
    AOI     - ATTRITION RATE OF INTERNS (MEN/YEAR)
    INTRES  - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
                YEAR)
    INTN    - INITIAL VALUE OF INTERNS (MEN)

HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-AOR.JK)            2, L
HRES=HRESN (MEN)                                       2.1, N
HRESN=4.7488 (MEN)                                     2.2, C
    HRES    - HOSPITAL RESIDENTS (MEN)
    DT      - INCREMENT IN TIME (YEARS)
    INTRES  - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
                YEAR)
    RHR     - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
                YEAR)
    AOR     - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    HRESN   - INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)

RES.K=1*HRES.K                                         3, A
    RES     - RESIDENTS (MEN)
    HRES    - HOSPITAL RESIDENTS (MEN)

RHI.KL=NRHI.K*DIM.K*ATPS.K                             4, R
    RHI     - RATE OF HIRING INTERNS (MEN/YEAR)
    NRHI    - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    DIM     - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    ATPS    - ATTRACTIVENESS TO POTENTIAL STAFF
                (DIMENSIONLESS)

NRHI.K=SMOOTH(RHI.JK,SMTI)                             5, A
NRHI=6.3152                                            5.1, N
SMTI=2 (YEARS)                                         5.2, C
    NRHI    - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    RHI     - RATE OF HIRING INTERNS (MEN/YEAR)
    SMTI    - SMOOTHING TIME FOR INTERNS (YEARS)

DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2)                  6, A
TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2           6.1, T
  (TABLE)
    DIM     - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    TABLE5  - TABLE FUNCTION
    DI      - DESIRED INTERNS (MEN)
    INT     - INTERNS (MEN)

DI.K=DITRR*DR.K                                        7, A
DITRR=2 (DIMENSIONLESS)                                7.1, C
    DI      - DESIRED INTERNS (MEN)
    DITRR   - DESIRED INTERN TO RESIDENT RATIO
                (DIMENSIONLESS)
    DR      - DESIRED RESIDENTS (MEN)
```

```
ATPS.K=DLINF3(ATCS.K,ATTDEL)                                    8, A
ATTDEL=5 (YEARS)                                                8.1, C
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    ATTDEL - TIME TO PERCEIVE ATTRACTIVENESS (YEARS)

AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K)                                9, R
AVSPI=1 (YEARS)                                                 9.1, C
    AOI    - ATTRITION RATE OF INTERNS (MEN/YEAR)
    AVSPI  - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT    - INTERNS (MEN)
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)

IDM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+EATS))                          10, A
LAWF=3 (DIMENSIONLESS)                                          10.1, C
EATS=1 (DIMENSIONLESS)                                          10.2, C
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)
    LAWF   - LOCAL ATTRACTIVENESS WEIGHTING FACTOR
               (DIMENSIONLESS)
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    EATS   - EXTERNAL ATTRACTIVENESS TO STAFF
               (DIMENSIONLESS)

INTRES.KL=(1/AVSPI)(INT.K)(IDM.K)                               11, R
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
               YEAR)
    AVSPI  - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT    - INTERNS (MEN)
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)

RHR.KL=NHRR.K*DRM.K*ATPS.K                                      12, R
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
               YEAR)
    NHRR   - NORMAL HIRING RATE OF RESIDENTS FROM
               OUTSIDE (MEN/YEAR)
    DRM    - DESIRED RESIDENTS MULTIPLIER
               (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)

NHRR.K=SMOOTH(RHR.JK,SMTR)                                      13, A
NHRR=0 (MEN/YEAR)                                               13.1, N
SMTR=2 (YEARS)                                                  13.2, C
    NHRR   - NORMAL HIRING RATE OF RESIDENTS FROM
               OUTSIDE (MEN/YEAR)
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
               YEAR)
    SMTR   - SMOOTHING TIME FOR RESIDENTS (YEARS)
```

```
DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2)                        14, A
    DRM     - DESIRED RESIDENTS MULTIPLIER
                (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DR      - DESIRED RESIDENTS (MEN)
    RES     - RESIDENTS (MEN)

DR.K=(NEP.K-SUPHY*(1/((PR.K/SPEC)+(1/SPNC))))/((1/   15, A
  ((PR.K/REC)+(1/RNC)))+(DITRR/((PR.K/IEC)+(1/
  INC))))
    DR      - DESIRED RESIDENTS (MEN)
    NEP     - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)
    PR      - PATIENT RATIO (DIMENSIONLESS)
    SPEC    - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
                (VISITS/YEAR)
    SPNC    - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
                (VISITS/YEAR)
    REC     - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RNC     - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    DITRR   - DESIRED INTERN TO RESIDENT RATIO
                (DIMENSIONLESS)
    IEC     - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    INC     - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)

AOR.KL=(1/AVSPR)(RES.K)                                      16, R
AVSPR=1 (YEARS)                                              16.1, C
    AOR     - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    AVSPR   - AVERAGE STAY PER RESIDENT (YEARS/MAN)
    RES     - RESIDENTS (MEN)
```

```
...S.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3)      17, A
INNORM=1.2 (DIMENSIONLESS)                               17.1, C
TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2        17.2, T
  (TABLE)
IEC=1/ITPE (VISITS/YEAR)                                 17.3, N
ITPE=(IMPE/60)/(IHPW*50)  (YEARS/VISIT)                  17.4, N
IMPE=45 (MINUTES)                                        17.5, C
IHPW=60 (HOURS/WEEK)                                     17.6, C
INC=1/ITPNE (VISITS/YEAR)                                17.7, N
ITPNE=(IMPNE/60)/(IHPW*50)  (YEARS/VISIT)                17.8, N
IMPNE=25 (MINUTES)                                       17.9, C
    ATCS    - ATTRACTIVENESS TO CURRENT STAFF
                (DIMENSIONLESS)
    TABLE7 - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)
    INNORM - INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)
    IEC     - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    ITPE    - INTERN TIME FOR PERCEIVED EMERGENCIES
                (YEARS/VISIT/MAN)
    IMPE    - INTERN MINUTES PER EMERGENCY (MINUTES/
                VISIT)
    IHPW    - INTERN HOURS PER WEEK (HOURS/WEEK)
    INC     - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
    ITPNE   - INTERN TIME FOR PERCEIVED NONEMERGENCIES
                (YEARS/VISIT/MAN)
    IMPNE   - INTERN MINUTES PER NONEMERGENCY (MINUTES/
                VISIT)
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REC=1/RTPE (VISITS/YEAR)                                    18, N
RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)                      18.1, N
RMPE=30 (MINUTES)                                           18.2, C
RHPW=60 (HOURS/WEEK)                                        18.3, C
RNC=1/RTPNE (VISITS/YEAR)                                   18.4, N
RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)                    18.5, N
RMPNE=20 (MINUTES)                                          18.6, C
SPEC=1/SPTPE (VISITS/YEAR)                                  18.7, N
SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)                   18.8, N
SPMPE=25 (MINUTES)                                          18.9, C
    REC    - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RTPE   - RESIDENT TIME FOR PERCEIVED EMERGENCY
               (YEARS/VISIT/MAN)
    RMPE   - RESIDENT MINUTES PER EMERGENCY (MINUTES/
               VISIT)
    RHPW   - RESIDENT HOURS PER WEEK (HOURS/WEEK)
    RNC    - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    RTPNE  - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
               (YEARS/VISIT/MAN)
    RMPNE  - RESIDENT MINUTES PER NONEMERGENCY (MINUTES/
               VISIT)
    SPEC   - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPE  - SUPERVISING PHYSICIAN TIME PER EMERGENCY
               (YEARS/VISIT/MAN)
    SPMPE  - SUPERVISING PHYSICIAN MINUTES PER EMERGENCY
               (MINUTES/VISIT)
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)

SPHPW=20 (HOURS/WEEK)                                       19, C
SPNC=1/SPTPNE (VISITS/YEAR)                                 19.1, N
SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)                 19.2, N
SPMPNE=20 (MINUTES)                                         19.3, C
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)
    SPNC   - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
               (YEARS/VISIT/MAN)
    SPMPNE - SUPERVISING PHYSICIAN MINUTES PER
               NONEMERGENCY (MINUTES/VISIT)

PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J)                      20, L
PAT=PATN (VISITS/YEAR)                                      20.1, N
PATN=60707 (VISITS/YEAR)                                    20.2, C
TTCH=1 (YEAR)                                               20.3, C
    PAT    - PATIENTS (VISITS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    TTCH   - TIME TO CHANGE HABITS (YEARS)
    CPL    - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PATN   - INITIAL VALUE OF PATIENTS (VISITS/YEAR)
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CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER                              21, R
    CPL     - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PAEDTP  - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
               PATIENTS (DIM.)
    PATPOOL- PATIENT POOL (MEN)
    PPEMER  - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PATPOOL.K=150000*EXP(PGC*TIME.K)                              22, A
PGC=0.015 (1/YEAR)                                            22.1, C
PPEMER=.4 (DIMENSIONLESS)                                     22.2, C
    PATPOOL- PATIENT POOL (MEN)
    PGC     - PATIENT POOL GROWTH CONSTANT (1/YEAR)
    PPEMER  - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PAEDTP.K=DLINF3(AEDTP.K,IDTTP)                                23, A
IDTTP=4 (YEARS)                                               23.1, C
    PAEDTP  - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
               PATIENTS (DIM.)
    AEDTP   - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    IDTTP   - INFORMATION DELAY TIME TO PATIENTS (YEARS)

AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/                 24, A
  ARNORM,0,2,.2)
ARNORM=1.2 (DIMENSIONLESS)                                    24.1, C
    AEDTP   - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    TABLE1  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)
    ARNORM  - AREA NORMAL OVERLOAD (DIMENSIONLESS)

CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK)                         25, L
CAPINV=CAPINVN (DOLLARS)                                      25.1, N
CAPINVN=262780C (DOLLARS)                                     25.2, C
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    DT      - INCREMENT IN TIME (YEARS)
    RCI     - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    DCI     - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINVN- INITIAL VALUE OF CAPITAL INVESTMENT
               (DOLLARS)

DCI.KL=CAPINV.K/DEPT.K                                        26, R
    DCI     - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    DEPT    - DEPRECIATION TIME (YEARS)

DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                             27, A
    DEPT    - DEPRECIATION TIME (YEARS)
    NORDT   - NORMAL DEPRECIATION TIME (YEARS)
    DEPF    - DEPRECIATION FUNCTION (DIMENSIONLESS)
    DEPDT   - DEPRECIATION DELAY TIME (YEARS)
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DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3)                    28, A
TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/            28.1, T
  .525/.5 (TABLE)
NORDT=30 (YEARS)                                            28.2, C
DEPDT=10 (YEARS)                                            28.3, C
    DEPF    - DEPRECIATION FUNCTION (DIMENSIONLESS)
    TABLE4  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    NORDT   - NORMAL DEPRECIATION TIME (YEARS)
    DEPDT   - DEPRECIATION DELAY TIME (YEARS)

RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K)                       29, R
CAPITC=4 (YEARS)                                            29.1, C
CIOO=CIOON (DOLLARS)                                        29.2, N
CIOON=320020 (DOLLARS)                                      29.3, C
    RCI     - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    CIOON   - INITIAL VALUE OF CAPITAL INVESTMENT ON
                ORDER (DOLLARS)

CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*          30, R
  EXFUND.K+SDCI.K
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    DCAPINV - DESIRED CAPITAL INVESTMENT (DOLLARS)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)

EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2)                  31, A
TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)         31.1, T
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)
    TABLE2  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)

DCAPINV.K=DCIPP*PAT.K                                       32, A
DCIPP=60 (DOLLARS/VISIT/YEAR)                               32.1, C
    DCAPINV - DESIRED CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
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SDCI.K=SMOOTH(DCI.JK,TSDCI)                                  33, A
TSDCI=1 (YEARS)                                              33.1, C
    SDCI   - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    TSDCI  - TIME TO SMOOTH DEPRECIATION OF CAPITAL
               INVESTMENT (YEARS)

SEXP.K=(IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/                  34, A
  (STAFF.K)
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)
    IEXP   - INTERN EXPERIENCE (DIMENSIONLESS)
    INT    - INTERNS (MEN)
    REXP   - RESIDENT EXPERIENCE (DIMENSIONLESS)
    RES    - RESIDENTS (MEN)
    SPEXP  - SUPERVISING PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    STAFF  - STAFF (MEN)

STAFF.K=INT.K+RES.K+SUPHY                                    35, A
IEXP=2 (DIMENSIONLESS)                                       35.1, N
REXP=3.5 (DIMENSIONLESS)                                     35.2, N
SPEXP=9 (DIMENSIONLESS)                                      35.3, N
SUPHY=1 (MEN)                                                35.4, C
    STAFF  - STAFF (MEN)
    INT    - INTERNS (MEN)
    RES    - RESIDENTS (MEN)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    IEXP   - INTERN EXPERIENCE (DIMENSIONLESS)
    REXP   - RESIDENT EXPERIENCE (DIMENSIONLESS)
    SPEXP  - SUPERVISING PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)

PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2)  36, A
TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5   36.1, T
  (TABLE)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    SCAP   - STAFF CAPACITY (VISITS/YEAR)
    TABLE3 - TABLE FUNCTION
    PCAP   - PHYSICAL CAPACITY (VISITS/YEAR)

OLOAD.K=PAT.K/PLCAP.K                                        37, A
    OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)

QOC.K=.7*QOCO.K+.3*QOCE.K                                    38, S
    QOC    - QUALITY OF CARE (DIMENSIONLESS)
    QOCO   - QUALITY OF CARE FROM OVERLOAD
               (DIMENSIONLESS)
    QOCE   - QUALITY OF CARE FROM EXPERIENCE
               (DIMENSIONLESS)
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QOCO.K=TABLE(TABLE1,OLOAD.K,0,2,.2)                         39, A
TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0                39.1, T
  (TABLE)
    QOCO    - QUALITY OF CARE FROM OVERLOAD
                (DIMENSIONLESS)
    TABLE1 - TABLE FUNCTION
    OLOAD   - OVERLOAD OF FACILITIES (DIMENSIONLESS)

QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9)                          40, A
    QOCE    - QUALITY OF CARE FROM EXPERIENCE
                (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)

SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY              41, A
    SCAP    - STAFF CAPACITY (VISITS/YEAR)
    RCAP    - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    RES     - RESIDENTS (MEN)
    ICAP    - INTERN CAPACITY (VISITS/YEAR/MAN)
    INT     - INTERNS (MEN)
    SPCAP   - SUPERVISING PHYSICIAN CAPACITY (VISITS/
                YEAR/MAN)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)

RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE)               42, A
    RCAP    - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    RTPE    - RESIDENT TIME FOR PERCEIVED EMERGENCY
                (YEARS/VISIT/MAN)
    RTPNE   - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
                (YEARS/VISIT/MAN)

ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE)               43, A
    ICAP    - INTERN CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    ITPE    - INTERN TIME FOR PERCEIVED EMERGENCIES
                (YEARS/VISIT/MAN)
    ITPNE   - INTERN TIME FOR PERCEIVED NONEMERGENCIES
                (YEARS/VISIT/MAN)

SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE)            44, A
    SPCAP   - SUPERVISING PHYSICIAN CAPACITY (VISITS/
                YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    SPTPE   - SUPERVISING PHYSICIAN TIME PER EMERGENCY
                (YEARS/VISIT/MAN)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
                (YEARS/VISIT/MAN)

PCAP.K=CAPINV.K/DCIPP                                       45, A
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
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PEREMER.K=AE+SE*(1-AE)                                      46, A
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)

PERNEM.K=1-PEREMER.K                                        47, A
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)

NEP.K=PAT.K*PERNEM.K                                        48, A
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    PAT    - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

PR.K=(PAT.K-NEP.K)/NEP.K                                    49, A
SE=.1 (DIMENSIONLESS)                                       49.1, C
AE=.33 (DIMENSIONLESS)                                      49.2, C
    PR     - PATIENT RATIO (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)

ANCOST.K=EANCST.K+NEANCST.K                                 50, A
    ANCOST - ANCILLARY COSTS (DOLLARS/YEAR)
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)

EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K                       51, A
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    PAT    - PATIENTS (VISITS/YEAR)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K                      52, A
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)
    PAT    - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
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ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9)                          53, A
AVCPE=15 (DOLLARS/VISIT)                                    53.1, C
AVCPNE=8 (DOLLARS/VISIT)                                    53.2, C
TABLE6=1.5/1.43/1.32/1.1/.9/.7/.61/.57/.52/.51/.5           53.3, T
  (TABLE)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    TABLE6 - TABLE FUNCTION
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)

OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K                      54, A
    OPEXP  - OPERATING EXPENSES (DOLLARS/YEAR)
    SSAL   - STAFF SALARY (DOLLARS/YEAR)
    PHSAL  - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    ANCOST - ANCILLARY COSTS (DOLLARS/YEAR)
    SDCI   - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)

SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY                    55, A
ISAL=10000 (DOLLARS/YEAR/MAN)                               55.1, C
RSAL=10500 (DOLLARS/YEAR/MAN)                               55.2, C
SPSAL=30000 (DOLLARS/YEAR/MAN)                              55.3, C
    SSAL   - STAFF SALARY (DOLLARS/YEAR)
    ISAL   - INTERN SALARY (DOLLARS/YEAR/MAN)
    INT    - INTERNS (MEN)
    RSAL   - RESIDENT SALARY (DOLLARS/YEAR/MAN)
    RES    - RESIDENTS (MEN)
    SPSAL  - SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/
               MAN)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)

PHSAL.K=PHCPV*PAT.K                                         56, A
PHCPV=18.33 (DOLLARS/VISIT)                                 56.1, C
    PHSAL  - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    PHCPV  - PROFFESSIONAL HELP COST PER VISIT (DOLLARS/
               VISIT)
    PAT    - PATIENTS (VISITS/YEAR)

INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*           57, A
  PERNEM.K)
    INCOME - INCOME (DOLLARS/YEAR)
    PAT    - PATIENTS (VISITS/YEAR)
    BDEBT  - BAD DEBTS (DIMENSIONLESS)
    CPE    - COST PER EMERGENCY (DOLLARS/VISIT)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    CPNE   - COST PER NONEMERGENCY (DOLLARS/VISIT)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
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CPE.K=BCTEP+AVCPE*ANCT.K                                    58, A
BCTEP=25 (DOLLARS/VISIT)                                    58.1, C
    CPE    - COST PER EMERGENCY (DOLLARS/VISIT)
    BCTEP  - BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/
               VISIT)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

CPNE.K=BCTNEP+AVCPNE*ANCT.K                                 59, A
BCTNEP=15 (DOLLARS/VISIT)                                   59.1, C
BDEBT=.01 (DIMENSIONLESS)                                   59.2, C
    CPNE   - COST PER NONEMERGENCY (DOLLARS/VISIT)
    BCTNEP - BASE CHARGE TO NONEMERGENCY PATIENT
               (DOLLARS/VISIT)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    BDEBT  - BAD DEBTS (DIMENSIONLESS)

PRFLSS.K=INCOME.K-OPEXP.K                                   60, A
DT=.1 (YEARS)                                               60.2, C
PLTPER=1 (YEARS)                                            60.3, C
LENGTH=50 (YEARS)                                           60.4, C
    PRFLSS - PROFIT/LOSS (DOLLARS/YEAR)
    INCOME - INCOME (DOLLARS/YEAR)
    OPEXP  - OPERATING EXPENSES (DOLLARS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    PLTPER - PLOTTING INTERVAL (YEARS)
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NAME	NO	T	DEFINITION	WHERE USED
AE	49.2	C	ACTUAL EMERGENCIES (DIMENSIONLESS)	PEREMER,A,46
AEDTP	24	A	ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO PATIENTS (DIM.)	PAEDTP,A,23
ANCOST	50	A	ANCILLARY COSTS (DOLLARS/YEAR)	CPEXP,A,54
ANCT	53	A	ANCILLARY COST TO EXPERIENCE FACTOR (DIMENSIONLESS)	EANCST,A,51/NEANCST,A,52/CPE,A,58/CPNE,A,59
AOI	9	R	ATTRITION RATE OF INTERNS (MEN/YEAR)	INT,L,1
AOR	16	R	ATTRITION RATE OF RESIDENTS (MEN/YEAR)	HRES,L,2
ARNORM	24.1	C	AREA NORMAL OVERLOAD (DIMENSIONLESS)	AEDTP,A,24
ATCS	17	A	ATTRACTIVENESS TO CURRENT STAFF (DIMENSIONLESS)	ATPS,A,8/IDM,A,10
ATPS	8	A	ATTRACTIVENESS TO POTENTIAL STAFF (DIMENSIONLESS)	RHI,R,4/RHR,R,12
ATTDEL	8.1	C	TIME TO PERCEIVE ATTRACTIVENESS (YEARS)	ATPS,A,8
AVCPE	53.1	C	AVERAGE COST PER PERCEIVED EMERGENCY (DOLLARS/VISIT)	EANCST,A,51/CPE,A,58
AVCPNE	53.2	C	AVERAGE COST PER PERCEIVED NONEMERGENCY (DOLLARS/VISIT)	NEANCST,A,52/CPNE,A,59
AVSPI	9.1	C	AVERAGE STAY PER INTERN (YEARS/MAN)	AOI,R,9/INTRES,R,11
AVSPR	16.1	C	AVERAGE STAY PER RESIDENT (YEARS/MAN)	AOR,R,16
BCTEP	58.1	C	BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/ VISIT)	CPE,A,58
BCTNEP	59.1	C	BASE CHARGE TO NONEMERGENCY PATIENT (DOLLARS/VISIT)	CPNE,A,59
BDEBT	59.2	C	BAD DEBTS (DIMENSIONLESS)	INCOME,A,57
CAPINV	25	L	CAPITAL INVESTMENT (DOLLARS)	DCI,R,26/CIOF,R,30/PCAP,A,45
	25.1	N		
CAPINVN	25.2	C	INITIAL VALUE OF CAPITAL INVESTMENT (DOLLARS)	CAPINV,N,25.1
CAPITC	29.1	C	CAPITAL INVESTMENT TIME CONSTANT (YEARS)	RCI,R,29/CIOF,R,30
CIOF	30	R	CAPITAL INVESTMENT ORDERING FUNCTION (DOLLARS/YEAR)	RCI,R,29
CIOO	29.2	N	CAPITAL INVESTMENT ON ORDER (DOLLARS)	RCI,R,29/CIOF,R,30
CIOON	29.3	C	INITIAL VALUE OF CAPITAL INVESTMENT ON ORDER (DOLLARS)	CIOO,N,29.2
CPE	58	A	COST PER EMERGENCY (DOLLARS/VISIT)	INCOME,A,57
CPL	21	R	CHANGE IN PATIENT LOAD (VISITS/YEAR)	PAT,L,20
CPNE	59	A	COST PER NONEMERGENCY (DOLLARS/VISIT)	INCOME,A,57
DCAPINV	32	A	DESIRED CAPITAL INVESTMENT (DOLLARS)	CIOF,R,30
DCI	26	R	DEPRECIATION OF CAPITAL INVESTMENT (DOLLARS/ YEAR)	CAPINV,L,25/SDCI,A,33
DCIPP	32.1	C	DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)	DCAPINV,A,32/PCAP,A,45
DEPDT	28.3	C	DEPRECIATION DELAY TIME (YEARS)	DEPT,A,27
DEPF	28	A	DEPRECIATION FUNCTION (DIMENSIONLESS)	DEPT,A,27
DEPT	27	A	DEPRECIATION TIME (YEARS)	DCI,R,26
DI	7	A	DESIRED INTERNS (MEN)	DIM,A,6
DIM	6	A	DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)	RHI,R,4
DITRR	7.1	C	DESIRED INTERN TO RESIDENT RATIO (DIMENSIONLESS)	DI,A,7/DR,A,15
DR	15	A	DESIRED RESIDENTS (MEN)	DI,A,7/DRM,A,14
DRM	14	A	DESIRED RESIDENTS MULTIPLIER (DIMENSIONLESS)	RHR,R,12
DT	60.2	C	INCREMENT IN TIME (YEARS)	INT,L,1/HRES,L,2/PAT,L,20/CAPINV,L,25
EANCST	51	A	EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)	ANCOST,A,50
EATS	10.2	C	EXTERNAL ATTRACTIVENESS TO STAFF (DIMENSIONLESS)	IDM,A,10

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EXFUND   31    A EXTERNAL FUNDING (DOLLARS/YEAR)              CICF,R,30
HRES      2    L HOSPITAL RESIDENTS (MEN)                     RES,A,3
          2.1  N
HRESN     2.2  C INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)    HRES,N,2.1
ICAP     43    A INTERN CAPACITY (VISITS/YEAR/MAN)            SCAP,A,41
IDM      10    A INTERN DESTINATION MULTIPLIER                AOI,R,9/INTRES,R,11
                   (DIMENSIONLESS)
IDTTP    23.1  C INFORMATION DELAY TIME TO PATIENTS (YEARS)   PAEDTP,A,23
IEC      17.3  N INTERN EMERGENCY CAPACITY (VISITS/YEAR)      DR,A,15
IEXP     15.1  N INTERN EXPERIENCE (DIMENSIONLESS)            SEXP,A,14
IHPW     17.6  C INTERN HOURS PER WEEK (HOURS/WEEK)           ITPE,N,17.4/ITPNE,N,17.8
IMPE     17.5  C INTERN MINUTES PER EMERGENCY (MINUTES/       ITPE,N,17.4
                   VISIT)
IMPNE    17.9  C INTERN MINUTES PER NONEMERGENCY (MINUTES/    ITPNE,N,17.8
                   VISIT)
INC      17.7  N INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)   DR,A,15
INCOME   57    A INCOME (DOLLARS/YEAR)                        PRFLSS,A,60
INNORM   17.1  C INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)     ATCS,A,17
INT       1    L INTERNS (MEN)                                DIM,A,6/AOI,R,9/INTRLS,R,11/SEXP,A,34/STAFF,A,35/SCAP,A,41
          1.1  N                                                SSAL,A,55
INTN      1.2  C INITIAL VALUE OF INTERNS (MEN)               INT,N,1.1
INTRES   11    R RATE OF RESIDENTS HIRED FROM INTERNS (MEN/   INT,L,1/HRES,L,2
                   YEAR)
ISAL     55.1  C INTERN SALARY (DOLLARS/YEAR/MAN)             SSAL,A,55
ITPE     17.4  N INTERN TIME FOR PERCEIVED EMERGENCIES        IEC,N,17.3/ICAP,A,43
                   (YEARS/VISIT/MAN)
ITPNE    17.8  N INTERN TIME FOR PERCEIVED NONEMERGENCIES     INC,N,17.7/ICAP,A,43
                   (YEARS/VISIT/MAN)
LAWF     10.1  C LOCAL ATTRACTIVENESS WEIGHTING FACTOR        IDM,A,10
                   (DIMENSIONLESS)
LENGTH   60.4  C
NEANCST  52    A NONEMERGENCY ANCILLARY COSTS (DOLLARS/       ANCOST,A,50
                   VISIT)
NEP      48    A NONEMERGENCY PATIENTS (VISITS/YEAR)          DR,A,15/PR,A,49
NHRR     13    A NORMAL HIRING RATE OF RESIDENTS FROM CUTSIDE RHR,R,12
         13.1  N   (MEN/YEAR)
NORDT    28.2  C NORMAL DEPRECIATION TIME (YEARS)             DEPT,A,27
NRHI      5    A NORMAL RATE OF HIRING INTERNS (MEN/YEAR)     RHI,R,4
          5.1  N
OLOAD    37    A OVERLOAD OF FACILITIES (DIMENSIONLESS)       QOCO,A,39
OPEXP    54    A OPERATING EXPENSES (DOLLARS/YEAR)            PRFLSS,A,60
PAEDTP   23    A PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO   CPL,R,21
                   PATIENTS (DIM.)
PAT      20    L PATIENTS (VISITS/YEAR)                       ATCS,A,17/AEDTP,A,24/DEPP,A,28/EXFUND,A,31/DCAPINV,A,32
         20.1  N                                                OLOAD,A,37/NEP,A,48/PR,A,49/EANCST,A,51/NEANCST,A,52
                                                                PHSAL,A,56/INCOME,A,57
PATN     20.2  C INITIAL VALUE OF PATIENTS (VISITS/YEAR)      PAT,N,20.1
PATPOOL  22    A PATIENT POOL (MEN)                           CPL,R,21
PCAP     45    A PHYSICAL CAPACITY (VISITS/YEAR)              DEPP,A,28/EXFUND,A,31/PLCAP,A,36
PEREMER  46    A PERCEIVED EMERGENCIES (DIMENSIONLESS)        RCAP,A,42/ICAP,A,43/SPCAP,A,44/PERNEM,A,47/EANCST,A,51
                                                                INCOME,A,57
PERNEM   47    A PERCEIVED NONEMERGENCIES (DIMENSIONLESS)     NEP,A,48/NEANCST,A,52/INCOME,A,57
PGC      22.1  C PATIENT POOL GROWTH CONSTANT (1/YEAR)        PATPOOL,A,22
PHCPV    56.1  C PROFFESSIONAL HELP COST PER VISIT (DOLLARS/  PHSAL,A,56
                   VISIT)
PHSAL    56    A PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)   OPEXP,A,54
PLCAP    36    A PLANNED CAPACITY (VISITS/YEAR)               ATCS,A,17/AEDTP,A,24/OLOAD,A,37
PLTPER   60.3  C PLOTTING INTERVAL (YEARS)
```

PPEMER	22.2	C	POPULATION PERCEIVED EMERGENCY (1/YEAR)	CPL,R,21
PR	49	A	PATIENT RATIO (DIMENSIONLESS)	DR,A,15
PRFLSS	60	A	PROFIT/LOSS (DOLLARS/YEAR)	
QOC	38	S	QUALITY OF CARE (DIMENSIONLESS)	
QOCE	40	A	QUALITY OF CARE FROM EXPERIENCE (DIMENSIONLESS)	QOC,S,38
QOCO	39	A	QUALITY OF CARE FROM OVERLOAD (DIMENSIONLESS)	QOC,S,38
RCAP	42	A	RESIDENT CAPACITY (VISITS/YEAR/MAN)	SCAP,A,41
RCI	29	R	RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)	CAPINV,L,25
REC	18	N	RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)	DR,A,15
RES	3	A	RESIDENTS (MEN)	DRM,A,14/ADR,R,16/SEXP,A,34/STAFF,A,35/SCAP,A,41/SSAL,A,55
REXP	35.2	N	RESIDENT EXPERIENCE (DIMENSIONLESS)	SEXP,A,34
RHI	4	R	RATE OF HIRING INTERNS (MEN/YEAR)	INT,L,1/NRHI,A,5
RHPW	18.3	C	RESIDENT HOURS PER WEEK (HOURS/WEEK)	RTPE,N,18.1/RTPNE,N,18.5
RHR	12	R	RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/YEAR)	HRES,L,2/NHRR,A,13
RMPE	18.2	C	RESIDENT MINUTES PER EMERGENCY (MINUTES/VISIT)	RTPE,N,18.1
RMPNE	18.6	C	RESIDENT MINUTES PER NONEMERGENCY (MINUTES/VISIT)	RTPNE,N,18.5
RNC	18.4	N	RESIDENT NONEMERGENCY CAPACITY (VISITS/YEAR)	DR,A,15
RSAL	55.2	C	RESIDENT SALARY (DOLLARS/YEAR/MAN)	SSAL,A,55
RTPE	18.1	N	RESIDENT TIME FOR PERCEIVED EMERGENCY (YEARS/VISIT/MAN)	REC,N,18/RCAP,A,42
RTPNE	18.5	N	RESIDENT TIME FOR PERCEIVED NONEMERGENCY (YEARS/VISIT/MAN)	RNC,N,18.4/RCAP,A,42
SCAP	41	A	STAFF CAPACITY (VISITS/YEAR)	PLCAP,A,36
SDCI	33	A	SMOOTHED RATE OF DEPRECIATION OF CAPITAL INVESTMENT ($/YEAR)	CIOP,R,30/OPEXP,A,54
SE	49.1	C	SORTING ERROR RATE (DIMENSIONLESS)	PEREMER,A,46
SEXP	34	A	STAFF EXPERIENCE (DIMENSIONLESS)	QOCE,A,40/ANCT,A,53
SMTI	5.2	C	SMOOTHING TIME FOR INTERNS (YEARS)	NRHI,A,5
SMTR	13.2	C	SMOOTHING TIME FOR RESIDENTS (YEARS)	NHRR,A,13
SPCAP	44	A	SUPERVISING PHYSICIAN CAPACITY (VISITS/YEAR/MAN)	SCAP,A,41
SPEC	18.7	N	SUPERVISING PHYSICIAN EMERGENCY CAPACITY (VISITS/YEAR)	DR,A,15
SPEXP	35.3	N	SUPERVISING PHYSICIAN EXPERIENCE (DIMENSIONLESS)	SEXP,A,34
SPHPW	19	C	SUPERVISING PHYSICIAN HOURS PER WEEK (HOURS/WEEK)	SPTPE,N,18.8/SPTPNE,N,19.2
SPMPE	18.9	C	SUPERVISING PHYSICIAN MINUTES PER EMERGENCY (MINUTES/VISIT)	SPTPE,N,18.8
SPMPNE	19.3	C	SUPERVISING PHYSICIAN MINUTES PER NONEMERGENCY (MINUTES/VISIT)	SPTPNE,N,19.2
SPNC	19.1	N	SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY (VISITS/YEAR)	DR,A,15
SPSAL	55.3	C	SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/MAN)	SSAL,A,55
SPTPE	18.8	N	SUPERVISING PHYSICIAN TIME PER EMERGENCY (YEARS/VISIT/MAN)	SPEC,N,18.7/SPCAP,A,44
SPTPNE	19.2	N	SUPERVISING PHYSICIAN TIME PER NONEMERGENCY (YEARS/VISIT/MAN)	SPNC,N,19.1/SPCAP,A,44
SSAL	55	A	STAFF SALARY (DOLLARS/YEAR)	OPEXP,A,54
STAFF	35	A	STAFF (MEN)	SEXP,A,34
SUPHY	35.4	C	SUPERVISING PHYSICIANS (MEN)	DR,A,15/SEXP,A,34/STAFF,A,35/SCAP,A,41/SSAL,A,55

```
TABLE1    39.1 T TABLE FUNCTION                                AEDTP,A,24/QOCO,A,39
TABLE2    31.1 T TABLE FUNCTICN                                EXFUND,A,31
TABLE3    36.1 T TABLE FUNCTION                                PLCAP,A,36
TABLE4    28.1 T TABLE FUNCTION                                DEPF,A,28
TABLE5     6.1 T TABLE FUNCTICN                                DIM,A,6/DRM,A,14/QOCE,A,40
TABLE6    53.3 T TABLE FUNCTION                                ANCT,A,53
TABLE7    17.2 T TABLE FUNCTION                                ATCS,A,17
TSDCI     33.1 C TIME TC SMOOTH DEPRECIATION OF CAPITAL        SDCI,A,33
                    INVESTMENT (YEARS)
TTCH      20.3 C TIME TO CHANGE HABITS (YEARS)                 PAT,L,20
```

APPENDIX II

DETAILED EXPLANATION OF THE MODEL

DETAILED EXPLANATION OF THE MODEL

The emergency department system described by this model has four major interactive components:

I. The patient pool and patient load

II. The professional staff

III. The capital investment in plant and equipment

IV. The financial aspects of the emergency department operations

I. Patients

```
PATPOOL.K=150000*EXP (PGC*TIME.K)                         22, A
   PATPOOL - PATIENT POOL (MEN)

PGC=0.015 (I/YEAR)                                        22.1, C
   PGC=POOL GROWTH CONSTANT
```

The patient pool (PATPOOL) is defined as the number of people in the catchment area of the urban emergency department modeled - in this case, 150,000 individuals. The patient pool is growing exponentially at the rate (PGC) of 1.5 per cent per year.

```
PPEMER=.4 (DIMENSIONLESS)                                 22.2, C
   PPEMER - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PAT=PATN (VISITS/YEAR)                                    20.1, N
   PAT - PATIENTS (VISITS/YEAR)
   PATN - INITIAL VALUE OF PATIENTS (VISITS/YEAR)

PATN=60707 (VISITS/YEAR)                                  20.2, C
   PATN - INITIAL VALUE OF PATIENTS (VISITS/YEAR)
```

We have estimated that about 40 per cent of the patient pool perceive an emergency annually (PPEMER). Thus, as an initial condition, the modeled emergency department has a patient load (PATN) of approximately

60,000 annual visits. A visit is defined as an entry into the emergency department system by an individual. If a person makes four trips to the emergency department in the course of a year this is counted as four visits.

```
CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER                          21,R
   CPL     -CHANGE IN PATIENT LOAD (VISITS/YEAR)
   PAEDTP  -PERCEIVED ATTRACTIVENESS OF EMERGENCY
            DEPARTMENT TO PATIENTS (DIM.)
   PATPOOL -PATIENT POOL (MEN)
   PPEMER  -POPULATION PERCEIVED EMERGENCY (1/YEAR)
```

Factors other than the perception of emergencies (PPEMER) by the member of the patient pool can change the patient load. Major among these is the attractiveness of the emergency department, as perceived by the prospective patients (PAEDTP). We have defined the rate of change in patient load (CPL), between two points in time, as a product of the patient pool size (PATPOOL), the ratio of perceived emergencies per year (PPEMER) and the perceived attractiveness of the emergency department (PAEDTP). PATPOOL and PPEMER are defined immedately above.

```
PAEDTP.K=DLINF3(AEDTP.K, IDTTP)                           23,A
   PAEDTP    -PERCEIVED ATTRACTIVENESS OF EMERGENCY
              DEPARTMENT TO PATIENTS (DIM.)
   AEDTP     -ATTRACTIVENESS OF EMERGENCY DEPARTMENT
              TO PATIENTS (DIM.)

   IDTTP     -INFORMATION DELAY TIME TO PATIENTS (YEARS)

IDTTP=4 (YEARS)                                           23.1, C
   IDTTP     -INFORMATION DELAY TIME TO PATIENTS (YEARS)
```

The perceived attractiveness of the emergency department to patients (PAEDTP) is, in turn, the actual attractiveness of the facility to prospective patients (AEDTP), moderated through a third order information delay function. The information delay time to patients is defined as four years.* That is, it takes four years for roughly 60 per cent of the patients to perceive a change in the emergency department's operation (IDTTP) which would alter their view as to its attractiveness. If the emergency department becomes overcrowded, or gives such poor service that it is no longer as attractive as alternative sources of health care, there is a delay of about eight years before this is perceived by 90 per cent of the patient pool. As will be noted below, once the perceived attractiveness changes, there is an additional delay before the patient changes his habits (TTCH) and uses alternate emergency facilities. The above time scales also apply to increased attractiveness.

