THE USE OF COMPUTER SIMULATION IN HEALTH CARE FACILITY DESIGN

O. George Kennedy, Ph.D.

Manager, Management Systems - Midwestern Region

MEDICUS Systems

ABSTRACT

In this paper a decision-making tool for managers of hospitals and health care facilities, the management sciences technique of computer simulation modeling, is introduced. Its benefits as a planning and evaluative tool for hospital managers is illustrated by explaining a successful modeling application, a computer simulation model of physical therapy, developed at the Rehabilitation Institute of Chicago. With the physical therapy simulation as an example, the advantages of computer simulation modeling for containing costs and improving resource utilization and quality care are illustrated.

This paper is based on research supported, in part, by Demonstration Grant No. 12-P-55189/5-01, from the Social and Rehabilitation Service, U.S. Department of Health, Education, and Welfare, awarded to the Rehabilitation Institute of Chicago and HEW-SRS Medical Rehabilitation Research and Training Center Number Twenty.

The technique of computer simulation modeling has often been called a decision-making tool for managers. It is an especially appropriate tool for managers of health care facilities, who every day must make decisions on present operating conditions and on plans for the future, while faced with constraints on funds, staff, and facilities. Coupled with these constraints are the ever-present conditions of uncertainty, characteristic of health care services delivery, which can cause any planning effort to devolve into a guessing game.

In an effort to demonstrate that computer simulation modeling can help health care decision-making proceed on informed, objective grounds, the Rehabilitation Institute of Chicago (RIC) and the U. S. Department of Health, Education, and Welfare - Social and Rehabilitation Service Medical Rehabilitation Research and Training Center Number Twenty (RT-20) undertook a twelve-month pilot project to apply the techniques of management sciences to the delivery of rehabilitation health care services. At the onset of the study, RIC was finalizing plans for a new eighteen-story facility, now under construction, and was particularly concerned with the problems of marshalling and allocating sufficient resources to serve a projected patient load more than double its present occupancy.

An integral part of the study was the development of a computer simulation model of RIC's Physical Therapy Department -- a successful application of computer simulation modeling to be described in this paper. Benefits achieved to date from use of the model have yielded significant dollar savings and productivity increases, all without jeopardizing the quality of care delivered.

THE COMPUTER SIMULATION MODEL OF PHYSICAL THERAPY

The physical therapy department of a rehabilitation health care facility, like the one modeled here, is typically second only to the nursing service in the size of its staff and budget. It is also typically the departmental leader in producing annual revenue from patient treatment, since an overwhelming majority of the total patient population served by a rehabilitation facility will have regular physical therapy services prescribed.

The treatment delivered in a physical therapy service consists of the application of physical agents, such as heat and light, to restore gross physical function of disabled patients; continued exercise and progressive execution of simple tasks involving gross body movements and motor coordination are characteristic of the activities performed by a patient during treatment.

Although a great deal of capital equipment is utilized, physical therapy, like other areas of health care, is a labor-intensive service, drawing upon the skills of staff members who

have been licensed at a number of levels of professional accreditation. It is precisely this labor-intensive characteristic of physical therapy which makes the technique of computer simulation modeling useful. In physical therapy, improvements are generally made by altering staffing patterns, not by merely rearranging work areas, altering work flows, or using more equipment. Changing staffing patterns or reallocating work loads would be an expensive, time-consuming, and potentially risky course to take in a real-world physical therapy system, if the expected outcomes of the changes were uncertain. With a computer simulation model, however, these changes can be tested before implementation, without disrupting the normal delivery of services.

Because of the importance of staffing patterns in a physical therapy service, the core of the simulation model of physical therapy described here is the allocation of manpower and facilities resources to serve any defined patient population. In the past, the computer simulation model of physical therapy has helped health care managers to make decisions on the following alternatives for staffing their physical therapy departments: 1) increasing or decreasing staff; 2) increasing the number of outpatients who can be served; 3) changing the allocation of job tasks to staff members of different skill levels; and 4) increasing services to patients of selected disability groups. Other alternatives tested for total systems operations have been: 5) changing the geographical location of physical therapy areas within a hospital; and 6) determining an equitable charging scheme for physical therapy services.

HOW THE MODEL WORKS

The physical therapy simulation model is a stochastic and dynamic discrete-event simulation. It accomodates the occurence of events, such as patient tardinesses and patient and therapist absences, on a random basis according to probability distributions rather than on a predetermined fixed time basis, and it accounts for the variability in time expanded for treatments in the physical therapy system.

The physical therapy simulation was written in FORTRAN IV, using the FORTRAN-based simulation subroutine package SPURT/70 (Simulation Package for University Research and Teaching) developed at Northwestern University for the CDC 6400 computer system. Because of the model's basic three-component structure -- to be described below -- and the overlay and random mass storage capabilities of the CDC system, the total simulation executes in less than 43000_8 core locations and less than five minutes of computer time.

The total model is composed of three separable components: 1) a patient generating program (PATMIX); 2) the computer simulation program (PTSIM); and 3) a set of data analysis and report generating programs (RPKGS). The

patient generating program, PATMIX, is used to create a number of potential patient populations to be served by the physical therapy department. The program can vary the number of patients, their disabilities, ages, sexes, and the specific physical therapy tasks prescribed for them. PTSIM, the simulation program, replicates the operations of the physical therapy system for a day, a week, or a month of time. It is through the PTSIM component that the resources of the department, such as staff and equipment, and the operating conditions of the department are altered to test alternatives. The set of data analysis and report generating programs, RPKGS, generates reports which summarize the performance of the department under various patient loads and operating conditions.

The three basic components of the model are separable, so the model may be used with either current real data from an existing physical therapy system, or with data from a simulated hypothetical operation, as indicated by the arrows in Figure 1. Hypothetical patient populations may be created through PATMIX and run through the PTSIM simulation and the RPKGS data analysis programs. Or current real data from a real-world physical therapy system may be used to create a patient list for PTSIM, or for direct input to the RPKGS component only. Thus, an indepth analysis of current or planned therapy systems may be made by using all three components, and continued evaluation of physical therapy operations may be made economically by using the data analysis component only.

Model entities. The status of the physical therapy system in the model is determined through the values of its entities, both permanent and temporary.

The permanent entities in the model are physicians, therapists, aides, equipment, and other facilities. Entities are accounted for on an individual basis, except for the aides, who are treated as a manpower pool. Physician activities accounted for include only therapist assignments and activities such as medical counsel. Utilization of equipment is calculated on an hourly, daily, and weekly basis.

The temporary entities of the model are the patients and the tasks to be performed with them in physical therapy.

Model attributes. The physical therapy simulation model uses a number of demographic attributes to describe the entities of the model. The permanent attributes for therapists are therapist number, therapist name, sex, patients assigned to each therapist, physicians to whom they are assigned, scheduled times for all treatment and non-treatment tasks, hourly wages, capability for performing a number of treatment tasks, capability for treating patients with a given medical diagnosis and physical disability, maximum number of treatment hours for which they can be scheduled per day, and the maximum number of simultaneous patients

and treatment tasks which each therapist can handle.

The permanent attributes for physicians are physician name, physician number, sex, therapists assigned to each physician, and diagnosis classes of patients whom each physician may treat. Permanent attributes for equipment include cost data, set-up time, usage capability, and space requirements.

The permanent attributes of patients are patient number, the therapist and physician to whom the patient is assigned, diagnosis and disability category, sex, age, therapist preference list, arrival time scheduled for therapy, admission data, list of tasks to be performed in physical therapy, list of prescribed duration times for each task to be performed, all other clinical activities scheduled for the patient for the week, and an indicator of whether the patient is an inpatient or an outpatient.

