SIMULATION MODELS AS A BASIS FOR DESIGNING EVALUATION DATA BANKS

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Simulation typically has been a tool which used data banks as a source of information. This project turns the problem around as simulation is used as a tool to help design an evaluation data bank. The Midwest Regional Spinal Cord Injury Care System (MRSCICS) centers around the Wesley Pavilion of Northwestern Memorial Hospital and the Rehabilitation Institute of Chicago. In the process of trying to develop and improve MRSCICS, an evaluation data bank was planned to determine the effects of different system changes. Martin (1973) developed a flow chart which illustrates the essential nature of this system. Illustration 1 is this flow chart. He then proceeded to use a computer data base language, RIQS (Borman, Dillaman and Chalice, 1971) to establish a data bank for the different types of information necessary to observe and evaluate the operation of the system. In many cases, a more rigorous basis was attempted. The system was implemented and an initial set of data has been entered. A detailed analysis of data quality and the problems of data gathering have made it critical to validate whether the data base has the right data and to determine where investments for the improvement of data quality seem important. Obviously, data to meet Federal data interchange requirements and the research needs of the medical staff and others are included. Our question was can we recover the essential nature of the system.

The first evaluation was to see whether a simple simulation could be developed using the data existing in the data bank and whether this simulation was capable of running. Such a simulation was developed using SPURT (Vogelback Computing Center, 1970). This FORTRAN based language was used to build a simulation in which the major flows were modeled but which did not track or get concerned with individual patients. This weakness was later remedied. Still, the ability of building a simulation using data, all of which was in the data bank, does increase the credibility of the data bank as it must have the minimum necessary information to reconstruct the system. Obviously, all the major ingredients must be in the data base or else a valid simulation cannot be built. A more sophisticated simulation using SIMSCRIPT has been developed but not run with final data at this time. The SIMSCRIPT simulation is capable of testing the relative sensitivity of the key variables to determine what the impact of error in the parameter estimation will have on the results of the simulation. A series of sensitivity studies will help determine where the investment in the improvement of the data system can be carried out. Thus, a simulation becomes a tool for the validation and improvement of a data base. A description of this simulation follows.

The first computer simulation was programmed in FORTRAN with SPURT routines in a parameterized, modular form providing flexibility to the structure of the simulated system and the parameters characterizing the flows through the various subsystems. These features are desirable in the developmental stages when the structure and flows in the present system are clarified; these features are useful as well in the evaluation of potential alternative systems. The program has about 480 instructions on the Northwestern University Vogelback Computing Center CDC 6400. A typical run costs about $5.00.

The flow charts shown below outline the simulation program (Illustration 2) and the system structural parameters (Illustration 3) chosen from the data bank which were employed in the simulation runs. Hypothetical distributions for the occurrence of events in the various parts of the system had been used here, as the data bank did not have a large enough sample for the distributions.

Modules representing empirical distributions of occurrences of events conditioned on factors of increasing complexity compatible

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with the desired approach to realism, are readily incorporated in the present modular structure of the program. Validity of each module may be investigated individually and in conjunction with the other modules in the system.

As the increasingly complex effects of patient characteristics, nature of injury, characteristics of the various phases of the rehabilitation process on the time, costs, and degree of success of treatment are incorporated in the modules, the simulation program in its present form may require revision in structure, coding, or both. The final form of the simulation program will be written in SIMSCRIPT while retaining its modular form. Illustration 4 shown below outlines the structure of a generalized simulation module.

Simulation offers an approach to the evaluation of data systems through its use in the identification of functions which bear on the choice of data. The relative importance of data quality and sample sizes in the design of data systems may be studied.

GENERALIZED SIMULATION MODULE STRUCTURE:

DATA ON PATIENTS - Depending on the process being studied and the level of detail, this table, chart, etc. contains those variables which are being studied in their effects on performance measures for the system.

DATA ON HEALTH FACILITY - Depending on the process and level of detail being considered, the data which are read into this store will pertain to variables consistent with those for the patient in that process.

GENERATE PATIENT - The patient generation may involve reading in actual historical cases or hypothetical cases based on DATA ON PATIENTS.

RECORD SIMULATED PATIENT DATA - This stage provides for the storing of information on the patient at every stage in the progress through the system.

DETERMINE NEXT STAGE FOR THIS PATIENT - On the basis of patient data at a given stage in the treatment of the patient and data on the existing health facility at that time, the next stage where the patient will proceed is determined. A basic consideration in this determination is the patient attribute mix at this time in relation to wha. the health facility could provide.