```
AEDTP.K=0.5+0.5*TABLE(TABLE1(PAT.K/PLCAP.K)/ARNORM,0,2,.2)  24, A
   AEDTP     -ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
              PATIENTS (DIM.)
   TABLE1    -TABLE FUNCTION
   PAT       -PATIENTS (VISITS/YEAR)
   PLCAP     -PLANNED CAPACITY (VISITS/YEAR)
   ARNORM    -AREA NORMAL OVERLOAD (DIMENSIONLESS)

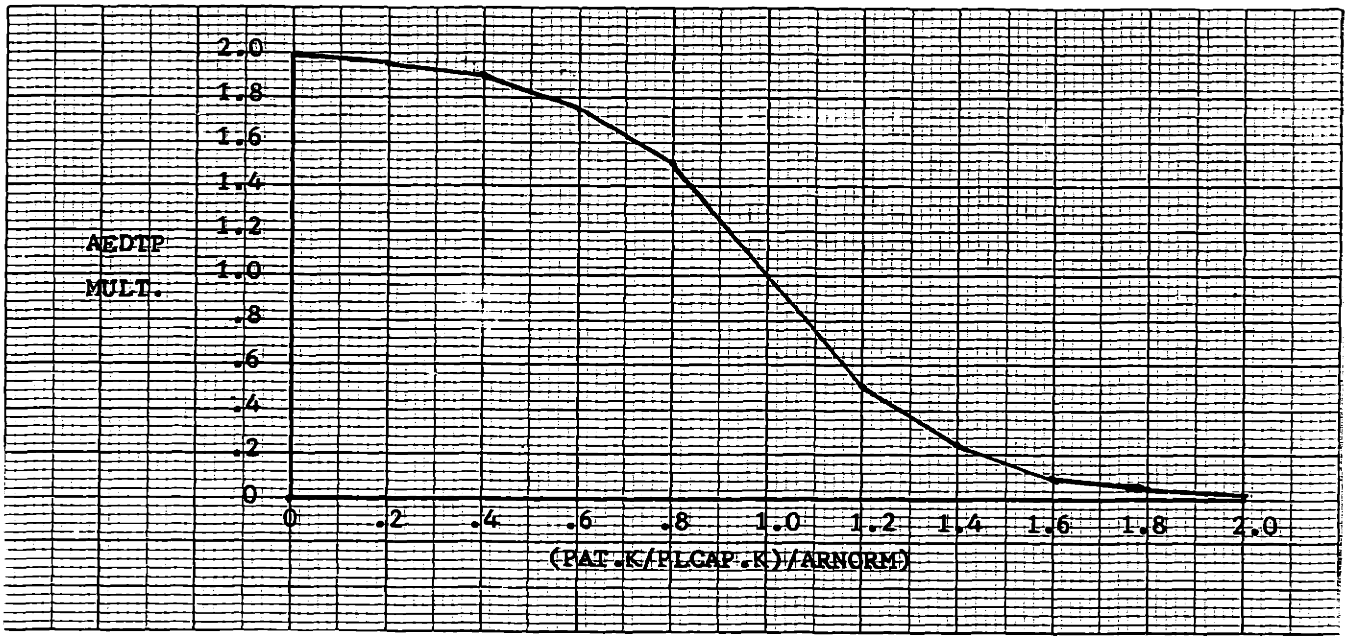
ARNORM=1.2 (DIMENSIONLESS)                               24.1,C
   ARNORM    -AREA NORMAL OVERLOAD (DIMENSIONLESS)
```

The actual (as opposed to the perceived) attractiveness of the emergency department to patients (AEDTP) is influenced by the ratio of the patient load in visits per year (PAT) to the planned capacity (PLCAP), divided by the normal overload in the area (ARNORM). The normal overload is initially defined as 1.2; that is, a 20 per cent excess of patients beyond the planned capacity of the emergency department will not have an adverse effect on the actual attractiveness of the emergency

* Sensitivity test 15 in Appendix III illustrates the behavior of the base simulation if this delay is shortened to one year.

facility. Beyond that point, however, attractiveness will fall, as the number of patients (PAT) exceeds the planned capacity (PLCAP). This effect is dampened by the fact that this calculation affects only half of the attractiveness function. The table and graph for Table function I are presented below:

TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 39.1, T

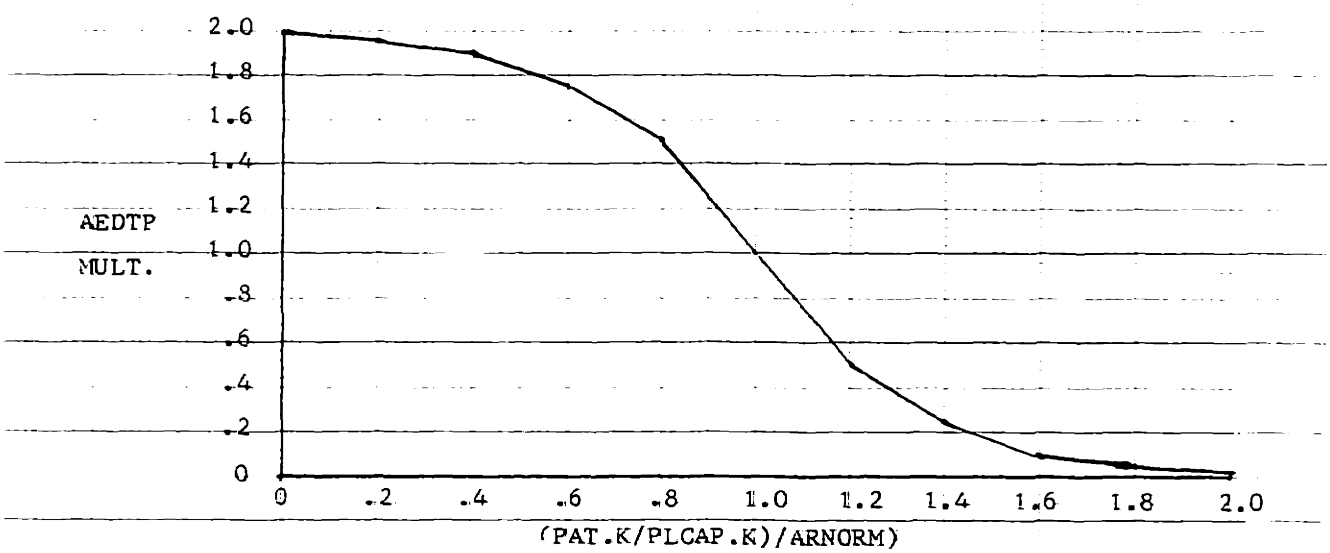


PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J) 20, L
PAT - PATIENTS (VISITS/YEAR)
TTCH - TIME TO CHANGE HABITS (YEARS)
CPL - CHANGE IN PATIENT LOAD (VISITS/YEAR)

TTCH=1 (YEAR) 20.3, C
TTCH - TIME TO CHANGE HABITS (YEARS)
DT=.1 (YEARS) 60.2, C

The patient load (PAT) obviously will change through time. Equation 20, above, defines the rate of change in terms of a first order exponentially smoothed function. The newly calculated patient load (PAT) at present time K is given as the previous value for the patient load (PAT.J), corrected by a fraction of the difference between the facility. Beyond that point, however, attractiveness will fall, as the number of patients (PAT) exceeds the planned capacity (PLCAP). This effect is dampened by the fact that this calculation affects only half of the attractiveness function. The table and graph for Table function 1 are presented below:

TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 39.1, T




```
PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J)                20, L
   PAT - PATIENTS (VISITS/YEAR)
   TTCH - TIME TO CHANGE HABITS (YEARS)
   CPL - CHANGE IN PATIENT LOAD (VISITS/YEAR)

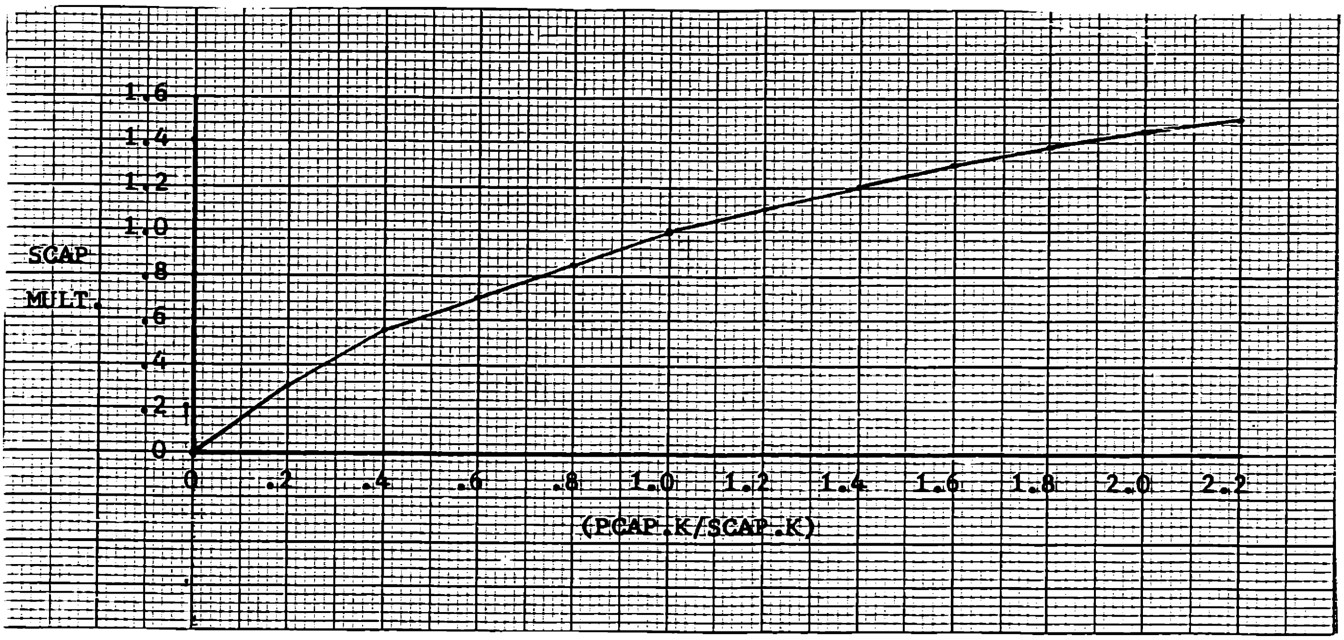
TTCH=1 (YEAR)                                         20.3, C
   TTCH - TIME TO CHANGE HABITS (YEARS)
DT=.1 (YEARS)                                         60.2, C
```

The patient load (PAT) obviously will change through time. Equation 20, above, defines the rate of change in terms of a first order exponentially smoothed function. The newly calculated patient load (PAT) at present time K is given as the previous value for the patient load (PAT.J), corrected by a fraction of the difference between the change in patient load during the last time interval (CPL.JK) and the previously computed patient load (PAT.J). The constant TTCH - the time it takes patients to change their habits - gives the fraction of the difference that is to be corrected each time period. This in turn is multiplied by the time interval DT to get the amount of correction in each computation time interval. Exponential smoothing weights the most recent data most heavily, with progressively decreasing weights on older data.

```
PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2)        36, A
   PLCAP - PLANNED CAPACITY (VISITS/YEAR)
   SCAP  - STAFF CAPACITY (VISITS/YEAR)
   TABLE3  - TABLE FUNCTION
   PCAP - PHYSICAL CAPACITY (VISITS/YEAR)
```

In equation 24 above, the ratio of patient load (PAT) to planned capacity (PLCAP) plays an important - though dampened - role in determining the attractiveness of the emergency department to the patient (AEDTP). Planned capacity, in turn, is a product of the staff capacity, (SCAP), that is, how many patients the staff can handle in a given unit of time, and the relationship between the <u>physical</u> capacity (PCAP) and the staff capacity (SCAP). Note that in Table 3 below, that the ratio of the physical capacity (PCAP) to the staff capacity (SCAP) has a limit of 1.5 times normal. Each variable has its limit. If the staff is 50 per cent overloaded no amount of additional space will improve their ability to handle patients. If the number of visits exceeds the physical plant capacity by 50 per cent, an increase in staff will not increase the patient processing rate.

TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5 36.1, T



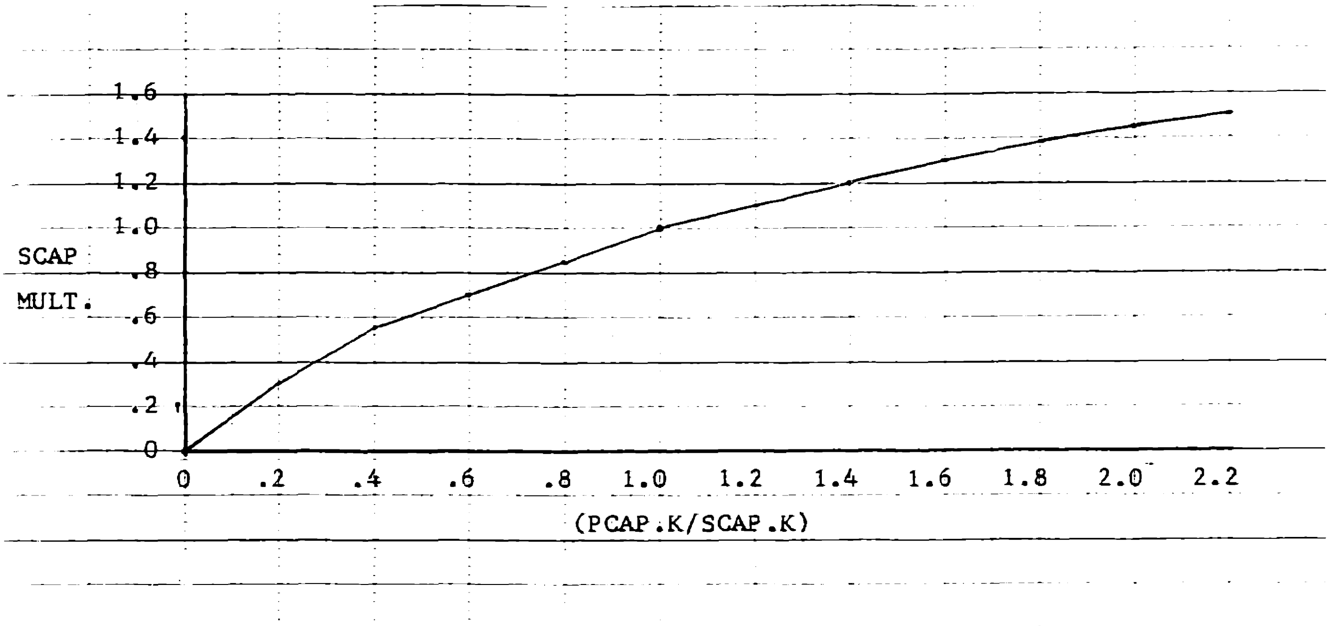

```
PCAP.K=CAPINV.K/DCIPP                                         45, A
   PCAP - PHYSICAL CAPACITY (VISITS/YEAR)
   CAPINV - CAPITAL INVESTMENT (DOLLARS)
   DCIPP - DESIRED CAPITAL INVESTMENT PER PATIENT
               (DOLLARS/VISIT/YEAR)

DCIPP=60 (DOLLARS/VISIT/YEAR)                                 32.1, C
   DCIPP - DESIRED CAPITAL INVESTMENT PER PATIENT
               (DOLLARS/VISIT/YEAR)
```

Physical capacity (PCAP) is defined as the ratio of capital investment in dollars (CAPINV) (see equations 25 and 25.2 in section III) to the desired capital investment per patient (DCIPP). The initial value of DCIPP is $60 per visit per year.

```
SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY                41, A
   SCAP - STAFF CAPACITY (VISITS/YEAR)
   RCAP - RESIDENT CAPACITY (VISITS/YEAR/MAN)
   RES  - RESIDENTS (MEN)
   ICAP - INTERN CAPACITY (VISITS/YEAR/MAN)
   INT  - INTERNS (MEN)
   SPCAP - SUPERVISING PHYSICIAN CAPACITY (VISITS/
               YEAR/MAN)
   SUPHY - SUPERVISING PHYSICIANS (MEN)
```

TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5 36.1, T



PCAP.K=CAPINV.K/DCIPP 45, A
PCAP - PHYSICAL CAPACITY (VISITS/YEAR)
CAPINV - CAPITAL INVESTMENT (DOLLARS)
DCIPP - DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)

DCIPP=60 (DOLLARS/VISIT/YEAR) 32.1, C
DCIPP - DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)

Physical capacity (PCAP) is defined as the ratio of capital investment in dollars (CAPINV) (see equations 25 and 25.2 in section III) to the desired capital investment per patient (DCIPP). The initial value of DCIPP is $60 per visit per year.

SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY 41, A
SCAP - STAFF CAPACITY (VISITS/YEAR)
RCAP - RESIDENT CAPACITY (VISITS/YEAR/MAN)
RES - RESIDENTS (MEN)
ICAP - INTERN CAPACITY (VISITS/YEAR/MAN)
INT - INTERNS (MEN)
SPCAP - SUPERVISING PHYSICIAN CAPACITY (VISITS/YEAR/MAN)
SUPHY - SUPERVISING PHYSICIANS (MEN)

Staff capacity (SCAP) is defined as the summation of the capacity of residents to handle patients (RCAP*RES), the capacity of the interns to handle patients (ICAP*INT) and the capacity of the supervising physician to handle patients (SPCAP*SUPHY). That is, given that a resident can treat an emergency patient in 30 minutes and a non-emergency patient in 20 minutes, and given 6 residents on the staff working a 60 hour week 50 weeks a year, we can calculate the residents "capacity" to handle visits in the emergency department. Similar calculations are made for the interns and for the supervising physician. The total of these three "capacities" is the total capacity of the staff in visits per year (SCAP).

The equations for the "capacities" fo the individual staff types follow:

```
ICAP.K=1/(PEREMER.K*ITPE+(1-PERMER.K)*ITPNE)                43, A
   ICAP    - INTERN CAPACITY (VISITS/YEAR/MAN)
   PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)
   ITPE    - INTERN TIME FOR PERCEIVED EMERGENCIES
                (YEARS/VISIT)
   ITPNE   - INTERN TIME FOR PERCEIVED NON-EMERGENCIES
                (YEARS/VISIT)
```

The intern capacity (ICAP), i.e. the visits which each intern can handle in one working year, is the reciprocal of the perceived emergencies (PEREMER - equation 46, Section IV) times the average time it takes an intern to handle a true emergency (ITPE), plus the perceived non-emergencies (1-PEREMER) times the average time it takes an intern to handle a non-emergent patient (ITPNE).

```
ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)                       17.4, N
   ITPE - INTERN TIME FOR PERCEIVED EMERGENCIES (YEARS)
   IMPE - INTERN MINUTES PER EMERGENCY (MINUTES/VISIT)
   IHPW - INTERN HOURS PER WEEK (HOURS/WEEK)
```

```
IMPE=45 (MINUTES)                                         17.5, C
  IMPE - INTERN MINUTES PER EMERGENCY
            (MINUTES/VISIT)

IHPW=60 (HOURS/WEEK)                                      17.6, C
   IHPW - INTERN HOURS PER WEEK (HOURS/WEEK)
```

In the base simulation the intern time for a perceived emergency (IMPE) becomes 45/60 of an hour divided by 60 hours per week times 50 weeks, or 1/4000 of a year for each visit. The basic assumption is that interns (and residents) average 60 hours per week on a 50 week basis.

```
ITPNE=(IMPNE/60)/(IHPW*50)   (YEARS/VISIT)                17.8, N
   ITPNE - INTERN TIME FOR PERCEIVED NON-EMERGENCIES
            (YEARS)
   IMPNE - INTERN MINUTES PER NON-EMERGENCY (MINUTES/
            VISIT)
   IHPW  - INTERN HOURS PER WEEK (HOURS/WEEK)

IMPNE=25 (MINUTES)                                        17.9, C
   IMPNE - INTERN MINUTES PER NON-EMERGENCY
            (MINUTES/VISIT)
```

Times for non-emergencies are calculated in the same manner.

```
RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE)             42, A
   RCAP    - RESIDENT CAPACITY (VISITS/YEAR/MAN)
   PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)
   RTPE    - RESIDENT TIME FOR PERCEIVED EMERGENCY
              (YEARS/VISIT)
   RTPNE   - RESIDENT TIME FOR PERCEIVED NON-EMERGENCY
              (YEARS/VISIT)

RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)                    18.1, N
   RTPE  - RESIDENT TIME FOR PERCEIVED EMERGENCY
              (YEARS/VISIT/MAN)
   RMPE  - RESIDENT MINUTES PER EMERGENCY (MINUTES/
              VISIT)
   RHPW  - RESIDENT HOURS PER WEEK (HOURS/WEEK)

RMPE=30 (MINUTES)                                         18.2, C
   RMPE  - RESIDENT MINUTES PER EMERGENCY (MINUTES/
              VISIT)

RHPW=60 (HOURS/WEEK)                                      18.3, C
   RHPW  - RESIDENT HOURS PER WEEK (HOURS/WEEK)
```

```
RTPNE=(RMPNE/60)/(RHPW*50)  (YEARS/VISITS)                 18.5, N
   RTPNE   - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
                (YEARS/VISIT/MAN)
   RMPNE   - RESIDENT MINUTES PER NONEMERGENCY
                (MINUTES/VISIT)
   RHPW    - RESIDENT HOURS PER WEEK (HOURS/WEEK)

RMPNE=20  (MINUTES)                                        18.6, C
   RMPNE   - RESIDENT MINUTES PER NONEMERGENCY
                (MINUTES/VISIT)
```

The residents' contribution (RCAP*RES) to staff capacity is calculated identically to that for the interns.

```
SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE)           44, A
   SPCAP   - SUPERVISING PHYSICIAN CAPACITY (VISITS/
                YEAR/MAN)
   PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)
   SPTPE   - SUPERVISING PHYSICIAN TIME PER EMERGENCY
                (YEARS/VISIT)
   SPTNE   - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
                (YEARS/VISIT)

SPTPE=(SPMPE/60)/(SPHPW*50)  (YEARS/VISIT)                 18.8, N
   SPTPE   - SUPERVISING PHYSICIAN TIME PER EMERGENCY
                (YEARS/VISIT)
   SPMPE   - SUPERVISING PHYSICIAN MINUTES PER EMERGENCY
                (MINUTES/VISIT)
   SPHPW   - SUPERVISING PHYSICIAN HOURS PER WEEK
                (HOURS/WEEK)

SPMPE=25  (MINUTES)                                        18.9, C
   SPMPE   - SUPERVISING PHYSICIAN MINUTES PER EMERGENCY
                (MINUTES/VISIT)

SPHPW=20  (HOURS/WEEK)                                     19, C
   SPHPW   - SUPERVISING PHYSICIAN HOURS PER WEEK
                (HOURS/WEEK)

SPTPNE=(SPMPNE/60)/(SPHPW*50)  (YEARS/VISIT)               19.2, N
   SPTPNE  - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
                (YEARS/VISIT)
   SPMPNE  - SUPERVISING PHYSICIAN MINUTES PER
                NONEMERGENCY (MINUTES/VISIT)
   SPHPW   - SUPERVISING PHYSICIAN HOURS PER WEEK
                (HOURS/WEEK)

SPMPNE=20  (MINUTES)                                       19.3, C
   SPMPNE  - SUPERVISING PHYSICIAN MINUTES PER NON-
                EMERGENCY (MINUTES/VISIT)
```

```
SUPHY=1 (MEN)                                              35.4, C
   SUPHY  - SUPERVISING PHYSICIANS (MEN)
```

Supervising physicians are handled in an almost identical manner. The only difference is that the number of supervising physicians (SUPHY) is constant, whereas the number of interns and residents varies with the patient load (see Section II).

```
OLOAD.K=PAT.K/PLCAP.K                                      37, A
   OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)
   PAT    - PATIENTS (VISITS/YEAR)
   PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
```

The final element related to the patient is the concept of overload (OLOAD). We have defined overload as the ratio which relates the number of patients, in visits per year (PAT), to the planned capacity (PLCAP), as defined above in equation 36. This concept is key to determining the dynamic effect of elements of the model on quality of care (QOC, defined in section II).

II. Staff

The physician staff of this "typical" urban hospital emergency department is composed of three distinct personnel categories: interns (INT), residents (RES), and supervising physicians (SUPHY). In the model we have related the levels of interns and residents to several other variables, key among which is the degree of attractiveness that the emergency department holds for its current and potential staff members (ATCS and ATPS respectively).

```
INT.K=INT.J+(DT)(RHI.JK-AOI.JK-INTRES.JK)                  1, L
INT=INTN (MEN)                                             1.1, N
```

```
INTN=6.315 (MEN)                                         1.2, C
   INT   - INTERNS (MEN)
   RHI   - RATE OF HIRING INTERNS (MEN/YEAR)
   AOI   - ATTRITION RATE OF INTERNS (MEN/YEAR)
   INTRES - RATE OF RESIDENTS HIRED FROM INTERS
              (MEN/YEAR)
   INTN   - INITIAL VALUE OF INTERNS (MEN)
```

The level of interns at any point in time (INT.K) is defined as the level of interns in the previous time period (INT.J), plus, for each time increment (DT), the number of interns hired from outside the system (RHI) less the interns lost from the emergency department to other hospitals, clinics, or private practices (AOI), less the interns who stay but become residents (INTRES). The initial value for the number of interns (INTN), when the system in equilibrium, is slightly more than six men.

```
RHI.KL=NRHI.K*DIM.K*ATPS.K                               4, R
   RHI  - RATE OF HIRING INTERNS (MEN/YEAR)
   NRHI - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
   DIM  - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
   ATPS - ATTRACTIVENESS TO POTENTIAL STAFF
            (DIMENSIONLESS)

NRHI.K=SMOOTH (RHI.JK,SMTI)                              5, A
NRHI=6.3152                                              5.1, N
SMTI=2 (YEARS)                                           5.2, C
   NRHI  - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
   RHI   - RATE OF HIRING INTERNS (MEN/YEAR)
   SMTI  - SMOOTHING TIME FOR INTERNS (YEARS)
```

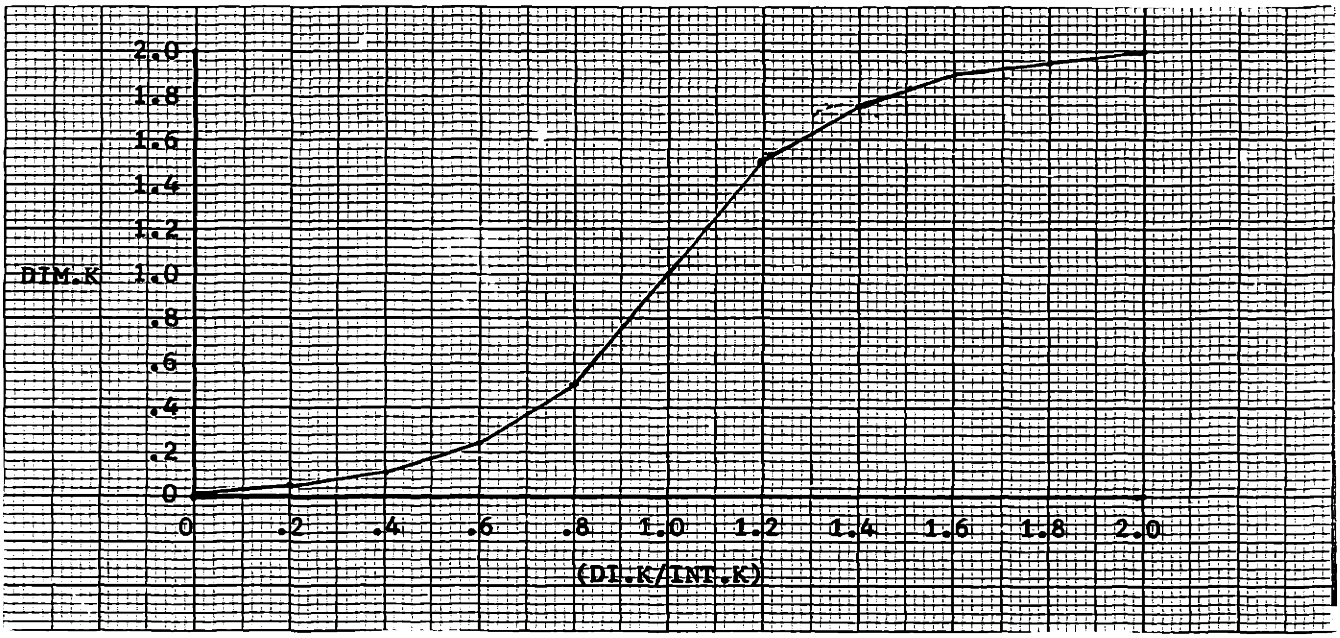
The rate of hiring interns from outside the system (RHI) is the product of: (1) the normal rate of hiring interns (NRHI) - a smoothed function of the hiring rate (RHI) over a two year time span (SMTI), (2) the desired intern multiplier (DIM) which is defined below in equation 6, and (3) a ratio representing the attractiveness of the emergency department to the potential staff (ATPS). See equation 8, below.

```
DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2)                 6, A
TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.91/1.95/2         6.1, T
   DIM       -DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
   TABLE5    -TABLE FUNCTION
   DI        -DESIRED INTERNS (MEN)
   INT       -INTERNS (MEN)

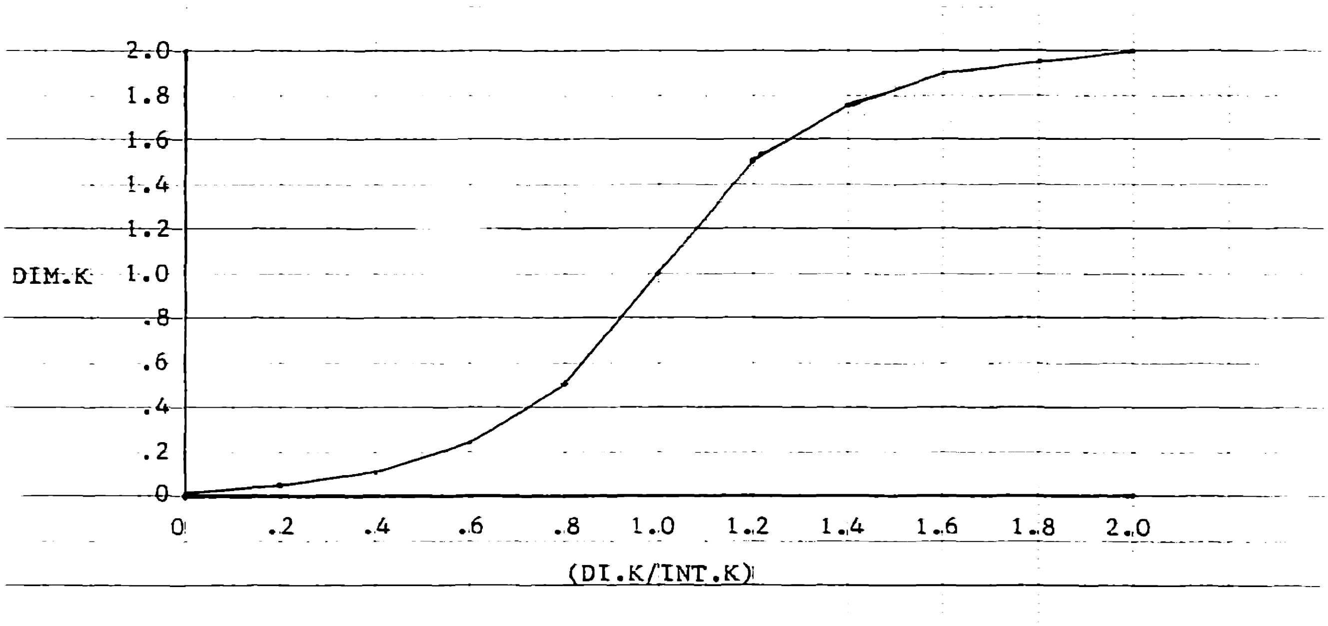
DI.K=DITRR*DR.K                                       7, A
DITRR=2 (DIMENSIONLESS)                               7.1, C
   DI        -DESIRED INTERNS (MEN)
   DITRR     -DESIRED INTERN TO RESIDENT RATIO
                (DIMENSIONLESS)
   DR        -DESIRED RESIDENTS (MEN)
```

The desired intern multiplier (DIM) is presented as a table function which relates the number of desired interns (DI) to the number of interns actually on hand at any point in time (INT.K). As this ratio increases, that is, as the number of desired interns approaches the number of interns on hand, the multiplier decreases to reach an equilibrium level of 1.0. If more interns are desired than are available, the multiplier (DIM) increases above 1.0 and thus effectively drives up the intern hiring rate (RHI) until equilibrium is once again reached.

The number of desired interns (DI) is, in turn, a product of the desired resident level (DR) (see equation 15 below) and the desired intern to resident ratio (DITRR). DITRR for this model has been set at 2. That is, in ideal conditions we would like one resident for every two interns on the staff. Table 5 is graphed below:



been set at 2. That is, in ideal conditions we would like one resident for every two interns on the staff. Table 5 is graphed below:



```
ATPS.K=DLINF3(ATCS.K,ATTDEL)                              8, A
ATTDEL=5 (YEARS)                                          8.1, C
   ATPS       -ATTRACTIVENESS TO POTENTIAL STAFF
                  (DIMENSIONLESS)
   ATCS       -ATTRACTIVENESS TO CURRENT STAFF
                  (DIMENSIONLESS)
   ATTDEL     -TIME TO PERCEIVE ATTRACTIVENESS (YEARS)
```

The attractiveness multiplier (ATPS), the third factor in the calculation of the rate of hiring interns from outside the "system" (RHI), is a third order information delay function of the attractiveness to current staff (ATCS) over a five year delay period (ATTDEL). This says that if the attractiveness of the modeled emergency department increases - due to better teaching, new facilities, decreased load, etc. - it takes roughly five years for 60 per cent of the medical school graduates outside the area to perceive its increased attractiveness and two time periods or ten years for more than 90 per cent to perceive the increased attractiveness. Conversely, overcrowding or poor facilities will have a delayed impact on the attractiveness of the emergency department to new interns (or residents) (ATPS).

```
ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3)         17, A
INNORM=1.2 (DIMENSIONLESS)                                 17.1, C
TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2          17.2, T
   ATCS       -ATTRACTIVENESS TO CURRENT STAFF
                  (DIMENSIONLESS)
   PAT        -PATIENTS (VISITS/YEAR)
   PLCAP      -PLANNED CAPACITY (VISITS/YEAR)
   INNORM     -INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)
```

The attractiveness of the emergency department to the <u>current</u> staff (ATCS) from which, as in equation 8 above, ATPS is derived, comes from table function 7. Table 7 expresses the relationship between the overload in the modeled emergency department - patients divided by planned capacity (PAT/ALCAP) - and the "industry" normal overload (INNORM). We stated in Section I that under normal emergency department conditions 20 per cent more patients (PAT) could be handled than the planned capacity (PLCAP) of the emergency facilities would indicate (INNORM). At this level, the attractiveness of the ED to the current staff is neutral, i.e., 1; at higher overloads the attractiveness falls off; when there is an excess of capacity in relation to patient load, the emergency department is more attractive than "normal".

```
AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K)                            9, R
AVSPI=1 (YEARS)                                             9.1, C
   AOI   - ATTRITION RATE OF INTERNS (MEN/YEAR)
   AVSPI - AVERAGE STAY PER INTERN (YEARS/MAN)
   INT   - INTERNS (MEN)
   IDM   - INTERN DESTINATION MULTIPLIER
              (DIMENSIONLESS)
```

The next element of the intern equation is the rate at which interns leave the emergency department for jobs outside the system. We have defined the attrition rate of interns (AOI) as the reciprocal of the average stay per intern (AVSPI) in years per man, multiplied by the number of interns (INT) and one minus the internal destination multiplier (IDM); see equation 10 below. The average stay per intern (AVSPI) is defined as one year.

```
IDM.K=LAWF*ATCS.K/(LAWF*ATCS.K+EATS)                        10, A
LAWF=3 (DIMENSIONLESS)                                      10.1, C
EATS=1 (DIMENSIONLESS)                                      10.2, C
   IDM  - INTERN DESTINATION MULTIPLIER
              (DIMENSIONLESS)
   LAWF - LOCAL ATTRACTIVENESS WEIGHTING FACTOR
              (DIMENSIONLESS)
   ATCS - ATTRACTIVENESS TO CURRENT STAFF
              (DIMENSIONLESS)
   EATS - EXTERNAL ATTRACTIVENESS TO STAFF
              (DIMENSIONLESS)
```

One minus the intern destination multiplier (1-IDM) in equation 9 above, represents the fraction of the total interns on hand who leave the modeled emergency system because they perceive outside attractiveness as greater than the attractiveness of their present job environment. The portion who remain (IDM) is a function of the relationship between attractiveness of the local emergency department (LAWF) and the attractiveness of external job opportunities for the intern (EATS). As a stable condition we have stated that the modeled ED is three times as attractive as outside opportunities, i.e., LAWF=3 and EATS=1.

If we insert hypothetical figures in the equation for the intern destination multiplier (IDM) we can more easily visualize its structure. If we presume, from equation 17 above, that the overload is 50 per cent, then the attractiveness of the emergency department to the current staff can be determined by finding the value of OLOAD/INNORM, or 1.5/1.2 = 1.25, in Table 7. This value is approximately .83. The numerator of the IDM equation becomes 3 X .83 = 2.49 and the denominator 3 X .83 +1 = 3.49. IDM then equals just over .7; that is to say, over 70 per cent of the interns will remain in the existing emergency department system, given the above conditions.

```
INTRES.KL=(1/AVSPI)(INT.K)(IDM.K)                          11, R
  INTRES  -  RATE OF RESIDENTS HIRED FROM INTERNS
                 (MEN/YEAR)
  AVSPI   -  AVERAGE STAY PER INTERN (YEARS/MAN)
  INT     -  INTERNS (MEN)
  IDM     -  INTERN DESTINATION MULTIPLIER
                 (DIMENSIONLESS)
```

The final determinant in the overall rate of change of interns is the rate at which interns move to become residents in the same hospital (INTRES). This rate is simply the product of (1) the reciprocal of the average stay per intern (AVSPI), (2) the number of interns available (INT), and (3) the intern destination multiplier (IDM) explained below.

```
HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-AOR.JK)                2, L
HRES=HRESN (MEN)                                           2.1, N
HRESN=4.7488 (MEN)                                         2.2, C
   HRES   - HOSPITAL RESIDENTS (MEN)
   INTRES - RATE OF RESIDENTS HIRED FROM INTERNS
              (MEN/YEAR)
   RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE
              (MEN/YEAR)
   AOR    - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
   HRESN  - INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)
```

The number of residents on the staff at any time period (HRES.K) is, in the same manner used for calculating intern strength, the number of residents on the staff in the previous time period (HRES.J) plus the resident inputs/outflows from three sources: (1) those interns who become residents in the same hospital (INTRES), (2) those residents who are hired from outside the system (RHR), less (3) those residents who leave the modeled hospital emergency facility (AOR). The initial value for the number of residents (HRES), when the system is in equilibrium, is close to five individuals. INTRES is explained in equation 11 above.

```
RHR.KL=NHRR.K*DRM.K*ATPS.K                                 12, R
   RHR  - RATE OF HIRING RESIDENTS FROM OUTSIDE
            (MEN/YEAR)
   NHRR - NORMAL HIRING RATE OF RESIDENTS FROM
            OUTSIDE (MEN/YEAR)
   DRM  - DESIRED RESIDENTS MULTIPLIER
            (DIMENSIONLESS)
   ATPS - ATTRACTIVENESS TO POTENTIAL STAFF
            (DIMENSIONLESS)

NHRR.K=SMOOTH(RHR.JK,SMTR)                                 13, A
NHRR=0 (MEN/YEAR)                                          13.1, N
```

```
SMTR=2(YEARS)                                             13.2, C
   NHRR  -  NORMAL HIRING RATE OF RESIDENTS FROM
               OUTSIDE (MEN/YEAR)
   RHR   -  RATE OF HIRING RESIDENTS FROM OUTSIDE
               (MEN/YEAR)
   SMTR  -  SMOOTHING TIME FOR RESIDENTS (YEARS)
```

The rate of hiring residents from outside the system (RHR) is, as in the case of interns, a product of three rates: (1) the normal rate of hiring residents (NHRR), which, in turn, is a two year smoothed function (SMTR) of the rate of external hiring (RHR), (2) the desired residents multiplier (DRM) - see equation 14 below - and (3) the attractiveness of the emergency department to the potential staff (ATPS) - see equation 8 above.

```
DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2)                     14, A
   DRM   -  DESIRED RESIDENTS MULTIPLIER
               (DIMENSIONLESS)
   TABLE5 - TABLE FUNCTION
   DR    -  DESIRED RESIDENTS (MEN)
   RES   -  RESIDENTS (MEN)

RES.K=1*HRES.K                                            3, A
   RES   -  RESIDENTS (MEN)
   HRES  -  HOSPITAL RESIDENTS (MEN)
```

The desired residents multiplier (DRM) is expressed as a table function (TABLE 5) which relates the number of residents desired (DR) to the number of residents on hand (RES). As with the case of interns (see equation 6 above, TABLE 5 and graph following), when the number of residents desired (DR) is greater than those on hand (RES), this fact has a multiplicative effect on the rate of hiring residents from outside the system (RHR - equation 12). Equation 3 above has been included if, in some future use of this model, the user wishes to distinguish between the emergency department resident staff and the total hospital resident pool.

```
AOR.KL=(1/AVSPR)(RES.K)                                          16, R
AVSPR=1 (YEARS)                                                  16.1, C
   AOR   -  ATTRITION RATE OF RESIDENTS
              (MEN/YEAR)
   AVSPR -  AVERAGE STAY PER RESIDENT
              (YEARS/MAN)
   RES   -  RESIDENTS (MEN)
```

Before defining the manner in which the level of desired residents is derived (DR), we shall look at the final portion of the hospital resident (HRES) equation, the attrition rate of residents (AOR) from the system, to private practice, further education, other hospitals, etc. This factor is simply defined as the reciprocal of the average stay per resident (AVSPR), times the number of residents in the emergency department at any point in time (RES.K). As most residents have a one year contract we have initialized the average stay value at 1 year.

```
DR.K=(NEP.K-SUPHY*(1/((PR.K/SPEC)+(1/SPNC))))/((1/               15, A
   ((PR.K/REC)+(1/RNC)))+(DITRR/((PR.K/IEC)+(1/INC))))

   DR    - DESIRED RESIDENTS (MEN)
   NEP   - NONEMERGENCY PATIENTS (VISITS/YEAR)
   SUPHY - SUPERVISING PHYSICIANS (MEN)
   PR    - PATIENT RATIO (DIMENSIONLESS)
   SPEC  - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
              (VISITS/YEAR)
   SPNC  - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
              (VISITS/YEAR)
   REC   - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
   RNC   - RESIDENT NONEMERGENCY CAPACITY (VISITS/YEAR)
   DITRR - DESIRED INTERN TO RESIDENT RATIO
              (DIMENSIONLESS)
   IEC   - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
   INC   - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
```

This rather lengthy formula presented above defines the desired number of residents (DR); because we have defined desired interns (DI) in terms of desired resident (DITRR*DR, equation 7) this formula also defines desired interns. The individual elements of this equation are listed below:

```
NEP.K=PAT.K*PERNEM.K                                    48, A
   NEP  -  NONEMERGENCY PATIENTS (VISITS/YEAR)
   PAT  -  PATIENTS (VISITS/YEAR)
   PERNEM - PERCEIVED NONEMERGENCIES
              (DIMENSIONLESS)

PR.K=(PAT.K-NEP.K)/NEP.K                                49, A
   PR  -  PATIENT RATIO (DIMENSIONLESS)
   PAT -  PATIENTS (VISITS/YEAR)
   NEP -  NONEMERGENCY PATIENTS (VISITS/YEAR)

SPEC=1/SPTPE (VISITS/YEAR)                              18.7, N
   SPEC  -  SUPERVISING PHYSICIAN EMERGENCY
             CAPACITY (VISITS/YEAR)
   SPTPE -  SUPERVISING PHYSICIAN TIME PER
             EMERGENCY (YEARS/VISIT/MAN)

SPNC=1/SPTPNE (VISITS/YEAR)                             19.1, N
   SPNC  -  SUPERVISING PHYSICIAN NONEMERGENCY
              CAPACITY (VISITS/YEAR)
   SPTPNE - SUPERVISING PHYSICIAN TIME PER NON-
              EMERGENCY(YEARS/VISIT/MAN)

REC=1/RTPE (VISITS/YEAR)                                18, N
   REC  -  RESIDENT EMERGENCY CAPACITY
             (VISITS/YEAR)
   RTPE -  RESIDENT TIME FOR PERCEIVED EMERGENCY
             (YEARS/VISIT/MAN)

RNC=1/RTPNE (VISITS/YEAR)                               18.4, N
   RNC  -  RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
   RTPNE - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
             (YEARS/VISIT/MAN)

IEC=1/ITPE (VISITS/YEAR)                                17.4, N
   IEC  -  INTERN EMERGENCY CAPACITY (VISITS/YEAR)
   ITPE -  INTERN TIME FOR PERCEIVED EMERGENCY
             (YEARS/VISIT/MAN)

INC=1/ITPNE                                             17.7, N
   INC  -  INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
   ITPNE - INTERN TIME FOR PERCEIVED NONEMERGENCY
             (YEARS/VISIT/MAN)
```

Equation 48 states that the number of non-emergency patients (NEP) is equal to the patient load (PAT) times the ratio of perceived non-emergencies (PERNEM), see equation 46. Equation 49 defines a variable called the patient ratio (PR), which is the relationship of number of emergency patients (PAT-NEP) to the number of non-emergency patients (NEP).

The next three sets of equations define the respective capacities of supervising physicians, residents, and interns in the system to treat emergencies and non-emergencies, in terms of visits per year.

The following grid sets forth the basic relationships between the types of staff personnel and their capacities to handle either emergent or non-emergent patients:

	Number of Each	Emergencies which can be handled/ year*	Non-Emergencies which can be handled/year*	Emergencies handled/ year	Non-Emergencies handled/ year
Supervising Interns	SUPHY**	SPEC	SPNC	E_s	N_s
Residents	DR	REC	RNC	E_r	N_r
Interns	DR*DITRR=DI	IEC	INC	E_i	N_i

* if the staff member devotes his entire time to this class of patient.
** given in equation 35.4 as 1.

Note that we have implicitly assumed that the supervising physicians, the residents and the interns each handle the same ratio of emergent to non-emergent patients.

From the grid above we can set forth the following equations:

$E_s/SPEC + N_s/SPNC = 1$

$E_r/REC + N_r/RNC = 1$

$E_i/IEC + N_i/INC = 1$

$$\left.\begin{array}{l} E_s/N_s = PR \\ E_r/N_r = PR \\ E_i/N_i = PR \end{array}\right\}$$ see assumption stated immediately above

$1*E_s + DR(E_r + DITRR*E_i) = PAT\text{-}NEP$

$1*N_s + DR(N_r + DITRR*N_i) = NEP$

From these relationships we know that:

$$N_s = \frac{1}{\left(\frac{PR}{SPEC} + \frac{1}{SPNC}\right)}$$

$$N_r = \frac{1}{\left(\frac{PR}{REC} + \frac{1}{RNC}\right)}$$

$$N_i = \frac{1}{\left(\frac{PR}{IEC} + \frac{1}{INC}\right)}$$

and by substituting these values for N_s, N_r, and N_i, we can solve for DR as follows:

$$DR = \frac{NEP\text{-}SUPHY \left(\frac{1}{\frac{PR}{SPEC} + \frac{1}{SPNC}}\right)}{\frac{1}{\left(\frac{PR}{REC} + \frac{1}{RNC}\right)} + \frac{DITRR}{\left(\frac{PR}{IEC} + \frac{1}{INC}\right)}}$$

The equation above is presented as statement 15, A.

One last set of equations needs explanation, that relating to the quality of care. The quality of care is a function of two factors: (1) the excess of patient load (PAT) to planned capacity (PLCAP) i.e., overload (OLOAD) and (2) the experience level of the emergency department staff (SEXP).