Model processes. The relationships between the entities, sets of entities, and attributes of the entities is determined by the processes involved in the functioning of the system. From Figure 2, the basic flow of patients through a physical therapy system can be seen. Starting with the beginning of a simulated working day in physical therapy, the simulation runs through all events which have been scheduled for the day. It should be noted that the model considers all patients to have been scheduled for clinical therapy on a weekly basis, i.e., patients enter physical therapy and other therapies on an appointment basis only. Randomness is introduced into the model, however, by the occurrence of unforeseen events, such as the absence of patients or scheduled therapists, the patients' arriving late for therapies, and so forth.

The recurrent events in the model, then, are the arrivals of patients for scheduled therapy visits, their performance of therapeutic tasks while in physical therapy, and their completion of tasks and departure from the physical therapy system. For therapists, a number of non-treatment tasks, such as inservice training sessions, conferences with physicians, and home visits, are recurrent events as well as are the scheduled physical therapy sessions with patients. These, and other processes and events performed in the simulation are described in more detail below.

Patient Generation Process. A patient generating program, PATMIX, is used to create a number of alternative patient populations to be served by the physical therapy department. The user supplies a matrix of physical therapy task prescriptions for patients of various disabilities, and specifies the size and disability mix of the patient population to be created. PATMIX then generates a file of patients and their demographic attributes, with a full week's schedule of rehabilitative therapies for each patient. The user is able to specify up to 75 different

types of physical therapy tasks to be performed by the patients and up to 50 different disability groups to be represented in the population, all as input commands for PATMIX, and any number of files of patient population information may be generated with one run of the program.

Therapist Assignment Process. Upon the patient's entrance into the rehabilitation facility, a permanent physical therapist is assigned to care for the patient. The selection of the therapist is governed by the team concept adhered to at the facility and is strongly dependent upon therapist availability and capability. The model treats this process as already having been completed, and considers the therapist assignment to be a permanent attribute of each patient. Throughout the simulation, continuity of care is taken into consideration, with all attempts made to maintain a fixed therapist assignment for each patient.

The following processes are performed within the computer simulation program, PTSIM:

Therapy Reassignment Process. The therapy reassignment process is the crux of testing alternative staffing patterns for physical therapy. In the model, since patients are scheduled for therapy a week in advance and since patient-therapist assignments are considered permanent, if a therapist's absence is known at the beginning of the day, therapists can be assigned to treat extra patients. At the beginning of the day therapist absences are reviewed and a list is made of those patients who have to be treated temporarily by another therapist during the permanent therapist's absence. Therapist assignment is based on availability, compatibility, and capability. Multiple searches are made in the model to find a therapist who is free to take over for all the scheduled visits for the patient, under the rule that only one therapist will take over temporarily for any given patient. If no therapist is available during the patient's scheduled therapy times, searches are made through the rest of his schedule, and if possible his physical therapy treatment times are rescheduled to fit into a time when a temporary therapist will be able to work with him. Limits on the number of treatment hours for which a therapist can be scheduled, the maximum number of patients and tasks which can be handled simultaneously, and the maximum size of each therapist's daily case load are respected so that no therapist is overloaded by reassignments.

Patient Arrival Process. Patients may arrive in physical therapy either through their own accord or transported by a nurse or an aide. Since the patients are disabled, many suffering from locomotor disability, location of a previous appointment within the hospital and the distance the patient has to travel are crucial factors in determining whether or not the patient will arrive in therapy on time. A

number of probability distributions in the model randomly generate patients "late", "early", or "on time" for their appointments; other routines calculate the expected travel times, based on the preceeding appointment in the patient's schedule, and generate the time the patient will arrive in therapy.

Patient Search Process. In many physical therapy departments, especially those which serve a large outpatient population, cancellation of therapy visits is frequent. In the model, therefore, a patient file is maintained for use in searching for patients who can have their therapy hours moved up to fill in times when other patients cancel. Patient rescheduling is dependent upon the patient's permanent therapist being available during the proposed rescheduled time. Reassignment of a temporary therapist is not involved in this process.

End-of-task and Discharge Process. The duration of time a patient spends in physical therapy is dependent upon his physical stamina, his desire to stay to practice techniques learned, and his remaining therapy schedule for the day. Again, using probability distributions, all of these contingencies are accomodated in the model, generating discharge times which vary from the scheduled times of departure. If the patient is due in another clinical therapy department when his scheduled time is up, the patient is discharged from physical therapy, even if not all the tasks for him were rendered. The patients are allowed to stay beyond their scheduled visit times if they do not have another appointment following physical therapy, if they are capable of performing with limited supervision, or if the regular physical therapist or appropriate supportive personnel are available to continue therapy.

When the patient leaves the department, statistical data is gathered on the equipment used, the amount of time spent by the therapist in treating the patient, the total time spent by the patient in therapy, the time spent by the patient and therapist in execution of each prescribed physical therapy task, etc. This information, along with all the permanent attributes of the patients and therapists, is written onto two event notice files, one for therapists and one for patients. An individual record for each patient visit (and for each therapist non-treatment activity) is written on the files, so that detail on the operations of the physical therapy department is retained.

MODEL OUTPUTS

The data analysis and report generating packages, RPKGS, work on the two event notice files, generating up to 17 graphical and tabular reports which have been designed for use by managers of physical therapy services and administrators of rehabilitation health care facilities. The reports depicting time variables show intervals running on five minutes, fifteen minutes, half-hourly, hourly,

daily, or weekly time scales. The reports are available on a user-selection basis, and may be requested in various combinations for various time periods within a single run.

The reports focus on three common problem areas in the management of physical therapy services:

1) What is the overall allocation and utilization of the physical therapy system's resources?

2) What are the distributions of patient loads and of clinical and non-clinical activities among physicians and physical therapy staff members?

3) What are the requirements of different disability groups for physical therapy care? And what capabilities must physical therapy personnel have for treating patient populations which consist of various disability group mixes?

Figures 3, 4, and 5 concentrate on individual therapist activities. Figure 3 is a graphical display of daily therapist activities, showing the patient number of the patient treated if the therapist is engaged in patient treatment, and the name of the non-treatment task if the therapist is engaged in other business. A tabular summary of the simultaneous therapy activities performed by therapists is shown in Figure 4 which shows, also on a daily basis, the number of patients treated simultaneously and the duration of such treatments. Figure 5 is a weekly summary of the total treatment hours in which each therapist was engaged each day.

Figures 6, 7, and 8 illustrate medical staff assignments. Figure 6 is a matrix of the number of inpatients assigned to a physician-therapist team, and is designed for use in studying the team concept practiced at the facility. Figure 7 and 8 show the distribution of patients by disability group assigned to therapists and physicians, respectively. From these outputs, it is easy to see the range of capability for treating different disability groups which must be expected of active therapists and physiatrists at a rehabilitation facility; analysis may also be made of the assignement policies underlying the distribution.

Figures 9 through 11 are oriented toward individual patient analysis. Figure 9 is a summary of the number of treatment tasks performed by individual patients during a week, classified by type of treatment task. Figure 10 totals the number of treatments scheduled, received, and cancelled by each individual patient during a week. Figure 11 is a detailed summary of the distribution of arrival and departure times, both scheduled and actual, for patients each day.