PATIENT ENTERS NEXT STAGE - and - PATIENT IS IDENTIFIED - These stages involve the arrival and identification of the patient as the time for entry into the next stage occurs in the simulation; this allows proper scheduling of patient admission according to desired admission criteria and priorities.

RESULTING DATA ON PATIENT - As a result of patient interaction with the next stage, additional simulated data are generated and these data are stored in "SIMULATED PATIENT DATA"; any system evaluation at this stage may also be performed.

RESULTING DATA ON FACILITY - As a result of patient interaction (or non-interaction) with the next stage, updated data on this stage are generated and recorded in "DATA ON HEALTH FACILITY"; system evaluation at this stage may also be performed.

EVALUATE SYSTEM MEASURES - Specified measures of system performance are computed and/or evaluated in the desired manner either at every stage in the process or at the conclusion of the simulation, or both.

BIBLIOGRAPHY

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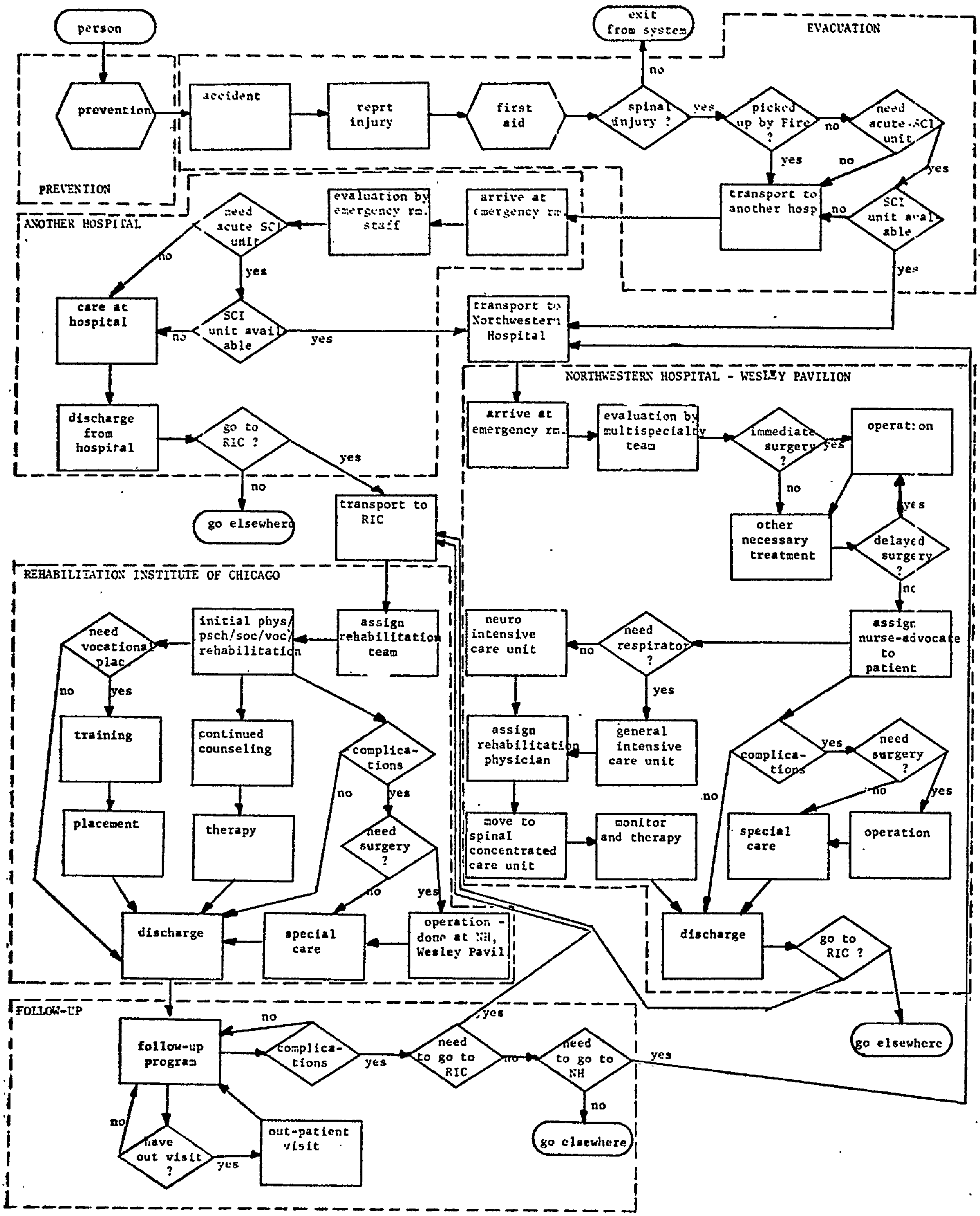
2. Martin, Thomas. "The Design of a System Evaluation Data Base for the Midwest Regional Spinal Cord Injury Care System", unpublished thesis, Graduate School, Northwestern University, Evanston, Illinois, 1973.
3. "SPURT/70", Vogelback Computing Center, Northwestern University, Evanston, Illinois, Dec. 1970.
4. Midwest Regional Spinal Cord Injury Rehabilitation System", Northwestern University, Evanston, Illinois, April, 1972.