```
QOC.K=.7*QOCO.K+.3*QOCE.K                                38, S
    QOC  -  QUALITY OF CARE (DIMENSIONLESS)
    QOCO -  QUALITY OF CARE FROM OVERLOAD
              (DIMENSIONLESS)
    QOCE -  QUALITY OF CARE FROM EXPERIENCE
              (DIMENSIONLESS)

QOCO.K=TABLE(TABLE1,LOAD.K,0,2,.2)                       39, A
    QOCO   -  QUALITY OF CARE FROM OVERLOAD
              (DIMENSIONLESS)
    TABLE1 - TABLE FUNCTION
    OLOAD  -  OVERLOAD OF FACILITIES (DIMENSIONLESS)

QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9)                       40, A
    QOCE   -  QUALITY OF CARE FROM EXPERIENCE
              (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    SEXP   -  STAFF EXPERIENCE (DIMENSIONLESS)
```

Quality of care (QOC) is defined as a function of the quality of care derived from the patient load (QOCO) plus the quality of care related to physician experience level (QOCE). The weighting of these two factors is .7 and .3 respectively.

Quality of care from overload (QOCO) is derived from table function 1, presented graphically following equation 24. Quality of care from staff experience (QOCE) is derived from table function 5, presented graphically following equation 6.

III. Capital Investment

```
CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK)                25, L
   CAPINV   - CAPITAL INVESTMENT (DOLLARS)
   RCI      - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
   DJI      - DEPRECIATION OF CAPITAL INVESTMENT (DOLLARS/YEAR)

CAPINV=CAPINVN (DOLLARS)                             25.1, N
   CAPINV   - CAPITAL INVESTMENT (DOLLARS)
   CAPINVN  - INITIAL VALUE OF CAPITAL INVESTMENT
                 (DOLLARS)

CAPINV=2601500 (DOLLARS)                             25.2, C
   CAPINVN  - INITIAL VALUE OF CAPITAL INVESTMENT
                 (DOLLARS)
```

The amount of capital investment at any point in time (CAPINV.K) is equal to the capital investment in the previous time period (CAPINV.J) plus the time increment (DT) multiplied by the change in investment (RCI-DCI).

```
RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K)                29, R
   RCI  -  RATE OF CAPITAL INVESTMENT
             (DOLLARS/YEAR)
   CIOF -  CAPITAL INVESTMENT ORDERING FUNCTION
             (DOLLARS/YEAR)
   CAPITC - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
   CIOO   - CAPITAL INVESTMENT ON ORDER (DOLLARS)
```

This change in investment is, in turn, composed of two elements: (1) the increase in capital investment (RCI) and (2) the depreciation of the capital investment base (DCI). The rate of capital investment (RCI) is a third order delay function relating the capital investment ordering function (CIOF), (i.e., the amount of capital additions ordered in each time interval), the delay time (CAPITC), and the initial amount of capital investment on order (CIOO).

```
CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*   30, R
  EXFUND.K+SDCI.K
    CIOF  -  CAPITAL INVESTMENT ORDERING FUNCTION
               (DOLLARS/YEAR)
```

DCAPINV	-DESIRED CAPITAL INVESTMENT (DOLLARS)
CAPINV	-CAPITAL INVESTMENT (DOLLARS)
SDCI	-SMOOTHED RATE OF DEPRECIATION OF CAPITAL INVESTMENT ($/YEAR)
CAPITC	-CAPITAL INVESTMENT TIME CONSTANT (YEARS)
CIOO	-CAPITAL INVESTMENT ON ORDER (DOLLARS)
EXFUND	-EXTERNAL FUNDING (DIMENSIONLESS)

The amount of capital additions "ordered" in any time interval (CIOF) is composed of several items. Prominent among these is the difference between the desired level of capital investment (DCAPINV) and the current level of capital investment (CAPINV), plus the smoothed amount of depreciation per year (SDCI*CAPITC), less the amount of capital already on order (CIOO). This net value, the amount of capital additions on order, is multiplied by the percentage that will be met by external funding which may be available (EXFUND) and added to the smoothed rate of depreciation of capital investment (SDCI) - see equation 33 in Section IV following.

```
DCAPINV.K=DCIPP*PAT.K                                32, A
```

DCAPINV	-DESIRED CAPITAL INVESTMENT (DOLLARS)
DCIPP	-DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)
PAT	-PATIENTS (VISITS/YEAR)

The desired capital investment (DCAPINV) is the product of the desired capital investment per patient (DCIPP), in dollars per visit per year (see equation 32.1 in Section 1 above), and the number of patient visits per year (PAT). Thus, there is a linear relationship between the growth in patient load and the desired level of capital investment. The initial level of actual capital investment (CAPINV) is approximately $2.6 million. It is obvious that with the initial patient load (PATN) at 60,130 visits and the desired capital investment of

$60 per visit per year (DCIPP), the desired capital investment (DCAPINV) - 60,130 X $60 = $3.6 million - is substantially in excess of the initial actual capital investment value ($2.6 million).

```
CAPITC=4 (YEARS)                                      29.1, C
   CAPITC     -CAPITAL INVESTMENT TIME CONSTANT
                   (YEARS)

CIOO=CIOON (DOLLARS)                                  29.2, N
   CIOO       -CAPITAL INVESTMENT ON ORDER (DOLLARS)
   CIOON      -INITIAL VALUE OF CAPITAL INVESTMENT ON
                   ORDER (DOLLARS)

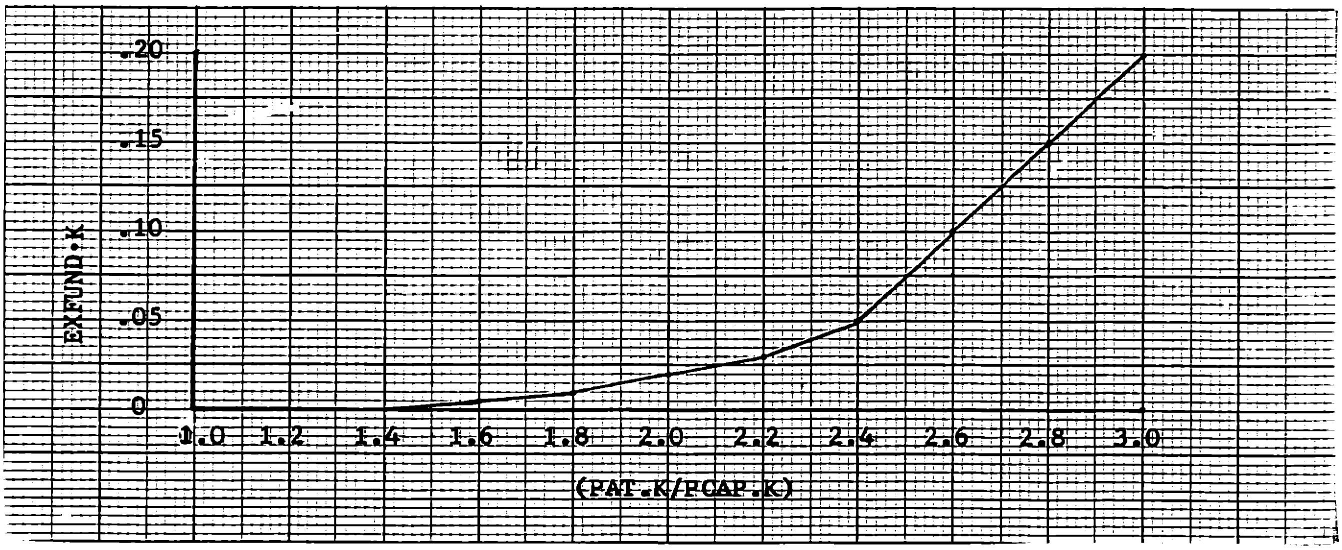
CIOON=316970 (DOLLARS)                                29.3
   CIOON      -INITIAL VALUE OF CAPITAL INVESTMENT ON
                   ORDER (DOLLARS)
```

The capital investment time constant (CAPITC) of four years represents the time it takes for additions to capital to come on stream, i.e., the elapsed time from date of order to the date when the capital can be put to use. The initial amount of capital investment on order (CIOON), when the emergency department model is in equilibrium, is $317,000.

```
EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2)       31, A
   EXFUND     -EXTERNAL FUNDING (DIMENSIONLESS)
   PAT        -PATIENTS (VISITS/YEAR)
   PCAP       -PHYSICAL CAPACITY (VISITS/YEAR)
```

External funding (EXFUND) is expressed as a table function relating patient load (PAT) to the physical capacity (PCAP) - see equation 45, Section 1. This table function, presented and graphed below, indicates that as the ratio of the patient load to the physical capacity increases, the ratio (i.e. the percent) of additional capital needs funded by external sources will also increase. Table function 2 also indicates, however, that even at an "overload" of two times physical capacity, very little external funding will be available to assist in the acquisition of additional emergency department facilities.

TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE) 31.1, T




```
DCI.KL=CAPINV.K/DEPT.K                                        26, R
   DCI    -  DEPRECIATION OF CAPITAL INVESTMENT
                (DOLLARS/YEAR)
   CAPINV -CAPITAL INVESTMENT (DOLLARS)
   DEPT   -  DEPRECIATION TIME (YEARS)
```

The depreciation of capital investment (DCI) in dollars per year equals the capital investment value (CAPINV) divided by the depreciation time (DEPT) in years.

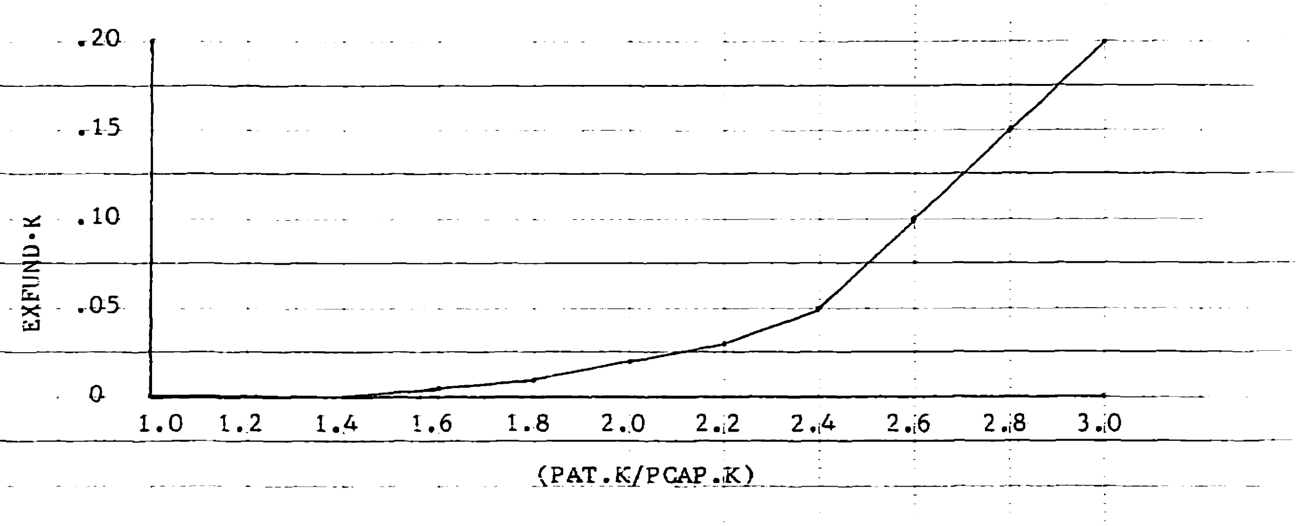
```
DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                             27, A
   DEPT   -  DEPRECIATION TIME (YEARS)
   NORDT  -  NORMAL DEPRECIATION TIME (YEARS)
   DEPF   -  DEPRECIATION FUNCTION (DIMENSIONLESS)
   DEPDT  -  DEPRECIATION DELAY TIME (YEARS)

NORDT=30 (YEARS)                                              28.2, C

DEPDT=10 (YEARS)                                              28.3, C
   DEPDT  -  DEPRECIATION DELAY TIME (YEARS)
```

The depreciation time (DEPT) is the actual time it takes for aggregate physical facilities to wear out, in contra distinction to the will be available to assist in the acquisition of additional emergency department facilities.

TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE) 31.1, T




```
DCI.KL=CAPINV.K/DEPT.K                                  26, R
   DCI   -  DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
   CAPINV -CAPITAL INVESTMENT (DOLLARS)
   DEPT -  DEPRECIATION TIME (YEARS)
```

The depreciation of capital investment (DCI) in dollars per year equals the capital investment value (CAPINV) divided by the depreciation time (DEPT) in years.

```
DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                       27, A
   DEPT  -  DEPRECIATION TIME (YEARS)
   NORDT -  NORMAL DEPRECIATION TIME (YEARS)
   DEPF  -  DEPRECIATION FUNCTION (DIMENSIONLESS)
   DEPDT -  DEPRECIATION DELAY TIME (YEARS)

NORDT=30 (YEARS)                                        28.2, C

DEPDT=10 (YEARS)                                        28.3, C
   DEPDT  -  DEPRECIATION DELAY TIME (YEARS)
```

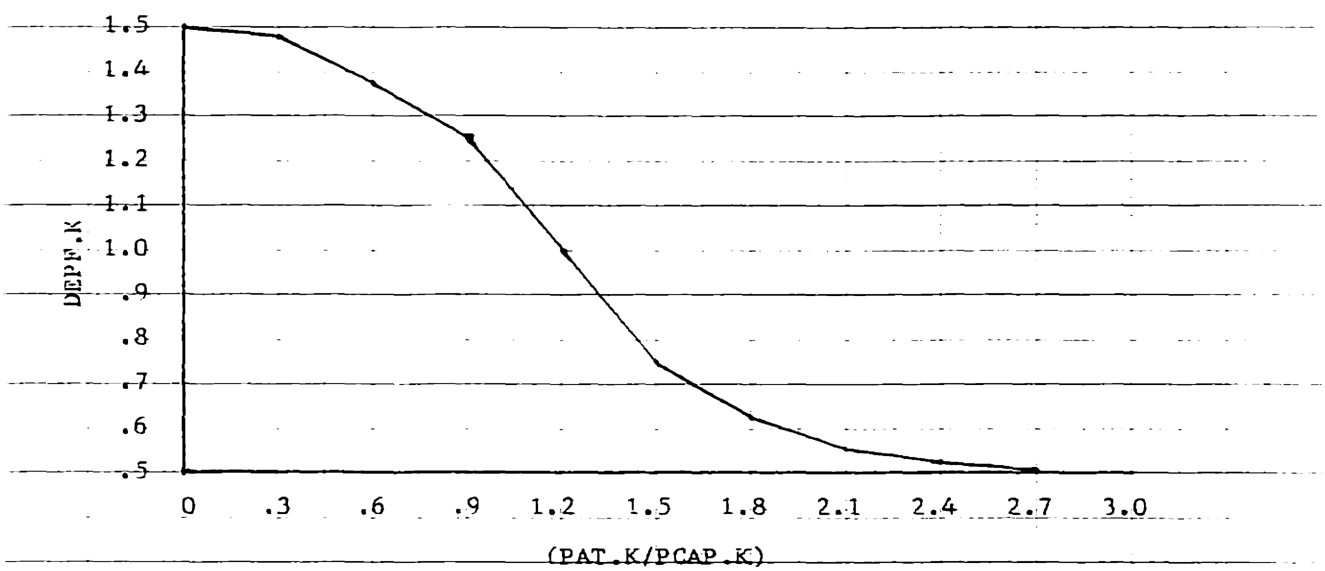
The depreciation time (DEPT) is the actual time it takes for aggregate physical facilities to wear out, in contra distinction to the depreciation time (NORDT) used for accounting and tax purposes. The latter is defined as 30 years, a weighting of "40 year" buildings and "10-15 year" equipment. DEPT is defined as a smoothed function relating the product of normal depreciation (NORDT) and the depreciation function (DEPF) to the depreciation delay time (DEPDT).

```
DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3)                    28, A
   DEPF   -  DEPRECIATION FUNCTION (DIMENSIONLESS)
   TABLE4 -  TABLE FUNCTION
   PAT    -  PATIENTS (VISITS/YEAR)
   PCAP   -  PHYSICAL CAPACITY (VISITS/YEAR)
```

The depreciation function (DEPF) which acts to modify the normal depreciation time (NORDT) is presented as a table function (TABLE4) relating the patient load (PAT) to the physical capacity (PCAP). As the ratio of patient visits to plant capacity increases, the factor DEPF decreases, thus speeding up the "real" depreciation of the emergency department's physical facilities, (DEPT).

Table four is presented and graphed below:

```
TABLE4=1.5/1.475/1.375/1.25/1/.75/.625/.55/.525/.5/.5     28.1, T
```



IV. Finances

The financial segment of the model is composed of two principal equations which summarize (1) the costs of operation of the emergency department - direct and allocated - and, (2) the income derived from the emergency department's operation:

(1)

```
OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K                    54, A
   OPEXP   -  OPERATING EXPENSES (DOLLARS/YEAR)
   SSAL    -  STAFF SALARY (DOLLARS/YEAR)
   PHSAL   -  PROFESSIONAL HELP SALARIES (DOLLARS/YEAR)
   ANCOST  -  ANCILLARY COSTS (DOLLARS/YEAR)
   SDCI    -  SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                 INVESTMENT($/YEAR)
```

Total operating expenses (OPEXP) for any time period is the summation of staff salaries (SSAL), the salaries of other professional and clerical help (PHSAL), the costs of ancillary services rendered (ANCOST), (e.g. laboratory tests, x-rays, pharmacy), and the depreciation allocated relative to the emergency department plant and equipment (SDCI).

```
SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY                  55, A
   SSAL  -  STAFF SALARY (DOLLARS/YEAR)
   ISAL  -  INTERN SALARY (DOLLARS/YEAR/MAN)
   INT   -  INTERNS (MEN)
   RSAL  -  RESIDENT SALARY (DOLLARS/YEAR/MAN)
   RES   -  RESIDENTS (MEN)
   SPSAL -  SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/MAN)
   SUPHY -  SUPERVISING PHYSICIANS (MEN)

ISAL=10000 (DOLLARS/YEAR/MAN)                             51.1, C
   ISAL  -  INTERN SALARY (DOLLARS/YEAR/MAN)

RSAL=10500 (DOLLARS/YEAR/MAN)                             55.2, C
   RSAL  -  RESIDENT SALARY (DOLLARS/YEAR/MAN)

SPSAL=30000 (DOLLARS/YEAR/MAN)                            55.3, C
   SPSAL -  SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/MAN)
```

Staff salaries (SSAL) are calculated by multiplying the number of interns at any point in time (INT) times the interns salary in dollars per year per man (ISAL) and adding this sum to similar figures for residents (RSAL*RES) and supervising physicians (SPSAL*SUPAY). The initial values for these staff salaries are given in equations 55.1, 55.2 and 55.3.

Salaries for professional help (nurses and paramedical personnel) and the clerical staff are given as a fixed dollar amount per patient visit (PHCPV) and multiplied times the number of visits per year (see also equation 20, Section I above). The initial value of $18.33 per staff member was arrived at by examining the recent experience of the University of Rochester Medical Center emergency department and relating their costs of nurses, clerks and paramedics to their annual patient load. Also included in this figure is a modest amount for operating supplies. It is felt that this support for the emergency department interns and residents will increase in approximate proportion to the number of patients handled through the range of patient loads tested in this model.

```
ANCOST.K=EANCST.K+NEANCST.K                                50, A
   ANCOST   -  ANCILLARY COSTS (DOLLARS/YEAR)
   EANCST   -  EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
   NEANCST  -  NON-EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
```

Costs of ancillary services (ANCOST) have been subdivided between those for true emergencies (EANCST) and those for non-emergency visits to the emergency department (NEANCST).

```
EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K                      51, A
   EANCST   -  EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
   PAT      -  PATIENTS (VISITS/YEAR)
```

PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)
AVCPE - AVERAGE COST PER PERCEIVED EMERGENCY (DOLLARS/VISIT)
ANCT - ANCILLARY COST TO EXPERIENCE FACTOR (DIMENSIONLESS)

Ancillary costs related to true emergencies (EANCST) are composed of the product of patient visits per year (PAT), perceived emergencies (PEREMER), the average cost per perceived emergency (AVCPE), and the ancillary cost to experience factor (ANCT).

PEREMER.K=AE+SE*(1-AE) 46, A
PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)
AE - ACTUAL EMERGENCIES (DIMENSIONLESS)
SE - SORTING ERROR RATE (DIMENSIONLESS)

SE=.1 (DIMENSIONLESS) 49.1,C
SE - SORTING ERROR RATE (DIMENSIONLESS)

AE=.33 (DIMENSIONLESS) 49.2, C
AE - ACTUAL EMERGENCIES (DIMENSIONLESS)

In our initial conditions we estimate that ratio of true emergencies to total emergency department visits (AE) is roughly one third. In addition, because of the normal sorting error in the triage function, a small fraction of the non-emergency cases are treated as emergencies rather than non-emergencies (SE*(1-AE)).

PERNEM.K=1-PEREMER.K 47, A
PERNEM - PERCEIVED NON-EMERGENCIES(DIMENSIONLESS)
PEREMER - PERCEIVED EMERGENCIES (DIMENSIONLESS)

The percentage of non-emergency visits (PERNEM) is simply one minus the perceived emergencies (PEREMER) calculated in equation 46.

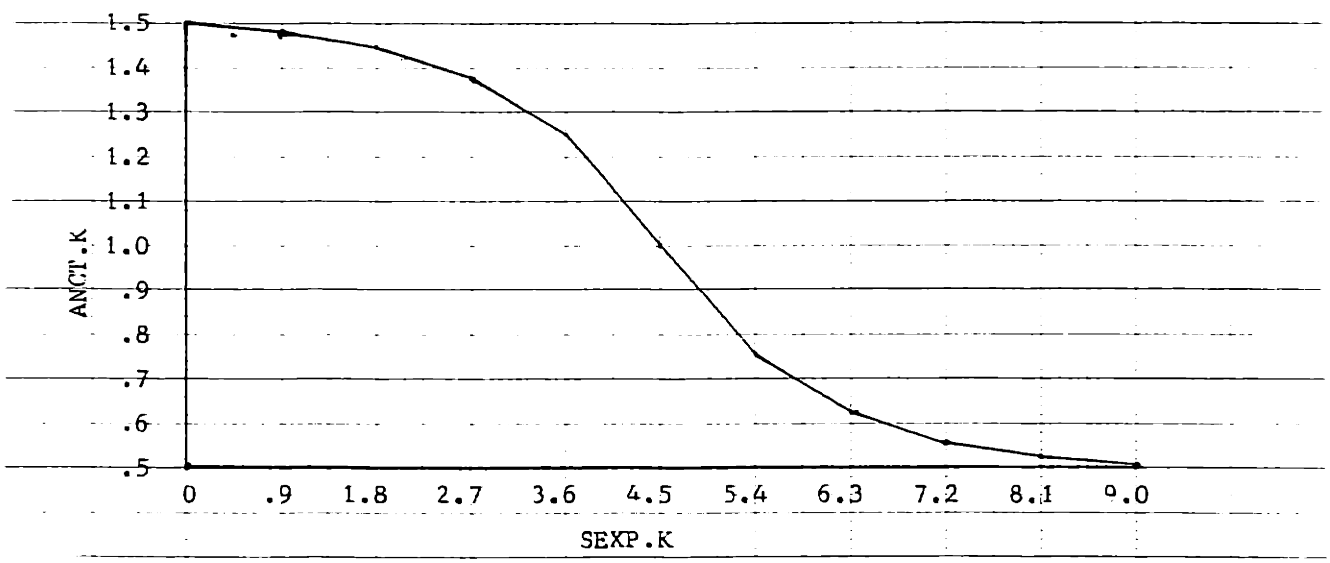
AVCPE=15 (DOLLARS/VISIT) 53.1, C
AVCPE - AVERAGE COST PER PERCEIVED EMERGENCY (DOLLARS/VISIT)

Based on data obtained from the Rochester General and Strong Memorial Hospital emergency departments, the average ancillary cost per emergency visit (AVCPE) is estimated to be $15.

```
ANCT.K=TABLE(TABLE6, SEXP.K,0,9.9)                          53, A
   ANCT    -   ANCILLARY COST TO EXPERIENCE FACTOR
                 (DIMENSIONLESS)
   TABLE6 -    TABLE FUNCTION
   SEXP    -   STAFF EXPERIENCE (DIMENSIONLESS)
```

This average ancillary cost (AVCPE) is multiplied by a factor (ANCT) which relates the average experience level of the physicians in the emergency department (SEXP) to the amount of ancillary service the doctor orders. We contend that the more experienced the physician, the lesser the amount of laboratory tests and x-rays that will be ordered for any given emergency. The relationship of experience to ancillary costs is given in TABLE6 below, presented in both tabular and graphic form:

```
TABLE6=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/.525/.5       53.3, T
       (TABLE)
```



As noted above, the initial average ancillary cost per emergency visit (AVCPE) is $15. TABLE6 indicates that this cost will be incurred when the aggregate staff experience level (SEXP) is at 3.0. This level corresponds roughly with the aggregate experience level of twelve interns and residents, in the ratio of 6 to 5, plus one supervising physician.

```
SEXP.K=(IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/STAFF.K        34, K
   SEXP   -   STAFF EXPERIENCE (DIMENSIONLESS)
   IEXP   -   INTERN EXPERIENCE (DIMENSIONLESS)
   INT    -   INTERNS (MEN)
   REXP   -   RESIDENT EXPERIENCE (DIMENSIONLESS)
   RES    -   RESIDENTS (MEN)
   SPEXP  -   SUPERVISING PHYSICIAN EXPERIENCE
                (DIMENSIONLESS)
   SUPHY  -   SUPERVISING PHYSICIANS (MEN)
   STAFF  -   STAFF (MEN)

STAFF.K=INT.K+RES.K+SUPHY                                 35, A
   STAFF  -   STAFF (MEN)
   INT    -   INTERNS (MEN)
   RES    -   RESIDENTS (MEN)
   SUPHY  -   SUPERVISING PHYSICIANS (MEN)

IEXP=2 (DIMENSIONLESS)                                    35.1, A
   IEXP   -   INTERN EXPERIENCE (DIMENSIONLESS)

REXP=3.5 (DIMENSIONLESS)                                  35.2, A
   REXP   -   RESIDENT EXPERIENCE (DIMENSIONLESS)

SPEXP=9 (DIMENSIONLESS)                                   35.3, N
   SPEXP  -   SUPERVISING PHYSICIAN EXPERIENCE
```

The staff experience level (SEXP) is the weighted average of the experience factors for interns, residents, and supervising physicians (IEXP,REXP,SPEXP respectively) multiplied by the various levels of staff in men (INT, RES, SUPHY), divided by the total staff of the emergency department (STAFF). The experience factors have been selected so as to be relative to one another, based on the authors' judgment.

```
NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K                    52, A
   NEANCST  -  NONEMERGENCY ANCILLARY COSTS (DOLLARS/
                  VISIT)
   PAT      -  PATIENTS (VISITS/YEAR)
   PERNEM   -  PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
   AVCPNE   -  AVERAGE COST PER PERCEIVED NONEMERGENCY
                 (DOLLARS/VISIT)
   ANCT     -  ANCILLARY COST TO EXPERIENCE FACTOR
                 (DIMENSIONLESS)
```

Ancillary costs related to non-emergencies (NEANCST) are calculated in the same manner as those related to true emergencies. The number of patients (PAT) is multiplied by the ratio representing perceived non-emergencies (PERNEM), times the same ancillary cost per perceived nonemergency (AVCPNE), times the same ancillary cost to experience factor (ANCT) noted in equation 53 above.

```
AVCPNE=8 (DOLLARS/VISIT)                                  53.2, C
   AVCPNE  -  AVERAGE COST PER PERCEIVED NON-
                EMERGENCY (DOLLARS/VISIT)
```

The average ancillary cost per non-emergency visit (AVCPNE) is estimated to be $8, again based on data obtained from the Rochester General and Strong Memorial Hospital emergency departments.

```
SDCI.K=SMOOTH(DCI.JK,TSDCI)                               33, A
   SDCI   -  SMOOTHED RATE OF DEPRECIATION OF
               CAPITAL INVESTMENT ($/YEAR)
   TSDCI  -  TIME TO SMOOTH DEPRECIATION OF
               CAPITAL INVESTMENT (YEARS)

TSDCI=1 (YEARS)                                           33.1, C
   TSDCI  -  TIME TO SMOOTH DEPRECIATION OF
               CAPITAL INVESTMENT (YEARS)
```

The final element of operating experience (OPEXP) is the depreciation charge for plant and equipment (SDCI). In introducing this cost element, we have used a first order exponential delay. We have smoothed the depreciation to account for the fact that full financial effect of the depreciation is not felt in the first year. This is due to the fact that plant and equipment are capitalized throughout the year. The amount of capital investment smoothed is the increment of additional capital (DCI) in the time period, JK. A time period of one year (TSDCI) has been chosen to smooth the investment increment. Roughly two thirds of the total incremental depreciation will be included in the first year's costs, over 90 per cent in the second year's costs. For further explanation of the treatment of depreciation and capital investment see equations 26 through 28 in section III.

```
INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*          57, A
           PERNEM.K)
   INCOME   -  INCOME (DOLLARS/YEAR)
   PAT      -  PATIENTS (VISITS/YEAR)
   BDEBT    -  BAD DEBTS (DIMENSIONLESS)
   CPE      -  COST PER EMERGENCY (DOLLARS/VISIT)
   PEREMER  -  PERCEIVED EMERGENCIES (DIMENSIONLESS)
   CPNE     -  COST PER NON-EMERGENCY (DOLLARS/VISIT)
   PERNEM   -  PERCEIVED NON-EMERGENCIES (DIMENSIONLESS)
```

The income (INCOME) for any time period is the product of the patient load (PAT), the amount of the charges made to these patients or their third party insurers that is recoverable (1-BDEBT), the cost per true emergency (CPE) times the ratio of perceived true emergencies to the total patient load (PEREMER), and the cost for each non-emergency (CPNE) times the ratio of perceived non-emergencies to the total patient load (PERNEM). The assumption here is that patients are charged the actual cost of each visit and that this cost, less the bad debt experience of the hospital, is recovered as income.

```
BDEBT=.01 (DIMENSIONLESS)                                   59.2, C
   BDEBT  -  BAD DEBTS (DIMENSIONLESS)
```

The bad debt ratio (BDEBT) is the per cent of emergency department accounts that is uncollectable by the hospital.

```
CPE.K=BCTER+AVCPE*ANCT.K                                  58, A
   CPE    -   COST PER EMERGENCY (DOLLARS/VISIT)
   BCTEP  -   BASE CHARGE TO EMERGENCY PATIENT
                 (DOLLARS/VISIT)
   AVCPE  -   AVERAGE COST PER PERCEIVED EMERGENCY
                 (DOLLARS/VISIT)
   ANCT   -   ANCILLARY COST TO EXPERIENCE FACTOR
                 (DIMENSIONLESS)

BCTEP=25 (DOLLARS/VISIT)                                  58.1, C
   BCTEP  -   BASE CHARGE TO EMERGENCY PATIENT
                 (DOLLARS/VISIT)
```

The cost per emergency (CPE) is the base charge per emergency visit (BCTEP), initially defined as $25, plus the product of the average cost per perceived emergency (AVCPE) - defined in equation 53.1 above - and the ancillary cost to emergency experience ratio (ANCT) - defined in equation 53 above.

The perceived emergencies (PEREMER) were defined in equation 46.

```
CPNE.K=BCTNEP+AVCPNE*ANCT.K                               59, A.
   CPNE    -   COST PER NONEMERGENCY (DOLLARS/VISIT)
   BCTNEP  -   BASE CHARGE TO NONEMERGENCY PATIENT
                  (DOLLARS/VISIT)
   AVCPNE  -   AVERAGE COST PER PERCEIVED NONEMERGENCY
                  (DOLLARS/VISIT)
   ANCT    -   ANCILLARY COST TO EXPERIENCE FACTOR
                  (DIMENSIONLESS)

BCTNEP=15 (DOLLARS/VISIT)                                 59.1, C
   BCTNEP  -   BASE CHARGE TO NONEMERGENCY PATIENT
                  (DOLLARS/VISIT)
```

The cost per non-emergency visit (CPNE) is calculated in the same manner. The base charged to each non-emergency patient (BCTNEP) - $15 - is added to the product of the average cost per perceived non-emergency (AVCPNE) - defined in equation 53.2 above - and the ancillary cost to emergency experience ratio (ANCT).

Perceived non-emergencies (PERNEM) are defined in equation 47.

(3)

```
PRFLSS.K=INCOME.K-OPEXP.K                              60, A
  PRFLSS   -  PROFIT/LOSS (DOLLARS/YEAR)
  INCOME   -  INCOME (DOLLARS/YEAR)
  OPEXP    -  OPERATING EXPENSES (DOLLARS/YEAR)
```

The annual operating profit or loss for the emergency department (PRFLSS) is the arithmetic sum of the income (INCOME) and operating expenses (OPEXP).

APPENDIX III

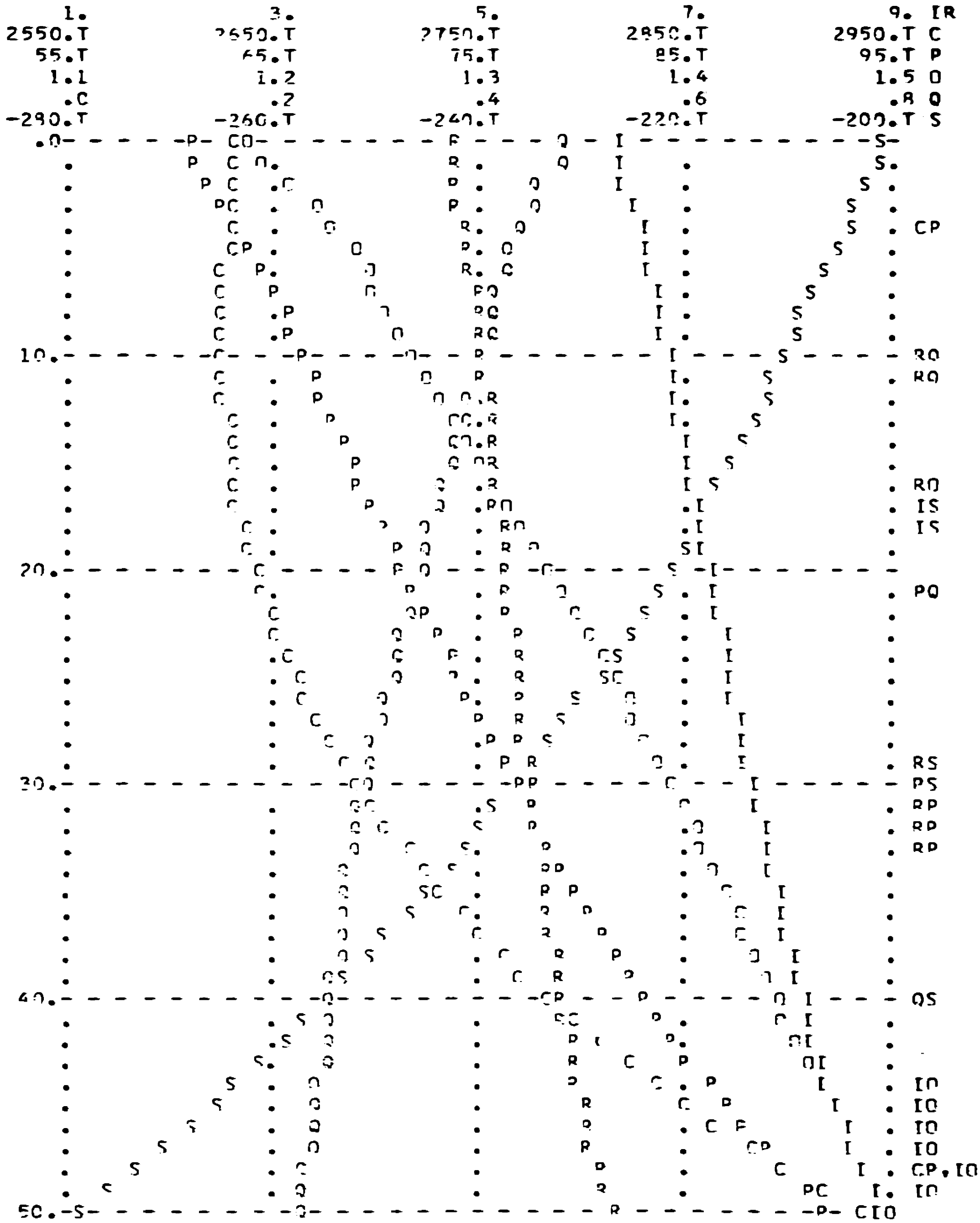
SENSITIVITY TESTS

```
PAGE 6          3/21/72    STEADY STATE                                    PRESENT     0.
                                                                           ORIGINAL   15.CCA
INT=I,RES=R,CAFINV=C,PAT=P,OLOAD=1,COC=Q,PRELSS=S