Overall utilization of physical therapy facilities by patients is best illustrated by two companion outputs, Figures 12 and 13, which show, by time of day, the number of inpatients

and the number of outpatients present in the physical therapy facilities. A more specific breakdown of the number of patients receiving individual treatment tasks, Figure 14, is also available. In a similar format, another report not illustrated here shows the load upon each type of therapeutic equipment used in the department. For purposes of predicting utilization and staff with different patient disability mixes, Figure 15 is generated, showing, on a weekly basis, the number of units of each therapeutic task rendered to patients in each disability group served. Variability shown in this report indicates that patient mix can, in some cases, make a significant difference in manpower and facilities utilization. Two similar reports, again not illustrated here, tabulate the breakdown of utilization according to more precise categories of "exercise" and "functional activities" tasks.

Figure 16, the summary of the therapist allocation for the total patient population, is perhaps the most useful illustration of the staff utilization patterns that are pointed out by use of the simulation model. This report tabulates the number of hours of treatment time, the number of total treatments rendered, the number and types of patients seen throughout the day, and, most importantly, the number of patients seen simultaneously and the number of different treatment tasks supervised simultaneously. As can be seen from the example of this output shown in Figure 16, at times the real-world allocation of workloads in a physical therapy department is far from equitable.

RESULTS AND CONCLUSIONS

Although developed during a pilot research and demonstration project, the use of the physical therapy simulation model has had some very pragmatic cost-saving results for the rehabilitation facility modeled. Concretely, recommendations of the simulation study have led to the following improvements in the delivery of physical therapy services:

1) It was found that 70% of the treatment delivered in the department could be rendered from decentralized areas closer to the patient's rooms. Putting an exercise area on each patient ward and eliminating one floor of planned central physical therapy space, as recommended, will save a total of $576,000 in construction costs for a new 18-story, $26 million rehabilitation facility being built.

2) An estimated additional $10,000 increase in revenue annually will be obtained by decreasing patient travel time to the decentralized physical therapy areas and thereby reducing patient tardinesses and absences.

3) The physical therapy staff could be reduced by one-third, at an annual savings of $50,000. To date, with staff positions frozen, normal staff attrition has reduced the physical

therapy staff expenses by $20,000.

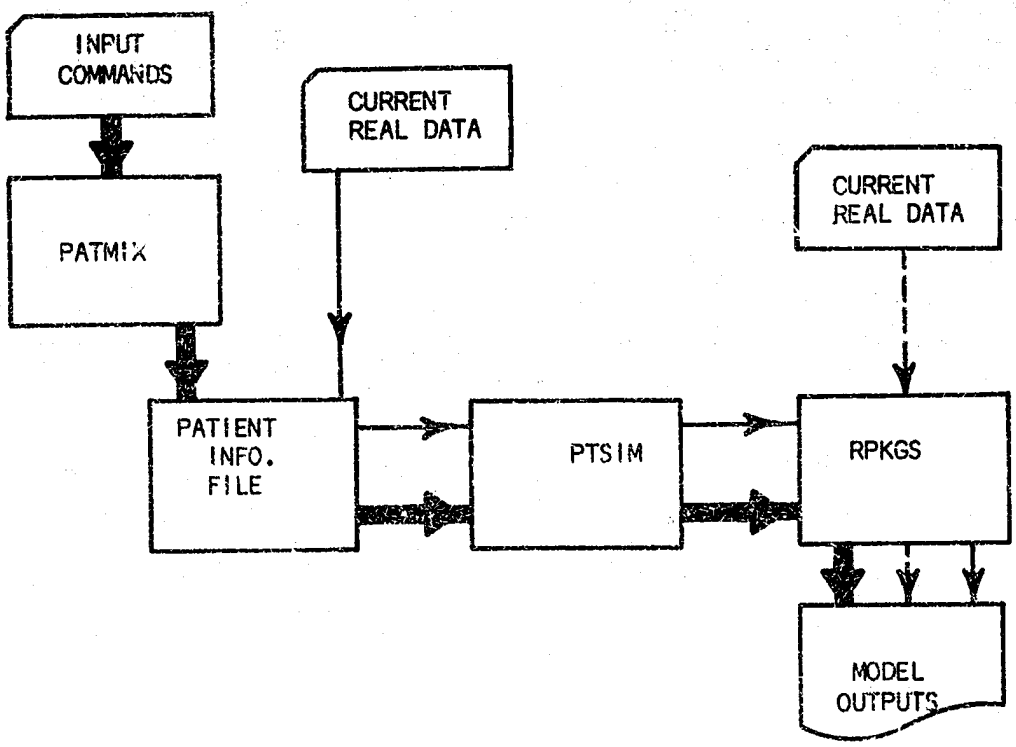
4) Even with decreased staff, the productivity of the physical therapy department has increased due to better scheduling of patient treatments and improved assignment of tasks to staff members of various skill levels. To date, productivity has increased by 30%, and the capacity to treat a burgeoning outpatient load has been increased by 25%.

More important for future research and progress in health care operations, however, are some results which cannot be so easily quantified. The first is the benefit shown by improved scheduling and rescheduling of patient treatments in physical therapy. In such a service, the performance of the total system may hinge upon the implicit rules used in assigning treatment times to incoming patients. Through use of the model, it has been demonstrated to physical therapy personnel that a relatively small number of patient and therapist attributes may be used to match capability, availability, and compatibility during a rescheduling effort. Hopefully, professionals in the field will work to define other of the "human factors" operative in scheduling, and advanced technological capabilities may be utilized in the future to perform much of the scheduling effort, to the benefit of overall departmental performance.

A second result is the awareness that the modeling approach is one step in proving that a large number of hospitals, although they savor their professed "uniqueness", are in fact very much alike. For instance, the variability of attributes, treatment tasks, staff and patient population sizes, etc., in the physical therapy model developed here have been used to show that, regardless of the specifics of the operating environment, the basic flow of activities through one physical therapy department resembles that of virtually any other physical therapy department. It is hoped that this characteristic of the modeling technique will be used in the future to produce results that may have "industry-wide" impact on our nation's health care system.