PATIENT FLOW CHART FOR

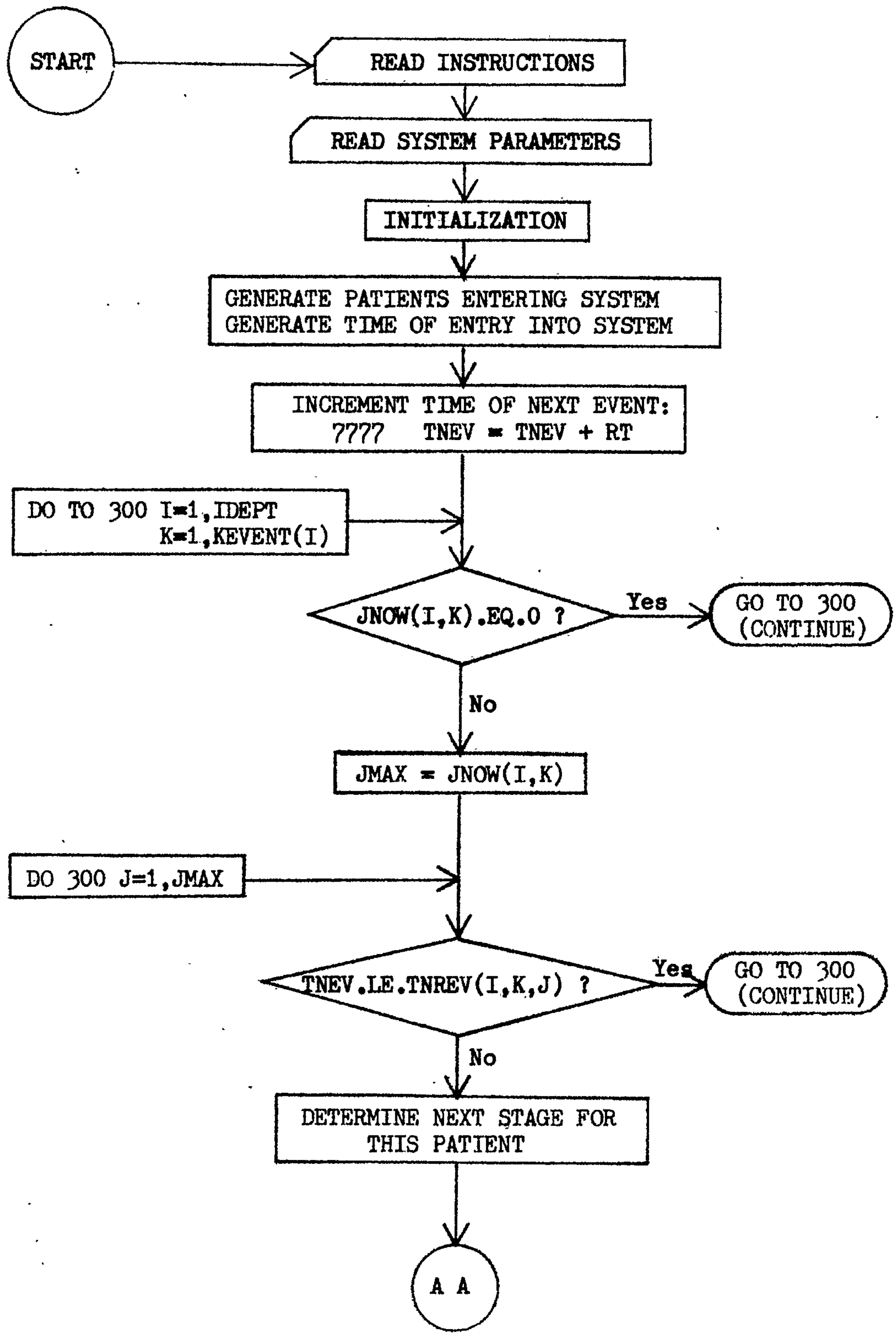
THE MIDWEST REGIONAL SPINAL CORD INJURY CARE SYSTEM.