        4.5              5.              5.5              6.              6.5 IR
         0.           1000.T          2000.T          3000.T          4000.T C
         .0             20.T            40.T            60.T            80.T P
         .0              .5              1.              1.5              2. O
         .0              .2              .4              .6              .8 Q
   -201.8T        -201.8T         -201.8T         -201.8T         -201.8T S
   .0- - - -R- - - - - - - - - - - - - - - 0 -C- - - P -S- - I - - - 0Q
     .     R          .    S            .     0  C      .P          I    . 0Q
     .  S  R          .                 .     0  C      .P          I    . 0Q
     .     R  S       .                 .     0  C      .P          I    . 0Q
     .     R        S.                  .     0  C      .P          I    . 0Q
     .     R        S.                  .     C  C      .P          I    . 0Q
     .     R          .    S            .     0  C      .P          I    . 0Q
     .     R          .    S            .     C  C      .P          I    . 0Q
     .     R        S.                  .     C  C      .P          I    . 0Q
     .     R          .    S            .     0  C      .P          I    . 0Q
  10.- - - -R- - - - - -S- - - - - - - - 0 -C- - - P - - - I - - - 0Q
     .     R          .    S            .     0  C      .P          I    . 0Q
     .     R          .    S            .     0  C      .P          I    . 0Q
     .     R          .         S       .     0  C      .P          I    . 0Q
     .     R          .         S       .     0  C      .P          I    . 0Q
     .     R          .         S       .     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
  20.- - - -R- - - - - - - - - - - - - -S- - 0 -C- - - P - - - I - - - 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
  30.- - - -R- - - - - - - - - - - - - -S- - 0 -C- - - P - - - I - - - 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
  40.- - - -R- - - - - - - - - - - - - -S- - 0 -C- - - P - - - I - - - 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
     .     R          .                S.     0  C      .P          I    . 0Q
  50.- - - - - - - - - - - - - - - - - -S- - - - - - - - P - - - I - - - 0Q
```

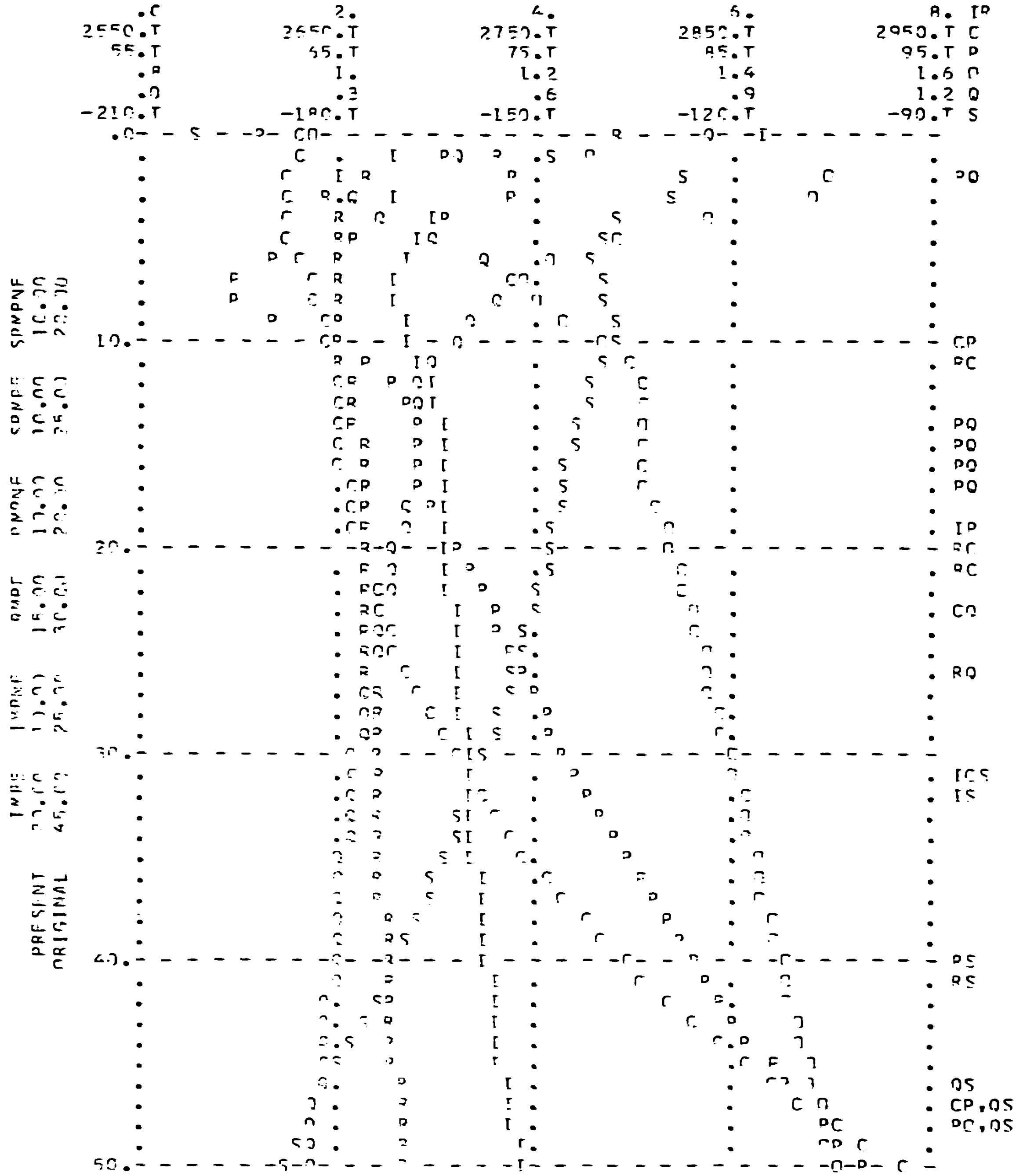
PAGE 4 ?/21/72 BASE RUN

INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=C,CGC=G,PRFLSS=S



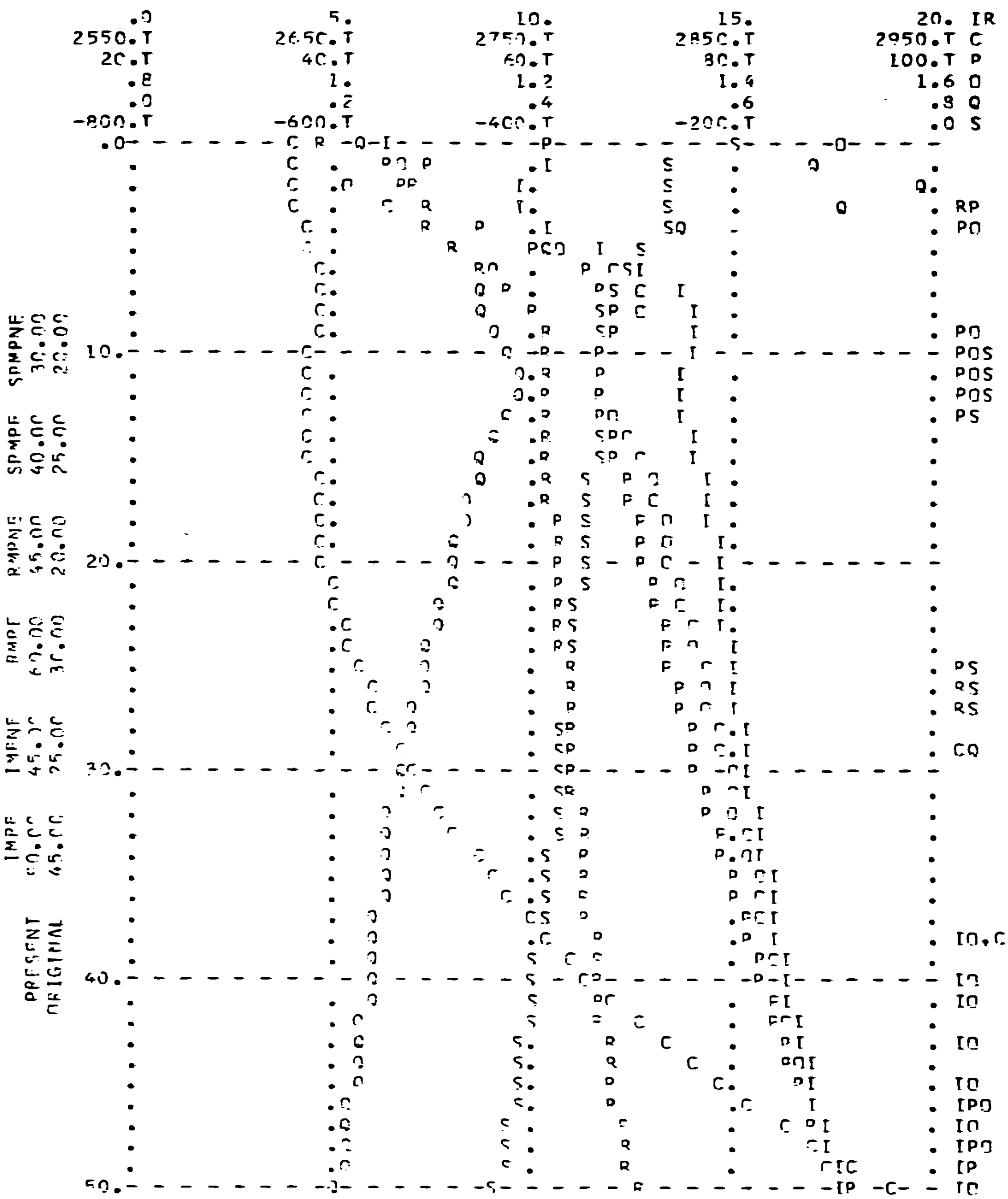
PAGE 8 ?/21/72 SHORT SERVICE TIMES

INT=I,RES=R,CAPINV=C,PAT=P,OLOAD=?,OCC=Q,PRFLSS=S



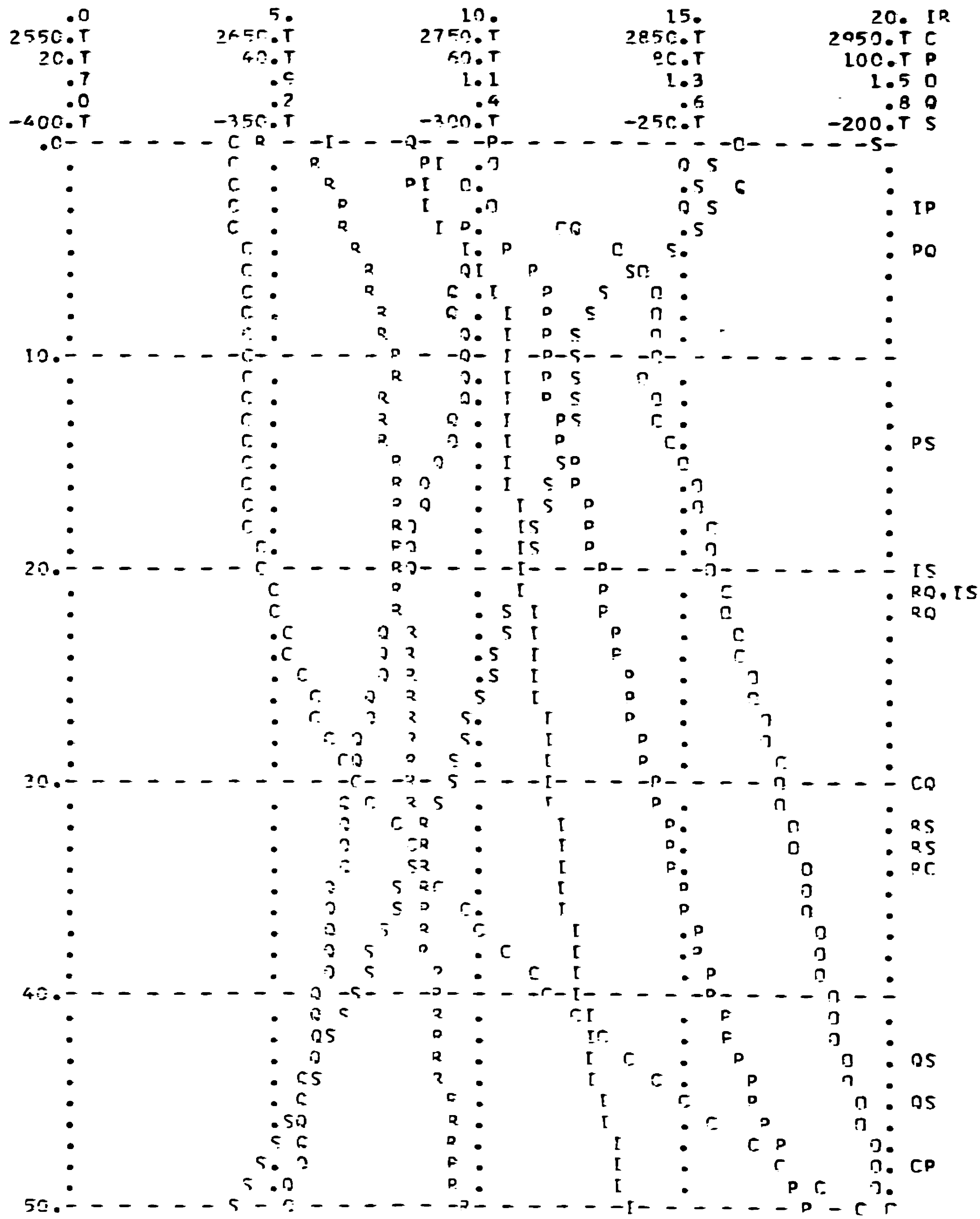
PAGE 10 3/21/72 LONG SERVICE TIMES

INT=I,RES=R,CAPINV=C,PAT=P,OLOAD=O,ODC=Q,PRFLSS=S



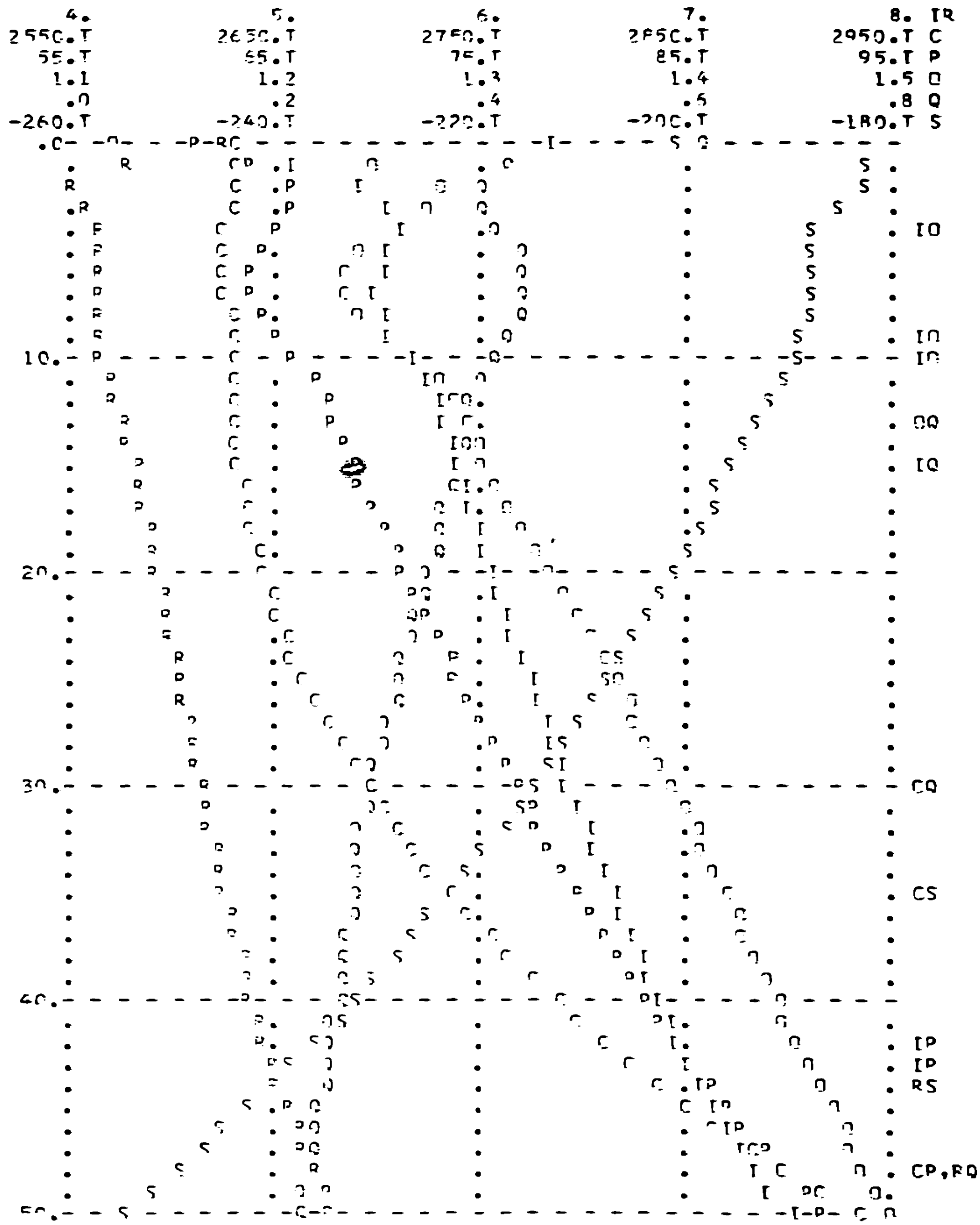
			IHPW	RHPW	SPHPW
PAGE 12	3/21/72 SHORT STAFF HOURS	PRESENT	40.00	40.00	10.00
		ORIGINAL	60.00	60.00	20.00

INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=O,GOC=Q,PRFLSS=S



PAGE 14	3/21/72	LONG STAFF HOURS		IFPW	RHPW	SPHPW
			PRESENT	70.00	70.00	30.00
			ORIGINAL	60.00	60.00	20.00

INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=O,OCC=Q,PRELSS=S



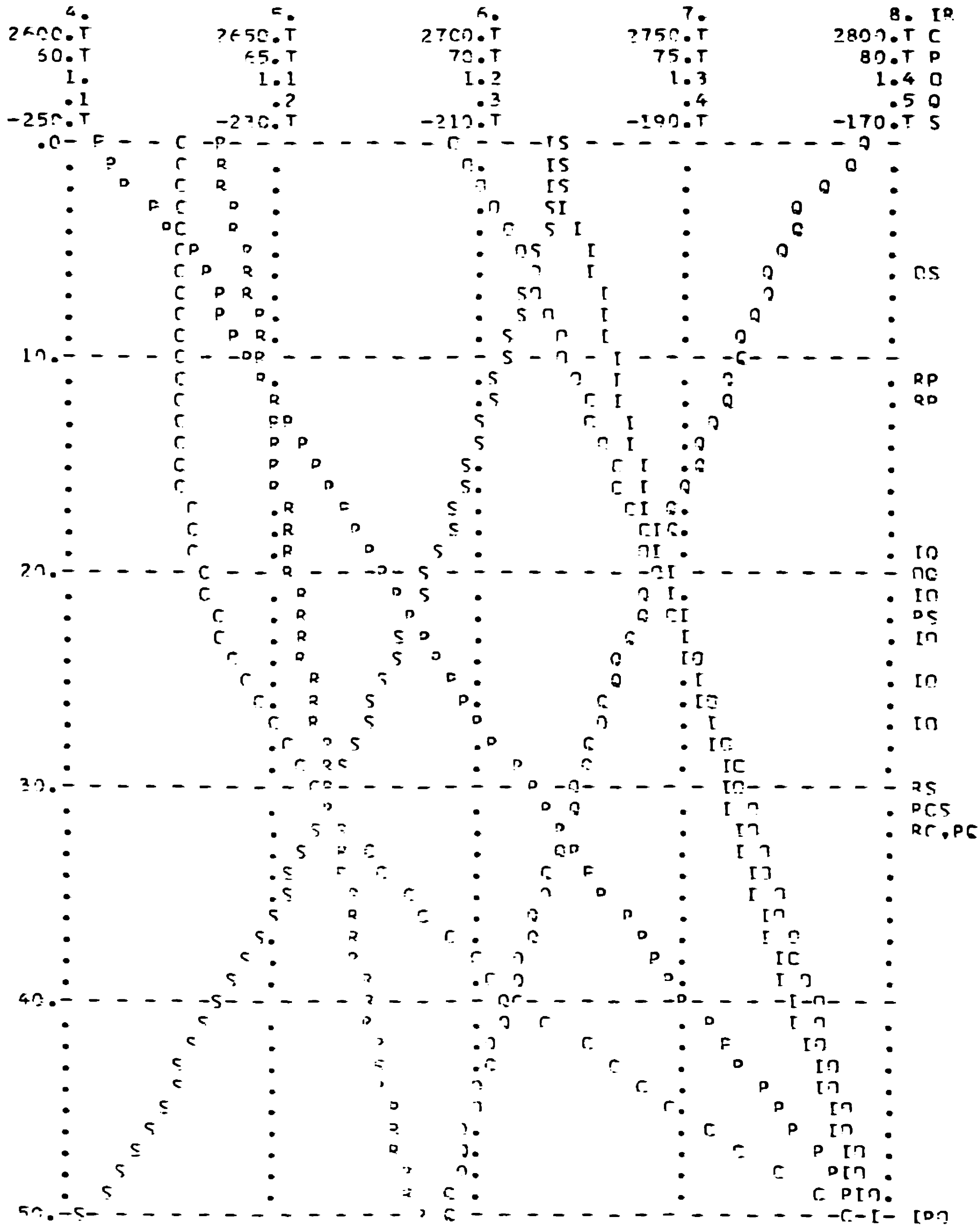
PAGE 16 3/21/72 DECR. PATIENT POOL GROWTH

PCC

PRESENT 10.CCA

ORIGINAL 15.00A

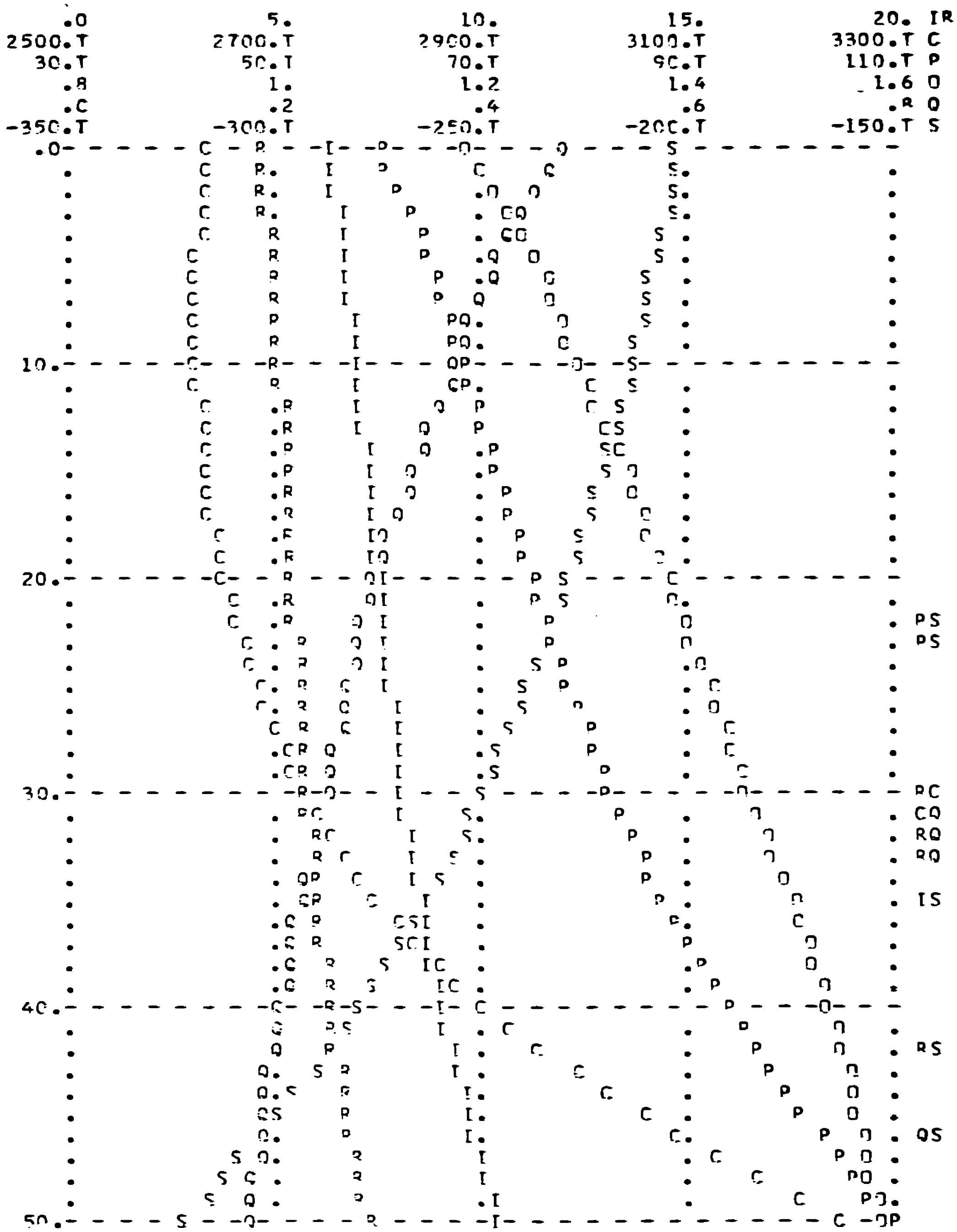
INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=C,OPC=O,PRELSS=S



PAGE 18 3/21/72 INCR. PATIENT POOL GROWTH

	PGC
PRESENT	20.00A
ORIGINAL	15.00A

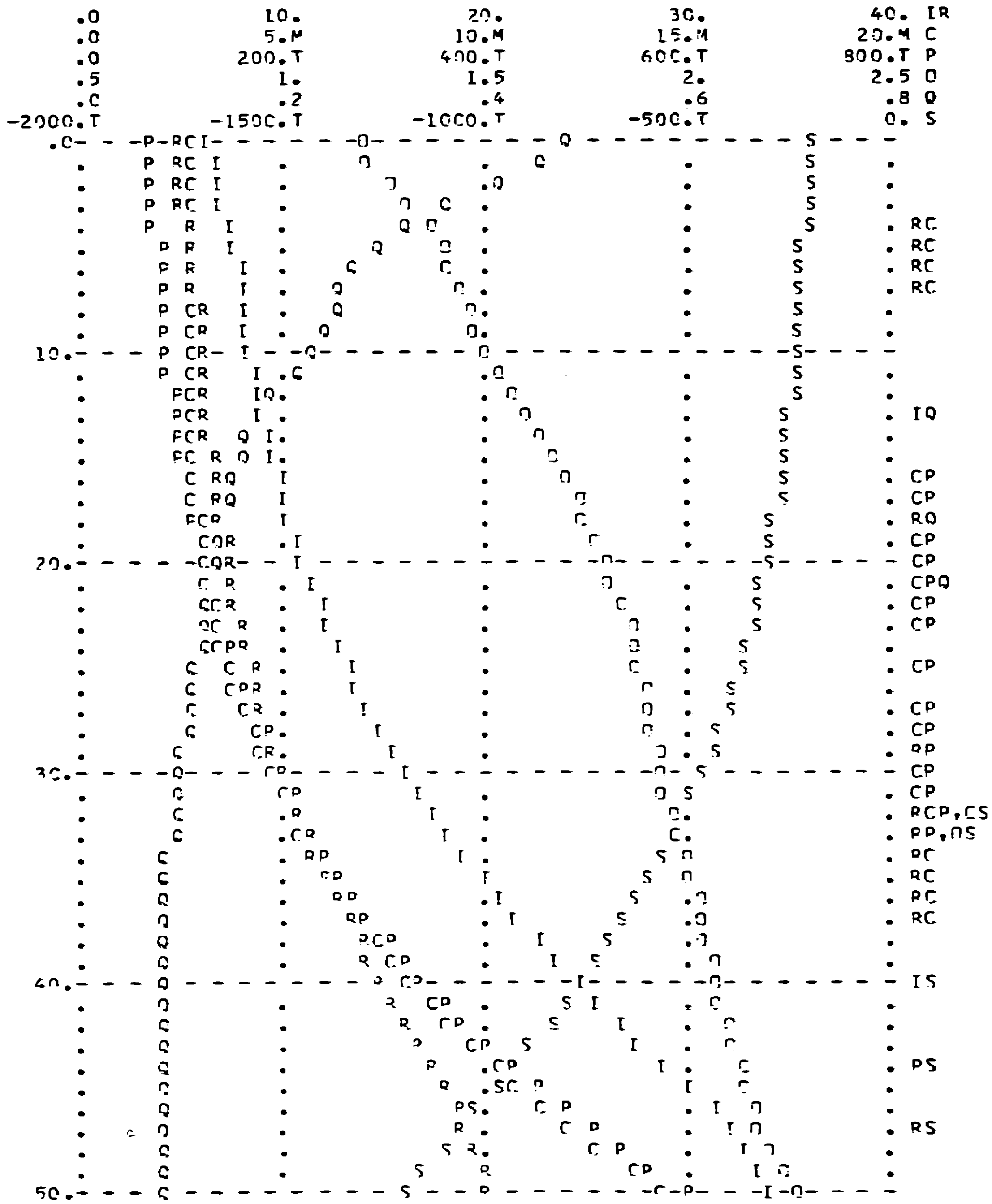
INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=O,CCC=Q,PRELSS=S



PAGE 20 3/21/72 EXPLODING PATIENT POOL

PCC
PRESENT 60.CCA
ORIGINAL 15.0CA

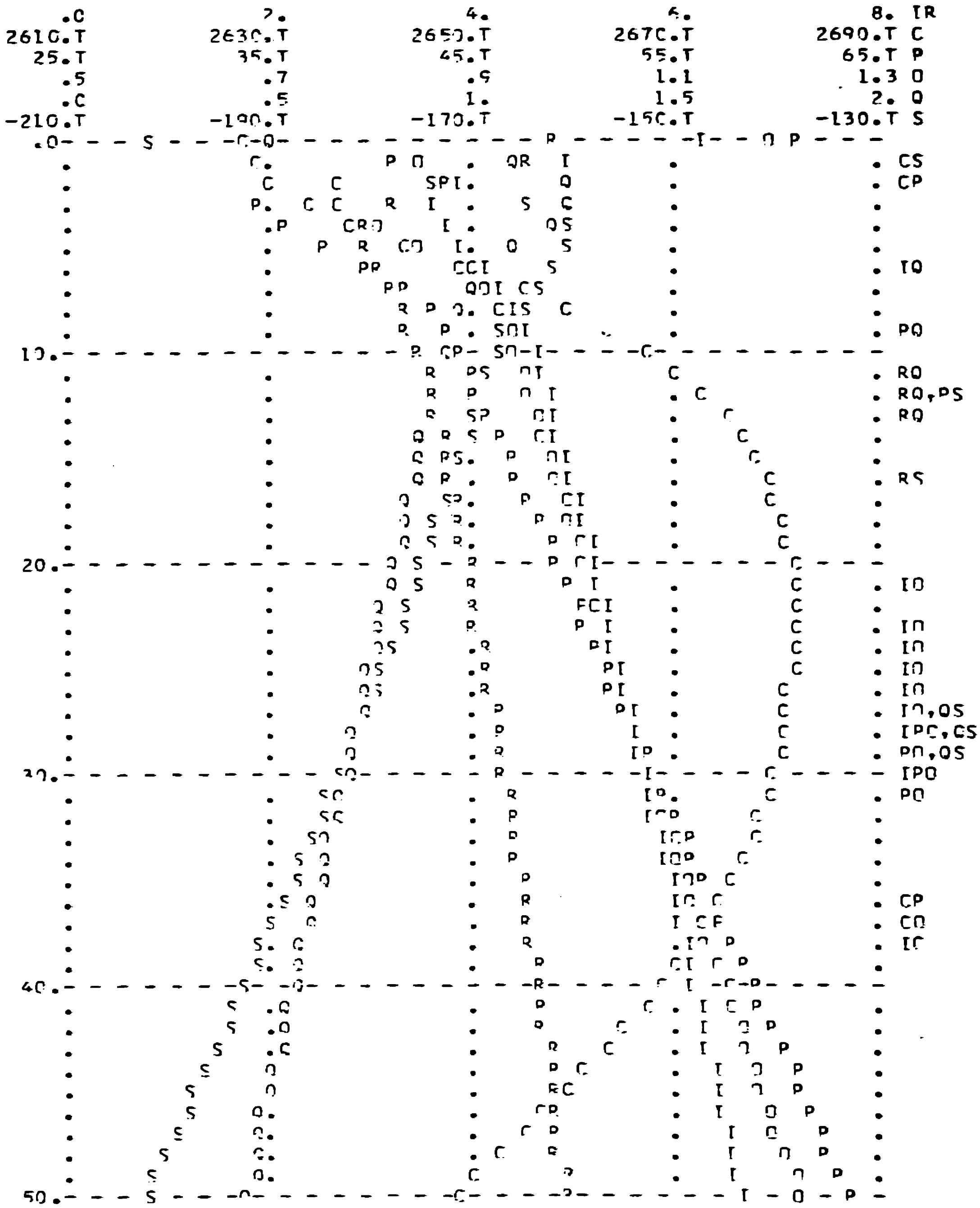
INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=Q,CCC=C,PRFLSS=S



PAGE 22 3/21/72 DECREASE IN PERCEIVED EMERGENCIES

	PPEMER
PRESENT	.2000
ORIGINAL	.4CCC

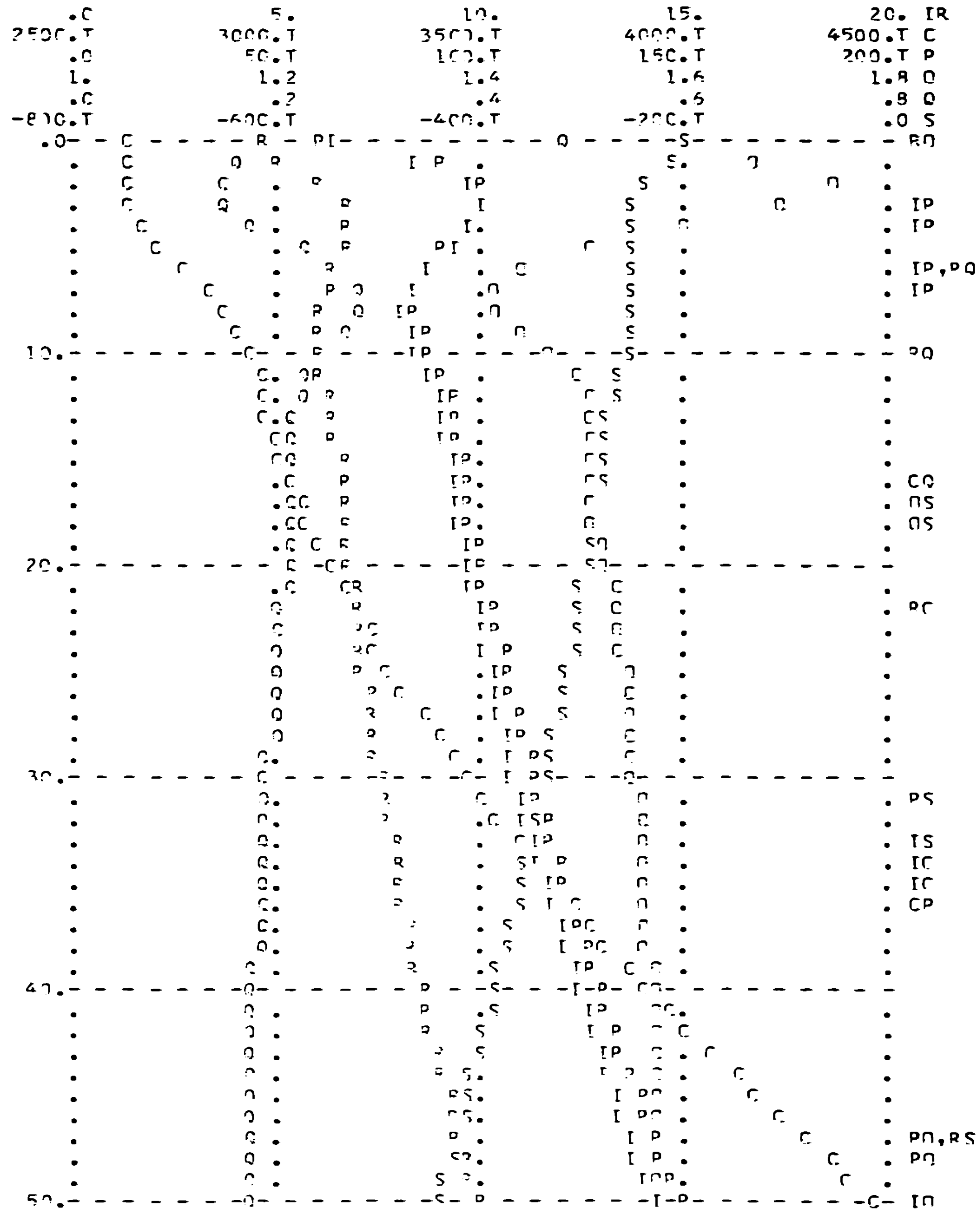
INT=I,RES=R,CAPINV=C,PAT=P,FLOAD=Q,CCC=O,PRELSS=S



PAGE 24 3/21/72 INCREASE IN PERCEIVED EMERGENCIES

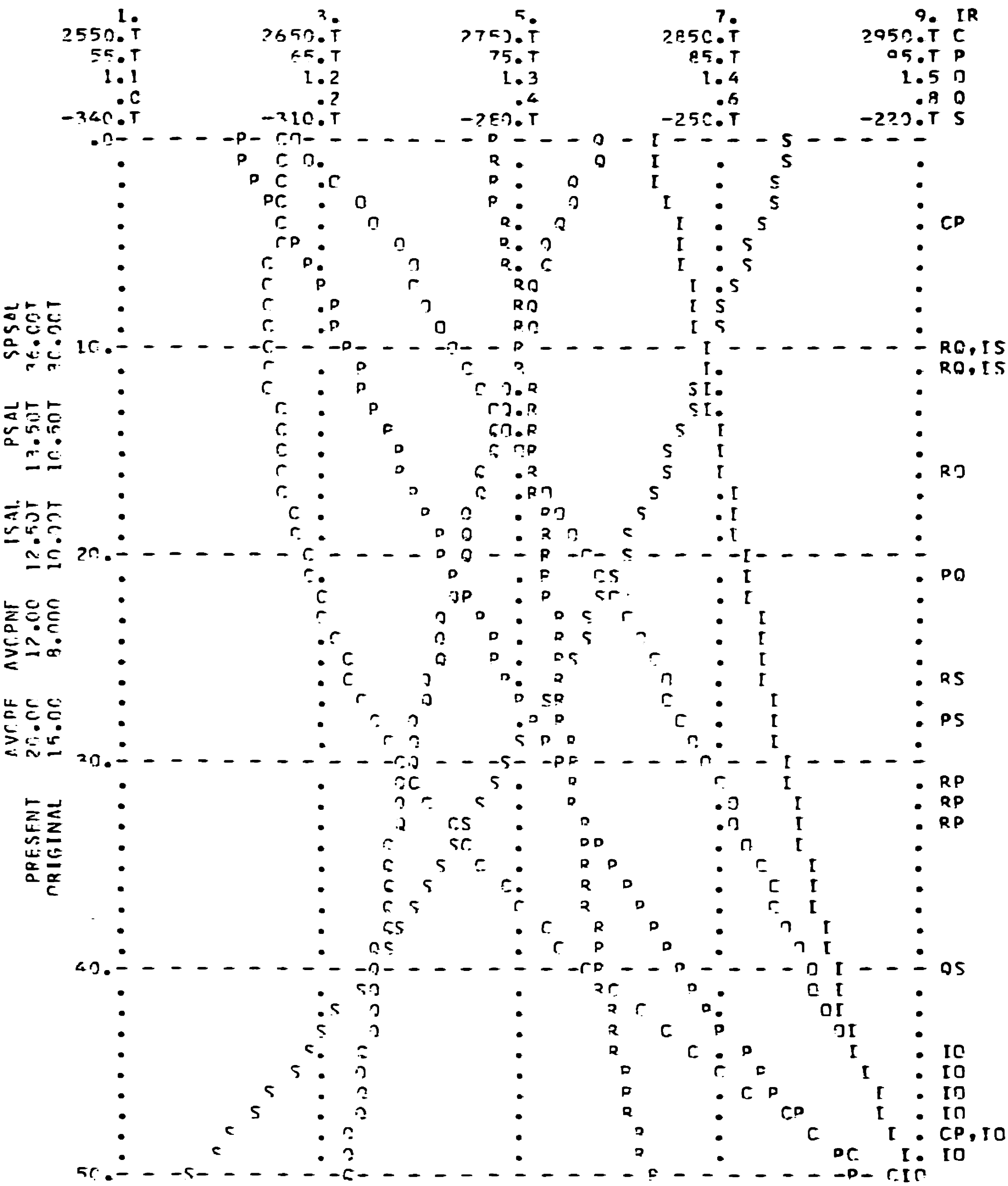
	PREMER
PRESENT	.7000
ORIGINAL	.4000

INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=Q,CCC=C,PRELSS=S



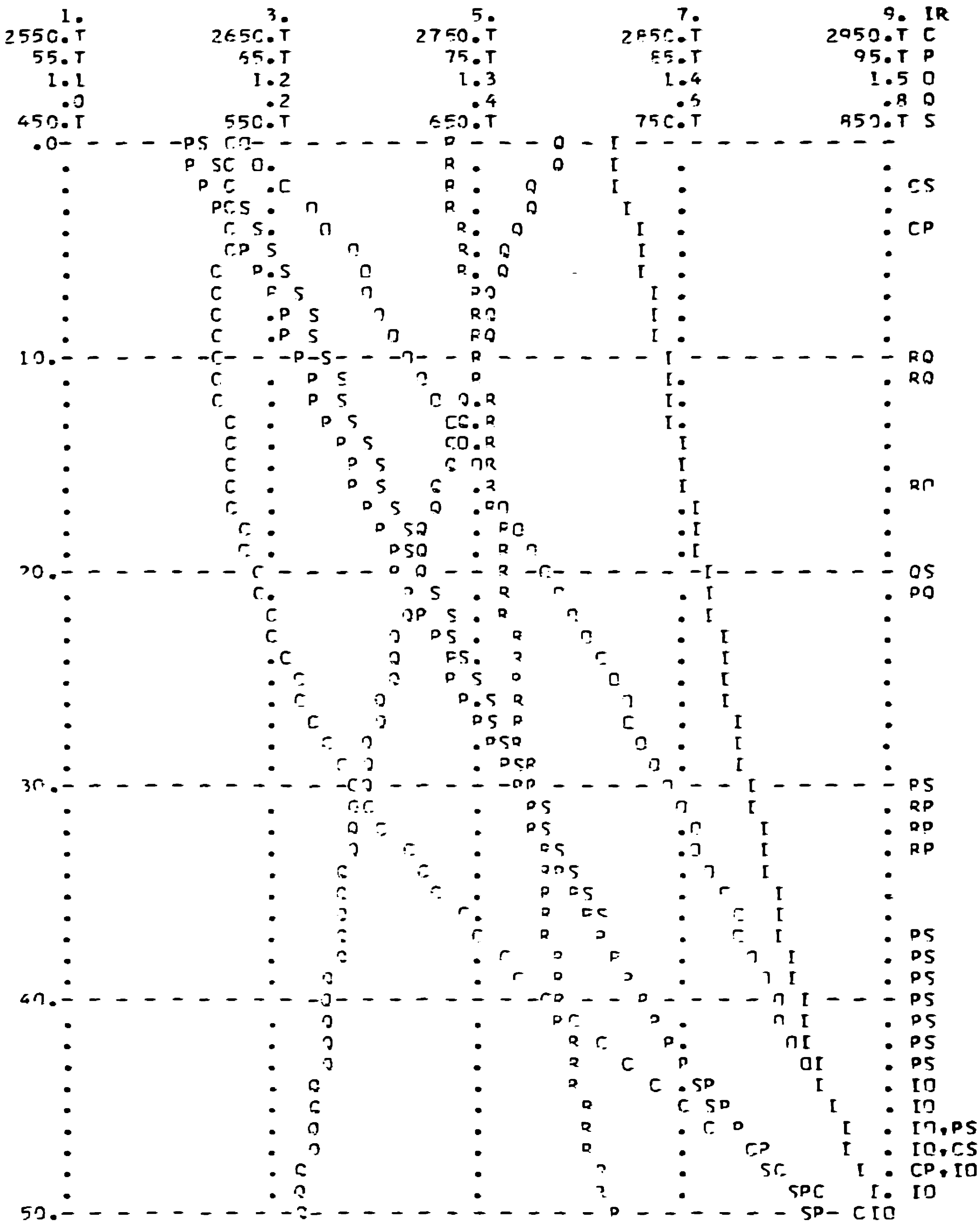
PAGE 26   3/21/72   INCREASED COSTS

INT=I,RES=R,CAPINV=C,PAT=P,OLOAD=O,COC=Q,PRFLSS=S



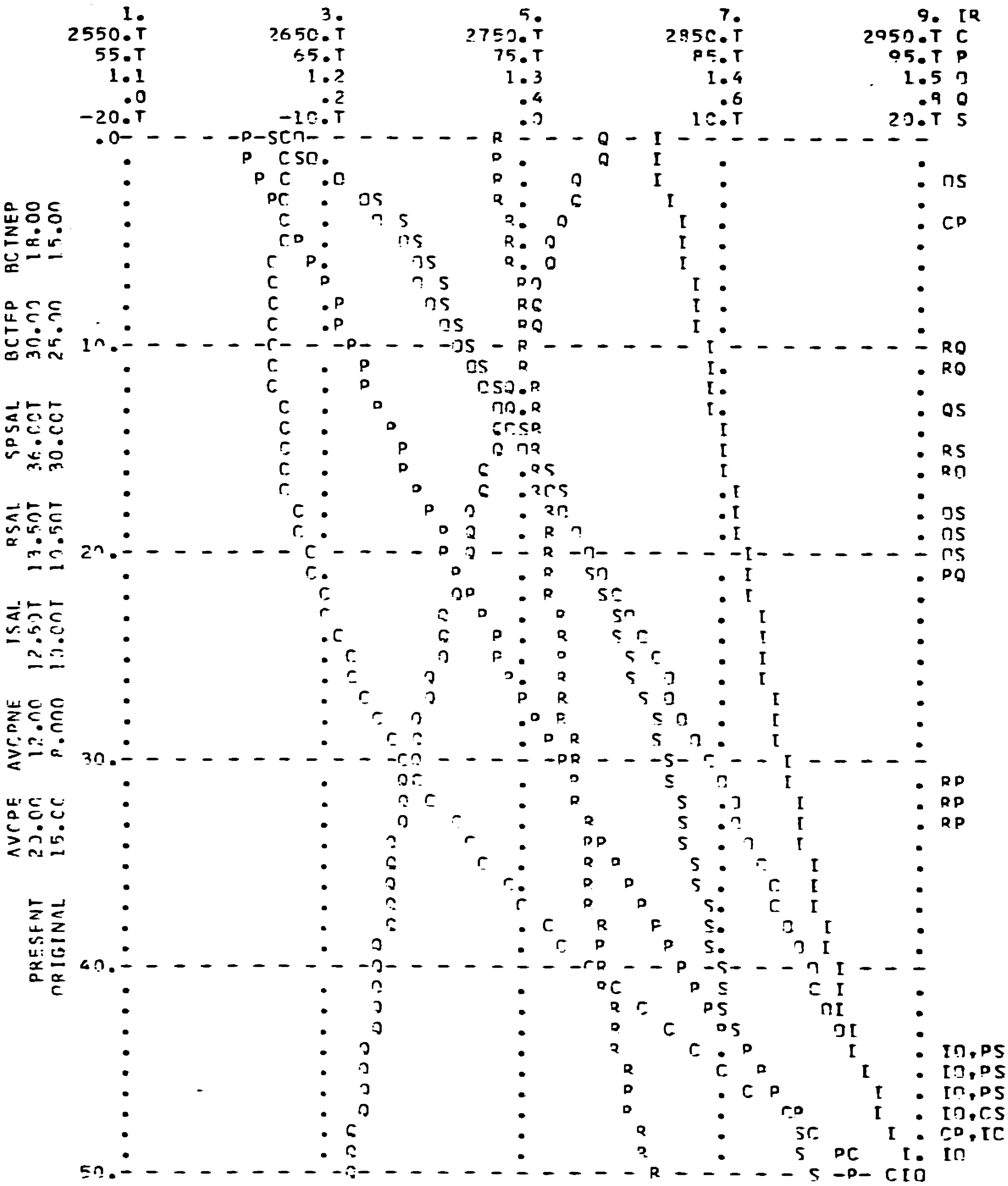
					BCTEP	BCTNEP
PAGE 28	3/21/72	INCREASED CHARGES		PRESENT	40.00	25.00
				ORIGINAL	25.00	15.00

INT=I,RES=P,CAPINV=C,PAT=P,CLOAD=Q,CCC=Q,PRFLSS=S



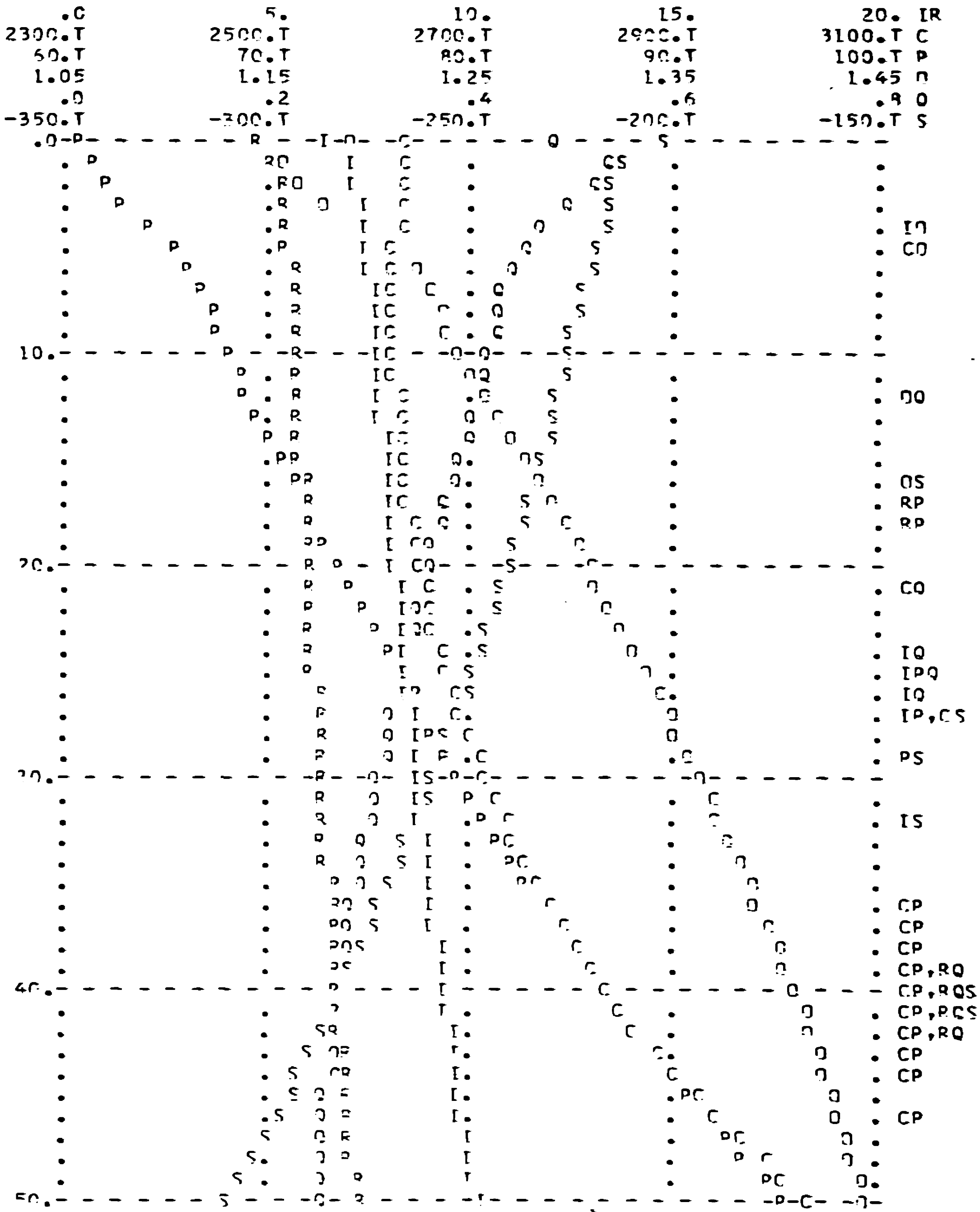
PAGE 30 3/21/72 INCREASED COSTS, INCREASED CHARGES

INT=I,RES=R,CAPINV=C,PAT=P,QLOAD=Q,CFC=C,PPFLSS=S



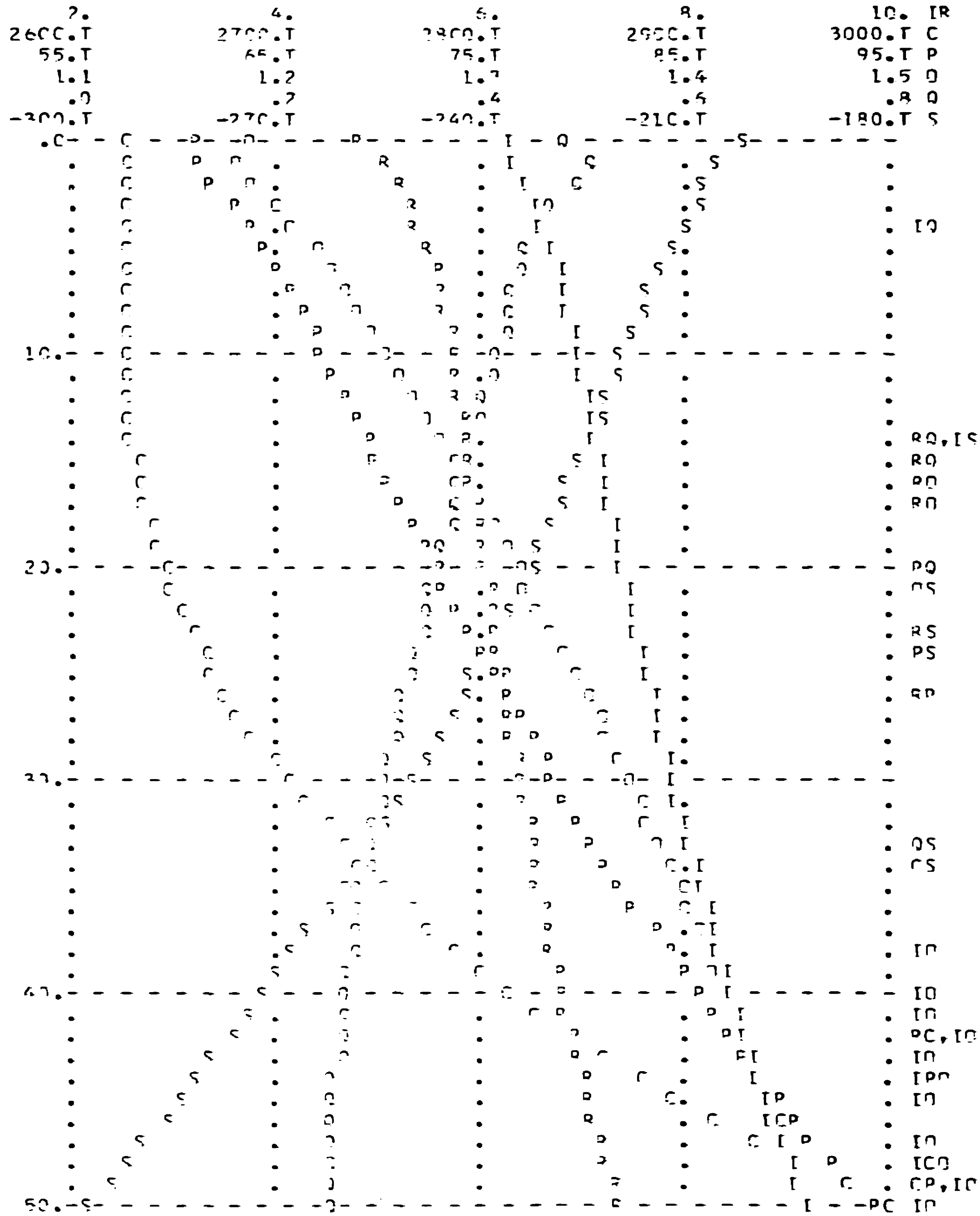
PAGE 32   3/21/72   INCREASE IN INTERN. TO RESIDENT RATIO   PRESENT 2.500 / ORIGINAL 2.000   DITRR

INT=I,RES=R,CAPINV=C,PAT=P,QLOAD=Q,COC=C,PRFLSS=S



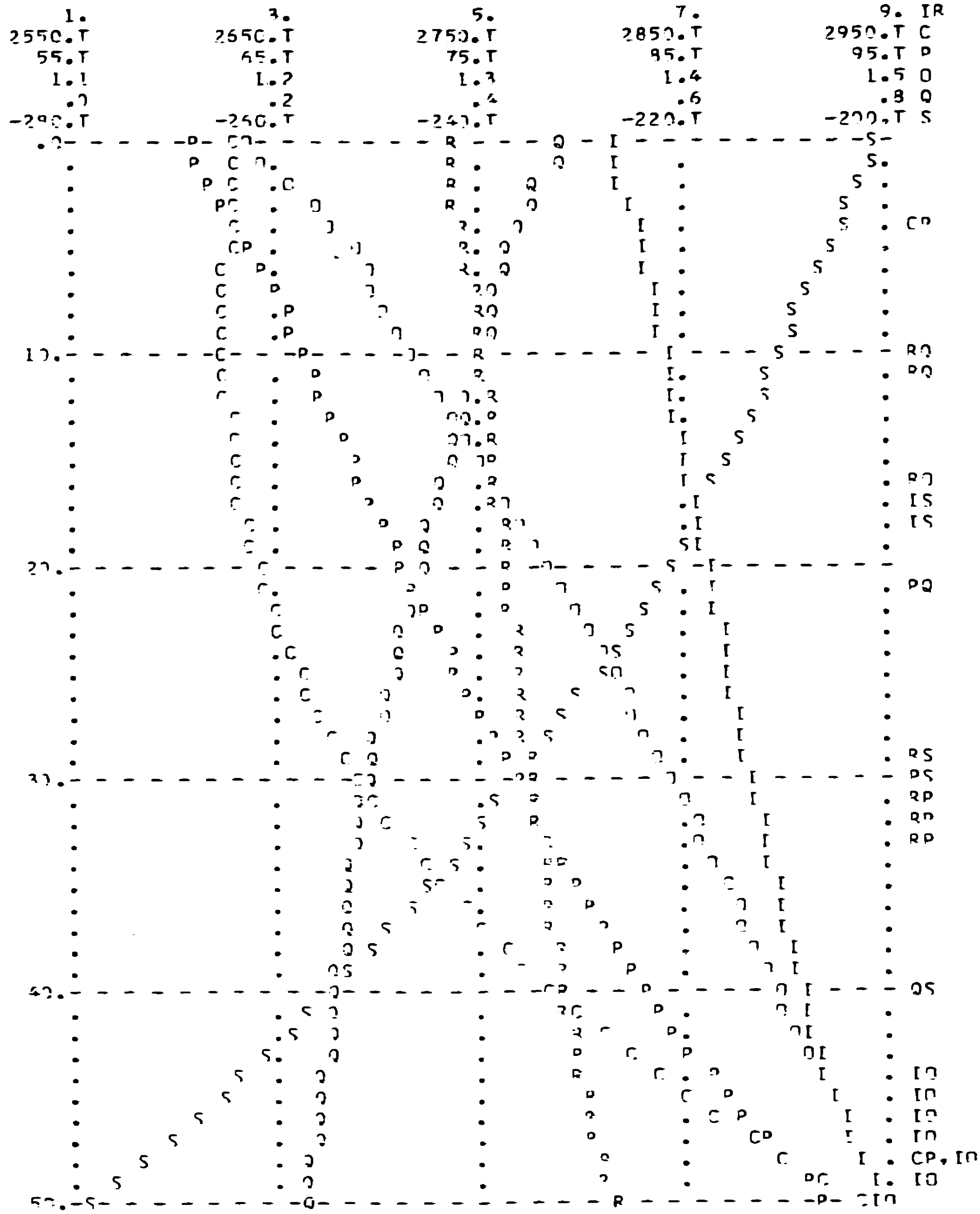
PAGE 34   3/21/72   INCR. IN LOCAL ATTRACTIVENESS   PRESENT LAWF 5.000
ORIGINAL 3.000

INT=I,RES=R,CAPINV=C,PAT=P,OLOAD=O,QCC=Q,PRFLSS=S



PAGE 4 4/04/72 IDTTP=1 YEAR

INT=I,RES=R,CAPINV=C,PAT=P,OLOAD=O,QOC=Q,PRFLSS=S



APPENDIX IV

EXOGENOUS VARIABLES