BASIC STRUCTURE
OF MODEL

FIGURE I



GENERAL PRIMARY SYSTEMS FLOW

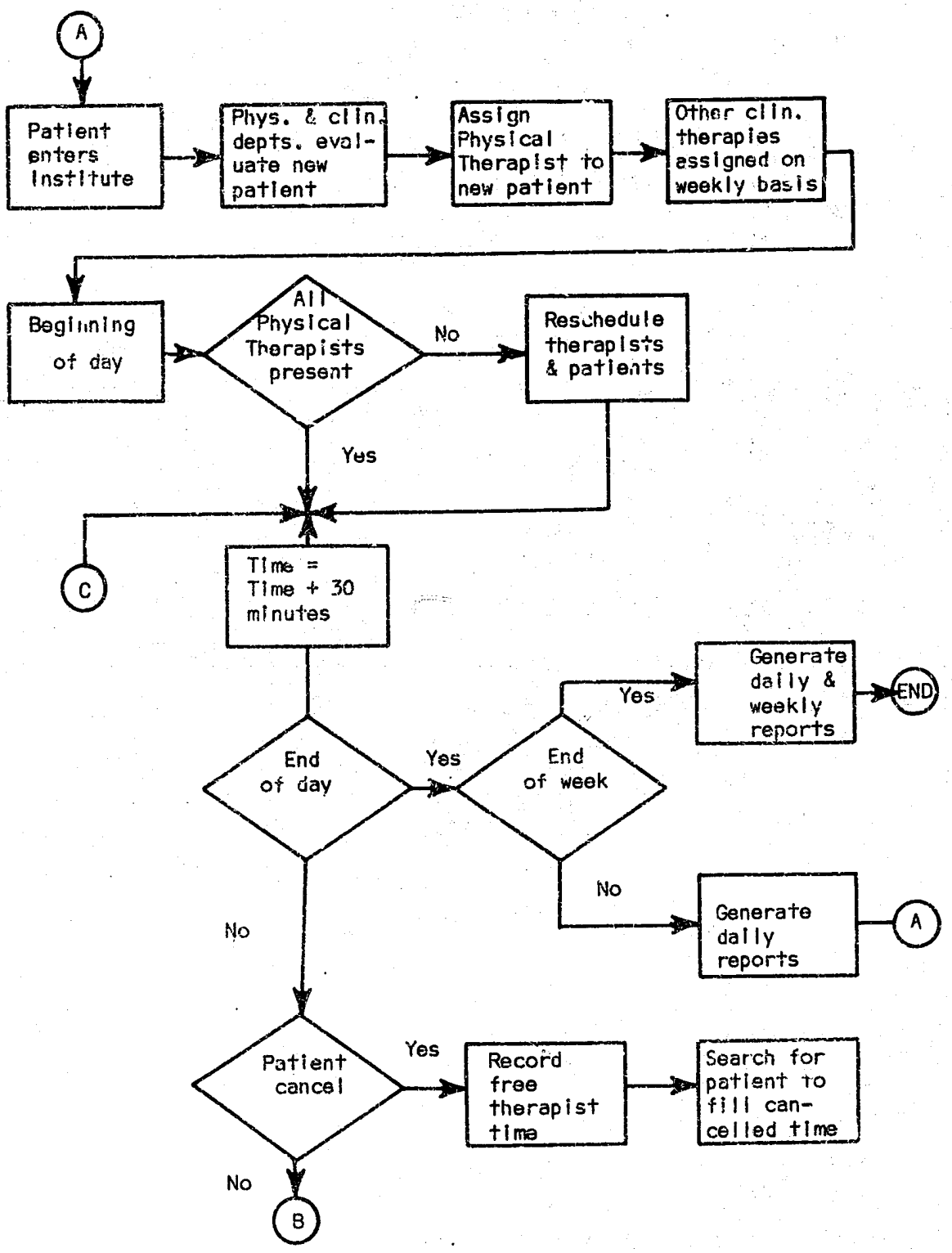


FIGURE 2

GENERAL PRIMARY SYSTEMS FLOW (con't)

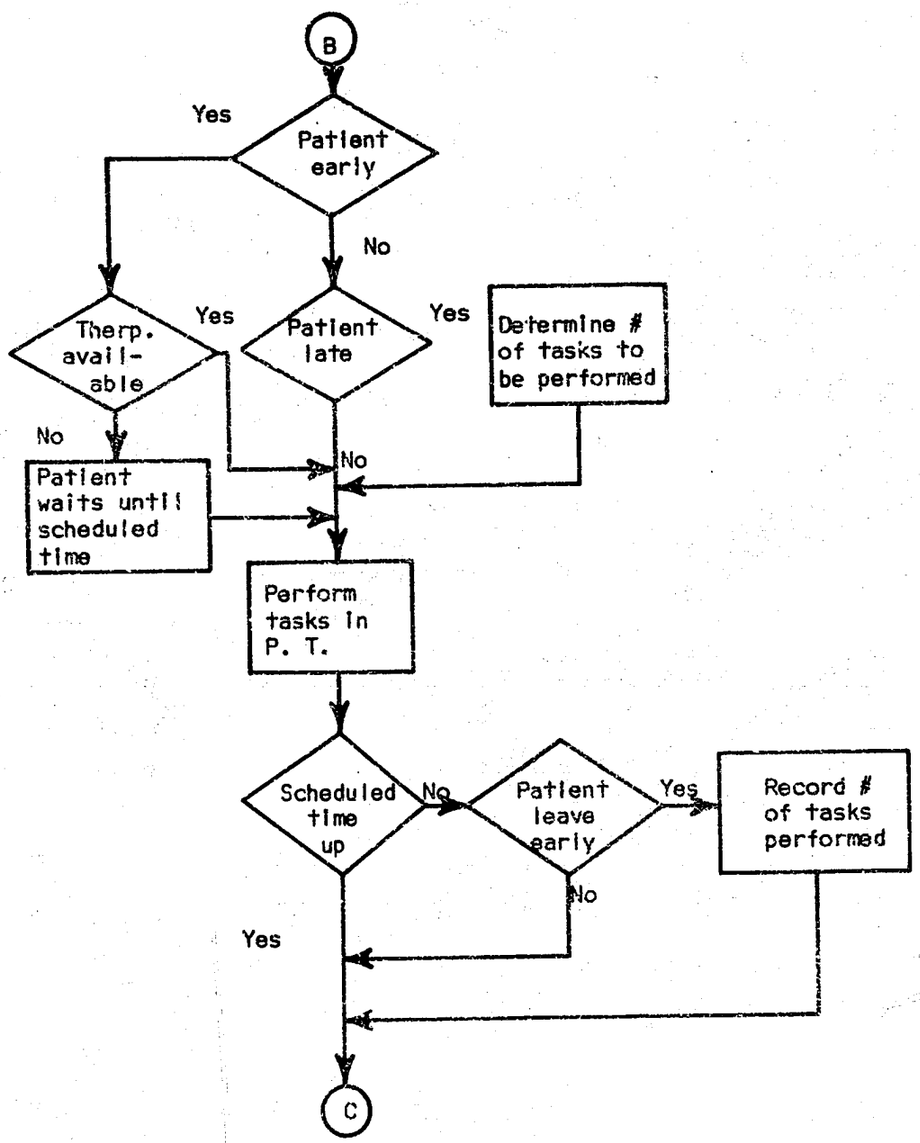


FIGURE 2

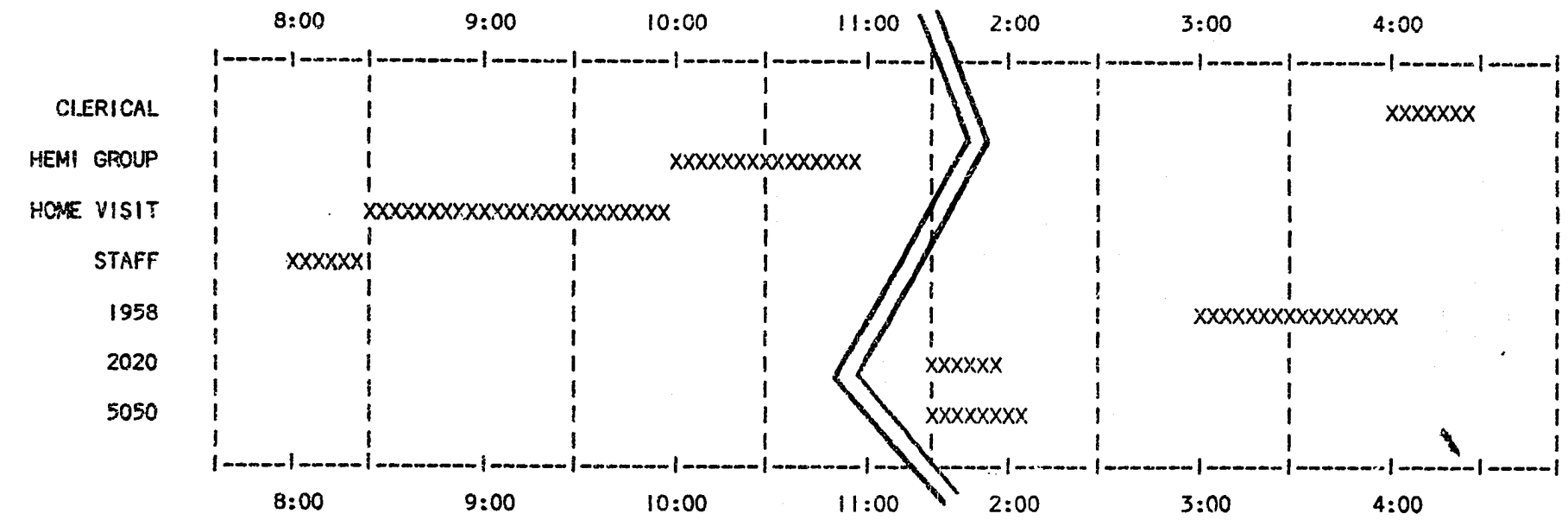
PHYSICAL THERAPY DEPARTMENT

DAILY THERAPIST ANALYSIS

THERAPIST NAME--- THERAPIST NO. DATE--- / /

PAT NO.