```
PAGE 1        INTRODUCTION OF NEIGBORHOOD HEALTH CLINICS *     3/21/72

              *       INTRODUCTION OF NEIGBORHOOD HEALTH CLINICS *
              MACRO DELAY3P(IN,DEL,PIPE)
              A       DELAY3P.K=$LV3.K/$DL.K
              L       $LV3.K=$LV3.J+DT*($RT2.JK-DELAY3P.J)
              N       $LV3=$DL*IN
              R       $RT2.KL=$LV2.K/$DL.K
              L       $LV2.K=$LV2.J+DT*($RT1.JK-$RT2.JK)
              N       $LV2=$LV3
              R       $RT1.KL=$LV1.K/$DL.K
              L       $LV1.K=$LV1.J+DT*(IN.JK-$RT1.JK)
              N       $LV1=$LV3
              A       $DL.K=DEL/3
              A       PIPE.K=$LV1.K+$LV2.K+$LV3.K
              MEND
   1          L       INT.K=INT.J+(DT)(RHI.JK-AOI.JK-INTRES.JK) (MEN)
   1.1        N       INT=INTN (MEN)
   1.2        C       INTN=6.315 (MEN)
   2          L       HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-AOR.JK) (MEN)
   2.1        N       HRES=HRESN (MEN)
   2.2        C       HRESN=4.7488 (MEN)
   3          A       RES.K=1*HRES.K (MEN)
   4          R       RHI.KL=NRHI.K*DIM.K*ATPS.K (MEN/YEAR)
   5          A       NRHI.K=SMOOTH(RHI.JK,SMTI) (MEN/YEAR)
   5.1        N       NRHI=6.3152
   5.2        C       SMTI=2 (YEARS)
   6          A       DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2) (DIMENSIONLESS)
   6.1        T       TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2 (TABLE)
   7          A       DI.K=DITRR*DR.K (MEN)
   7.1        C       DITRR=2 (DIMENSIONLESS)
   8          A       ATPS.K=DLINF3(ATCS.K,ATTDEL)
   8.1        C       ATTDEL=5 (YEARS)
   9          R       AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K) (MEN/YEAR)
   9.1        C       AVSPI=1 (YEARS)
  10          A       IDM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+EATS)) (DIMENSIONLESS)
  10.1        C       LAWF=[illegible] (DIMENSIONLESS)
  10.2        C       EATS=1 (DIMENSIONLESS)
  11          R       INTRES.KL=(1/AVSPI)(INT.K)(IDM.K) (MEN/YEAR)
  12          R       RHR.KL=NHRR.K*DRM.K*ATPS.K (MEN/YEAR)
  13          A       NHRR.K=SMOOTH(RHR.JK,SMTR) (MEN/YEAR)
  13.1        N       NHRR=0 (MEN/YEAR)
  13.2        C       SMTR=2 (YEARS)
  14          A       DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2) (DIMENSIONLESS)
  15          A       DR.K=(NEP.K-SUPHY*(1/((PR.K/SPEC)+(1/SPNC))))/
              X       ((1/((PR.K/REC)+(1/RNC)))+(DITRR/((PR.K/IEC)+(1/INC)))) (MEN)
  16          R       AOR.KL=(1/AVSPR)(RES.K) (MEN/YEAR)
  16.1        C       AVSPR=1 (YEARS)
  17          A       ATCS.K=TABLE(TABLE7,(PAT.K/FLCAP.K)/INNORM,0,3,.3) (DIMENSIONLESS
  17.1        C       INNORM=1.2 (DIMENSIONLESS)
  17.2        T       TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2 (TABLE)
  17.3        N       IEC=1/ITPE (VISITS/YEAR)
  17.4        N       ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)
  17.5        C       IMPE=45 (MINUTES)
  17.6        C       IHPW=60 (HOURS/WEEK)
  17.7        N       INC=1/ITPNE (VISITS/YEAR)
  17.8        N       ITPNE=(IMPNE/60)/(IHPW*50) (YEARS/VISIT)
  17.9        C       IMPNE=25 (MINUTES)
  18          N       REC=1/RTPE (VISITS/YEAR)
  18.1        N       RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)
```

```
18.2    C   RMPE=30 (MINUTES)
18.3    C   RHPW=60 (HOURS/WEEK)
18.4    N   RNC=1/RTPNE (VISITS/YEAR)
18.5    N   RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)
18.6    C   RMPNE=20 (MINUTES)
18.7    N   SPEC=1/SPTPE (VISITS/YEAR)
18.8    N   SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)
18.9    C   SPMPE=25 (MINUTES)
19      C   SPHPW=20 (HOURS/WEEK)
19.1    N   SPNC=1/SPTPNE (VISITS/YEAR)
19.2    N   SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)
19.3    C   SPMPNE=20 (MINUTES)
20      L   PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J) (VISITS/YEAR)
20.1    N   PAT=PATN (VISITS/YEAR)
20.2    C   PATN=60707 (VISITS/YEAR)
20.3    C   TTCH=1 (YEAR)
21      R   CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER.K (VISITS/YEAR)
22      A   PATPOOL.K=150000*EXP(PGC*TIME.K) (PEOPLE)
22.1    C   PGC=0.015 (1/YEAR)
23      A   PPEMER.K=.4+SMOOTH(STEP(PSTEPH,STEPT),PPEST) (DIMENSIONLESS)
23.1    C   PSTEPH=-.15 (DIMENSIONLESS)
23.2    C   PPEST=5 (YEARS)
24      A   PAEDTP.K=DLINF3(AEDTP.K,IDTTP) (DIMENSIONLESS)
24.1    C   IDTTP=4 (YEARS)
25      A   AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/ARNORM,0,2,.2) (DIM.
25.1    C   ARNORM=1.2 (DIMENSIONLESS)
26      L   CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK) (DOLLARS)
26.1    N   CAPINV=CAPINVN (DOLLARS)
26.2    C   CAPINVN=2627800 (DOLLARS)
27      R   DCI.KL=CAPINV.K/DEPT.K (DOLLARS/YEAR)
28      A   DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT) (YEARS)
29      A   DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3) (DIMENSIONLESS)
29.1    T   TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/.525/.5 (TABLE)
29.2    C   NORDT=30 (YEARS)
29.3    C   DEPDT=10 (YEARS)
30      R   RCI.KL=DELAY3P(CIOF.JK,CAPITC,CICC.K) (DOLLARS/YEAR)
30.1    C   CAPITC=4 (YEARS)
30.2    N   CICC=CICCN (DOLLARS)
30.3    C   CICCN=320020 (DOLLARS)
31      R   CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CICC.K)*EXFUND.K
        X   +SDCI.K (DOLLARS/YEAR)
32      A   EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2) (DIMENSIONLESS)
32.1    T   TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)
33      A   DCAPINV.K=DCIPP*PAT.K (DOLLARS)
33.1    C   DCIPP=60 (DOLLARS/VISIT/YEAR)
34      A   SDCI.K=SMOOTH(DCI.JK,TSDCI) (YEARS)
34.1    C   TSDCI=1 (YEARS)
35      A   SEXP.K=(IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/(STAFF.K) (DIM.)
36      A   STAFF.K=INT.K+RES.K+SUPHY (MEN)
36.1    N   IEXP=2 (DIMENSIONLESS)
36.2    N   REXP=3.5 (DIMENSIONLESS)
36.3    N   SPEXP=9 (DIMENSIONLESS)
36.4    C   SUPHY=1 (MEN)
37      A   PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) (VISITS/YEAR)
37.1    T   TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.39/1.45/1.5 (TABLE)
38      A   CLOAD.K=PAT.K/PLCAP.K (DIMENSIONLESS)
39      S   QOC.K=.7*COCO.K+.3*COCE.K (DIMENSIONLESS)
40      A   COCO.K=TABLE(TABLE1,CLOAD.K,0,2,.2) (DIMENSIONLESS)
```

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PAGE 3       INTRODUCTION OF NEIGBORHOOD HEALTH CLINICS *    3/21/72

40.1   T     TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 (TABLE)
41     A     COCE.K=TABLE(TABLE5,SEXP.K,0,9,.9) (DIMENSIONLESS)
42     A     SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY (VISITS/YEAR)
43     A     RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE) (VISITS/YEAR)
44     A     ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE) (VISITS/YEAR)
45     A     SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE) (VISITS/YEAR)
46     A     PCAP.K=CAPINV.K/DCIPP (VISITS/YEAR)
47     A     PEREMER.K=AE.K+SE*(1-AE.K) (DIMENSIONLESS)
48     A     PERNEM.K=1-PEREMER.K (DIMENSIONLESS)
49     A     NEP.K=PAT.K*PERNEM.K (VISITS/YEAR)
50     A     PR.K=(PAT.K-NEP.K)/NEP.K (DIMENSIONLESS)
50.1   C     SE=.1 (DIMENSIONLESS)
51     A     AE.K=.33+SMOOTH(STEP(STEPH,STEPT),AEST) (DIMENSIONLESS)
51.1   C     STEPH=.27 (DIMENSIONLESS)
51.2   C     STEPT=10 (YEARS)
51.3   C     AEST=5 (YEARS)
52     A     ANCOST.K=EANCST.K+NEANCST.K (DOLLARS/YEAR)
53     A     EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K (DOLLARS/YEAR)
54     A     NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K (DOLLARS/YEAR)
55     A     ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9) (DIMENSIONLESS)
55.1   C     AVCPE=15 (DOLLARS/VISIT)
55.2   C     AVCPNE=8 (DOLLARS/VISIT)
55.3   T     TABLE6=1.5/1.43/1.32/1.1/.8/.7/.61/.57/.52/.51/.5 (TABLE)
56     A     OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K (DOLLARS/YEAR)
57     A     SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY (DOLLARS/YEAR)
57.1   C     ISAL=10000 (DOLLARS/YEAR/MAN)
57.2   C     RSAL=10500 (DOLLARS/YEAR/MAN)
57.3   C     SPSAL=30000 (DOLLARS/YEAR/MAN)
58     A     PHSAL.K=PHCPV*PAT.K (DOLLARS/YEAR)
58.1   C     PHCPV=18.33 (DOLLARS/VISIT)
59     A     INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*PERNEM.K) ($/YR)
60     A     CPE.K=BCTEP+AVCPE*ANCT.K (DOLLARS/VISIT)
60.1   C     BCTEP=25 (DOLLARS/VISIT)
61     A     CPNE.K=BCTNEP+AVCPNE*ANCT.K (DOLLARS/VISIT)
61.1   C     BCTNEP=15 (DOLLARS/VISIT)
61.2   C     BDEBT=.01 (DIMENSIONLESS)
62     A     PRFLSS.K=INCOME.K-OPEXP.K (DOLLARS/YEAR)
       PLOT  INT=I,RES=R/CAPINV=C/PAT=P/CLCAC=C/COC=Q/PRFLSS=S
62.2   C     DT=.1 (YEARS)
62.3   C     PLTPER=1 (YEARS)
62.4   C     LENGTH=50 (YEARS)
       RUN
```

```
INT.K=INT.J+(DT)(RHI.JK-AOI.JK-INTRES.JK)                     1, L
INT=INTN (MEN)                                                1.1, N
INTN=6.315 (MEN)                                              1.2, C
    INT    - INTERNS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    AOI    - ATTRITION RATE OF INTERNS (MEN/YEAR)
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
               YEAR)
    INTN   - INITIAL VALUE OF INTERNS (MEN)

HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-AOR.JK)                   2, L
HRES=HRESN (MEN)                                              2.1, N
HRESN=4.7488 (MEN)                                            2.2, C
    HRES   - HOSPITAL RESIDENTS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
               YEAR)
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
               YEAR)
    AOR    - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    HRESN  - INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)

RES.K=1*HRES.K                                                3, A
    RES    - RESIDENTS (MEN)
    HRES   - HOSPITAL RESIDENTS (MEN)

RHI.KL=NRHI.K*DIM.K*ATPS.K                                    4, R
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    NRHI   - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    DIM    - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)

NRHI.K=SMOOTH(RHI.JK,SMTI)                                    5, A
NRHI=6.3152                                                   5.1, N
SMTI=2 (YEARS)                                                5.2, C
    NRHI   - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    SMTI   - SMOOTHING TIME FOR INTERNS (YEARS)

DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2)                         6, A
TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2                  6.1, T
  (TABLE)
    DIM    - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DI     - DESIRED INTERNS (MEN)
    INT    - INTERNS (MEN)

DI.K=DITRR*DR.K                                               7, A
DITRR=2 (DIMENSIONLESS)                                       7.1, C
    DI     - DESIRED INTERNS (MEN)
    DITRR  - DESIRED INTERN TO RESIDENT RATIO
               (DIMENSIONLESS)
    DR     - DESIRED RESIDENTS (MEN)
```

```
ATPS.K=DLINF3(ATCS.K,ATTDEL)                                  8, A
ATTDEL=5 (YEARS)                                              8.1, C
    ATPS    - ATTRACTIVENESS TO POTENTIAL STAFF
                (DIMENSIONLESS)
    ATCS    - ATTRACTIVENESS TO CURRENT STAFF
                (DIMENSIONLESS)
    ATTDEL  - TIME TO PERCEIVE ATTRACTIVENESS (YEARS)

AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K)                              9, R
AVSPI=1 (YEARS)                                               9.1, C
    AOI     - ATTRITION RATE OF INTERNS (MEN/YEAR)
    AVSPI   - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT     - INTERNS (MEN)
    IDM     - INTERN DESTINATION MULTIPLIER
                (DIMENSIONLESS)

IDM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+EATS))                        10, A
LAWF=3 (DIMENSIONLESS)                                        10.1, C
EATS=1 (DIMENSIONLESS)                                        10.2, C
    IDM     - INTERN DESTINATION MULTIPLIER
                (DIMENSIONLESS)
    LAWF    - LOCAL ATTRACTIVENESS WEIGHTING FACTOR
                (DIMENSIONLESS)
    ATCS    - ATTRACTIVENESS TO CURRENT STAFF
                (DIMENSIONLESS)
    EATS    - EXTERNAL ATTRACTIVENESS TO STAFF
                (DIMENSIONLESS)

INTRES.KL=(1/AVSPI)(INT.K)(IDM.K)                             11, R
    INTRES  - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
                YEAR)
    AVSPI   - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT     - INTERNS (MEN)
    IDM     - INTERN DESTINATION MULTIPLIER
                (DIMENSIONLESS)

RHR.KL=NHRR.K*DRM.K*ATPS.K                                    12, R
    RHR     - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
                YEAR)
    NHRR    - NORMAL HIRING RATE OF RESIDENTS FROM
                OUTSIDE (MEN/YEAR)
    DRM     - DESIRED RESIDENTS MULTIPLIER
                (DIMENSIONLESS)
    ATPS    - ATTRACTIVENESS TO POTENTIAL STAFF
                (DIMENSIONLESS)

NHRR.K=SMOOTH(RHR.JK,SMTR)                                    13, A
NHRR=0 (MEN/YEAR)                                             13.1, N
SMTR=2 (YEARS)                                                13.2, C
    NHRR    - NORMAL HIRING RATE OF RESIDENTS FROM
                OUTSIDE (MEN/YEAR)
    RHR     - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
                YEAR)
    SMTR    - SMOOTHING TIME FOR RESIDENTS (YEARS)
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DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2)                           14, A
    DRM     - DESIRED RESIDENTS MULTIPLIER
                (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DR      - DESIRED RESIDENTS (MEN)
    RES     - RESIDENTS (MEN)

DR.K=(NEP.K-SUPHY*(1/((PR.K/SPEC)+(1/SPNC))))/((1/  15, A
  ((PR.K/REC)+(1/RNC)))+(DITRR/((PR.K/IEC)+(1/
  INC))))
    DR      - DESIRED RESIDENTS (MEN)
    NEP     - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)
    PR      - PATIENT RATIO (DIMENSIONLESS)
    SPEC    - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
                (VISITS/YEAR)
    SPNC    - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
                (VISITS/YEAR)
    REC     - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RNC     - RESIDENT NONEMERGENCY CAPACITY (VISITS/
                YEAR)
    DITRR   - DESIRED INTERN TO RESIDENT RATIO
                (DIMENSIONLESS)
    IEC     - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    INC     - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)

AOR.KL=(1/AVSPR)(RES.K)                                          16, R
AVSPR=1 (YEARS)                                                  16.1, C
    AOR     - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    AVSPR   - AVERAGE STAY PER RESIDENT (YEARS/MAN)
    RES     - RESIDENTS (MEN)
```

```
ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3)     17, A
INNORM=1.2 (DIMENSIONLESS)                             17.1, C
TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2      17.2, T
  (TABLE)
IEC=1/ITPE (VISITS/YEAR)                               17.3, N
ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)                 17.4, N
IMPE=45 (MINUTES)                                      17.5, C
IHPW=60 (HOURS/WEEK)                                   17.6, C
INC=1/ITPNE (VISITS/YEAR)                              17.7, N
ITPNE=(IMPNE/60)/(IHPW*50) (YEARS/VISIT)               17.8, N
IMPNE=25 (MINUTES)                                     17.9, C
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    TABLE7 - TABLE FUNCTION
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    INNORM - INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)
    IEC    - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    ITPE   - INTERN TIME FOR PERCEIVED EMERGENCIES
               (YEARS/VISIT/MAN)
    IMPE   - INTERN MINUTES PER EMERGENCY (MINUTES/
               VISIT)
    IHPW   - INTERN HOURS PER WEEK (HOURS/WEEK)
    INC    - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
    ITPNE  - INTERN TIME FOR PERCEIVED NONEMERGENCIES
               (YEARS/VISIT/MAN)
    IMPNE  - INTERN MINUTES PER NONEMERGENCY (MINUTES/
               VISIT)
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REC=1/RTPE (VISITS/YEAR)                                    18, N
RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)                      18.1, N
RMPE=30 (MINUTES)                                           18.2, C
RHPW=60 (HOURS/WEEK)                                        18.3, C
RNC=1/RTPNE (VISITS/YEAR)                                   18.4, N
RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)                    18.5, N
RMPNE=20 (MINUTES)                                          18.6, C
SPEC=1/SPTPE (VISITS/YEAR)                                  18.7, N
SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)                   18.8, N
SPMPE=25 (MINUTES)                                          18.9, C
    REC    - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RTPE   - RESIDENT TIME FOR PERCEIVED EMERGENCY
               (YEARS/VISIT/MAN)
    RMPE   - RESIDENT MINUTES PER EMERGENCY (MINUTES/
               VISIT)
    RHPW   - RESIDENT HOURS PER WEEK (HOURS/WEEK)
    RNC    - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    RTPNE  - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
               (YEARS/VISIT/MAN)
    RMPNE  - RESIDENT MINUTES PER NONEMERGENCY (MINUTES/
               VISIT)
    SPEC   - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPE  - SUPERVISING PHYSICIAN TIME PER EMERGENCY
               (YEARS/VISIT/MAN)
    SPMPE  - SUPERVISING PHYSICIAN MINUTES PER EMERGENCY
               (MINUTES/VISIT)
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)

SPHPW=20 (HOURS/WEEK)                                       19, C
SPNC=1/SPTPNE (VISITS/YEAR)                                 19.1, N
SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)                 19.2, N
SPMPNE=20 (MINUTES)                                         19.3, C
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)
    SPNC   - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
               (YEARS/VISIT/MAN)
    SPMPNE - SUPERVISING PHYSICIAN MINUTES PER
               NONEMERGENCY (MINUTES/VISIT)

PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J)                      20, L
PAT=PATN (VISITS/YEAR)                                      20.1, N
PATN=60727 (VISITS/YEAR)                                    20.2, C
TTCH=1 (YEAR)                                               20.3, C
    PAT    - PATIENTS (VISITS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    TTCH   - TIME TO CHANGE HABITS (YEARS)
    CPL    - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PATN   - INITIAL VALUE OF PATIENTS (VISITS/YEAR)
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CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER.K                         21, R
    CPL     - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PAEDTP  - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
                PATIENTS (DIM.)
    PATPOOL - PATIENT POOL (MEN)
    PPEMER  - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PATPOOL.K=150000*EXP(PGC*TIME.K)                           22, A
PGC=0.015 (1/YEAR)                                         22.1, C
    PATPOOL - PATIENT POOL (MEN)
    PGC     - PATIENT POOL GROWTH CONSTANT (1/YEAR)

PPEMER.K=.4+SMOOTH(STEP(PSTEPH,STEPT),PPEST)               23, A
PSTEPH=-.15 (DIMENSIONLESS)                                23.1, C
PPEST=5 (YEARS)                                            23.2, C
    PPEMER  - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PAEDTP.K=DLINF3(AEDTP.K,IDTTP)                             24, A
IDTTP=4 (YEARS)                                            24.1, C
    PAEDTP  - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
                PATIENTS (DIM.)
    AEDTP   - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
                PATIENTS (DIM.)
    IDTTP   - INFORMATION DELAY TIME TO PATIENTS (YEARS)

AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/              25, A
  ARNORM,0,2,.2)
ARNORM=1.2 (DIMENSIONLESS)                                 25.1, C
    AEDTP   - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
                PATIENTS (DIM.)
    TABLE1  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)
    ARNORM  - AREA NORMAL OVERLOAD (DIMENSIONLESS)

CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK)                      26, L
CAPINV=CAPINVN (DOLLARS)                                   26.1, N
CAPINVN=2627800 (DOLLARS)                                  26.2, C
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    DT      - INCREMENT IN TIME (YEARS)
    RCI     - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    DCI     - DEPRECIATION OF CAPITAL INVESTMENT
                (DOLLARS/YEAR)
    CAPINVN - INITIAL VALUE OF CAPITAL INVESTMENT
                (DOLLARS)

DCI.KL=CAPINV.K/DEPT.K                                     27, R
    DCI     - DEPRECIATION OF CAPITAL INVESTMENT
                (DOLLARS/YEAR)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    DEPT    - DEPRECIATION TIME (YEARS)

DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                          28, A
    DEPT    - DEPRECIATION TIME (YEARS)
    NORDT   - NORMAL DEPRECIATION TIME (YEARS)
    DEPF    - DEPRECIATION FUNCTION (DIMENSIONLESS)
    DEPDT   - DEPRECIATION DELAY TIME (YEARS)
```

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DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3)                    29, A
TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/            29.1, T
  .525/.5 (TABLE)
NORDT=30  (YEARS)                                           29.2, C
DEPDT=10  (YEARS)                                           29.3, C
    DEPF    - DEPRECIATION FUNCTION (DIMENSIONLESS)
    TABLE4  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    NORDT   - NORMAL DEPRECIATION TIME (YEARS)
    DEPDT   - DEPRECIATION DELAY TIME (YEARS)

RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K)                       30, R
CAPITC=4  (YEARS)                                           30.1, C
CIOO=CIOON  (DOLLARS)                                       30.2, N
CIOON=320020  (DOLLARS)                                     30.3, C
    RCI     - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    CIOON   - INITIAL VALUE OF CAPITAL INVESTMENT ON
                ORDER (DOLLARS)

CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*          31, R
  EXFUND.K+SDCI.K
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)

EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2)                  32, A
TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)         32.1, T
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)
    TABLE2  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)

DCAPINV.K=DCIPP*PAT.K                                       33, A
DCIPP=60  (DOLLARS/VISIT/YEAR)                              33.1, C
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
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SDCI.K=SMOOTH(DCI.JK,TSDCI)                                  34, A
TSDCI=1 (YEARS)                                              34.1, C
    SDCI   - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    TSDCI  - TIME TO SMOOTH DEPRECIATION OF CAPITAL
               INVESTMENT (YEARS)

SEXP.K=(IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/                  35, A
  (STAFF.K)
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)
    IEXP   - INTERN EXPERIENCE (DIMENSIONLESS)
    INT    - INTERNS (MEN)
    REXP   - RESIDENT EXPERIENCE (DIMENSIONLESS)
    RES    - RESIDENTS (MEN)
    SPEXP  - SUPERVISING PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    STAFF  - STAFF (MEN)

STAFF.K=INT.K+RES.K+SUPHY                                    36, A
IEXP=2 (DIMENSIONLESS)                                       36.1, N
REXP=3.5 (DIMENSIONLESS)                                     36.2, N
SPEXP=9 (DIMENSIONLESS)                                      36.3, N
SUPHY=1 (MEN)                                                36.4, C
    STAFF  - STAFF (MEN)
    INT    - INTERNS (MEN)
    RES    - RESIDENTS (MEN)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    IEXP   - INTERN EXPERIENCE (DIMENSIONLESS)
    REXP   - RESIDENT EXPERIENCE (DIMENSIONLESS)
    SPEXP  - SUPERVISING PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)

PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) 37, A
TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5  37.1, T
  (TABLE)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    SCAP   - STAFF CAPACITY (VISITS/YEAR)
    TABLE3 - TABLE FUNCTION
    PCAP   - PHYSICAL CAPACITY (VISITS/YEAR)

OLOAD.K=PAT.K/PLCAP.K                                        38, A
    OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)

QOC.K=.7*QOCO.K+.3*QOCE.K                                    39, S
    QOC    - QUALITY OF CARE (DIMENSIONLESS)
    QOCO   - QUALITY OF CARE FROM OVERLOAD
               (DIMENSIONLESS)
    QOCE   - QUALITY OF CARE FROM EXPERIENCE
               (DIMENSIONLESS)
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QOCO.K=TABLE(TABLE1,OLOAD.K,0,2,.2)                          40, A
TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0                 40.1, T
  (TABLE)
    QOCO    - QUALITY OF CARE FROM OVERLOAD
                (DIMENSIONLESS)
    TABLE1 - TABLE FUNCTION
    OLOAD   - OVERLOAD OF FACILITIES (DIMENSIONLESS)

QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9)                           41, A
    QOCE    - QUALITY OF CARE FROM EXPERIENCE
                (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)

SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY               42, A
    SCAP    - STAFF CAPACITY (VISITS/YEAR)
    RCAP    - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    RES     - RESIDENTS (MEN)
    ICAP    - INTERN CAPACITY (VISITS/YEAR/MAN)
    INT     - INTERNS (MEN)
    SPCAP   - SUPERVISING PHYSICIAN CAPACITY (VISITS/
                YEAR/MAN)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)

RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE)                43, A
    RCAP    - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    RTPE    - RESIDENT TIME FOR PERCEIVED EMERGENCY
                (YEARS/VISIT/MAN)
    RTPNE   - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
                (YEARS/VISIT/MAN)

ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE)                44, A
    ICAP    - INTERN CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    ITPE    - INTERN TIME FOR PERCEIVED EMERGENCIES
                (YEARS/VISIT/MAN)
    ITPNE   - INTERN TIME FOR PERCEIVED NONEMERGENCIES
                (YEARS/VISIT/MAN)

SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE)             45, A
    SPCAP   - SUPERVISING PHYSICIAN CAPACITY (VISITS/
                YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    SPTPE   - SUPERVISING PHYSICIAN TIME PER EMERGENCY
                (YEARS/VISIT/MAN)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
                (YEARS/VISIT/MAN)