--- TIME OF DAY ---



NOTE: Figure is only partial output of computer print-out.

FIGURE 3

PHYSICAL THERAPY DEPARTMENT

THERAPIST TREATMENT SUMMARY

THERAPIST NAME THERAPIST NO. DATE -- / /

0 PATIENTS TREATED DURING 1.50 HOURS

1 PATIENTS TREATED DURING 1.00 HOURS

2 PATIENTS TREATED DURING 3.25 HOURS

3 PATIENTS TREATED DURING 1.25 HOURS

4 PATIENTS TREATED DURING 1.00 HOURS

THERAPIST NAME THERAPIST NO. DATE -- / /

0 PATIENTS TREATED DURING 1.75 HOURS

1 PATIENTS TREATED DURING 4.75 HOURS

2 PATIENTS TREATED DURING 1.50 HOURS

FIGURE 4

THERAPIST TREATMENT SUMMARY

PHYSICAL THERAPY DEPARTMENT

THERAPIST ATTENDANCE SUMMARY WEEK OF / /

THERAPIST	3/18	3/19	3/20	3/21	3/22	3/23	3/24
	7.00	6.75	0.00	0.00	6.25	6.25	6.25
	7.00	7.50	0.00	0.00	7.50	7.00	7.25
	6.25	5.75	0.00	0.00	6.50	6.50	6.00
	7.00	7.25	0.00	0.00	4.50	6.50	6.00
	3.25	7.00	0.00	0.00	6.25	6.75	7.25
	6.50	5.00	0.00	0.00	6.25	7.00	6.25
	4.00	4.25	0.00	0.00	3.50	3.00	4.00
	6.00	6.00	0.00	0.00	4.50	6.25	5.50
	7.00	7.00	0.00	0.00	6.75	6.00	6.50
	6.25	6.50	0.00	0.00	6.50	6.25	7.00
	3.75	5.25	0.00	0.00	5.25	2.00	5.00
	6.00	6.50	0 00	0.00	5.50	5.25	6.50
	7.25	3.75	0.00	0.00	6.00	5.00	5.25
	4.25	3.50	0.00	0.00	3.50	4.25	3.75

FIGURE 5

PHYSICAL THERAPY DEPARTMENT

PHYSICIAN-THERAPIST ASSIGNMENT WEEK OF / /

	--- PHYSICIAN NUMBER ---					
	7	11	50	65	80	
THERAPIST NO.						TOTALS
7	1	1	1	2	1	6
9	1	0	4	0	1	6
13	2	0	1	1	1	5
17	2	2	2	0	0	6
20	1	1	1	2	2	7
54	0	1	0	2	4	7
60	1	0	0	0	1	2
65	3	0	0	1	1	5
70	2	0	1	2	3	8
72	2	0	1	1	0	4
78	0	3	0	0	0	3
80	1	0	1	3	2	7
88	0	1	0	1	1	3
98	0	2	2	0	0	4
TOTALS	16	11	14	15	17	73

LEGEND: Matrix represents number of in-patients assigned to a physician and a therapist.

FIGURE 6

PHYSICAL THERAPY DEPARTMENT

DIAGNOSIS VS. TASKS RENDERED SUMMARY WEEK OF / /

DIAGNOSIS	--- TASKS --- B	FX	G	H	TR	LET	F	ROM	MT	XTRA	TOTALS
A/K AMPUTEE	1	13	11	0	2	2	2	0	0	0	49
BILATERAL A/K AMP	8	19	9	0	0	19	0	0	0	0	55
BILATERAL B/K AMP	0	0	0	0	0	9	0	0	0	0	9
OTHER OR MULT. AMP	0	9	2	2	0	10	0	1	0	0	26
TOTAL AMPUTEES	9	41	22	2	2	58		1	0	0	139
ARTHRITIS	0	18	11	10	0	0	0	2	0	0	50
RHEUMATOID ARTHRITIS	0	11	6	6	0	0	3	1	0	0	36
TOTAL ARTHRITIS	0	29	17	16	0	0	3		0	0	86
BURN	0	8	0	0	0	0	0	0	0	4	19
CEREBRAL PALSY	0	7	9	0	0	0	5		0	1	30
C.V.A	0	3	4	0	0	0	2	0	0	5	18
EVALUATION OR EMG	0	3	4	0	0	0	0	0	1	4	13
LEFT HEMIPLEGIA	0	24	22	0	0	0	1	4	0	11	85
RIGHT HEMIPLEGIA	0	8	4	3	0	0	0	0	0	0	15
RIGHT HEMI/APHASIA	0	21	21	0	0	0	10	0	0	3	64
TOTAL HEMIPLEGIA	0	53	47	3	0		24	4	0	14	164
POST FRACTURE	0	12	11	0	0	0	6	2	0	0	40
POST POLIO	0	5	0	0	0	0	3	0	0	0	8
PARAPLEGIA/PARESIS	1	119	58	0	0	0	45	12	2	26	303
QUADRIPLEGIA/PARESIS	0	53	15	0	0		31	5	0	0	108
TOTAL SPINAL CORD	1	172	73	0	0	0	76	17	2	26	411
POST SURGERY	0	5	5	0	0	0		0	0	4	19
OTHER INJURY	0	13	9	0	0	0		0	0	0	34
OTHER PARALYSIS	0	17	3	1	0	0	8	3	3	0	43
CENTRAL NERVOUS	0	9	8	0	0	0	9	0	0	0	27
CARDIO-VASCULAR	1	5	5	0	0	0	0	3	0	0	16
MUSCULAR SKELETAL	0	3	6	0	0	7	3	0	0	0	22
--- GRAND TOTALS	11	385	223	22	2	65	147	3	6	58	1089

NOTE: Figure is only partial output of computer print-out.