PCAP.K=CAPINV.K/DCIPP                                        46, A
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
```

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PEREMER.K=AE.K+SE*(1-AE.K)                                    47, A
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)

PERNEM.K=1-PEREMER.K                                          48, A
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)

NEP.K=PAT.K*PERNEM.K                                          49, A
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    PAT    - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

PR.K=(PAT.K-NEP.K)/NEP.K                                      50, A
SE=.1 (DIMENSIONLESS)                                         50.1, C
    PR     - PATIENT RATIO (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)

AE.K=.33+SMOOTH(STEP(STEPH,STEPT),AEST)                       51, A
STEPH=.27 (DIMENSIONLESS)                                     51.1, C
STEPT=10 (YEARS)                                              51.2, C
AEST=5 (YEARS)                                                51.3, C
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)

ANCOST.K=EANCST.K+NEANCST.K                                   52, A
    ANCOST - ANCILLARY COSTS (DOLLARS/YEAR)
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)

EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K                         53, A
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    PAT    - PATIENTS (VISITS/YEAR)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K                        54, A
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)
    PAT    - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
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ANCT.K=TABLE(TABLE6,SEXP.K,C,9,.9)                          55, A
AVCPE=15 (DOLLARS/VISIT)                                    55.1, C
AVCPNE=8 (DOLLARS/VISIT)                                    55.2, C
TABLE6=1.5/1.43/1.32/1.1/.8/.7/.61/.57/.52/.51/.5           55.3, T
  (TABLE)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
                (DIMENSIONLESS)
    TABLE6  - TABLE FUNCTION
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)
    AVCPE   - AVERAGE COST PER PERCEIVED EMERGENCY
                (DOLLARS/VISIT)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
                (DOLLARS/VISIT)

OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K                      56, A
    OPEXP   - OPERATING EXPENSES (DOLLARS/YEAR)
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    PHSAL   - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    ANCOST  - ANCILLARY COSTS (DOLLARS/YEAR)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)

SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY                    57, A
ISAL=10000 (DOLLARS/YEAR/MAN)                               57.1, C
RSAL=10500 (DOLLARS/YEAR/MAN)                               57.2, C
SPSAL=30000 (DOLLARS/YEAR/MAN)                              57.3, C
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    ISAL    - INTERN SALARY (DOLLARS/YEAR/MAN)
    INT     - INTERNS (MEN)
    RSAL    - RESIDENT SALARY (DOLLARS/YEAR/MAN)
    RES     - RESIDENTS (MEN)
    SPSAL   - SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/
                MAN)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)

PHSAL.K=PHCPV*PAT.K                                         58, A
PHCPV=18.33 (DOLLARS/VISIT)                                 58.1, C
    PHSAL   - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    PHCPV   - PROFFESSIONAL HELP COST PER VISIT (DOLLARS/
                VISIT)
    PAT     - PATIENTS (VISITS/YEAR)

INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*           59, A
  PERNEM.K)
    INCOME  - INCOME (DOLLARS/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
    BDEBT   - BAD DEBTS (DIMENSIONLESS)
    CPE     - COST PER EMERGENCY (DOLLARS/VISIT)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    CPNE    - COST PER NONEMERGENCY (DOLLARS/VISIT)
    PERNEM  - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
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CPE.K=BCTEP+AVCPE*ANCT.K                                    60, A
BCTEP=25 (DOLLARS/VISIT)                                    60.1, C
    CPE    - COST PER EMERGENCY (DOLLARS/VISIT)
    BCTEP  - BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/
               VISIT)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

CPNE.K=BCTNEP+AVCPNE*ANCT.K                                 61, A
BCTNEP=15 (DOLLARS/VISIT)                                   61.1, C
BDEBT=.01 (DIMENSIONLESS)                                   61.2, C
    CPNE   - COST PER NONEMERGENCY (DOLLARS/VISIT)
    BCTNEP - BASE CHARGE TO NONEMERGENCY PATIENT
               (DOLLARS/VISIT)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    BDEBT  - BAD DEBTS (DIMENSIONLESS)

PRFLSS.K=INCOME.K-OPEXP.K                                   62, A
DT=.1 (YEARS)                                               62.2, C
PLTPER=1 (YEARS)                                            62.3, C
LENGTH=50 (YEARS)                                           62.4, C
    PRFLSS - PROFIT/LOSS (DOLLARS/YEAR)
    INCOME - INCOME (DOLLARS/YEAR)
    OPEXP  - OPERATING EXPENSES (DOLLARS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    PLTPER - PLOTTING INTERVAL (YEARS)
    LENGTH - LENGTH OF RUN (YEARS)
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PAGE 1   FILE EHC_2HC   EMERGENCY UNIT WITH NEIGHBORHOOD HEALTH CENTERS   3/22/72

NAME	NO	T	DEFINITION	WHERE USED
AE	51	A	ACTUAL EMERGENCIES (DIMENSIONLESS)	PEREMER,A,47
AEDTP	25	A	ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO PATIENTS (DIM.)	PAEDTP,A,24
AEST	51.3	C		AE,A,51
ANCOST	52	A	ANCILLARY COSTS (DOLLARS/YEAR)	OPEXP,A,56
ANCT	55	A	ANCILLARY COST TO EXPERIENCE FACTOR (DIMENSIONLESS)	EANCST,A,53/NEANCST,A,54/CPE,A,60/CPNE,A,61
AOI	9	R	ATTRITION RATE OF INTERNS (MEN/YEAR)	INT,L,1
AOR	16	R	ATTRITION RATE OF RESIDENTS (MEN/YEAR)	HRES,L,2
ARNORM	25.1	C	AREA NORMAL OVERLOAD (DIMENSIONLESS)	AEDTP,A,25
ATCS	17	A	ATTRACTIVENESS TO CURRENT STAFF (DIMENSIONLESS)	ATPS,A,8/IDM,A,10
ATPS	8	A	ATTRACTIVENESS TO POTENTIAL STAFF (DIMENSIONLESS)	RHI,R,4/RHR,R,12
ATTDEL	8.1	C	TIME TO PERCEIVE ATTRACTIVENESS (YEARS)	ATPS,A,8
AVCPE	55.1	C	AVERAGE COST PER PERCEIVED EMERGENCY (DOLLARS/VISIT)	EANCST,A,53/CPE,A,60
AVCPNE	55.2	C	AVERAGE COST PER PERCEIVED NONEMERGENCY (DOLLARS/VISIT)	NEANCST,A,54/CPNE,A,61
AVSPI	9.1	C	AVERAGE STAY PER INTERN (YEARS/MAN)	AOI,R,9/INTRES,R,11
AVSPR	16.1	C	AVERAGE STAY PER RESIDENT (YEARS/MAN)	AOR,R,16
BCTEP	60.1	C	BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/ VISIT)	CPE,A,60
BCTNEP	61.1	C	BASE CHARGE TO NONEMERGENCY PATIENT (DOLLARS/VISIT)	CPNE,A,61
BDEBT	61.2	C	BAD DEBTS (DIMENSIONLESS)	INCOME,A,59
CAPINV	26	L	CAPITAL INVESTMENT (DOLLARS)	DCI,R,27/CIOF,R,31/PCAP,A,46
	26.1	N		
CAPINVN	26.2	C	INITIAL VALUE OF CAPITAL INVESTMENT (DOLLARS)	CAPINV,N,26.1
CAPITC	30.1	C	CAPITAL INVESTMENT TIME CONSTANT (YEARS)	RCI,R,30/CIOF,R,31
CIOF	31	R	CAPITAL INVESTMENT ORDERING FUNCTION (DOLLARS/YEAR)	RCI,R,30
CIOO	30.2	N	CAPITAL INVESTMENT ON ORDER (DOLLARS)	RCI,R,30/CIOF,R,31
CIOON	30.3	C	INITIAL VALUE OF CAPITAL INVESTMENT ON ORDER (DOLLARS)	CIOO,N,30.2
CPE	60	A	COST PER EMERGENCY (DOLLARS/VISIT)	INCOME,A,59
CPL	21	R	CHANGE IN PATIENT LOAD (VISITS/YEAR)	PAT,L,20
CPNE	61	A	COST PER NONEMERGENCY (DOLLARS/VISIT)	INCOME,A,59
DCAPINV	33	A	DESIRED CAPITAL INVESTMENT (DOLLARS)	CIOF,R,31
DCI	27	R	DEPRECIATION OF CAPITAL INVESTMENT (DOLLARS/ YEAR)	CAPINV,L,26/SDCI,A,34
DCIPP	33.1	C	DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)	DCAPINV,A,33/PCAP,A,46
DEPDT	29.3	C	DEPRECIATION DELAY TIME (YEARS)	DEPT,A,28
DEPF	29	A	DEPRECIATION FUNCTION (DIMENSIONLESS)	DEPT,A,28
DEPT	28	A	DEPRECIATION TIME (YEARS)	DCI,R,27
DI	7	A	DESIRED INTERNS (MEN)	DIM,A,6
DIM	6	A	DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)	RHI,R,4
DITRR	7.1	C	DESIRED INTERN TO RESIDENT RATIO (DIMENSIONLESS)	DI,A,7/DR,A,15
DR	15	A	DESIRED RESIDENTS (MEN)	DI,A,7/DRM,A,14
DRM	14	A	DESIRED RESIDENTS MULTIPLIER (DIMENSIONLESS)	RHR,R,12
DT	62.2	C	INCREMENT IN TIME (YEARS)	INT,L,1/HRES,L,2/PAT,L,20/CAPINV,L,26
EANCST	53	A	EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)	ANCOST,A,52

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PAGE 2   FILE EUC_2HC   EMERGENCY UNIT WITH NEIGHBORHOOD HEALTH CENTER

HATS      10.2 C EXTERNAL ATTRACTIVENESS TO STAFF              IDM,A,10
                 (DIMENSIONLESS)
EXFUND    32   A EXTERNAL FUNDING (DOLLARS/YEAR)               CIOP,R,31
HRES       2   L HOSPITAL RESIDENTS (MEN)                      RES,A,1
           2.1 N
HRESN      2.2 C INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)     HRES,N,2.1
ICAP      44   A INTERN CAPACITY (VISITS/YEAR/MAN)             SCAP,A,42
IDM       10   A INTERN DESTINATION MULTIPLIER                 AOI,R,9/INTRES,R,11
                 (DIMENSIONLESS)
IDTTP     24.1 C INFORMATION DELAY TIME TO PATIENTS (YEARS)    PAEDTP,A,24
IEC       17.3 N INTERN EMERGENCY CAPACITY (VISITS/YEAR)       DP,A,15
IEXP      36.1 N INTERN EXPERIENCE (DIMENSIONLESS)             SEXP,A,35
IHPW      17.6 C INTERN HOURS PER WEEK (HOURS/WEEK)            ITPE,N,17.4/ITPNE,N,17.8
IMPE      17.5 C INTERN MINUTES PER EMERGENCY (MINUTES/        ITPE,N,17.4
                 VISIT)
IMPNE     17.9 C INTERN MINUTES PER NONEMERGENCY (MINUTES/     ITPNE,N,17.8
                 VISIT)
INC       17.7 N INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)    DP,A,15
INCOME    59   A INCOME (DOLLARS/YEAR)                         PRFLSS,A,62
INNORM    17.1 C INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)      ATCS,A,17
INT        1   L INTERNS (MEN)                                 DIM,A,6/AOI,R,9/INTRES,R,11/SEXP,A,35/STAFF,A,36/SCAP,A,42
           1.1 N                                                 SSAL,A,57
INTN       1.2 C INITIAL VALUE OF INTERNS (MEN)                INT,N,1.1
INTRES    11   R RATE OF RESIDENTS HIRED FROM INTERNS (MEN/    INT,L,1/HRES,L,2
                 YEAR)
ISAL      57.1 C INTERN SALARY (DOLLARS/YEAR/MAN)              SSAL,A,57
ITPE      17.4 N INTERN TIME FOR PERCEIVED EMERGENCIES         IEC,N,17.3/ICAP,A,44
                 (YEARS/VISIT/MAN)
ITPNE     17.8 N INTERN TIME FOR PERCEIVED NONEMERGENCIES      INC,N,17.7/ICAP,A,44
                 (YEARS/VISIT/MAN)
LAWF      10.1 C LOCAL ATTRACTIVENESS WEIGHTING FACTOR         IDM,A,10
                 (DIMENSIONLESS)
LENGTH    62.4 C LENGTH OF RUN (YEARS)
NEANCST   54   A NONEMERGENCY ANCILLARY COSTS (DOLLARS/        ANCOST,A,52
                 VISIT)
NEP       49   A NONEMERGENCY PATIENTS (VISITS/YEAR)           DP,A,15/PR,A,50
NHRR      13   A NORMAL HIRING RATE OF RESIDENTS FROM OUTSIDE  RHR,R,12
          13.1 N   (MEN/YEAR)
NORDT     29.2 C NORMAL DEPRECIATION TIME (YEARS)              DEPT,A,28
NRHI       5   A NORMAL RATE OF HIRING INTERNS (MEN/YEAR)      RHI,3,4
           5.1 N
OLOAD     38   A OVERLOAD OF FACILITIES (DIMENSIONLESS)        OOCO,A,40
OPEXP     56   A OPERATING EXPENSES (DOLLARS/YEAR)             PRFLSS,A,62
PAEDTP    24   A PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO    CPL,R,21
                 PATIENTS (DIM.)
PAT       20   L PATIENTS (VISITS/YEAR)                        ATCS,A,17/AEDTP,A,25/DEPF,A,29/EXFUND,A,32/DCAPINV,A,33
          20.1 N                                                 OLOAD,A,38/NEP,A,49/PR,A,50/EANCST,A,53/NEANCST,A,54
                                                                 PHSAL,A,58/INCOME,A,59
PATN      20.2 C INITIAL VALUE OF PATIENTS (VISITS/YEAR)       PAT,N,20.1
PATPOOL   22   A PATIENT POOL (MEN)                            CPL,R,21
PCAP      46   A PHYSICAL CAPACITY (VISITS/YEAR)               DEPT,A,29/EXFUND,A,32/PLCAP,A,37
PEREMER   47   A PERCEIVED EMERGENCIES (DIMENSIONLESS)         RCAP,A,43/ICAP,A,44/SPCAP,A,45/PERNEM,A,48/EANCST,A,53
                                                                 INCOME,A,59
PERNEM    48   A PERCEIVED NONEMERGENCIES (DIMENSIONLESS)      NEP,A,49/NEANCST,A,54/INCOME,A,59
PGC       22.1 C PATIENT POOL GROWTH CONSTANT (1/YEAR)         PATPOOL,A,22
PHCPV     58.1 C PROFFESSIONAL HELP COST PER VISIT (DOLLARS/   PHSAL,A,58
                 VISIT)
PHSAL     58   A PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)    OPEXP,A,56
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PLCAP    37   A PLANNED CAPACITY (VISITS/YEAR)               ATCS,A,17/AHDTP,A,35/OLOAD,A,38
PLTPER   62.1 C PLOTTING INTERVAL (YEARS)
PPEMER   23   A POPULATION PERCEIVED EMERGENCY (1/YEAR)      CPL,R,21
PPEST    23.2 C                                              PPEMER,A,23
PR       50   A PATIENT RATIO (DIMENSIONLESS)                DR,A,15
PRFLSS   62   A PROFIT/LOSS (DOLLARS/YEAR)
PSTEPH   23.1 C                                              PPEMER,A,23
QOC      39   S QUALITY OF CARE (DIMENSIONLESS)
QOCE     41   A QUALITY OF CARE FROM EXPERIENCE              QOC,S,39
                 (DIMENSIONLESS)
QOCO     40   A QUALITY OF CARE FROM OVERLOAD                QOC,S,39
                 (DIMENSIONLESS)
RCAP     43   A RESIDENT CAPACITY (VISITS/YEAR/MAN)          SCAP,A,42
RCI      30   R RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)    CAPINV,L,26
REC      18   N RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)    DR,A,15
RES      3    A RESIDENTS (MEN)                              DRM,A,14/ACR,R,16/SEXP,A,35/STAFF,A,36/SCAP,A,42/SSAL,A,57
REXP     36.2 N RESIDENT EXPERIENCE (DIMENSIONLESS)          SEXP,A,35
RHI      4    R RATE OF HIRING INTERNS (MEN/YEAR)            INT,L,1/NRHI,A,5
RHPW     18.3 C RESIDENT HOURS PER WEEK (HOURS/WEEK)         RTPE,N,18.1/RTPNE,N,18.5
RHR      12   R RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/  HRES,L,2/NHRR,A,13
                 YEAR)
RMPE     18.2 C RESIDENT MINUTES PER EMERGENCY (MINUTES/     RTPE,N,18.1
                 VISIT)
RMPNE    18.6 C RESIDENT MINUTES PER NONEMERGENCY (MINUTES/  RTPNE,N,18.5
                 VISIT)
RNC      18.4 N RESIDENT NONEMERGENCY CAPACITY (VISITS/      DR,A,15
                 YEAR)
RSAL     57.2 C RESIDENT SALARY (DOLLARS/YEAR/MAN)           SSAL,A,57
RTPE     18.1 N RESIDENT TIME FOR PERCEIVED EMERGENCY        REC,N,18/RCAP,A,43
                 (YEARS/VISIT/MAN)
RTPNE    18.5 N RESIDENT TIME FOR PERCEIVED NONEMERGENCY     RNC,N,18.4/RCAP,A,43
                 (YEARS/VISIT/MAN)
SCAP     42   A STAFF CAPACITY (VISITS/YEAR)                 PLCAP,A,37
SDCI     34   A SMOOTHED RATE OF DEPRECIATION OF CAPITAL     CIOF,R,31/OPEXP,A,56
                 INVESTMENT ($/YEAR)
SE       50.1 C SORTING ERROR RATE (DIMENSIONLESS)           PEREMER,A,47
SEXP     35   A STAFF EXPERIENCE (DIMENSIONLESS)             QOCE,A,41/ANCT,A,55
SMTI     5.2  C SMOOTHING TIME FOR INTERNS (YEARS)           NRHI,A,5
SMTR     13.2 C SMOOTHING TIME FOR RESIDENTS (YEARS)         NHRR,A,13
SPCAP    45   A SUPERVISING PHYSICIAN CAPACITY (VISITS/      SCAP,A,42
                 YEAR/MAN)
SPEC     18.7 N SUPERVISING PHYSICIAN EMERGENCY CAPACITY     DR,A,15
                 (VISITS/YEAR)
SPEXP    36.1 N SUPERVISING PHYSICIAN EXPERIENCE             SEXP,A,35
                 (DIMENSIONLESS)
SPHPW    19   C SUPERVISING PHYSICIAN HOURS PER WEEK (HOURS/ SPTPE,N,18.8/SPTPNE,N,19.2
                 WEEK)
SPMPE    18.9 C SUPERVISING PHYSICIAN MINUTES PER EMERGENCY  SPTPE,N,18.8
                 (MINUTES/VISIT)
SPMPNE   19.3 C SUPERVISING PHYSICIAN MINUTES PER            SPTPNE,N,19.2
                 NONEMERGENCY (MINUTES/VISIT)
SPNC     19.1 N SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY  DR,A,15
                 (VISITS/YEAR)
SPSAL    57.3 C SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/  SSAL,A,57
                 MAN)
SPTPE    18.8 N SUPERVISING PHYSICIAN TIME PER EMERGENCY     SPEC,N,18.7/SPCAP,A,45
                 (YEARS/VISIT/MAN)
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SPTPNE   19.2 N SUPERVISING PHYSICIAN TIME PER NONEMERGENCY  SPNC,N,19.1/SPCAP,A,45
                  (YEARS/VISIT/MAN)
SSAL     57   A STAFF SALARY (DOLLARS/YEAR)                  OPEXP,A,56
STAFF    36   A STAFF (MEN)                                  SEXP,A,35
STEPH    51.1 C                                              AE,A,51
STEPT    51.2 C                                              PPEMER,A,23/AE,A,51
SUPHY    36.4 C SUPERVISING PHYSICIANS (MEN)                 DR,A,15/SEXP,A,35/STAFF,A,36/SCAP,A,42/SSAL,A,57
TABLE1   40.1 T TABLE FUNCTION                               AEDTP,A,25/QOCO,A,40
TABLE2   32.1 T TABLE FUNCTION                               EXFUND,A,32
TABLE3   37.1 T TABLE FUNCTION                               PLCAP,A,37
TABLE4   29.1 T TABLE FUNCTION                               DEPF,A,29
TABLE5    6.1 T TABLE FUNCTION                               DIM,A,6/DRM,A,14/QOCE,A,41
TABLE6   55.3 T TABLE FUNCTION                               ANCT,A,55
TABLE7   17.2 T TABLE FUNCTION                               ATCS,A,17
TSDCI    34.1 C TIME TO SMOOTH DEPRECIATION OF CAPITAL       SDCI,A,34
                  INVESTMENT (YEARS)
TTCH     20.3 C TIME TO CHANGE HABITS (YEARS)                PAT,L,20
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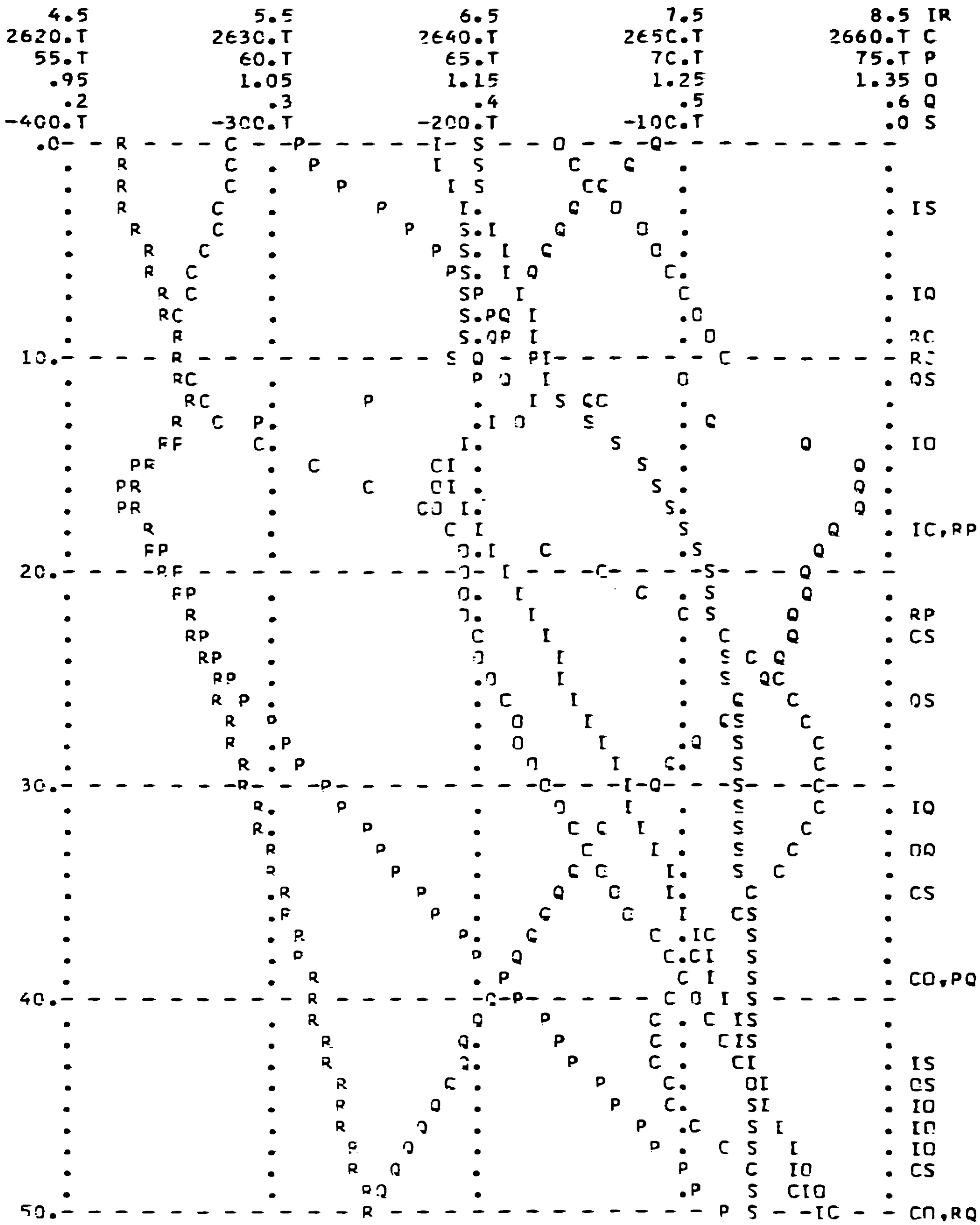
PAGE 4 INTRODUCTION OF NEIGBORHOOD HEALTH CLINICS * 3/21/72

INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=O,CCC=C,PRFLSS=S



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PAGE 1        EMERGENCY UNIT WITH PARAMEDICS      3/24/72

              * EMERGENCY UNIT WITH PARAMEDICS
              MACRO DELAY3P(IN,DEL,PIPE)
              A       DELAY3P.K=$LV3.K/$DL.K
              L       $LV3.K=$LV3.J+DT*($RT2.JK-DELAY3P.J)
              N       $LV3=$DL*IN
              R       $RT2.KL=$LV2.K/$DL.K
              L       $LV2.K=$LV2.J+DT*($RT1.JK-$RT2.JK)
              N       $LV2=$LV3
              R       $RT1.KL=$LV1.K/$DL.K
              L       $LV1.K=$LV1.J+DT*(IN.JK-$RT1.JK)
              N       $LV1=$LV3
              A       $DL.K=DEL/3
              A       PIPE.K=$LV1.K+$LV2.K+$LV3.K
              MEND
      1       L       PMED.K=PMED.J+(DT)(PMEDHP.JK-PMEDAR.JK) (MEN)
      1.1     N       PMED=PMEDN (MEN)
      1.2     C       PMEDN=6.6947 (MEN)
      2       R       PMEDHP.KL=NPHPM.K*DPMM.K*ATPS.K (MEN/YEAR)
      3       A       NPHPM.K=SMOOTH(PMEDHP.JK,SMTPM) (MEN/YEAR)
      3.1     N       NPHPM=NPHPMN (MEN/YEAR)
      3.2     C       NPHPMN=1.337 (MEN/YEAR)
      3.3     C       SMTPM=2 (YEARS)
      4       A       DPMM.K=TABLE(TABLES,DP.K/PMED.K,0,2,.2) (DIMENSIONLESS)
      5       A       DP.K=SUPHY*PMPSP+RES.K*PMPR+INT.K*PMPI (MEN)
      6       R       PMEDAR.KL=(1/AVSPPM)(PMED.K) (MEN/YEAR)
      6.1     C       AVSPPM=5 (YEARS)
              NOTE***INTERNS, RESIDENTS, AND SUPV. PHY. WORK 60***NOTE
              NOTE***HOUR WEEKS, 52 WEEKS PER YEAR****************NOTE
      7       L       INT.K=INT.J+(DT)(RHI.JK-ARI.JK-INTRES.JK) (MEN)
      7.1     N       INT=INTN (MEN)
      7.2     C       INTN=1.4620 (MEN)
      8       L       HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-ARR.JK) (MEN)
      8.1     N       HRES=HRESN (MEN)
      8.2     C       HRESN=1.0990 (MEN)
      9       A       RES.K=1*HRES.K (MEN)
     10       R       RHI.KL=NRHI.K*DIM.K*ATPS.K (MEN/YEAR)
     11       A       NRHI.K=SMOOTH(RHI.JK,SMTI) (MEN/YEAR)
     11.1     N       NRHI=1.4620 (MEN/YEAR)
     11.2     C       SMTI=2 (YEARS)
     12       A       DIM.K=TABLE(TABLES,DI.K/INT.K,0,2,.2) (DIMENSIONLESS)
     12.1     T       TABLES=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2 (TABLE)
     13       A       DI.K=DITRP*DP.K (MEN)
     13.1     C       DITRP=2 (DIMENSIONLESS)
     14       A       ATPS.K=DLINF3(ATCS.K,ATTPEL)
     14.1     C       ATTPEL=5 (YEARS)
     15       R       ARI.KL=(1/AVSPI)(INT.K)(1-IPM.K) (MEN/YEAR)
     15.1     C       AVSPI=1 (YEARS)
     16       A       IPM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+FATS)) (DIMENSIONLESS)
     16.1     C       LAWF=3 (DIMENSIONLESS)
     16.2     C       FATS=1 (DIMENSIONLESS)
     17       R       INTRES.KL=(1/AVSPI)(INT.K)(IPM.K) (MEN/YEAR)
     18       R       RHR.KL=NHRR.K*DRM.K*ATPS.K (MEN/YEAR)
     19       A       NHRR.K=SMOOTH(RHR.JK,SMTR) (MEN/YEAR)
     19.1     N       NHRR=0 (MEN/YEAR)
     19.2     C       SMTR=2 (YEARS)
     20       A       DRM.K=TABLE(TABLES,DR.K/RES.K,0,2,.2) (DIMENSIONLESS)
     21       A       DR.K=(NER.K-SUPHY*((1/((DR.K/SPEC)+(1/SPNC)))
              X       +(PMPSP/((DR.K/PMEC)+(1/PMNC)))))/
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          X    (((1/((PR.K/REC)+(1/RNC)))+(DITPR/((PR.K/IEC)+(1/INC)))
          X    +((PMPR+PMPI*DITPR)/((PR.K/PMEC)+(1/PMNC))))
21.4      C    PMPSP=3 (DIMENSIONLESS)
21.5      C    PMPR=2 (DIMENSIONLESS)
21.6      C    PMPI=1 (DIMENSIONLESS)
22        R    ADR.KL=(1/AVSPR)(PES.K) (MEN/YEAR)
22.1      C    AVSPR=1 (YEARS)
23        A    ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3) (DIMENSIONLESS)
23.1      C    INNORM=1.2 (DIMENSIONLESS)
23.2      T    TABLE7=1.2/1.18/1.15/1.08/.95/.7/.52/.4/.3/.22/.2 (TABLE)
23.3      N    IEC=1/ITPE (VISITS/YEAR)
23.4      N    ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)
23.5      C    IMPE=45 (MINUTES)
23.6      C    IHPW=60 (HOURS/WEEK)
23.7      N    INC=1/ITPNE (VISITS/YEAR)
23.8      N    ITPNE=(IMPNE/60)/(IHPW*50) (YEARS/VISIT)
23.9      C    IMPNE=25 (MINUTES)
24        N    REC=1/RTPE (VISITS/YEAR)
24.1      N    RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)
24.2      C    RMPE=30 (MINUTES)
24.3      C    RHPW=60 (HOURS/WEEK)
24.4      N    RNC=1/RTPNE (VISITS/YEAR)
24.5      N    RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)
24.6      C    RMPNE=20 (MINUTES)
24.7      N    SPEC=1/SPTPE (VISITS/YEAR)
24.8      N    SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)
24.9      C    SPMPE=25 (MINUTES)
25        C    SPHPW=20 (HOURS/WEEK)
25.1      N    SPNC=1/SPTPNE (VISITS/YEAR)
25.2      N    SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)
25.3      C    SPMPNE=20 (MINUTES)
25.4      N    PMEC=REC (VISITS/YEAR)
25.5      N    PMNC=RNC (VISITS/YEAR)
25.6      N    PMTPE=RTPE (YEARS/VISIT)
25.7      N    PMTPNE=RTPNE (YEARS/VISIT)
26        L    PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J) (VISITS/YEAR)
26.1      N    PAT=PATN (VISITS/YEAR)
26.2      C    PATN=60567 (VISITS/YEAR)
26.3      C    TTCH=1 (YEAR)
27        R    CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER (VISITS/YEAR)
28        A    PATPOOL.K=150000*EXP(PGC*TIME.K) (PEOPLE)
28.1      C    PGC=0.015 (1/YEAR)
28.2      C    PPEMER=.4 (DIMENSIONLESS)
29        A    PAEDTP.K=DLINF3(AEDTP.K,IDTTP) (DIMENSIONLESS)
29.1      C    IDTTP=4 (YEARS)
30        A    AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/APNORM,0,2,.2) (DIM.)
30.1      C    APNORM=1.2 (DIMENSIONLESS)
31        L    CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK) (DOLLARS)
31.1      N    CAPINV=CAPINVN (DOLLARS)
31.2      C    CAPINVN=2685300 (DOLLARS)
32        R    DCI.KL=CAPINV.K/DEPT.K (DOLLARS/YEAR)
33        A    DEPT.K=SMOOTH(NDPDT*DEPF.K,DEPDT) (YEARS)
34        A    DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3) (DIMENSIONLESS)
34.1      T    TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/.525/.5 (TABLE)
34.2      C    NDPDT=30 (YEARS)
34.3      C    DEPDT=10 (YEARS)
35        R    RCI.KL=DELAY3P(TICF.JK,CAPITC,CIPP.K) (DOLLARS/YEAR)
35.1      C    CAPITC=4 (YEARS)
```

```
35.2    N    CIOO=CIOON (DOLLARS)
35.3    C    CIOON=320020 (DOLLARS)
36      R    CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*EXFUND.K
        X    +SDCI.K (DOLLARS/YEAR)
37      A    EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2) (DIMENSIONLESS)
37.1    T    TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)
38      A    DCAPINV.K=DCIPP*PAT.K (DOLLARS)
38.1    C    DCIPP=60 (DOLLARS/VISIT/YEAR)
39      A    SDCI.K=SMOOTH(DCI.JK,TSDCI) (YEARS)
39.1    C    TSDCI=1 (YEARS)
40      A    SEXP.K=(PMEXP*PMED.K+IEXP*INT.K+REXP*RES.K+SPEXP*SUPHY)/(STAFF.K)
41      A    STAFF.K=INT.K+RES.K+SUPHY+PMED.K (MEN)
41.1    C    PMEXP=2.5 (DIMENSIONLESS)
41.2    N    IEXP=2 (DIMENSIONLESS)
41.3    N    REXP=3.5 (DIMENSIONLESS)
41.4    N    SPEXP=9 (DIMENSIONLESS)
41.5    C    SUPHY=1 (MEN)
42      A    PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) (VISITS/YEAR)
42.1    T    TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5 (TABLE)
43      A    PLOAD.K=PAT.K/PLCAP.K (DIMENSIONLESS)
44      S    QOC.K=.7*QOCP.K+.3*QOCE.K (DIMENSIONLESS)
45      A    QOCP.K=TABLE(TABLE1,PLOAD.K,0,2,.2) (DIMENSIONLESS)
45.1    T    TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 (TABLE)
46      A    QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9) (DIMENSIONLESS)
47      A    SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY+PMCAP.K*PMED.K
48      A    RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE) (VISITS/YEAR)
49      A    ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE) (VISITS/YEAR)
50      A    SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE) (VISITS/YEAR)
51      A    PMCAP.K=1/(PEREMER.K*PMTPE+PERNEM.K*PMTPNE) (VISITS/YEAR)
52      A    PCAP.K=CAPINV.K/DCIPP (VISITS/YEAR)
53      A    PEREMER.K=AE+SE*(1-AE) (DIMENSIONLESS)
54      A    PERNEM.K=1-PEREMER.K (DIMENSIONLESS)
55      A    NEP.K=PAT.K*PERNEM.K (VISITS/YEAR)
56      A    PR.K=(PAT.K-NEP.K)/NEP.K (DIMENSIONLESS)
56.1    C    SE=.1 (DIMENSIONLESS)
56.2    C    AE=.33 (DIMENSIONLESS)
57      A    ANCOST.K=EANCST.K+NEANCST.K (DOLLARS/YEAR)
58      A    EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K (DOLLARS/YEAR)
59      A    NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K (DOLLARS/YEAR)
60      A    ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9) (DIMENSIONLESS)
60.1    C    AVCPE=15 (DOLLARS/VISIT)
60.2    C    AVCPNE=8 (DOLLARS/VISIT)
60.3    T    TABLE6=1.5/1.43/1.32/1.1/.9/.7/.61/.57/.52/.51/.5 (TABLE)
61      A    OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K (DOLLARS/YEAR)
62      A    SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY+PMSAL*PMED.K ($/YEAR)
62.1    C    ISAL=10000 (DOLLARS/YEAR/MAN)
62.2    C    RSAL=10500 (DOLLARS/YEAR/MAN)
62.3    C    SPSAL=30000 (DOLLARS/YEAR/MAN)
62.4    C    PMSAL=12000 (DOLLARS/YEAR/MAN)
63      A    PHSAL.K=PHCPV*PAT.K (DOLLARS/YEAR)
63.1    C    PHCPV=18.33 (DOLLARS/VISIT)
64      A    INCOME.K=(PAT.K)(1-PDEBT)(CPE.K*PEREMER.K+CPNE.K*PERNEM.K) ($/YR)
65      A    CPE.K=BCTER+AVCPE*ANCT.K (DOLLARS/VISIT)
65.1    C    BCTER=25 (DOLLARS/VISIT)
66      A    CPNE.K=BCTNER+AVCPNE*ANCT.K (DOLLARS/VISIT)
66.1    C    BCTNER=15 (DOLLARS/VISIT)
66.2    C    PDEBT=.01 (DIMENSIONLESS)
67      A    PEELSS.K=INCOME.K-OPEXP.K (DOLLARS/YEAR)
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PAGE 4 EMERGENCY UNIT WITH PARAMEDICS 3/24/72

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        PLOT  INT=I,RES=R,PMED=M/CAPINV=C/PAT=P/OLOAD=O/OPC=O/PRELSS=S
67.2    C     DT=.1 (YEARS)
67.3    C     PLTPER=1 (YEARS)
67.4    C     LENGTH=50 (YEARS)
        RUN
```

```
PMED.K=PMED.J+(DT)(PMEDHR.JK-PMEDAR.JK)                  1, L
PMED=PMEDN (MEN)                                          1.1, N
PMEDN=6.6842 (MEN)                                        1.2, C
    PMED   - PARAMEDICS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    PMEDHR - PARAMEDIC HIRING RATE (MEN/YEAR)
    PMEDAR - PARAMEDIC ATTRITION RATE (MEN/YEAR)
    PMEDN  - INITIAL NUMBER OF PARAMEDICS (MEN)

PMEDHR.KL=NRHPM.K*DPMM.K*ATPS.K                           2, R
    PMEDHR - PARAMEDIC HIRING RATE (MEN/YEAR)
    NRHPM  - NORMAL RATE OF HIRING PARAMEDICS (MEN/YEAR)
    DPMM   - DESIRED PARAMEDIC MULTIPLIER
               (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)

NRHPM.K=SMOOTH(PMEDHR.JK,SMTPM)                           3, A
NRHPM=NRHPMN (MEN/YEAR)                                   3.1, N
NRHPMN=1.337 (MEN/YEAR)                                   3.2, C
SMTPM=2 (YEARS)                                           3.3, C
    NRHPM  - NORMAL RATE OF HIRING PARAMEDICS (MEN/YEAR)
    PMEDHR - PARAMEDIC HIRING RATE (MEN/YEAR)
    SMTPM  - SMOOTHING TIME FOR PARAMEDICS (YEARS)
    NRHPMN - INITIAL NORMAL RATE OF HIRING PARAMEDICS
               (MEN/YEAR)

DPMM.K=TABLE(TABLE5,DP.K/PMED.K,0,2,.2)                   4, A
    DPMM   - DESIRED PARAMEDIC MULTIPLIER
               (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DP     - DESIRED PARAMEDICS (MEN)
    PMED   - PARAMEDICS (MEN)

DP.K=SUPHY*PMPSP+RES.K*PMPR+INT.K*PMPI                    5, A
    DP     - DESIRED PARAMEDICS (MEN)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    PMPSP  - DESIRED PARAMEDICS PER SUPERVISING
               PHYSICIAN (DIMENSIONLESS)
    RES    - RESIDENTS (MEN)
    PMPR   - DESIRED PARAMEDICS PER RESIDENT
               (DIMENSIONLESS)
    INT    - INTERNS (MEN)
    PMPI   - DESIRED PARAMEDICS PER INTERN
               (DIMENSIONLESS)

PMEDAR.KL=(1/AVSPPM)(PMED.K)                              6, R
AVSPPM=5 (YEARS)                                          6.1, C
    PMEDAR - PARAMEDIC ATTRITION RATE (MEN/YEAR)
    AVSPPM - AVERAGE STAY PER PARAMEDIC (YEARS)
    PMED   - PARAMEDICS (MEN)
```

```
INT.K=INT.J+(DT)(RHI.JK-AOI.JK-INTRES.JK)                7, L
INT=INTN (MEN)                                           7.1, N
INTN=1.4620 (MEN)                                        7.2, C
    INT    - INTERNS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    AOI    - ATTRITION RATE OF INTERNS (MEN/YEAR)
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
              YEAR)
    INTN   - INITIAL VALUE OF INTERNS (MEN)

HRES.K=HRES.J+(DT)(INTRES.JK+RHR.JK-AOR.JK)              8, L
HRES=HRESN (MEN)                                         8.1, N
HRESN=1.0990 (MEN)                                       8.2, C
    HRES   - HOSPITAL RESIDENTS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
              YEAR)
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
              YEAR)
    AOR    - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    HRESN  - INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)

RES.K=1*HRES.K                                           9, A
    RES    - RESIDENTS (MEN)
    HRES   - HOSPITAL RESIDENTS (MEN)

RHI.KL=NRHI.K*DIM.K*ATPS.K                               10, R
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    NRHI   - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    DIM    - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
              (DIMENSIONLESS)

NRHI.K=SMOOTH(RHI.JK,SMTI)                               11, A
NRHI=1.4620 (MEN/YEAR)                                   11.1, N
SMTI=2 (YEARS)                                           11.2, C
    NRHI   - NORMAL RATE OF HIRING INTERNS (MEN/YEAR)
    RHI    - RATE OF HIRING INTERNS (MEN/YEAR)
    SMTI   - SMOOTHING TIME FOR INTERNS (YEARS)

DIM.K=TABLE(TABLE5,DI.K/INT.K,0,2,.2)                    12, A
TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2             12.1, T
  (TABLE)
    DIM    - DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DI     - DESIRED INTERNS (MEN)
    INT    - INTERNS (MEN)

DI.K=DITRR*DR.K                                          13, A
DITRR=2 (DIMENSIONLESS)                                  13.1, C
    DI     - DESIRED INTERNS (MEN)
    DITRR  - DESIRED INTERN TO RESIDENT RATIO
              (DIMENSIONLESS)
    DR     - DESIRED RESIDENTS (MEN)
```

```
ATPS.K=DLINF3(ATCS.K,ATTDEL)                                14, A
ATTDEL=5 (YEARS)                                            14.1, C
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    ATTDEL - TIME TO PERCEIVE ATTRACTIVENESS (YEARS)

AOI.KL=(1/AVSPI)(INT.K)(1-IDM.K)                            15, R
AVSPI=1 (YEARS)                                             15.1, C
    AOI    - ATTRITION RATE OF INTERNS (MEN/YEAR)
    AVSPI  - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT    - INTERNS (MEN)
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)

IDM.K=(LAWF*ATCS.K/(LAWF*ATCS.K+EATS))                      16, A
LAWF=3 (DIMENSIONLESS)                                      16.1, C
EATS=1 (DIMENSIONLESS)                                      16.2, C
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)
    LAWF   - LOCAL ATTRACTIVENESS WEIGHTING FACTOR
               (DIMENSIONLESS)
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    EATS   - EXTERNAL ATTRACTIVENESS TO STAFF
               (DIMENSIONLESS)

INTRES.KL=(1/AVSPI)(INT.K)(IDM.K)                           17, R
    INTRES - RATE OF RESIDENTS HIRED FROM INTERNS (MEN/
               YEAR)
    AVSPI  - AVERAGE STAY PER INTERN (YEARS/MAN)
    INT    - INTERNS (MEN)
    IDM    - INTERN DESTINATION MULTIPLIER
               (DIMENSIONLESS)

RHR.KL=NHRR.K*DRM.K*ATPS.K                                  18, R
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
               YEAR)
    NHRR   - NORMAL HIRING RATE OF RESIDENTS FROM
               OUTSIDE (MEN/YEAR)
    DRM    - DESIRED RESIDENTS MULTIPLIER
               (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)

NHRR.K=SMOOTH(RHR.JK,SMTR)                                  19, A
NHRR=C (MEN/YEAR)                                           19.1, N
SMTR=2 (YEARS)                                              19.2, C
    NHRR   - NORMAL HIRING RATE OF RESIDENTS FROM
               OUTSIDE (MEN/YEAR)
    RHR    - RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/
               YEAR)
    SMTR   - SMOOTHING TIME FOR RESIDENTS (YEARS)
```

```
DRM.K=TABLE(TABLE5,DR.K/RES.K,0,2,.2)                        20, A
    DRM    - DESIRED RESIDENTS MULTIPLIER
               (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DR     - DESIRED RESIDENTS (MEN)
    RES    - RESIDENTS (MEN)

DR.K=(NEP.K-SUPHY*((1/((PR.K/SPEC)+(1/SPNC))+                21, A
  (PMPSP/((PR.K/PMEC)+(1/PMNC)))))/((1/((PR.K/REC)+
  (1/RNC))+(DITRR/((PR.K/IEC)+(1/INC)))+((PMPR+
  PMPI*DITRR)/((PR.K/PMEC)+(1/PMNC))))
PMPSP=3 (DIMENSIONLESS)                                      21.4, C
PMPR=2 (DIMENSIONLESS)                                       21.5, C
PMPI=1 (DIMENSIONLESS)                                       21.6, C
    DR     - DESIRED RESIDENTS (MEN)
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    PR     - PATIENT RATIO (DIMENSIONLESS)
    SPEC   - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
               (VISITS/YEAR)
    SPNC   - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
               (VISITS/YEAR)
    PMPSP  - DESIRED PARAMEDICS PER SUPERVISING
               PHYSICIAN (DIMENSIONLESS)
    PMEC   - PARAMEDIC EMERGENCY CAPACITY (VISITS/YEAR/
               MAN)
    PMNC   - PARAMEDIC NONEMERGENCY CAPACITY (VISITS/
               YEAR/MAN)
    REC    - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RNC    - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    DITRR  - DESIRED INTERN TO RESIDENT RATIO
               (DIMENSIONLESS)
    IEC    - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    INC    - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
    PMPR   - DESIRED PARAMEDICS PER RESIDENT
               (DIMENSIONLESS)
    PMPI   - DESIRED PARAMEDICS PER INTERN
               (DIMENSIONLESS)

AOR.KL=(1/AVSPR)(RES.K)                                      22, R
AVSPR=1 (YEARS)                                              22.1, C
    AOR    - ATTRITION RATE OF RESIDENTS (MEN/YEAR)
    AVSPR  - AVERAGE STAY PER RESIDENT (YEARS/MAN)
    RES    - RESIDENTS (MEN)
```

```
ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3)    23, A
INNORM=1.2 (DIMENSIONLESS)                            23.1, C
TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2     23.2, T
  (TABLE)
IEC=1/ITPE (VISITS/YEAR)                              23.3, N
ITPE=(IMPE/60)/(IHPW*50) (YEARS/VISIT)                23.4, N
IMPE=45 (MINUTES)                                     23.5, C
IHPW=60 (HOURS/WEEK)                                  23.6, C
INC=1/ITPNE (VISITS/YEAR)                             23.7, N
ITPNE=(IMPNE/60)/(IHPW*50) (YEARS/VISIT)              23.8, N
IMPNE=25 (MINUTES)                                    23.9, C
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    TABLE7 - TABLE FUNCTION
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    INNORM - INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)
    IEC    - INTERN EMERGENCY CAPACITY (VISITS/YEAR)
    ITPE   - INTERN TIME FOR PERCEIVED EMERGENCIES
               (YEARS/VISIT/MAN)
    IMPE   - INTERN MINUTES PER EMERGENCY (MINUTES/
               VISIT)
    IHPW   - INTERN HOURS PER WEEK (HOURS/WEEK)
    INC    - INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)
    ITPNE  - INTERN TIME FOR PERCEIVED NONEMERGENCIES
               (YEARS/VISIT/MAN)
    IMPNE  - INTERN MINUTES PER NONEMERGENCY (MINUTES/
               VISIT)
```

```
REC=1/RTPE (VISITS/YEAR)                                  24, N
RTPE=(RMPE/60)/(RHPW*50) (YEARS/VISIT)                    24.1, N
RMPE=30 (MINUTES)                                         24.2, C
RHPW=60 (HOURS/WEEK)                                      24.3, C
RNC=1/RTPNE (VISITS/YEAR)                                 24.4, N
RTPNE=(RMPNE/60)/(RHPW*50) (YEARS/VISIT)                  24.5, N
RMPNE=20 (MINUTES)                                        24.6, C
SPEC=1/SPTPE (VISITS/YEAR)                                24.7, N
SPTPE=(SPMPE/60)/(SPHPW*50) (YEARS/VISIT)                 24.8, N
SPMPE=25 (MINUTES)                                        24.9, C
    REC    - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    RTPE   - RESIDENT TIME FOR PERCEIVED EMERGENCY
               (YEARS/VISIT/MAN)
    RMPE   - RESIDENT MINUTES PER EMERGENCY (MINUTES/
               VISIT)
    RHPW   - RESIDENT HOURS PER WEEK (HOURS/WEEK)
    RNC    - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    RTPNE  - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
               (YEARS/VISIT/MAN)
    RMPNE  - RESIDENT MINUTES PER NONEMERGENCY (MINUTES/
               VISIT)
    SPEC   - SUPERVISING PHYSICIAN EMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPE  - SUPERVISING PHYSICIAN TIME PER EMERGENCY
               (YEARS/VISIT/MAN)
    SPMPE  - SUPERVISING PHYSICIAN MINUTES PER EMERGENCY
               (MINUTES/VISIT)
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)
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```
SPHPW=20 (HOURS/WEEK)                                          25, C
SPNC=1/SPTPNE (VISITS/YEAR)                                    25.1, N
SPTPNE=(SPMPNE/60)/(SPHPW*50) (YEARS/VISIT)                    25.2, N
SPMPNE=20 (MINUTES)                                            25.3, C
PMEC=REC (VISITS/YEAR)                                         25.4, N
PMNC=RNC (VISITS/YEAR)                                         25.5, N
PMTPE=RTPE (YEARS/VISIT)                                       25.6, N
PMTPNE=RTPNE (YEARS/VISIT)                                     25.7, N
    SPHPW  - SUPERVISING PHYSICIAN HOURS PER WEEK
               (HOURS/WEEK)
    SPNC   - SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY
               (VISITS/YEAR)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
               (YEARS/VISIT/MAN)
    SPMPNE - SUPERVISING PHYSICIAN MINUTES PER
               NONEMERGENCY (MINUTES/VISIT)
    PMEC   - PARAMEDIC EMERGENCY CAPACITY (VISITS/YEAR/
               MAN)
    REC    - RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)
    PMNC   - PARAMEDIC NONEMERGENCY CAPACITY (VISITS/
               YEAR/MAN)
    RNC    - RESIDENT NONEMERGENCY CAPACITY (VISITS/
               YEAR)
    PMTPE  - PARAMEDIC TIME PER EMERGENCY (YEARS/VISIT/
               MAN)
    RTPE   - RESIDENT TIME FOR PERCEIVED EMERGENCY
               (YEARS/VISIT/MAN)
    PMTPNE - PARAMEDIC TIME PER NONEMERGENCY (YEARS/
               VISIT/MAN)
    RTPNE  - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
               (YEARS/VISIT/MAN)

PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J)                         26, L
PAT=PATN (VISITS/YEAR)                                         26.1, N
PATN=60567 (VISITS/YEAR)                                       26.2, C
TTCH=1 (YEAR)                                                  26.3, C
    PAT    - PATIENTS (VISITS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    TTCH   - TIME TO CHANGE HABITS (YEARS)
    CPL    - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PATN   - INITIAL VALUE OF PATIENTS (VISITS/YEAR)

CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER                               27, R
    CPL    - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PAEDTP - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
               PATIENTS (DIM.)
    PATPOOL- PATIENT POOL (MEN)
    PPEMER - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PATPOOL.K=150000*EXP(PGC*TIME.K)                               28, A
PGC=0.015 (1/YEAR)                                             28.1, C
PPEMER=.4 (DIMENSIONLESS)                                      28.2, C
    PATPOOL- PATIENT POOL (MEN)
    PGC    - PATIENT POOL GROWTH CONSTANT (1/YEAR)
    PPEMER - POPULATION PERCEIVED EMERGENCY (1/YEAR)
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PAEDTP.K=DLINF3(AEDTP.K,IDTTP)                              29, A
IDTTP=4 (YEARS)                                             29.1, C
    PAEDTP - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
               PATIENTS (DIM.)
    AEDTP  - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    IDTTP  - INFORMATION DELAY TIME TO PATIENTS (YEARS)

AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/               30, A
  ARNORM,0,2,.2)
ARNORM=1.2 (DIMENSIONLESS)                                  30.1, C
    AEDTP  - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    TABLE1 - TABLE FUNCTION
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    ARNORM - AREA NORMAL OVERLOAD (DIMENSIONLESS)

CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK)                       31, L
CAPINV=CAPINVN (DOLLARS)                                    31.1, N
CAPINVN=2685300 (DOLLARS)                                   31.2, C
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DT     - INCREMENT IN TIME (YEARS)
    RCI    - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINVN- INITIAL VALUE OF CAPITAL INVESTMENT
               (DOLLARS)

DCI.KL=CAPINV.K/DEPT.K                                      32, R
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DEPT   - DEPRECIATION TIME (YEARS)

DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                           33, A
    DEPT   - DEPRECIATION TIME (YEARS)
    NORDT  - NORMAL DEPRECIATION TIME (YEARS)
    DEPF   - DEPRECIATION FUNCTION (DIMENSIONLESS)
    DEPDT  - DEPRECIATION DELAY TIME (YEARS)

DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3)                    34, A
TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/            34.1, T
  .525/.5 (TABLE)
NORDT=30 (YEARS)                                            34.2, C
DEPDT=10 (YEARS)                                            34.3, C
    DEPF   - DEPRECIATION FUNCTION (DIMENSIONLESS)
    TABLE4 - TABLE FUNCTION
    PAT    - PATIENTS (VISITS/YEAR)
    PCAP   - PHYSICAL CAPACITY (VISITS/YEAR)
    NORDT  - NORMAL DEPRECIATION TIME (YEARS)
    DEPDT  - DEPRECIATION DELAY TIME (YEARS)
```

```
RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K)                        35, R
CAPITC=4  (YEARS)                                            35.1, C
CIOO=CIOON  (DOLLARS)                                        35.2, N
CIOON=320020  (DOLLARS)                                      35.3, C
    RCI     - RATE OF CAPITAL INVESTMENT  (DOLLARS/YEAR)
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT  (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    CIOON   - INITIAL VALUE OF CAPITAL INVESTMENT ON
                ORDER (DOLLARS)

CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*  36, R
  EXFUND.K+SDCI.K
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    CAPINV  - CAPITAL INVESTMENT  (DOLLARS)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)

EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2)                   37, A
TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2  (TABLE)  37.1, T
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)
    TABLE2  - TABLE FUNCTION
    PAT     - PATIENTS  (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY  (VISITS/YEAR)

DCAPINV.K=DCIPP*PAT.K                                        38, A
DCIPP=60  (DOLLARS/VISIT/YEAR)                               38.1, C
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
    PAT     - PATIENTS  (VISITS/YEAR)

SDCI.K=SMOOTH(DCI.JK,TSDCI)                                  39, A
TSDCI=1  (YEARS)                                             39.1, C
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)
    DCI     - DEPRECIATION OF CAPITAL INVESTMENT
                (DOLLARS/YEAR)
    TSDCI   - TIME TO SMOOTH DEPRECIATION OF CAPITAL
                INVESTMENT (YEARS)
```