FIGURE 7

PHYSICAL THERAPY DEPARTMENT

MEDICAL STAFF ASSIGNMENT VS. DIAGNOSIS CLASS WEEK OF / /

	--- PHYSICIAN NUMBER ---					
DIAGNOSIS	7	11	50	65	80	TOTALS
A/K AMPUTEE	0	0	1	2	0	3
BILATERAL A/K AMP	1	0	0	1	0	2
BILATERAL B/K AMP	1	0	0	0	0	1
OTHER OR MULT. AMP	0	0	0	1	0	1
TOTAL AMPUTEES	2	0	1	4	0	7
ARTHRITIS	1	0	0	1	0	2
RHEUMATOID ARTHRITIS	0	1	0	1	0	2
TOTAL ARTHRITIS	1	1	0	2	0	4
BURN	0	1	0	0	0	1
CEREBRAL PALSY	0	3	0	0	0	3
C.V.A.	1	0	0	0	0	1
EVALUATION OR EMG	0	0	0	1	0	1
LEFT HEMIPLEGIA	3	0	2	3	4	12
RIGHT HEMIPLEGIA	0	0	0	0	1	1
RIGHT HEMI/APHASIS	2	0	2	0	1	5
TOTAL HEMIPLEGIA	3	0	2	3	4	12
POST FRACTURE	1	0	0	0	1	2
POST POLIO	0	0	1	0	0	1
PARAPLEGIA/PARESIS	6	3	5	4	5	23
QUADRIPLEGIA/PARESIS	2	0	4	0	3	9
TOTAL SPINAL CORD	8	3	9	4	8	32
POST SURGERY	0	0	0	0	1	1
OTHER INJURY	0	2	0	0	1	3
OTHER PARALYSIS	0	0	1	0	2	3
CENTRAL NERVOUS	0	1	0	1	0	2
--- GRAND TOTALS	16	11	14	15	17	73

FIGURE 8

PHYSICAL THERAPY DEPARTMENT

SUMMARY OF TASK COUNTS WEEK OF / /

PATIENT NUMBER	--- TASKS --- B	EX	G	H	IR	LET	M	W	UFT	UV	HT	WT	TT	F	ICE	E	ROM	MT	XTRA	TOTALS
1958	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
4521	0	5	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	10
4639	0	3	0	0	0	0	0	0	0	0	0	0	0	2	5	1	0	0	0	11
5546	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
5859	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	6
6370	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
6497	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
6990	0	4	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	8
7233	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
7556	0	4	4	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	12
7612	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
7617	0	3	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	9
8001	0	2	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	8
8128	0	1	2	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	13
8134	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
8189	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	7
8196	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	8
8200	0	1	5	0	0	0	0	0	0	0	10	0	2	0	0	0	0	0	0	18
8227	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	10
8303	0	8	8	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	10
8325	0	5	5	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	
	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0		8
	0	3	3	0	0	0	0	0	0	0	0	0	0	0	2	1	0	3		12
845	0	1	1	0	0	0	0	0	0	0	0	0	0	4	0	5	2	0	0	13
8846	0	2	6	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	14
8847	0	4	0	0	-	0	0	0	0	0	0	0	0	0	0	3	2	3	0	12
TOTALS	11	385	223	22	2	65	9	8	1	0	16	14	38	147	16	25	34	6	58	1089

TOTAL PATIENTS--- 100 NOTE: Figure is only partial output of computer print-out.

FIGURE 9

PHYSICAL THERAPY DEPARTMENT

PATIENT ATTENDANCE SUMMARY WEEK OF / /

PATIENT NUMBER	VISITS SCHEDULED	VISITS RENDERED	VISITS CANCELLED
1958	8	7	1
4521	5	5	0
4639	5	5	0
5546	10	7	3
5859	2	2	0
6370	3	3	0
6497	5	4	1
6990	5	4	1
7233	5	5	0
7556	5	5	0
7612	5	3	2
7617	3	3	0
8001	3	3	0
8128	10	10	0
8134	1	1	0
8189	8	7	1
8196	5	4	1
8200	10	10	0
8227	5	5	0
8303	5	5	0
8325	10	9	1
8336	4	2	2
8357	4	4	0
8376	1	1	0
8421	3	3	0
8440	10	10	0
8446	5	5	0
8487	9	8	1
8513	2	2	
8519	3	3	0
8525	5	4	0
[illegible]	10	9	0
8828	10	[illegible]	0
8832	5	8	2
8834		5	0
6837	5	5	0
8842	5	5	0
8845	8	6	2
8846	8	7	1
8847	4	4	0
8848	1	0	1
TOTALS	620	564	56
TOTAL PATIENTS	101		

NOTE: Figure is only partial output of computer print-out.

FIGURE 10

PHYSICAL THERAPY DEPARTMENT

PATIENT THERAPY SCHEDULE

DATE --- / /

PATIENT NUMBER	MORNING SCHEDULED IN	MORNING SCHEDULED OUT	MORNING ACTUAL IN	MORNING ACTUAL OUT	AFTERNOON SCHEDULED IN	AFTERNOON SCHEDULED OUT	AFTERNOON ACTUAL IN	AFTERNOON ACTUAL OUT
1958	10:00	11:00	10:00	11:00	12:30	1:30	12:30	1:50
4521					2:00	3:00	2:00	3:00
4639					2:30	3:30	2:30	3:30
5546	9:00	10:00	-----	-----	1:00	3:00	1:00	3:00
6370	9:30	10:30	9:30	10:30				
6497					2:30	3:30	2:30	3:30
6990	10:30	11:30	10:30	11:30				
7233					3:00	4:00	3:00	4:00
7556	11:00	12:00	11:15	12:00				
7612					1:00	2:00	1:00	2:00
7617	9:00	11:00	9:00	11:00				
8001	8:30	9:30	8:30	9:30				
8128	9:00	11:30	9:00	11:30	12:30	3:30	1:00	3:30
8189	9:00	11:30	-----	-----	1:00	2:00	1:00	2:00
8196					1:30	2:30	1:30	2:30
8200	10:00	11:00	10:00	11:10	2:30	3:30	2:30	3:50
8227					2:30	3:30	2:30	3:30
8303					2:00	3:00	2:00	3:00
8325	9:00	10:30	9:00	10:30	1:00	2:30	1:00	3:00
8357	10:00	11:30	10:00	12:00	1:30	3:00	1:30	3:25
8421	10:00	11:00	10:00	11:00				
8440	8:30	10:00	8:30	10:00	1:00	3:30	1:00	3:50
8446	9:00	10:00	9:00	10:00				
8487	8:30	9:30	-----	-----				
8513					1:00	3:00	1:00	3:00
8519					2:00	3:00	2:00	3:00
8525	10:00	11:00	10:00	11:00				
8528	8:30	9:30	-----	-----	12:30	1:30		
8537	8:30		8:30	9:45	1:00	2:00		
85		9:30			2:00		1:00	3:15
				10:30		3:14	-----	3:;4
8797	10:00	12:00	10:00					
8812					1:30	2:30	1:30	2:30
8816	8:30	9:30	8:30	9:30				
8823	8:30	10:00	8:30	10:00				
8826					2:00	3:00	2:00	3:00
8832	10:00	11:00	10:00	11:00	12:30	1:30	12:30	1:30
8834	10:00	11:00	10:00	11:45				
8837	9:30	10:30	9:30	10:40				
8842	10:00	11:00	10:30	11:25				
8845	10:00	11:00	10:00	11:00	1:00	2:00	1:25	2:00
8846	8:30	10:30	8:30	10:30	3:00	4:00	-----	-----
8847					2:30	3:30	2:30	3:30

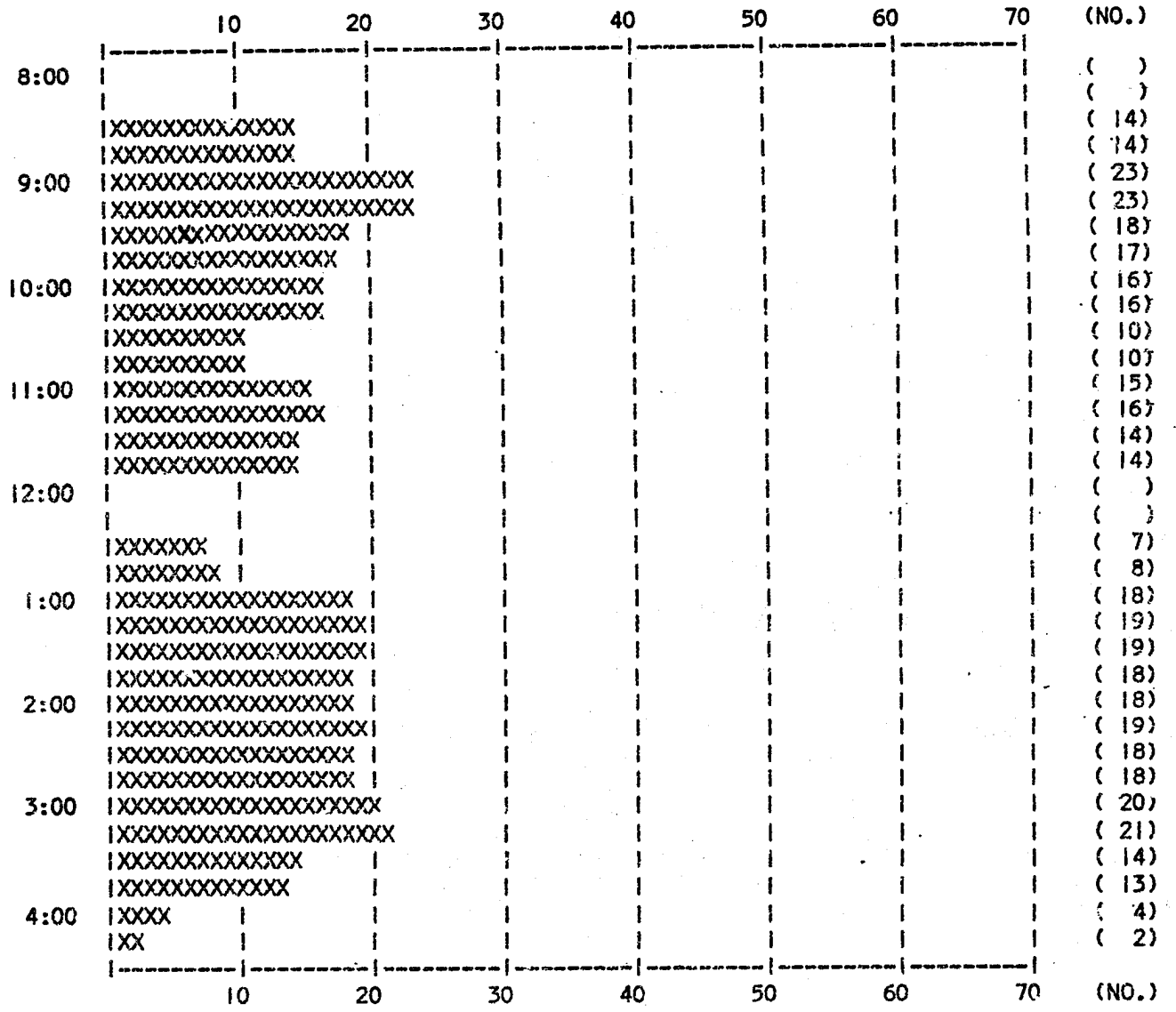
TOTAL PATIENTS: 89

NOTE: CANCELLATION DENOTED BY: -----

NOTE: Figure is only partial output of computer print-out.

FIGURE 11

NO. OF IN-PATIENTS IN PHYSICAL THERAPY VS. TIME OF DAY DATE --- / /



NO. OF IN-PATIENTS IN PHYSICAL THERAPY VS. TIME OF DAY

FIGURE 12

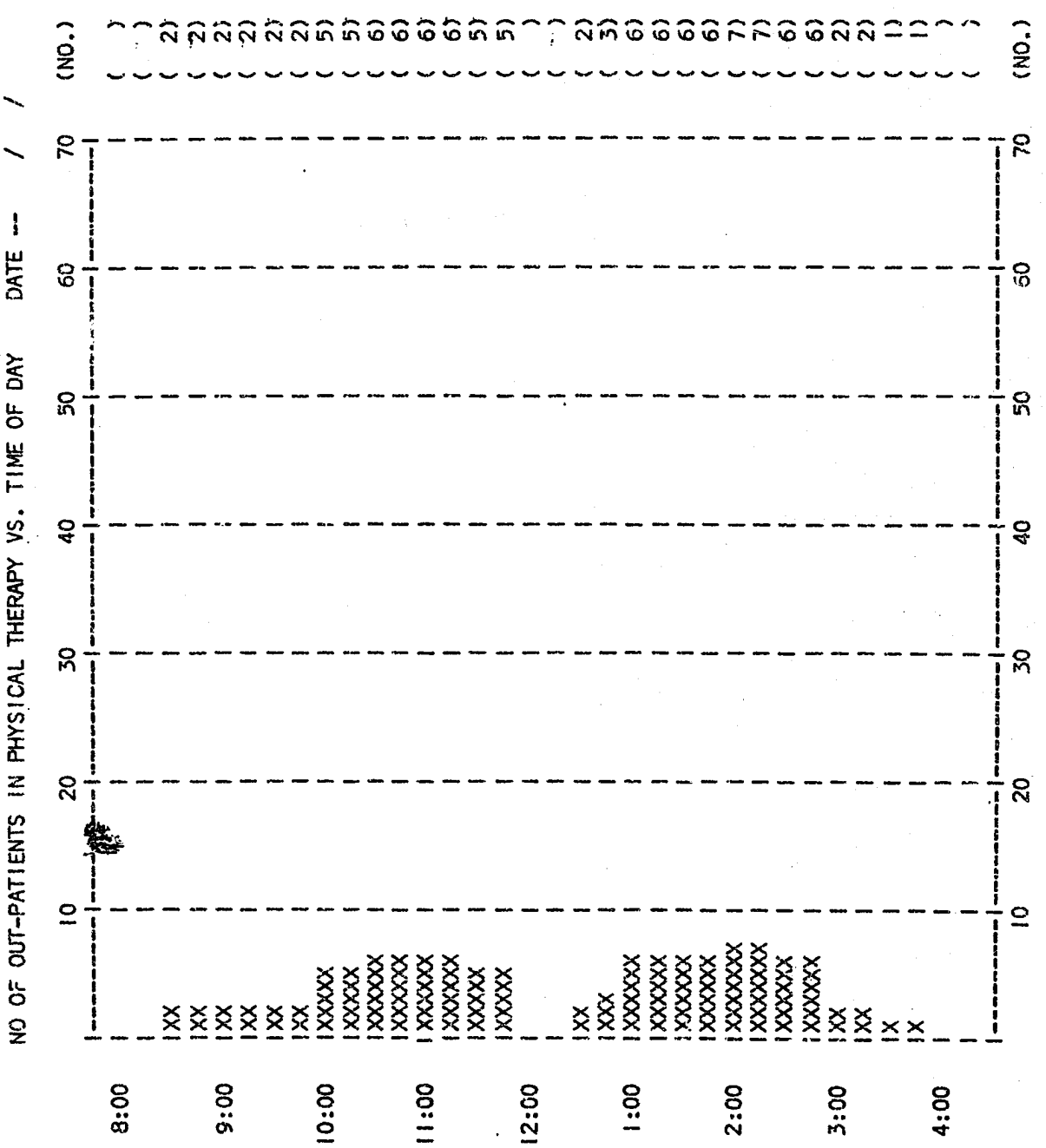

NO. OF OUT-PATIENTS IN PHYSICAL THERAPY VS. TIME OF DAY
NO OF OUT-PATIENTS IN PHYSICAL THERAPY VS. TIME OF DAY
DATE -- / /
(NO.)
(NO.)
10
20
30
40
50
60
70
8:00
9:00
10:00
11:00
12:00
1:00
2:00
3:00
4:00