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SEXP.K=(PMEXP*PMED.K+IEXP*INT.K+REXP*RES.K+SPEXP*      40, A
  SUPHY)/(STAFF.K)
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)
    PMEXP   - PARAMEDIC EXPERIENCE (DIMENSIONLESS)
    PMED    - PARAMEDICS (MEN)
    IEXP    - INTERN EXPERIENCE (DIMENSIONLESS)
    INT     - INTERNS (MEN)
    REXP    - RESIDENT EXPERIENCE (DIMENSIONLESS)
    RES     - RESIDENTS (MEN)
    SPEXP   - SUPERVISING PHYSICIAN EXPERIENCE
                (DIMENSIONLESS)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)
    STAFF   - STAFF (MEN)

STAFF.K=INT.K+RES.K+SUPHY+PMED.K                          41, A
PMEXP=2.5 (DIMENSIONLESS)                                 41.1, C
IEXP=2 (DIMENSIONLESS)                                    41.2, N
REXP=3.5 (DIMENSIONLESS)                                  41.3, N
SPEXP=9 (DIMENSIONLESS)                                   41.4, N
SUPHY=1 (MEN)                                             41.5, C
    STAFF   - STAFF (MEN)
    INT     - INTERNS (MEN)
    RES     - RESIDENTS (MEN)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)
    PMED    - PARAMEDICS (MEN)
    PMEXP   - PARAMEDIC EXPERIENCE (DIMENSIONLESS)
    IEXP    - INTERN EXPERIENCE (DIMENSIONLESS)
    REXP    - RESIDENT EXPERIENCE (DIMENSIONLESS)
    SPEXP   - SUPERVISING PHYSICIAN EXPERIENCE
                (DIMENSIONLESS)

PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2)  42, A
TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5   42.1, T
  (TABLE)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)
    SCAP    - STAFF CAPACITY (VISITS/YEAR)
    TABLE3  - TABLE FUNCTION
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)

OLOAD.K=PAT.K/PLCAP.K                                     43, A
    OLOAD   - OVERLOAD OF FACILITIES (DIMENSIONLESS)
    PAT     - PATIENTS (VISITS/YEAR)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)

QOC.K=.7*QOCO.K+.3*QOCE.K                                 44, S
    QOC     - QUALITY OF CARE (DIMENSIONLESS)
    QOCO    - QUALITY OF CARE FROM OVERLOAD
                (DIMENSIONLESS)
    QOCE    - QUALITY OF CARE FROM EXPERIENCE
                (DIMENSIONLESS)
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QOCO.K=TABLE(TABLE1,OLOAD.K,0,2,.2)                          45, A
TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0                 45.1, T
  (TABLE)
    QOCO    - QUALITY OF CARE FROM OVERLOAD
                (DIMENSIONLESS)
    TABLE1 - TABLE FUNCTION
    OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)

QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9)                           46, A
    QOCE    - QUALITY OF CARE FROM EXPERIENCE
                (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)

SCAP.K=RCAP.K*RES.K+ICAP.K*INT.K+SPCAP.K*SUPHY+              47, A
  PMCAP.K*PMED.K
    SCAP   - STAFF CAPACITY (VISITS/YEAR)
    RCAP   - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    RES    - RESIDENTS (MEN)
    ICAP   - INTERN CAPACITY (VISITS/YEAR/MAN)
    INT    - INTERNS (MEN)
    SPCAP  - SUPERVISING PHYSICIAN CAPACITY (VISITS/
               YEAR/MAN)
    SUPHY  - SUPERVISING PHYSICIANS (MEN)
    PMCAP  - PARAMEDIC CAPACITY (VISITS/YEAR/MAN)
    PMED   - PARAMEDICS (MEN)

RCAP.K=1/(PEREMER.K*RTPE+(1-PEREMER.K)*RTPNE)                48, A
    RCAP   - RESIDENT CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    RTPE   - RESIDENT TIME FOR PERCEIVED EMERGENCY
               (YEARS/VISIT/MAN)
    RTPNE  - RESIDENT TIME FOR PERCEIVED NONEMERGENCY
               (YEARS/VISIT/MAN)

ICAP.K=1/(PEREMER.K*ITPE+(1-PEREMER.K)*ITPNE)                49, A
    ICAP   - INTERN CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    ITPE   - INTERN TIME FOR PERCEIVED EMERGENCIES
               (YEARS/VISIT/MAN)
    ITPNE  - INTERN TIME FOR PERCEIVED NONEMERGENCIES
               (YEARS/VISIT/MAN)

SPCAP.K=1/(PEREMER.K*SPTPE+(1-PEREMER.K)*SPTPNE)             50, A
    SPCAP  - SUPERVISING PHYSICIAN CAPACITY (VISITS/
               YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    SPTPE  - SUPERVISING PHYSICIAN TIME PER EMERGENCY
               (YEARS/VISIT/MAN)
    SPTPNE - SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
               (YEARS/VISIT/MAN)
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PMCAP.K=1/(PEREMER.K*PMTPE+PERNEM.K*PMTPNE)              51, A
    PMCAP  - PARAMEDIC CAPACITY (VISITS/YEAR/MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    PMTPE  - PARAMEDIC TIME PER EMERGENCY (YEARS/VISIT/
               MAN)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    PMTPNE - PARAMEDIC TIME PER NONEMERGENCY (YEARS/
               VISIT/MAN)

PCAP.K=CAPINV.K/DCIPP                                    52, A
    PCAP   - PHYSICAL CAPACITY (VISITS/YEAR)
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DCIPP  - DESIRED CAPITAL INVESTMENT PER PATIENT
               (DOLLARS/VISIT/YEAR)

PEREMER.K=AE+SE*(1-AE)                                   53, A
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)

PERNEM.K=1-PEREMER.K                                     54, A
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)

NEP.K=PAT.K*PERNEM.K                                     55, A
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    PAT    - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

PR.K=(PAT.K-NEP.K)/NEP.K                                 56, A
SE=.1 (DIMENSIONLESS)                                    56.1, C
AE=.33 (DIMENSIONLESS)                                   56.2, C
    PR     - PATIENT RATIO (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    NEP    - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SE     - SORTING ERROR RATE (DIMENSIONLESS)
    AE     - ACTUAL EMERGENCIES (DIMENSIONLESS)

ANCOST.K=EANCST.K+NEANCST.K                              57, A
    ANCOST - ANCILLARY COSTS (DOLLARS/YEAR)
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)

EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K                    58, A
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    PAT    - PATIENTS (VISITS/YEAR)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
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NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K                      59, A
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)
    PAT     - PATIENTS (VISITS/YEAR)
    PERNEM  - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9)                           60, A
AVCPE=15 (DOLLARS/VISIT)                                     60.1, C
AVCPNE=8 (DOLLARS/VISIT)                                     60.2, C
TABLE6=1.5/1.43/1.32/1.1/.8/.7/.61/.57/.52/.51/.5            60.3, T
  (TABLE)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    TABLE6  - TABLE FUNCTION
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)
    AVCPE   - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)

OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K                       61, A
    OPEXP   - OPERATING EXPENSES (DOLLARS/YEAR)
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    PHSAL   - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    ANCOST  - ANCILLARY COSTS (DOLLARS/YEAR)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)

SSAL.K=ISAL*INT.K+RSAL*RES.K+SPSAL*SUPHY+PMSAL*              62, A
  PMED.K
ISAL=10000 (DOLLARS/YEAR/MAN)                                62.1, C
RSAL=17500 (DOLLARS/YEAR/MAN)                                62.2, C
SPSAL=30000 (DOLLARS/YEAR/MAN)                               62.3, C
PMSAL=12000 (DOLLARS/YEAR/MAN)                               62.4, C
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    ISAL    - INTERN SALARY (DOLLARS/YEAR/MAN)
    INT     - INTERNS (MEN)
    RSAL    - RESIDENT SALARY (DOLLARS/YEAR/MAN)
    RES     - RESIDENTS (MEN)
    SPSAL   - SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/
               MAN)
    SUPHY   - SUPERVISING PHYSICIANS (MEN)
    PMSAL   - PARAMEDIC SALARY (DOLLARS/YEAR/MAN)
    PMED    - PARAMEDICS (MEN)

PHSAL.K=PHCPV*PAT.K                                          63, A
PHCPV=18.33 (DOLLARS/VISIT)                                  63.1, C
    PHSAL   - PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    PHCPV   - PROFFESSIONAL HELP COST PER VISIT (DOLLARS/
               VISIT)
    PAT     - PATIENTS (VISITS/YEAR)
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INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*     64, A
  PERNEM.K)
    INCOME  - INCOME (DOLLARS/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
    BDEBT   - BAD DEBTS (DIMENSIONLESS)
    CPE     - COST PER EMERGENCY (DOLLARS/VISIT)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    CPNE    - COST PER NONEMERGENCY (DOLLARS/VISIT)
    PERNEM  - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

CPE.K=BCTEP+AVCPE*ANCT.K                               65, A
BCTEP=25 (DOLLARS/VISIT)                               65.1, C
    CPE     - COST PER EMERGENCY (DOLLARS/VISIT)
    BCTEP   - BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/
                VISIT)
    AVCPE   - AVERAGE COST PER PERCEIVED EMERGENCY
                (DOLLARS/VISIT)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
                (DIMENSIONLESS)

CPNE.K=BCTNEP+AVCPNE*ANCT.K                            66, A
BCTNEP=15 (DOLLARS/VISIT)                              66.1, C
BDEBT=.01 (DIMENSIONLESS)                              66.2, C
    CPNE    - COST PER NONEMERGENCY (DOLLARS/VISIT)
    BCTNEP  - BASE CHARGE TO NONEMERGENCY PATIENT
                (DOLLARS/VISIT)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
                (DOLLARS/VISIT)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
                (DIMENSIONLESS)
    BDEBT   - BAD DEBTS (DIMENSIONLESS)

PRFLSS.K=INCOME.K-OPEXP.K                              67, A
DT=.1 (YEARS)                                          67.2, C
PLTPER=1 (YEARS)                                       67.3, C
LENGTH=50 (YEARS)                                      67.4, C
    PRFLSS  PROFIT/LOSS (DOLLARS/YEAR)
    INCOME  - INCOME (DOLLARS/YEAR)
    OPEXP   - OPERATING EXPENSES (DOLLARS/YEAR)
    DT      - INCREMENT IN TIME (YEARS)
    PLTPER  - PLOTTING INTERVAL (YEARS)
    LENGTH  - LENGTH OF RUN (YEARS)
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PAGE 1   FILE EHC_2P   EMERGENCY UNIT WITH PARAMEDICS   3/22/72

NAME	NO	T	DEFINITION	WHERE USED
AE	56.2	C	ACTUAL EMERGENCIES (DIMENSIONLESS)	PEREMER,A,53
AEDTP	30	A	ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO PATIENTS (DIM.)	PAEDTP,A,29
ANCOST	57	A	ANCILLARY COSTS (DOLLARS/YEAR)	OPEXP,A,61
ANCT	60	A	ANCILLARY COST TO EXPERIENCE FACTOR (DIMENSIONLESS)	EANCST,A,58/NEANCST,A,59/CPE,A,65/CPNE,A,66
AOI	15	R	ATTRITION RATE OF INTERNS (MEN/YEAR)	INT,L,7
AOR	22	R	ATTRITION RATE OF RESIDENTS (MEN/YEAR)	HRES,L,8
ARNORM	30.1	C	AREA NORMAL OVERLOAD (DIMENSIONLESS)	AEDTP,A,30
ATCS	23	A	ATTRACTIVENESS TO CURRENT STAFF (DIMENSIONLESS)	ATPS,A,14/IDM,A,16
ATPS	14	A	ATTRACTIVENESS TO POTENTIAL STAFF (DIMENSIONLESS)	PMEDHR,R,2/RHI,R,10/RHR,R,18
ATTDEL	14.1	C	TIME TC PERCEIVE ATTRACTIVENESS (YEARS)	ATPS,A,14
AVCPE	60.1	C	AVERAGE COST PER PERCEIVED EMERGENCY (DCLLARS/VISIT)	EANCST,A,58/CPE,A,65
AVCPNE	60.2	C	AVERAGE COST PER PERCEIVED NONEMERGENCY (DCLLARS/VISIT)	NEANCST,A,59/CPNE,A,66
AVSPI	15.1	C	AVERAGE STAY PER INTERN (YEARS/MAN)	AOI,R,15/INTRES,R,17
AVSPPM	6.1	C	AVERAGE STAY PER PARAMEDIC (YEARS)	PMEDAR,R,6
AVSPR	22.1	C	AVERAGE STAY PER RESIDENT (YEARS/MAN)	AOR,R,22
BCTEP	65.1	C	BASE CHARGE TO EMERGENCY PATIENT (DCLLARS/ VISIT)	CPE,A,65
BCTNEP	66.1	C	BASE CHARGE TO NONEMERGENCY PATIENT (DCLLARS/VISIT)	CPNE,A,66
BDEBT	66.2	C	BAD DEBTS (DIMENSIONLESS)	INCOME,A,64
CAPINV	31	L	CAPITAL INVESTMENT (DOLLARS)	DCI,R,32/CIOF,R,36/PCAP,A,52
	31.1	N		
CAPINVN	31.2	C	INITIAL VALUE OF CAPITAL INVESTMENT (DOLLARS)	CAPINV,N,31.1
CAPITC	35.1	C	CAPITAL INVESTMENT TIME CONSTANT (YEARS)	RCI,R,35/CIOF,R,36
CIOF	36	R	CAPITAL INVESTMENT ORDERING FUNCTICN (DCLLARS/YEAR)	RCI,R,35
CIOO	35.2	N	CAPITAL INVESTMENT ON ORDER (DOLLARS)	RCI,R,35/CIOF,R,36
CIOON	35.3	C	INITIAL VALUE OF CAPITAL INVESTMENT ON ORDER (DOLLARS)	CIOO,N,35.2
CPE	65	A	COST PER EMERGENCY (DOLLARS/VISIT)	INCOME,A,64
CPL	27	R	CHANGE IN PATIENT LOAD (VISITS/YEAR)	PAT,L,26
CPNE	66	A	COST PER NONEMERGENCY (DOLLARS/VISIT)	INCOME,A,64
DCAPINV	38	A	DESIRED CAPITAL INVESTMENT (DOLLARS)	CIOF,R,36
DCI	32	R	DEPRECIATION OF CAPITAL INVESTMENT (DOLLARS/ YEAR)	CAPINV,L,31/SDCI,A,39
DCIPP	38.1	C	DESIRED CAPITAL INVESTMENT PER PATIENT (DOLLARS/VISIT/YEAR)	DCAPINV,A,38/PCAP,A,52
DEPDT	34.3	C	DEPRECIATION DELAY TIME (YEARS)	DEPT,A,33
DEPF	34	A	DEPRECIATION FUNCTION (DIMENSIONLESS)	DEPT,A,33
DEPT	33	A	DEPRECIATION TIME (YEARS)	DCI,R,32
DI	13	A	DESIRED INTERNS (MEN)	DIM,A,12
DIM	12	A	DESIRED INTERNS MULTIPLIER (DIMENSIONLESS)	RHI,R,10
DITRR	13.1	C	DESIRED INTERN TO RESIDENT RATIO (DIMENSIONLESS)	DI,A,13/DR,A,21
DP	5	A	DESIRED PARAMEDICS (MEN)	DPMM,A,4
DPMM	4	A	DESIRED PARAMEDIC MULTIPLIER (DIMENSIONLESS)	PMEDHR,R,2
DR	21	A	DESIRED RESIDENTS (MEN)	DI,A,13/DRM,A,20
DRM	20	A	DESIRED RESIDENTS MULTIPLIER (DIMENSIONLESS)	RHR,R,18
DT	67.2	C	INCREMENT IN TIME (YEARS)	PMED,L,1/INT,L,7/HRES,L,8/PAT,L,26/CAPINV,L,31

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PAGE 2    FILE EMC_2P   EMERGENCY UNIT WITH PARAMEDICS    3/22/72

EANCST    58    A EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)    ANCOST,A,57
EATS      16.2 C EXTERNAL ATTRACTIVENESS TO STAFF               IDM,A,16
                  (DIMENSIONLESS)
EXFUND    37    A EXTERNAL FUNDING (DOLLARS/YEAR)               CIOP,R,36
HRES      8     L HOSPITAL RESIDENTS (MEN)                      RES,A,9
          8.1 N
HRESN     8.2 C INITIAL VALUE OF HOSPITAL RESIDENTS (MEN)      HRES,N,8.1
ICAP      49    A INTERN CAPACITY (VISITS/YEAR/MAN)             SCAP,A,47
IDM       16    A INTERN DESTINATION MULTIPLIER                 AOI,R,15/INTRES,R,17
                  (DIMENSIONLESS)
IDTTP     29.1 C INFORMATION DELAY TIME TO PATIENTS (YEARS)    PAEDTP,A,29
IEC       23.3 N INTERN EMERGENCY CAPACITY (VISITS/YEAR)       DR,A,21
IEXP      41.2 N INTERN EXPERIENCE (DIMENSIONLESS)              SEXP,A,40
IHPW      23.6 C INTERN HOURS PER WEEK (HOURS/WEEK)            ITPE,N,23.4/ITPNE,N,23.8
IMPE      23.5 C INTERN MINUTES PER EMERGENCY (MINUTES/        ITPE,N,23.4
                  VISIT)
IMPNE     23.9 C INTERN MINUTES PER NONEMERGENCY (MINUTES/     ITPNE,N,23.8
                  VISIT)
INC       23.7 N INTERN NONEMERGENCY CAPACITY (VISITS/YEAR)    DR,A,21
INCOME    64    A INCOME (DOLLARS/YEAR)                         PRPLSS,A,67
INNORM    23.1 C INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)      ATCS,A,23
INT       7     L INTERNS (MEN)                                 DP,A,5/DIM,A,12/AOI,R,15/INTRES,R,17/SEXP,A,40/STAFF,A,41
          7.1 N                                                   SCAP,A,47/SSAL,A,62
INTN      7.2 C INITIAL VALUE OF INTERNS (MEN)                 INT,N,7.1
INTRES    17    R RATE OF RESIDENTS HIRED FROM INTERNS (MEN/   INT,L,7/HRES,L,8
                  YEAR)
ISAL      62.1 C INTERN SALARY (DOLLARS/YEAR/MAN)              SSAL,A,62
ITPE      23.4 N INTERN TIME FOR PERCEIVED EMERGENCIES         IEC,N,23.3/ICAP,A,49
                  (YEARS/VISIT/MAN)
ITPNE     23.8 N INTERN TIME FOR PERCEIVED NONEMERGENCIES      INC,N,23.7/ICAP,A,49
                  (YEARS/VISIT/MAN)
LAWP      16.1 C LOCAL ATTRACTIVENESS WEIGHTING FACTOR         IDM,A,16
                  (DIMENSIONLESS)
LENGTH    67.4 C LENGTH OF RUN (YEARS)
NEANCST   59    A NONEMERGENCY ANCILLARY COSTS (DOLLARS/       ANCOST,A,57
                  VISIT)
NEP       55    A NONEMERGENCY PATIENTS (VISITS/YEAR)          DR,A,21/PR,A,56
NHRR      19    A NORMAL HIRING RATE OF RESIDENTS FROM OUTSIDE RHR,R,18
          19.1 N   (MEN/YEAR)
NORDT     34.2 C NORMAL DEPRECIATION TIME (YEARS)              DEPT,A,33
NRHI      11    A NORMAL RATE OF HIRING INTERNS (MEN/YEAR)     RHI,R,10
          11.1 N
NRHPM     3     A NORMAL RATE OF HIRING PARAMEDICS (MEN/YEAR)  PMEDHR,R,2
          3.1 N
NRHPMN    3.2 C INITIAL NORMAL RATE OF HIRING PARAMEDICS       NRHPM,N,3.1
                  (MEN/YEAR)
OLOAD     43    A OVERLOAD OF FACILITIES (DIMENSIONLESS)       QOCO,A,45
OPEXP     61    A OPERATING EXPENSES (DOLLARS/YEAR)            PRPLSS,A,67
PAEDTP    29    A PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO   CPL,R,27
                  PATIENTS (DIM.)
PAT       26    L PATIENTS (VISITS/YEAR)                       ATCS,A,23/AEDTP,A,30/DEPP,A,34/EXFUND,A,37/DCAPINV,A,38
          26.1 N                                                 OLOAD,A,43/NEP,A,55/PR,A,56/EANCST,A,58/NEANCST,A,59
                                                                 PHSAL,A,63/INCOME,A,64
PATN      26.2 C INITIAL VALUE OF PATIENTS (VISITS/YEAR)       PAT,N,26.1
PATPOOL   28    A PATIENT POOL (MEN)                            CPL,R,27
PCAP      52    A PHYSICAL CAPACITY (VISITS/YEAR)              DEPP,A,34/EXFUND,A,37/PLCAP,A,42
PEREMER   53    A PERCEIVED EMERGENCIES (DIMENSIONLESS)        RCAP,A,48/ICAP,A,49/SPCAP,A,50/PMCAP,A,51/PERNEM,A,54
                                                                 EANCST,A,58/INCOME,A,64
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PAGE 3    FILE EHC_2P    EMERGENCY UNIT WITH PARAMEDICS    1/22/72

PERNEM   54    A PERCEIVED NONEMERGENCIES (DIMENSIONLESS)       PMCAP,A,51/NEP,A,55/NIANCST,A,59/INCOMF,A,64
PGC      28.1  C PATIENT POOL GROWTH CONSTANT (1/YEAR)          PATPOOL,A,28
PHCPV    63.1  C PROFESSIONAL HELP COST PER VISIT (DOLLARS/     PHSAL,A,63
                 VISIT)
PHSAL    63    A PROFESSIONAL HELP SALARIES (DOLLARS/YEAR)      OPEXP,A,61
PLCAP    42    A PLANNED CAPACITY (VISITS/YEAR)                 ATCS,A,21/ARDTP,A,10/OLOAD,A,41
PLTPER   67.3  C PLOTTING INTERVAL (YEARS)
PMCAP    51    A PARAMEDIC CAPACITY (VISITS/YEAR/MAN)           SCAP,A,47
PMEC     25.4  N PARAMEDIC EMERGENCY CAPACITY (VISITS/YEAR/     DR,A,21
                 MAN)
PMED     1     L PARAMEDICS (MEN)                               DPMM,A,4/PMEDAP,P,6/SEXP,A,40/STAFF,A,41/SCAP,A,47/SSAL,A,
         1.1   N                                                  62
PMEDAR   6     R PARAMEDIC ATTRITION RATE (MEN/YEAR)            PMED,L,1
PMEDHR   2     R PARAMEDIC HIRING RATE (MEN/YEAR)               PMED,L,1/NPPDM,A,3
PMEDN    1.2   C INITIAL NUMBER OF PARAMEDICS (MEN)             PMED,N,1.1
PMEXP    41.1  C PARAMEDIC EXPERIENCE (DIMENSIONLESS)           SEXP,A,40
PMNC     25.5  N PARAMEDIC NONEMERGENCY CAPACITY (VISITS/       DP,A,21
                 YEAR/MAN)
PMPI     21.6  C DESIRED PARAMEDICS PER INTERN                  DP,A,5/DR,A,21
                 (DIMENSIONLESS)
PMPR     21.5  C DESIRED PARAMEDICS PER RESIDENT                DP,A,5/DR,A,21
                 (DIMENSIONLESS)
PMPSP    21.4  C DESIRED PARAMEDICS PER SUPERVISING PHYSICIAN   DP,A,5/DR,A,21
                 (DIMENSIONLESS)
PMSAL    62.4  C PARAMEDIC SALARY (DOLLARS/YEAR/MAN)            SSAL,A,62
PMTPE    25.6  N PARAMEDIC TIME PER EMERGENCY (YEARS/VISIT/     PMCAP,A,51
                 MAN)
PMTPNE   25.7  N PARAMEDIC TIME PER NONEMERGENCY (YEARS/        PMCAP,A,51
                 VISIT/MAN)
PPEMER   28.2  C POPULATION PERCEIVED EMERGENCY (1/YEAR)        CPL,R,27
PR       56    A PATIENT RATIO (DIMENSIONLESS)                  DR,A,21
PRFLSS   67    A PROFIT/LOSS (DOLLARS/YEAR)
QOC      44    S QUALITY OF CARE (DIMENSIONLESS)
QOCE     46    A QUALITY OF CARE FROM EXPERIENCE                QOC,S,44
                 (DIMENSIONLESS)
QOCO     45    A QUALITY OF CARE FROM OVERLOAD                  QOC,S,44
                 (DIMENSIONLESS)
RCAP     48    A RESIDENT CAPACITY (VISITS/YEAR/MAN)            SCAP,A,47
RCI      35    R RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)      CAPINV,L,31
REC      24    N RESIDENT EMERGENCY CAPACITY (VISITS/YEAR)      DR,A,21/PMEC,N,25.4
RES      9     A RESIDENTS (MEN)                                DP,A,5/DRM,A,20/AOR,R,22/SEXP,A,40/STAFF,A,41/SCAP,A,47
                                                                  SSAL,A,62
REXP     41.3  N RESIDENT EXPERIENCE (DIMENSIONLESS)            SEXP,A,40
RHI      10    R RATE OF HIRING INTERNS (MEN/YEAR)              INT,L,7/NRHI,A,11
RHPW     24.3  C RESIDENT HOURS PER WEEK (HOURS/WEEK)           RTPE,N,24.1/RTPNE,N,24.5
RHR      18    R RATE OF HIRING RESIDENTS FROM OUTSIDE (MEN/    HRES,L,8/NHRR,A,19
                 YEAR)
RMPE     24.2  C RESIDENT MINUTES PER EMERGENCY (MINUTES/       RTPE,N,24.1
                 VISIT)
RMPNE    24.6  C RESIDENT MINUTES PER NONEMERGENCY (MINUTES/    RTPNE,N,24.5
                 VISIT)
RNC      24.4  N RESIDENT NONEMERGENCY CAPACITY (VISITS/        DP,A,21/PMNC,N,25.5
                 YEAR)
RSAL     62.2  C RESIDENT SALARY (DOLLARS/YEAR/MAN)             SSAL,A,62
RTPE     24.1  N RESIDENT TIME FOR PERCEIVED EMERGENCY          REC,N,24/PMTPE,N,25.6/RCAP,A,48
                 (YEARS/VISIT/MAN)
RTPNE    24.5  N RESIDENT TIME FOR PERCEIVED NONEMERGENCY       RNC,N,24.4/PMTPNE,N,25.7/RCAP,A,48
                 (YEARS/VISIT/MAN)
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PAGE 4   FILE EHC_2P   EMERGENCY UNIT WITH PARAMEDICS     3/22/72

SCAP     47   A STAFF CAPACITY (VISITS/YEAR)                 PLCAP,A,42
SDCI     39   A SMOOTHED RATE OF DEPRECIATION OF CAPITAL     CIOF,R,36/OPEXP,A,61
                  INVESTMENT ($/YEAR)
SE       56.1 C SORTING ERROR RATE (DIMENSIONLESS)           PEREMER,A,53
SEXP     40   A STAFF EXPERIENCE (DIMENSIONLESS)             QOCE,A,46/ANCT,A,60
SMTI     11.2 C SMOOTHING TIME FOR INTERNS (YEARS)           NBHI,A,11
SMTPM     3.3 C SMOOTHING TIME FOR PARAMEDICS (YEARS)        NRHPM,A,3
SMTR     19.2 C SMOOTHING TIME FOR RESIDENTS (YEARS)         NHRR,A,19
SPCAP    50   A SUPERVISING PHYSICIAN CAPACITY (VISITS/      SCAP,A,47
                  YEAR/MAN)
SPEC     24.7 N SUPERVISING PHYSICIAN EMERGENCY CAPACITY     DR,A,21
                  (VISITS/YEAR)
SPEXP    41.4 N SUPERVISING PHYSICIAN EXPERIENCE             SEXP,A,40
                  (DIMENSIONLESS)
SPHPW    25   C SUPERVISING PHYSICIAN HOURS PER WEEK (HOURS/ SPTPE,N,24.8/SPTPNE,N,25.2
                  WEEK)
SPMPE    24.9 C SUPERVISING PHYSICIAN MINUTES PER EMERGENCY  SPTPE,N,24.8
                  (MINUTES/VISIT)
SPMPNE   25.3 C SUPERVISING PHYSICIAN MINUTES PER            SPTPNE,N,25.2
                  NONEMERGENCY (MINUTES/VISIT)
SPNC     25.1 N SUPERVISING PHYSICIAN NONEMERGENCY CAPACITY  DR,A,21
                  (VISITS/YEAR)
SPSAL    62.3 C SUPERVISING PHYSICIAN SALARY (DOLLARS/YEAR/  SSAL,A,62
                  MAN)
SPTPE    24.8 N SUPERVISING PHYSICIAN TIME PER EMERGENCY     SPEC,N,24.7/SPCAP,A,50
                  (YEARS/VISIT/MAN)
SPTPNE   25.2 N SUPERVISING PHYSICIAN TIME PER NONEMERGENCY  SPNC,N,25.1/SPCAP,A,50
                  (YEARS/VISIT/MAN)
SSAL     62   A STAFF SALARY (DOLLARS/YEAR)                  OPEXP,A,61
STAFF    41   A STAFF (MEN)                                  SEXP,A,40
SUPHY    41.5 C SUPERVISING PHYSICIANS (MEN)                 DP,A,5/DR,A,21/SEXP,A,40/STAFF,A,41/SCAP,A,47/SSAL,A,62
TABLE1   45.1 T TABLE FUNCTION                               AEDTP,A,30/QOCO,A,45
TABLE2   37.1 T TABLE FUNCTION                               EXFUND,A,37
TABLE3   42.1 T TABLE FUNCTION                               PLCAP,A,42
TABLE4   34.1 T TABLE FUNCTION                               DRPP,A,34
TABLE5   12.1 T TABLE FUNCTION                               DPMM,A,4/DIM,A,12/DRM,A,20/QOCE,A,46
TABLE6   60.3 T TABLE FUNCTION                               ANCT,A,60
TABLE7   23.2 T TABLE FUNCTION                               ATCS,A,23
TSDCI    39.1 C TIME TO SMOOTH DEPRECIATION OF CAPITAL       SDCI,A,39
                  INVESTMENT (YEARS)
TTCH     26.1 C TIME TO CHANGE HABITS (YEARS)                PAT,L,26
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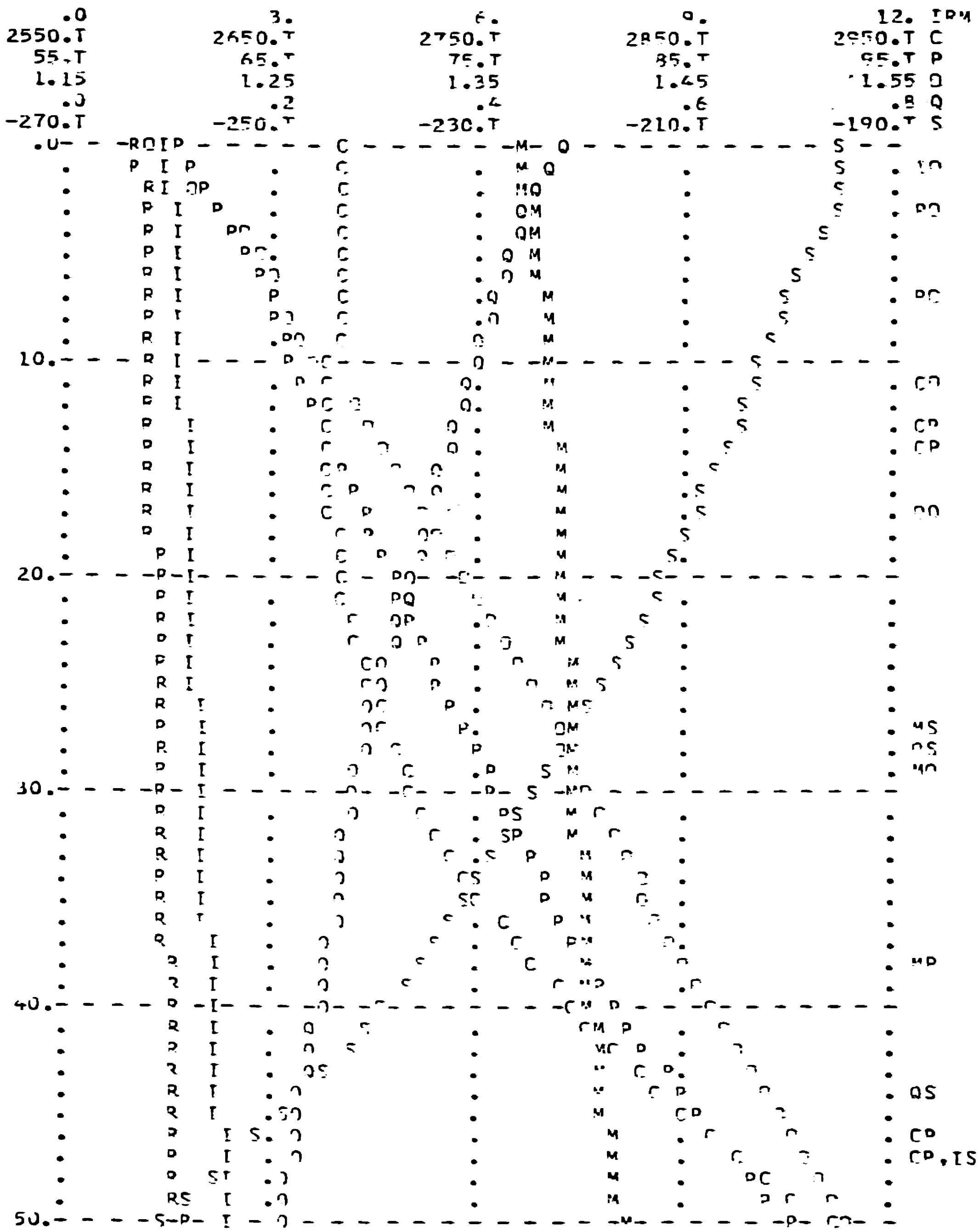
PAGE 5 EMERGENCY UNIT WITH PARAMEDICS 3/24/72

INT=I,RES=R,PMED=M,CAPINV=C,PAT=P,CLOAD=O,OCC=Q,PRFLSS=S



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        *       USE OF CONTRACTED PHYSICIANS TO MAN EMERGENCY DEPARTMENT*
        MACRO   DELAY3P(IN,DEL,PIPE)
        A       DELAY3P.K=$LV3.K/$DL.K
        L       $LV3.K=$LV3.J+DT*($RT2.JK-DELAY3P.J)
        N       $LV3=$DL*IN
        R       $RT2.KL=$LV2.K/$DL.K
        L       $LV2.K=$LV2.J+DT*($RT1.JK-$RT2.JK)
        N       $LV2=$LV3
        R       $RT1.KL=$LV1.K/$DL.K
        L       $LV1.K=$LV1.J+DT*(IN.JK-$RT1.JK)
        N       $LV1=$LV3
        A       $DL.K=DEL/3
        A       PIPE.K=$LV1.K+$LV2.K+$LV3.K
        MEND
1       L       CPHY.K=CPHY.J+(DT)(CPHYHR.JK-CPHYAR.JK) (MEN)
1.1     N       CPHY=CPHYN
1.2     C       CPHYN=9.511 (MEN)
2       R       CPHYHR.KL=NPHCP.K*DCPM.K*ATPS.K (MEN/YEAR)
3       A       NPHCP.K=SMOOTH(CPHYHR.JK,SMTCP) (MEN/YEAR)
3.1     N       NPHCP=NPHCPN (MEN/YEAR)
3.2     C       NPHCPN=.9511 (MEN/YEAR)
3.3     C       SMTCP=2 (YEARS)
4       R       CPHYAR.KL=(1/AVSPCP)(CPHY.K) (MEN/YEAR)
4.1     C       AVSPCP=10 (YEARS)
5       A       DCPM.K=TABLE(TABLE5,DCP.K/CPHY.K,0,2,.2) (DIMENSIONLESS)
5.1     T       TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2 (TABLE)
6       A       ATPS.K=DLINF3(ATCS.K,ATTDEL)
6.1     C       ATTDEL=5 (YEARS)
7       A       DCP.K=(NEP.K)((PP.K/CPEC)+(1/CPNC)) (MEN)
8       A       ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3) (DIMENSIONLESS
8.1     C       INNORM=1.2 (DIMENSIONLESS)
8.2     T       TABLE7=1.2/1.18/1.15/1.09/.95/.7/.52/.4/.3/.22/.2 (TABLE)
8.3     N       CPEC=1/CPTPE (VISITS/YEAR)
8.4     N       CPTPE=(CPMPE/60)/(CPHPW*50) (YEARS/VISIT)
8.5     C       CPMPE=25 (MINUTES)
8.6     C       CPHPW=50 (HOURS/WEEK)
8.7     N       CPNC=1/CPTPNE (VISITS/YEAR)
8.8     N       CPTPNE=(CPMPNE/60)/(CPHPW*50) (YEARS/VISIT)
8.9     C       CPMPNE=20 (MINUTES)
9       L       PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J) (VISITS/YEAR)
9.1     N       PAT=PATN (VISITS/YEAR)
9.2     C       PATN=58782 (VISITS/YEAR)
9.3     C       TTCH=1 (YEAR)
10      R       CPL.KL=PAFDTP.K*PATPOOL.K*PPEMER (VISITS/YEAR)
11      A       PATPOOL.K=150000*EXP(PGC*TIME.K) (PEOPLE)
11.1    C       PGC=0.015 (1/YEAR)
11.2    C       PPEMER=.4 (DIMENSIONLESS)
12      A       PAFDTP.K=DLINF3(AFDTP.K,IDTTP) (DIMENSIONLESS)
12.1    C       IDTTP=4 (YEARS)
13      A       AFDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/ARNORM,0,2,.2) (DIM.)
13.1    C       ARNORM=1.2 (DIMENSIONLESS)
14      L       CAPINV.K=CAPINV.J+(DT)(FCI.JK-DCI.JK) (DOLLARS)
14.1    N       CAPINV=CAPINVN (DOLLARS)
14.2    C       CAPINVN=2648000 (DOLLARS)
15      R       DCI.KL=CAPINV.K/DEPT.K (DOLLARS/YEAR)
16      A       DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT) (YEARS)
17      A       DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3) (DIMENSIONLESS)
17.1    T       TABLE4=1.5/1.175/1.45/1.375/1.25/1/.75/.625/.55/.525/.5 (TABLE)
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PAGE 2       USE OF CONTRACTED PHYSICIANS TO MAN EMERGENCY      3/21/72