FIGURE 13

PHYSICAL THERAPY DEPARTMENT

NO. OF PATIENTS RECEIVING TREATMENT VS. TIME OF DAY

TASK: EXERCISE DATE -- / /

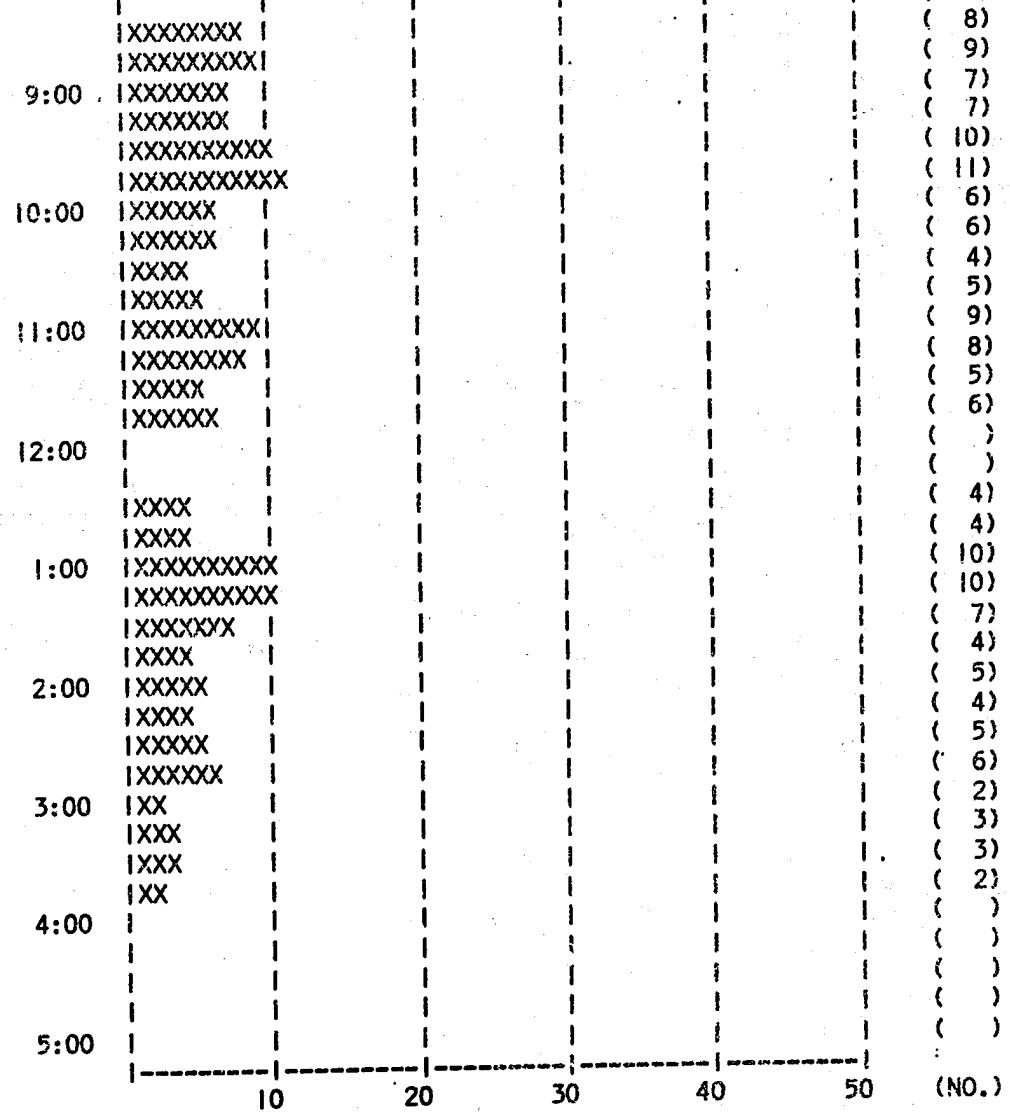


FIGURE 14

PHYSICAL THERAPY DEPARTMENT

MEDICAL STAFF ASSIGNMENT VS. DIAGNOSIS CLASS WEEK OF / /

	--- THERAPIST NUMBER ---						
DIAGNOSIS	7	9	13	80	88	98	TOTALS
A/K AMPUTEE	2	0	0	0	0	0	3
BILATERAL A/K AMP	1	0	0	0	0	0	2
BILATERAL B/K AMP	0	0	0	1	0	0	1
OTHER OR MULT. AMP	0	0		0	0	0	1
TOTAL AMPUTEES	3	0	0	1	0	0	7
ARTHRITIS	0	0	0	1	0	0	2
RHEUMATOID ARTHRITIS	0	0	0	1	0	0	2
TOTAL ARTHRITIS	0	0	0	2	0	0	4
BURN	0	0		0	0	0	1
CEREBRAL PALSY	0	0	0	0	1	0	3
C.V.A.	0	1	0	0	0	0	1
EVALUATION OR EMG	0	0	1	0	0	0	1
LEFT HEMIPLEGIA	1	0	1	0	0	0	6
RIGHT HEMIPLEGIA	0	0	0	0	0	0	1
RIGHT HEMI/APHASIA	0	0	1	1	0	0	5
TOTAL HEMIPLEGIA	1	0		1	0	0	12
POST FRACTURE	0	0	0	0	0	0	2
POST POLIO	0	1	0	0	0	0	1
PARAPLEGIA/PARESIS	1	2	0	2	1	2	23
QUADRIPLEGIA/PARESIS	0	1	0	1	0	1	9
TOTAL SPINAL CORD	1	3	0	3	1	3	32
POST SURGERY	0	0	0	0	1	0	1
OTHER INJURY	1	0	0	0	0	0	3
OTHER PARALYSIS	0	1	0	0	0	0	3
CENTRAL NERVOUS	0	0	0	0	0	1	2
--- GRAND TOTALS	6	6	5	7	3	4	73

LEGEND: Matrix represents number of in-patients assigned to a therapist.
Figure is only partial output of computer print-out.

FIGURE 15

FIGURE 16

THERAPIST ALLOCATION FOR 14 THERAPISTS
TREATING PATIENT POPULATION: 71 IN-PATIENTS, 17 OUT-PATIENTS

THERAPIST NUMBER	TOTAL # OF TREATMENT HOURS	MAX. # OF PATIENTS TREATED*	MAX # OF TASKS PERFORMED*	# OF PATIENTS WITH ONE VISIT	# OF PATIENTS WITH TWO VISITS	TOTAL PATIENTS	TOTAL VISITS
1	6.5	5	5	3	5	8	13
2	6.5	4	3	6	2	8	10
3	4.5	3	2	5	1	6	7
4	6.0	2	2	8	0	8	8
5	6.0	4	3	8	0	8	8
6	6.5	3	3	4	3	7	10
7	4.0	2	2	0	2	2	4
8	6.0	3	2	2	3	5	8
9	6.5	3	3	7	2	9	11
10	6.0	4	4	5	2	7	9
11	4.0	3	3	2	2	4	6
12	6.5	3	3	4	4	8	12
13	5.0	2	1	3	1	4	5
14	2.5	3	2	4	0	4	4

*Treatment based on 15 minute intervals
(Therapists #7 and #11 are supervisors, maximum of 4.5 treatment hours per day)