    17.2     C      NCEDT=30 (YEARS)
    17.3     C      DEPDT=10 (YEARS)
    18       R      RCI.KL=DELAY3P(CIDF.JK,CAPITC,CIOD.K) (DOLLARS/YEAR)
    18.1     C      CAPITC=4 (YEARS)
    18.2     N      CIOD=CIODN (DOLLARS)
    18.3     C      CIODN=320020 (DOLLARS)
    19       R      CIDF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOD.K)*EXFUND.K
             X      +SDCI.K (DOLLARS/YEAR)
    20       A      EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2) (DIMENSIONLESS)
    20.1     T      TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)
    21       A      DCAPINV.K=DCIPP*PAT.K (DOLLARS)
    21.1     C      DCIPP=60 (DOLLARS/VISIT/YEAR)
    22       A      SDCI.K=SMOOTH(DCI.JK,TSDCI) (YEARS)
    22.1     C      TSDCI=1 (YEARS)
    23       A      SEXP.K=(CPHY.K*CPEXP)/STAFF.K (DIMENSIONLESS)
    24       A      STAFF.K=CPHY.K (MEN)
    24.1     C      CPEXP=2 (DIMENSIONLESS)
    25       A      PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) (VISITS/YEAR)
    25.1     T      TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.39/1.45/1.5 (TABLE)
    26       A      OLOAD.K=PAT.K/PLCAP.K (DIMENSIONLESS)
    27       S      QOC.K=.7*QOCD.K+.3*QOCE.K (DIMENSIONLESS)
    28       A      QOCD.K=TABLE(TABLE1,OLOAD.K,0,2,.2) (DIMENSIONLESS)
    28.1     T      TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0 (TABLE)
    29       A      QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9) (DIMENSIONLESS)
    30       A      SCAP.K=CPCAP.K*CPHY.K (VISITS/YEAR)
    31       A      CPCAP.K=1/(PEREMEP.K*CPTPE+PERNEM.K*CPTPNE) (VISITS/YEAR)
    32       A      PCAP.K=CAPINV.K/DCIPP (VISITS/YEAR)
    33       A      PEREMEP.K=AE+SE*(1-AE) (DIMENSIONLESS)
    34       A      PERNEM.K=1-PEREMEP.K (DIMENSIONLESS)
    35       A      NEP.K=PAT.K*PERNEM.K (VISITS/YEAR)
    36       A      PR.K=(PAT.K-NEP.K)/NEP.K (DIMENSIONLESS)
    36.1     C      SE=.1 (DIMENSIONLESS)
    36.2     C      AE=.33 (DIMENSIONLESS)
    37       A      ANCOST.K=EANCST.K+NEANCST.K (DOLLARS/YEAR)
    38       A      EANCST.K=PAT.K*PEREMEP.K*AVCPE*ANCT.K (DOLLARS/YEAR)
    39       A      NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K (DOLLARS/YEAR)
    40       A      ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9) (DIMENSIONLESS)
    40.1     C      AVCPE=15 (DOLLARS/VISIT)
    40.2     C      AVCPNE=8 (DOLLARS/VISIT)
    40.3     T      TABLE6=1.5/1.43/1.33/1.1/.8/.7/.61/.57/.52/.51/.5 (TABLE)
    41       A      CPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K (DOLLARS/YEAR)
    42       A      SSAL.K=CPSAL*CPHY.K (DOLLARS/YEAR)
    42.1     C      CPSAL=40000 (DOLLARS/YEAR)
    43       A      PHSAL.K=PHCPV*PAT.K (DOLLARS/YEAR)
    43.1     C      PHCPV=18.33 (DOLLARS/VISIT)
    44       A      INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMEP.K+CPNE.K*PERNEM.K) ($/YR)
    45       A      CPE.K=BCTEP+AVCPE*ANCT.K (DOLLARS/VISIT)
    45.1     C      BCTEP=25 (DOLLARS/VISIT)
    46       A      CPNE.K=BCTNEP+AVCPNE*ANCT.K (DOLLARS/VISIT)
    46.1     C      BCTNEP=15 (DOLLARS/VISIT)
    46.2     C      BDEBT=.01 (DIMENSIONLESS)
    47       A      PRFLSS.K=INCOME.K-CPEXP.K (DOLLARS/YEAR)
             PLOT   CPHY=H/CAPINV=C/PAT=P/OLOAD=O/QOC=Q/PRFLSS=S
    47.2     C      DT=.1 (YEARS)
    47.3     C      PLTPER=1 (YEARS)
    47.4     C      LENGTH=50 (YEARS)
             RUN
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CPHY.K=CPHY.J+(DT)(CPHYHR.JK-CPHYAR.JK)                 1, L
CPHY=CPHYN                                              1.1, N
CPHYN=8.511 (MEN)                                       1.2, C
    CPHY   - CONTRACTED PHYSICIANS (MEN)
    DT     - INCREMENT IN TIME (YEARS)
    CPHYHR - CONTRACTED PHYSICIAN HIRING RATE (MEN/YEAR)
    CPHYAR - CONTRACTED PHYSICIAN ATTRITION RATE (MEN/
               YEAR)
    CPHYN  - INITIAL NUMBER OF CONTRACTED PHYSICIANS
               (MEN)

CPHYHR.KL=NRHCP.K*DCPM.K*ATPS.K                         2, R
    CPHYHR - CONTRACTED PHYSICIAN HIRING RATE (MEN/YEAR)
    NRHCP  - NORMAL RATE OF HIRING CONTRACTED PHYSICIANS
               (MEN/YEAR)
    DCPM   - DESIRED CONTRACTED PHYSICIAN MULTIPLIER
               (DIMENSIONLESS)
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)

NRHCP.K=SMOOTH(CPHYHR.JK,SMTCP)                         3, A
NRHCP=NRHCPN (MEN/YEAR)                                 3.1, N
NRHCPN=.8511 (MEN/YEAR)                                 3.2, C
SMTCP=2 (YEARS)                                         3.3, C
    NRHCP  - NORMAL RATE OF HIRING CONTRACTED PHYSICIANS
               (MEN/YEAR)
    CPHYHR - CONTRACTED PHYSICIAN HIRING RATE (MEN/YEAR)
    SMTCP  - SMOOTHING TIME FOR CONTRACTED PHYSICIANS
               (YEARS)
    NRHCPN - INITIAL NORMAL RATE OF HIRING CONTRACTED
               PHYSICIANS (MEN/YEAR)

CPHYAR.KL=(1/AVSPCP)(CPHY.K)                            4, R
AVSPCP=10 (YEARS)                                       4.1, C
    CPHYAR - CONTRACTED PHYSICIAN ATTRITION RATE (MEN/
               YEAR)
    AVSPCP - AVERAGE STAY PER CONTRACTED PHYSICIAN
               (YEARS/MAN)
    CPHY   - CONTRACTED PHYSICIANS (MEN)

DCPM.K=TABLE(TABLE5,DCP.K/CPHY.K,0,2,.2)                5, A
TABLE5=0/.05/.1/.25/.5/1/1.5/1.75/1.9/1.95/2            5.1, T
  (TABLE)
    DCPM   - DESIRED CONTRACTED PHYSICIAN MULTIPLIER
               (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    DCP    - DESIRED CONTRACTED PHYSICIANS (MEN)
    CPHY   - CONTRACTED PHYSICIANS (MEN)

ATPS.K=DLINF3(ATCS.K,ATTDEL)                            6, A
ATTDEL=5 (YEARS)                                        6.1, C
    ATPS   - ATTRACTIVENESS TO POTENTIAL STAFF
               (DIMENSIONLESS)
    ATCS   - ATTRACTIVENESS TO CURRENT STAFF
               (DIMENSIONLESS)
    ATTDEL - TIME TO PERCEIVE ATTRACTIVENESS (YEARS)
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DCP.K=(NEP.K)((PR.K/CPEC)+(1/CPNC))                          7, A
    DCP     - DESIRED CONTRACTED PHYSICIANS (MEN)
    NEP     - NONEMERGENCY PATIENTS (VISITS/YEAR)
    PR      - PATIENT RATIO (DIMENSIONLESS)
    CPEC    - CONTRACTED PHYSICIAN EMERGENCY CAPACITY
                 (VISITS/YEAR/MAN)
    CPNC    - CONTRACTED PHYSICIAN NONEMERGENCY CAPACITY
                 (VISITS/YEAR/MAN)

ATCS.K=TABLE(TABLE7,(PAT.K/PLCAP.K)/INNORM,0,3,.3)           8, A
INNORM=1.2 (DIMENSIONLESS)                                   8.1, C
TABLE7=1.2/1.18/1.15/1.08/.85/.7/.52/.4/.3/.22/.2            8.2, T
  (TABLE)
CPEC=1/CPTPE (VISITS/YEAR)                                   8.3, N
CPTPE=(CPMPE/60)/(CPHPW*50) (YEARS/VISIT)                    8.4, N
CPMPE=25 (MINUTES)                                           8.5, C
CPHPW=50 (HOURS/WEEK)                                        8.6, C
CPNC=1/CPTPNE (VISITS/YEAR)                                  8.7, N
CPTPNE=(CPMPNE/60)/(CPHPW*50) (YEARS/VISIT)                  8.8, N
CPMPNE=20 (MINUTES)                                          8.9, C
    ATCS    - ATTRACTIVENESS TO CURRENT STAFF
                 (DIMENSIONLESS)
    TABLE7  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PLCAP   - PLANNED CAPACITY (VISITS/YEAR)
    INNORM  - INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)
    CPEC    - CONTRACTED PHYSICIAN EMERGENCY CAPACITY
                 (VISITS/YEAR/MAN)
    CPTPE   - CONTRACTED PHYSICIAN TIME PER EMERGENCY
                 (YEARS/VISIT/MAN)
    CPMPE   - CONTRACTED PHYSICIAN MINUTES PER EMERGENCY
                 (MINUTES/VISIT)
    CPHPW   - CONTRACTED PHYSICIAN HOURS PER WEEK (HOURS/
                 WEEK)
    CPNC    - CONTRACTED PHYSICIAN NONEMERGENCY CAPACITY
                 (VISITS/YEAR/MAN)
    CPTPNE  - CONTRACTED PHYSICIAN TIME PER NONEMERGENCY
                 (YEARS/VISIT/MAN)
    CPMPNE  - CONTRACTED PHYSICIAN MINUTES PER
                 NONEMERGENCY (MINUTES/VISIT)

PAT.K=PAT.J+(DT)(1/TTCH)(CPL.JK-PAT.J)                       9, L
PAT=PATN (VISITS/YEAR)                                       9.1, N
PATN=58382 (VISITS/YEAR)                                     9.2, C
TTCH=1 (YEAR)                                                9.3, C
    PAT     - PATIENTS (VISITS/YEAR)
    DT      - INCREMENT IN TIME (YEARS)
    TTCH    - TIME TO CHANGE HABITS (YEARS)
    CPL     - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PATN    - INITIAL VALUE OF PATIENTS (VISITS/YEAR)

CPL.KL=PAEDTP.K*PATPOOL.K*PPEMER                             10, R
    CPL     - CHANGE IN PATIENT LOAD (VISITS/YEAR)
    PAEDTP  - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
                 PATIENTS (DIM.)
    PATPOOL - PATIENT POOL (MEN)
    PPEMER  - POPULATION PERCEIVED EMERGENCY (1/YEAR)
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PATPOOL.K=150000*EXP(PGC*TIME.K)                          11, A
PGC=0.015 (1/YEAR)                                        11.1, C
PPEMER=.4 (DIMENSIONLESS)                                 11.2, C
    PATPOOL- PATIENT POOL (MEN)
    PGC    - PATIENT POOL GROWTH CONSTANT (1/YEAR)
    PPEMER - POPULATION PERCEIVED EMERGENCY (1/YEAR)

PAEDTP.K=DLINF3(AEDTP.K,IDTTP)                            12, A
IDTTP=4 (YEARS)                                           12.1, C
    PAEDTP - PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO
               PATIENTS (DIM.)
    AEDTP  - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    IDTTP  - INFORMATION DELAY TIME TO PATIENTS (YEARS)

AEDTP.K=0.5+0.5*TABLE(TABLE1,(PAT.K/PLCAP.K)/             13, A
  ARNORM,0,2,.2)
ARNORM=1.2 (DIMENSIONLESS)                                13.1, C
    AEDTP  - ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO
               PATIENTS (DIM.)
    TABLE1 - TABLE FUNCTION
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    ARNORM - AREA NORMAL OVERLOAD (DIMENSIONLESS)

CAPINV.K=CAPINV.J+(DT)(RCI.JK-DCI.JK)                     14, L
CAPINV=CAPINVN (DOLLARS)                                  14.1, N
CAPINVN=2648500 (DOLLARS)                                 14.2, C
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DT     - INCREMENT IN TIME (YEARS)
    RCI    - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINVN- INITIAL VALUE OF CAPITAL INVESTMENT
               (DOLLARS)

DCI.KL=CAPINV.K/DEPT.K                                    15, R
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    CAPINV - CAPITAL INVESTMENT (DOLLARS)
    DEPT   - DEPRECIATION TIME (YEARS)

DEPT.K=SMOOTH(NORDT*DEPF.K,DEPDT)                         16, A
    DEPT   - DEPRECIATION TIME (YEARS)
    NORDT  - NORMAL DEPRECIATION TIME (YEARS)
    DEPF   - DEPRECIATION FUNCTION (DIMENSIONLESS)
    DEPDT  - DEPRECIATION DELAY TIME (YEARS)
```

```
DEPF.K=TABLE(TABLE4,PAT.K/PCAP.K,0,3,.3)                  17, A
TABLE4=1.5/1.475/1.45/1.375/1.25/1/.75/.625/.55/          17.1, T
  .525/.5 (TABLE)
NORDT=30 (YEARS)                                          17.2, C
DEPDT=10 (YEARS)                                          17.3, C
    DEPF    - DEPRECIATION FUNCTION (DIMENSIONLESS)
    TABLE4  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    NORDT   - NORMAL DEPRECIATION TIME (YEARS)
    DEPDT   - DEPRECIATION DELAY TIME (YEARS)

RCI.KL=DELAY3P(CIOF.JK,CAPITC,CIOO.K)                     18, R
CAPITC=4 (YEARS)                                          18.1, C
CIOO=CIOON (DOLLARS)                                      18.2, N
CIOON=320020 (DOLLARS)                                    18.3, C
    RCI     - RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    CIOON   - INITIAL VALUE OF CAPITAL INVESTMENT ON
                ORDER (DOLLARS)

CIOF.KL=(DCAPINV.K-CAPINV.K+SDCI.K*CAPITC-CIOO.K)*        19, R
  EXFUND.K+SDCI.K
    CIOF    - CAPITAL INVESTMENT ORDERING FUNCTION
                (DOLLARS/YEAR)
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
                INVESTMENT ($/YEAR)
    CAPITC  - CAPITAL INVESTMENT TIME CONSTANT (YEARS)
    CIOO    - CAPITAL INVESTMENT ON ORDER (DOLLARS)
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)

EXFUND.K=TABLE(TABLE2,PAT.K/PCAP.K,1,3,.2)                20, A
TABLE2=0/0/0/.005/.01/.02/.03/.05/.1/.15/.2 (TABLE)       20.1, T
    EXFUND  - EXTERNAL FUNDING (DOLLARS/YEAR)
    TABLE2  - TABLE FUNCTION
    PAT     - PATIENTS (VISITS/YEAR)
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)

DCAPINV.K=DCIPP*PAT.K                                     21, A
DCIPP=60 (DOLLARS/VISIT/YEAR)                             21.1, C
    DCAPINV- DESIRED CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
                (DOLLARS/VISIT/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
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SDCI.K=SMOOTH(DCI.JK,TSDCI)                                 22, A
TSDCI=1 (YEARS)                                             22.1, C
    SDCI   - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)
    DCI    - DEPRECIATION OF CAPITAL INVESTMENT
               (DOLLARS/YEAR)
    TSDCI  - TIME TO SMOOTH DEPRECIATION OF CAPITAL
               INVESTMENT (YEARS)

SEXP.K=(CPHY.K*CPEXP)/STAFF.K                               23, A
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)
    CPHY   - CONTRACTED PHYSICIANS (MEN)
    CPEXP  - CONTRACTED PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)
    STAFF  - STAFF (MEN)

STAFF.K=CPHY.K                                              24, A
CPEXP=9 (DIMENSIONLESS)                                     24.1, C
    STAFF  - STAFF (MEN)
    CPHY   - CONTRACTED PHYSICIANS (MEN)
    CPEXP  - CONTRACTED PHYSICIAN EXPERIENCE
               (DIMENSIONLESS)

PLCAP.K=SCAP.K*TABLE(TABLE3,PCAP.K/SCAP.K,0,2.2,.2) 25, A
TABLE3=0/.3/.55/.7/.85/1/1.1/1.2/1.3/1.38/1.45/1.5  25.1, T
  (TABLE)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)
    SCAP   - STAFF CAPACITY (VISITS/YEAR)
    TABLE3 - TABLE FUNCTION
    PCAP   - PHYSICAL CAPACITY (VISITS/YEAR)

OLOAD.K=PAT.K/PLCAP.K                                       26, A
    OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)
    PAT    - PATIENTS (VISITS/YEAR)
    PLCAP  - PLANNED CAPACITY (VISITS/YEAR)

QOC.K=.7*QOCO.K+.3*QOCE.K                                   27, S
    QOC    - QUALITY OF CARE (DIMENSIONLESS)
    QOCO   - QUALITY OF CARE FROM OVERLOAD
               (DIMENSIONLESS)
    QOCE   - QUALITY OF CARE FROM EXPERIENCE
               (DIMENSIONLESS)

QOCO.K=TABLE(TABLE1,OLOAD.K,0,2,.2)                         28, A
TABLE1=2/1.95/1.9/1.75/1.5/1/.5/.25/.1/.05/0                28.1, T
  (TABLE)
    QOCO   - QUALITY OF CARE FROM OVERLOAD
               (DIMENSIONLESS)
    TABLE1 - TABLE FUNCTION
    OLOAD  - OVERLOAD OF FACILITIES (DIMENSIONLESS)

QOCE.K=TABLE(TABLE5,SEXP.K,0,9,.9)                          29, A
    QOCE   - QUALITY OF CARE FROM EXPERIENCE
               (DIMENSIONLESS)
    TABLE5 - TABLE FUNCTION
    SEXP   - STAFF EXPERIENCE (DIMENSIONLESS)
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SCAP.K=CPCAP.K*CPHY.K                                          30, A
    SCAP    - STAFF CAPACITY (VISITS/YEAR)
    CPCAP   - CONTRACTED PHYSICIAN CAPACITY (VISITS/YEAR/
              MAN)
    CPHY    - CONTRACTED PHYSICIANS (MEN)

CPCAP.K=1/(PEREMER.K*CPTPE+PERNEM.K*CPTPNE)                    31, A
    CPCAP   - CONTRACTED PHYSICIAN CAPACITY (VISITS/YEAR/
              MAN)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    CPTPE   - CONTRACTED PHYSICIAN TIME PER EMERGENCY
              (YEARS/VISIT/MAN)
    PERNEM  - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    CPTPNE  - CONTRACTED PHYSICIAN TIME PER NONEMERGENCY
              (YEARS/VISIT/MAN)

PCAP.K=CAPINV.K/DCIPP                                          32, A
    PCAP    - PHYSICAL CAPACITY (VISITS/YEAR)
    CAPINV  - CAPITAL INVESTMENT (DOLLARS)
    DCIPP   - DESIRED CAPITAL INVESTMENT PER PATIENT
              (DOLLARS/VISIT/YEAR)

PEREMER.K=AE+SE*(1-AE)                                         33, A
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AE      - ACTUAL EMERGENCIES (DIMENSIONLESS)
    SE      - SORTING ERROR RATE (DIMENSIONLESS)

PERNEM.K=1-PEREMER.K                                           34, A
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)

NEP.K=PAT.K*PERNEM.K                                           35, A
    NEP     - NONEMERGENCY PATIENTS (VISITS/YEAR)
    PAT     - PATIENTS (VISITS/YEAR)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

PR.K=(PAT.K-NEP.K)/NEP.K                                       36, A
SE=.1 (DIMENSIONLESS)                                          36.1, C
AE=.33 (DIMENSIONLESS)                                         36.2, C
    PR      - PATIENT RATIO (DIMENSIONLESS)
    PAT     - PATIENTS (VISITS/YEAR)
    NEP     - NONEMERGENCY PATIENTS (VISITS/YEAR)
    SE      - SORTING ERROR RATE (DIMENSIONLESS)
    AE      - ACTUAL EMERGENCIES (DIMENSIONLESS)

ANCCST.K=EANCST.K+NEANCST.K                                    37, A
    ANCCST - ANCILLARY COSTS (DOLLARS/YEAR)
    EANCST - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
             VISIT)
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EANCST.K=PAT.K*PEREMER.K*AVCPE*ANCT.K                          38, A
    EANCST  - EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)
    PAT     - PATIENTS (VISITS/YEAR)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    AVCPE   - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

NEANCST.K=PAT.K*PERNEM.K*AVCPNE*ANCT.K                         39, A
    NEANCST- NONEMERGENCY ANCILLARY COSTS (DOLLARS/
               VISIT)
    PAT     - PATIENTS (VISITS/YEAR)
    PERNEM  - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

ANCT.K=TABLE(TABLE6,SEXP.K,0,9,.9)                             40, A
AVCPE=15 (DOLLARS/VISIT)                                       40.1, C
AVCPNE=8 (DOLLARS/VISIT)                                       40.2, C
TABLE6=1.5/1.43/1.32/1.1/.8/.7/.61/.57/.52/.51/.5              40.3, T
  (TABLE)
    ANCT    - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    TABLE6  - TABLE FUNCTION
    SEXP    - STAFF EXPERIENCE (DIMENSIONLESS)
    AVCPE   - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    AVCPNE  - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)

OPEXP.K=SSAL.K+PHSAL.K+ANCOST.K+SDCI.K                         41, A
    OPEXP   - OPERATING EXPENSES (DOLLARS/YEAR)
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    PHSAL   - PROFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    ANCOST  - ANCILLARY COSTS (DOLLARS/YEAR)
    SDCI    - SMOOTHED RATE OF DEPRECIATION OF CAPITAL
               INVESTMENT ($/YEAR)

SSAL.K=CPSAL*CPHY.K                                            42, A
CPSAL=40000 (DOLLARS/YEAR)                                     42.1, C
    SSAL    - STAFF SALARY (DOLLARS/YEAR)
    CPSAL   - CONTRACTED PHYSICIAN SALARY (DOLLARS/YEAR/
               MAN)
    CPHY    - CONTRACTED PHYSICIANS (MEN)

PHSAL.K=PHCPV*PAT.K                                            43, A
PHCPV=18.33 (DOLLARS/VISIT)                                    43.1, C
    PHSAL   - PROFESSIONAL HELP SALARIES (DOLLARS/YEAR)
    PHCPV   - PROFESSIONAL HELP COST PER VISIT (DOLLARS/
               VISIT)
    PAT     - PATIENTS (VISITS/YEAR)
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INCOME.K=(PAT.K)(1-BDEBT)(CPE.K*PEREMER.K+CPNE.K*      44, A
  PERNEM.K)
    INCOME - INCOME (DOLLARS/YEAR)
    PAT    - PATIENTS (VISITS/YEAR)
    BDEBT  - BAD DEBTS (DIMENSIONLESS)
    CPE    - COST PER EMERGENCY (DOLLARS/VISIT)
    PEREMER- PERCEIVED EMERGENCIES (DIMENSIONLESS)
    CPNE   - COST PER NONEMERGENCY (DOLLARS/VISIT)
    PERNEM - PERCEIVED NONEMERGENCIES (DIMENSIONLESS)

CPE.K=BCTEP+AVCPE*ANCT.K                                45, A
BCTEP=25 (DOLLARS/VISIT)                                45.1, C
    CPE    - COST PER EMERGENCY (DOLLARS/VISIT)
    BCTEP  - BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/
               VISIT)
    AVCPE  - AVERAGE COST PER PERCEIVED EMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)

CPNE.K=BCTNEP+AVCPNE*ANCT.K                             46, A
BCTNEP=15 (DOLLARS/VISIT)                               46.1, C
BDEBT=.01 (DIMENSIONLESS)                               46.2, C
    CPNE   - COST PER NONEMERGENCY (DOLLARS/VISIT)
    BCTNEP - BASE CHARGE TO NONEMERGENCY PATIENT
               (DOLLARS/VISIT)
    AVCPNE - AVERAGE COST PER PERCEIVED NONEMERGENCY
               (DOLLARS/VISIT)
    ANCT   - ANCILLARY COST TO EXPERIENCE FACTOR
               (DIMENSIONLESS)
    BDEBT  - BAD DEBTS (DIMENSIONLESS)

PRFLSS.K=INCOME.K-OPEXP.K                               47, A
DT=.1 (YEARS)                                           47.2, C
PLTPER=1 (YEARS)                                        47.3, C
LENGTH=50 (YEARS)                                       47.4, C
    PRFLSS - PROFIT/LOSS (DOLLARS/YEAR)
    INCOME - INCOME (DOLLARS/YEAR)
    OPEXP  - OPERATING EXPENSES (DOLLARS/YEAR)
    DT     - INCREMENT IN TIME (YEARS)
    PLTPER - PLOTTING INTERVAL (YEARS)
    LENGTH - LENGTH OF RUN (YEARS)
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PAGE 1    FILE EMC_2CP    EMERGENCY UNIT WITH CONTRACTED PHYSICIANS     3/22/72

NAME      NO    T DEFINITION                                      WHERE USED

AE        36.2 C ACTUAL EMERGENCIES (DIMENSIONLESS)               PEREMPP,A,11
AEDTP     11    A ATTRACTIVENESS OF EMERGENCY DEPARTMENT TO        PAEDTP,A,12
                  PATIENTS (DIM.)
ANCOST    37    A ANCILLARY COSTS (DOLLARS/YEAR)                   OPEXP,A,41
ANCT      40    A ANCILLARY COST TO EXPERIENCE FACTOR              EANCST,A,38/NEANCST,A,39/CPE,A,45/CPNE,A,46
                  (DIMENSIONLESS)
ARNORM    11.1 C AREA NORMAL OVERLOAD (DIMENSIONLESS)             AEDTP,A,11
ATCS      9     A ATTRACTIVENESS TO CURRENT STAFF                  ATPS,A,6
                  (DIMENSIONLESS)
ATPS      6     A ATTRACTIVENESS TO POTENTIAL STAFF                CPHYHR,R,2
                  (DIMENSIONLESS)
ATTDEL    6.1 C TIME TO PERCEIVE ATTRACTIVENESS (YEARS)           ATPS,A,6
AVCPE     40.1 C AVERAGE COST PER PERCEIVED EMERGENCY             EANCST,A,38/CPE,A,45
                  (DOLLARS/VISIT)
AVCPNE    40.2 C AVERAGE COST PER PERCEIVED NONEMERGENCY          NEANCST,A,39/CPNE,A,46
                  (DOLLARS/VISIT)
AVSPCP    4.1 C AVERAGE STAY PER CONTRACTED PHYSICIAN             CPHYAR,R,4
                  (YEARS/MAN)
BCTEP     45.1 C BASE CHARGE TO EMERGENCY PATIENT (DOLLARS/       CPE,A,45
                  VISIT)
BCTNEP    46.1 C BASE CHARGE TO NONEMERGENCY PATIENT              CPNE,A,46
                  (DOLLARS/VISIT)
BDEBT     46.2 C BAD DEBTS (DIMENSIONLESS)                        INCOME,A,44
CAPINV    14    L CAPITAL INVESTMENT (DOLLARS)                     DCI,R,15/CIOF,R,19/PCAP,A,32
          14.1 N
CAPINVN   14.2 C INITIAL VALUE OF CAPITAL INVESTMENT              CAPINV,N,14.1
                  (DOLLARS)
CAPITC    18.1 C CAPITAL INVESTMENT TIME CONSTANT (YEARS)         RCI,R,18/CIOF,R,19
CIOF      19    R CAPITAL INVESTMENT ORDERING FUNCTION             RCI,R,18
                  (DOLLARS/YEAR)
CIOO      18.2 N CAPITAL INVESTMENT ON ORDER (DOLLARS)            RCI,R,18/CIOF,R,19
CIOON     18.3 C INITIAL VALUE OF CAPITAL INVESTMENT ON ORDER     CIOO,N,18.2
                  (DOLLARS)
CPCAP     31    A CONTRACTED PHYSICIAN CAPACITY (VISITS/YEAR/      SCAP,A,30
                  MAN)
CPE       45    A COST PER EMERGENCY (DOLLARS/VISIT)               INCOME,A,44
CPEC      8.3 N CONTRACTED PHYSICIAN EMERGENCY CAPACITY           DCP,A,7
                  (VISITS/YEAR/MAN)
CPEXP     24.1 C CONTRACTED PHYSICIAN EXPERIENCE                  SEXP,A,23
                  (DIMENSIONLESS)
CPHPW     8.6 C CONTRACTED PHYSICIAN HOURS PER WEEK (HOURS/       CPTPE,N,8.4/CPTPNE,N,8.8
                  WEEK)
CPHY      1     L CONTRACTED PHYSICIANS (MEN)                      CPHYAR,R,4/DCPM,A,5/SEXP,A,23/STAFF,A,24/SCAP,A,30/SSAL,A,
          1.1 N                                                      42
CPHYAR    4     R CONTRACTED PHYSICIAN ATTRITION RATE (MEN/        CPHY,L,1
                  YEAR)
CPHYHR    2     R CONTRACTED PHYSICIAN HIRING RATE (MEN/YEAR)      CPHY,L,1/NRHCL,A,3
CPHYN     1.2 C INITIAL NUMBER OF CONTRACTED PHYSICIANS           CPHY,N,1.1
                  (MEN)
CPL       10    R CHANGE IN PATIENT LOAD (VISITS/YEAR)             PAT,L,9
CPMPE     8.5 C CONTRACTED PHYSICIAN MINUTES PER EMERGENCY        CPTPE,N,8.4
                  (MINUTES/VISIT)
CPMPNE    8.9 C CONTRACTED PHYSICIAN MINUTES PER                  CPTPNE,N,8.8
                  NONEMERGENCY (MINUTES/VISIT)
CPNC      8.7 N CONTRACTED PHYSICIAN NONEMERGENCY CAPACITY        DCP,A,7
                  (VISITS/YEAR/MAN)
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PAGE 2   FILE EHC_2CP   EMERGENCY UNIT WITH CONTRACTED PHYSICIANS    1/22/72

CPNE      46    A COST PER NONEMERGENCY (DOLLARS/VISIT)          INCOME,A,44
CPSAL     42.1  C CONTRACTED PHYSICIAN SALARY (DOLLARS/YEAR/     SSAL,A,42
                    MAN)
CPTPE      8.4  N CONTRACTED PHYSICIAN TIME PER EMERGENCY        CPEC,E,8.1/PCAP,A,11
                    (YEARS/VISIT/MAN)
CPTPNE     8.8  N CONTRACTED PHYSICIAN TIME PER NONEMERGENCY     CPNC,E,8.7/PCAP,A,11
                    (YEARS/VISIT/MAN)
DCAPINV   21    A DESIRED CAPITAL INVESTMENT (DOLLARS)           CIOP,R,19
DCI       15    R DEPRECIATION OF CAPITAL INVESTMENT (DOLLARS/ CAPINV,L,14/SICI,A,22
                    YEAR)
DCIPP     21.1  C DESIRED CAPITAL INVESTMENT PER PATIENT         DCAPINV,A,21/PCAP,A,32
                    (DOLLARS/VISIT/YEAR)
DCP        7    A DESIRED CONTRACTED PHYSICIANS (MEN)            DCPM,A,5
DCPM       5    A DESIRED CONTRACTED PHYSICIAN MULTIPLIER        CPHYHR,R,2
                    (DIMENSIONLESS)
DEPDT     17.3  C DEPRECIATION DELAY TIME (YEARS)                DEPT,A,16
DEPF      17    A DEPRECIATION FUNCTION (DIMENSIONLESS)          DEPT,A,16
DEPT      16    A DEPRECIATION TIME (YEARS)                      DCI,R,15
DT        47.2  C INCREMENT IN TIME (YEARS)                      CPHY,L,1/PAT,L,9/CAPINV,L,14
EANCST    38    A EMERGENCY ANCILLARY COSTS (DOLLARS/VISIT)      ANCOST,A,37
EXFUND    20    A EXTERNAL FUNDING (DOLLARS/YEAR)                CIOP,R,19
IDTTP     12.1  C INFORMATION DELAY TIME TO PATIENTS (YEARS)     PAEDTP,A,12
INCOME    44    A INCOME (DOLLARS/YEAR)                          PRPLSS,A,47
INNORM     8.1  C INDUSTRY NORMAL OVERLOAD (DIMENSIONLESS)       ATCS,A,8
LENGTH    47.4  C LENGTH OF RUN (YEARS)
NEANCST   39    A NONEMERGENCY ANCILLARY COSTS (DOLLARS/         ANCOST,A,37
                    VISIT)
NEP       35    A NONEMERGENCY PATIENTS (VISITS/YEAR)            DCP,A,7/PR,A,36
NORDT     17.2  C NORMAL DEPRECIATION TIME (YEARS)               DEPT,A,16
NRHCP      3    A NORMAL RATE OF HIRING CONTRACTED PHYSICIANS    CPHYHR,R,2
           3.1  N   (MEN/YEAR)
NRHCPN     3.2  C INITIAL NORMAL RATE OF HIRING CONTRACTED       NRHCP,N,3.1
                    PHYSICIANS (MEN/YEAR)
OLOAD     26    A OVERLOAD OF FACILITIES (DIMENSIONLESS)         QOCO,A,28
OPEXP     41    A OPERATING EXPENSES (DOLLARS/YEAR)              PRPLSS,A,47
PAEDTP    12    A PERCEIVED ATTRACT. OF EMERGENCY DEPART. TO     CPL,R,10
                    PATIENTS (DIM.)
PAT        9    L PATIENTS (VISITS/YEAR)                         ATCS,A,8/AEDTP,A,13/DEPF,A,17/EXFUND,A,20/DCAPINV,A,21
           9.1  N                                                  CLOAD,A,26/NEP,A,35/PR,A,36/EANCST,A,38/NEANCST,A,39
                                                                   PHSAL,A,43/INCOME,A,44
PATN       9.2  C INITIAL VALUE OF PATIENTS (VISITS/YEAR)        PAT,N,9.1
PATPOOL   11    A PATIENT POOL (MEN)                             CPL,R,10
PCAP      32    A PHYSICAL CAPACITY (VISITS/YEAR)                DEPF,A,17/EXFUND,A,20/PLCAP,A,25
PEREMER   13    A PERCEIVED EMERGENCIES (DIMENSIONLESS)          CPCAP,A,33/PERNEM,A,34/EANCST,A,38/INCOME,A,44
PERNEM    14    A PERCEIVED NONEMERGENCIES (DIMENSIONLESS)       CPCAP,A,33/NEP,A,35/NEANCST,A,39/INCOME,A,44
PGC       11.1  C PATIENT POOL GROWTH CONSTANT (1/YEAR)          PATPOOL,A,11
PHCPV     43.1  C PROFFESSIONAL HELP COST PER VISIT (DOLLARS/    PHSAL,A,43
                    VISIT)
PHSAL     43    A PROFFESSIONAL HELP SALARIES (DOLLARS/YEAR)     OPEXP,A,41
PLCAP     25    A PLANNED CAPACITY (VISITS/YEAR)                 ATCS,A,8/AEDTP,A,13/OLOAD,A,26
PLTPER    47.3  C PLOTTING INTERVAL (YEARS)
PPEMER    11.2  C POPULATION PERCEIVED EMERGENCY (1/YEAR)        CPL,R,10
PR        36    A PATIENT RATIO (DIMENSIONLESS)                  DCP,A,7
PRPLSS    47    A PROFIT/LOSS (DOLLARS/YEAR)
QOC       27    S QUALITY OF CARE (DIMENSIONLESS)
QOCE      29    A QUALITY OF CARE FROM EXPERIENCE                QOC,S,27
                    (DIMENSIONLESS)
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PAGE 3   FILE EHC_2CP   EMERGENCY UNIT WITH CONTRACTED PHYSICIANS    3/22/72

QOCO     28   A QUALITY OF CARE FROM OVERLOAD                      QOC,S,27
                  (DIMENSIONLESS)
RCI      18   R RATE OF CAPITAL INVESTMENT (DOLLARS/YEAR)          CAPINV,L,14
SCAP     30   A STAFF CAPACITY (VISITS/YEAR)                       PLCAP,A,25
SDCI     22   A SMOOTHED RATE OF DEPRECIATION OF CAPITAL           CIOF,R,19/OPEXP,A,41
                  INVESTMENT ($/YEAR)
SE       36.1 C SORTING ERROR RATE (DIMENSIONLESS)                 PEREMER,A,33
SEXP     23   A STAFF EXPERIENCE (DIMENSIONLESS)                   QOCE,A,29/ANCT,A,40
SMTCP     3.3 C SMOOTHING TIME FOR CONTRACTED PHYSICIANS           NRHCP,A,3
                  (YEARS)
SPTPNE          SUPERVISING PHYSICIAN TIME PER NONEMERGENCY
                  (YEARS/VISIT/MAN)
SSAL     42   A STAFF SALARY (DOLLARS/YEAR)                        OPEXP,A,4
STAFF    24   A STAFF (MEN)                                        SEXP,A,23
TABLE1   28.1 T TABLE FUNCTION                                     AEDTP,A,13/QOCO,A,28
TABLE2   20.1 T TABLE FUNCTION                                     EXFUND,A,20
TABLE3   25.1 T TABLE FUNCTION                                     PLCAP,A,25
TABLE4   17.1 T TABLE FUNCTION                                     DEPF,A,17
TABLE5    5.1 T TABLE FUNCTION                                     DCPM,A,5/QOCE,A,29
TABLE6   40.3 T TABLE FUNCTION                                     ANCT,A,40
TABLE7    8.2 T TABLE FUNCTION                                     ATCS,A,8
TSDCI    22.1 C TIME TO SMOOTH DEPRECIATION OF CAPITAL             SDCI,A,22
                  INVESTMENT (YEARS)
TTCH      9.3 C TIME TO CHANGE HABITS (YEARS)                      PAT,L,9
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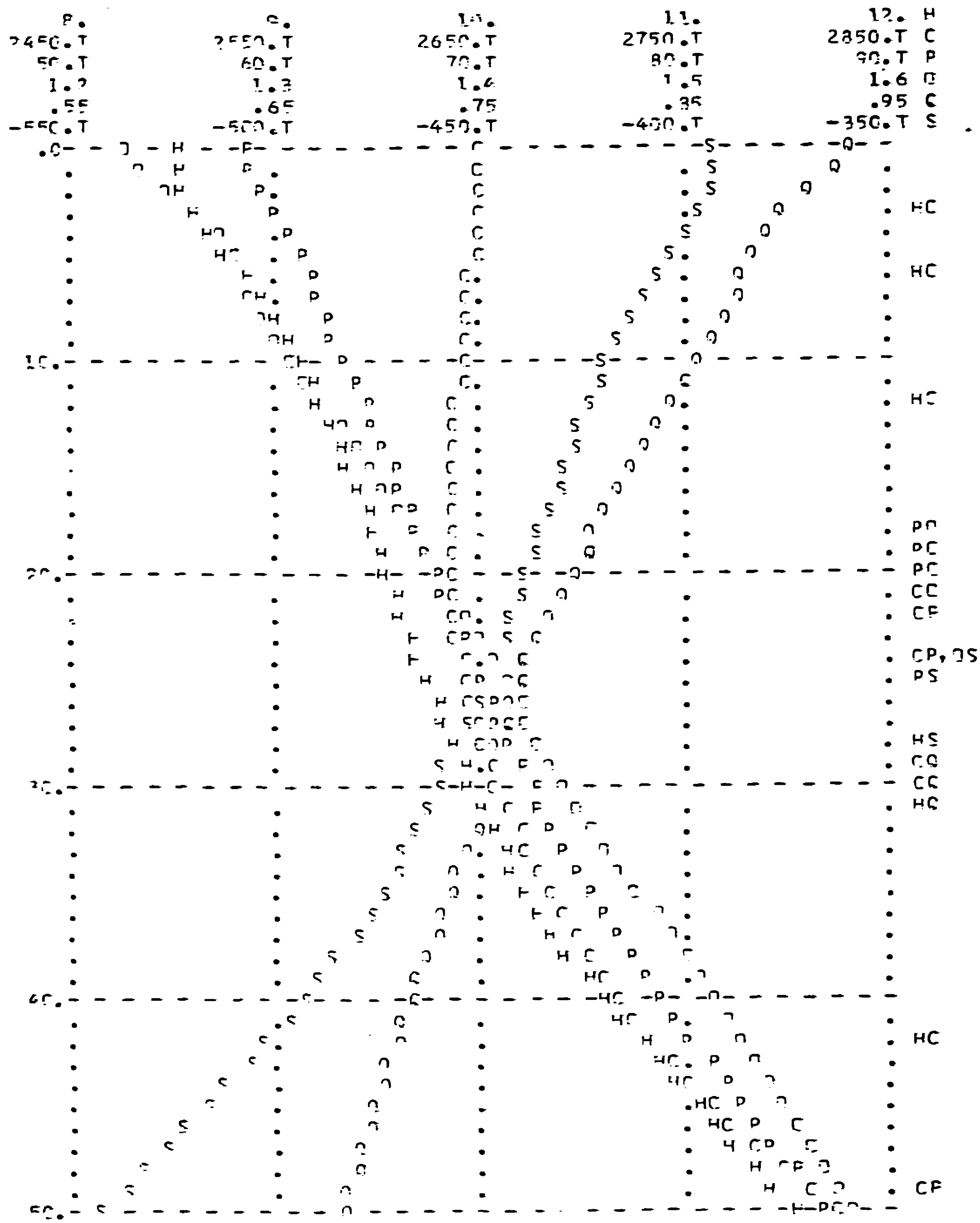
PAGE 3   USE OF CONTRACTED PHYSICIANS TO MAN EMERGENCY   3/21/72

CPHY=H,CAPINV=C,PAT=P,OLOAD=O,CPC=Q,PRELSS=S



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INT=I,RES=R,CAPINV=C,PAT=P,CLOAD=Q,CFC=G,PRELSS=S