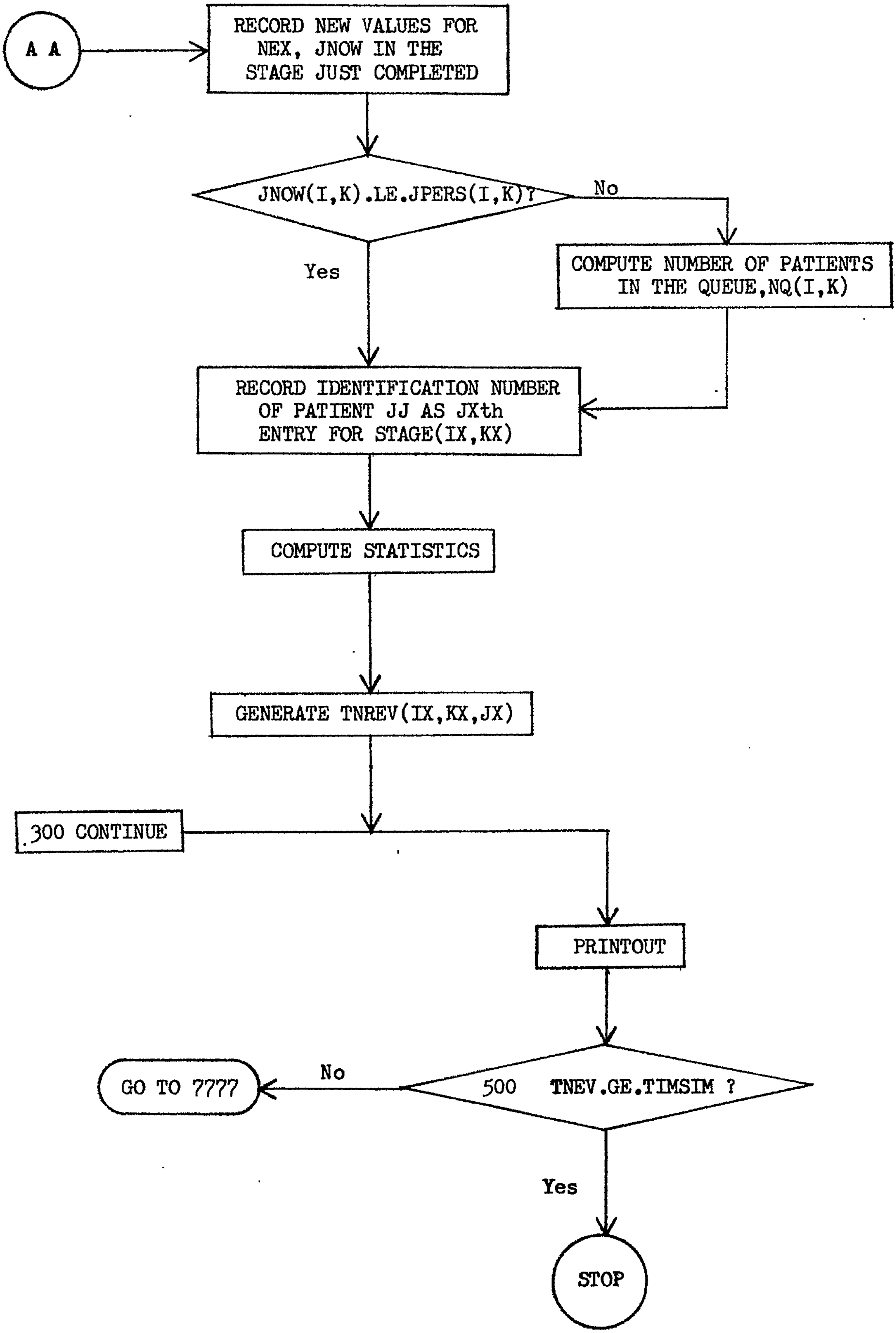


Martin, Thomas, "The Design of a System Evaluation Data Base for the Midwest Regional Spinal Cord Injury Care System", unplublised thesis, Graduate School, Northwestern Univ., Evanston, Illinois, 1973.

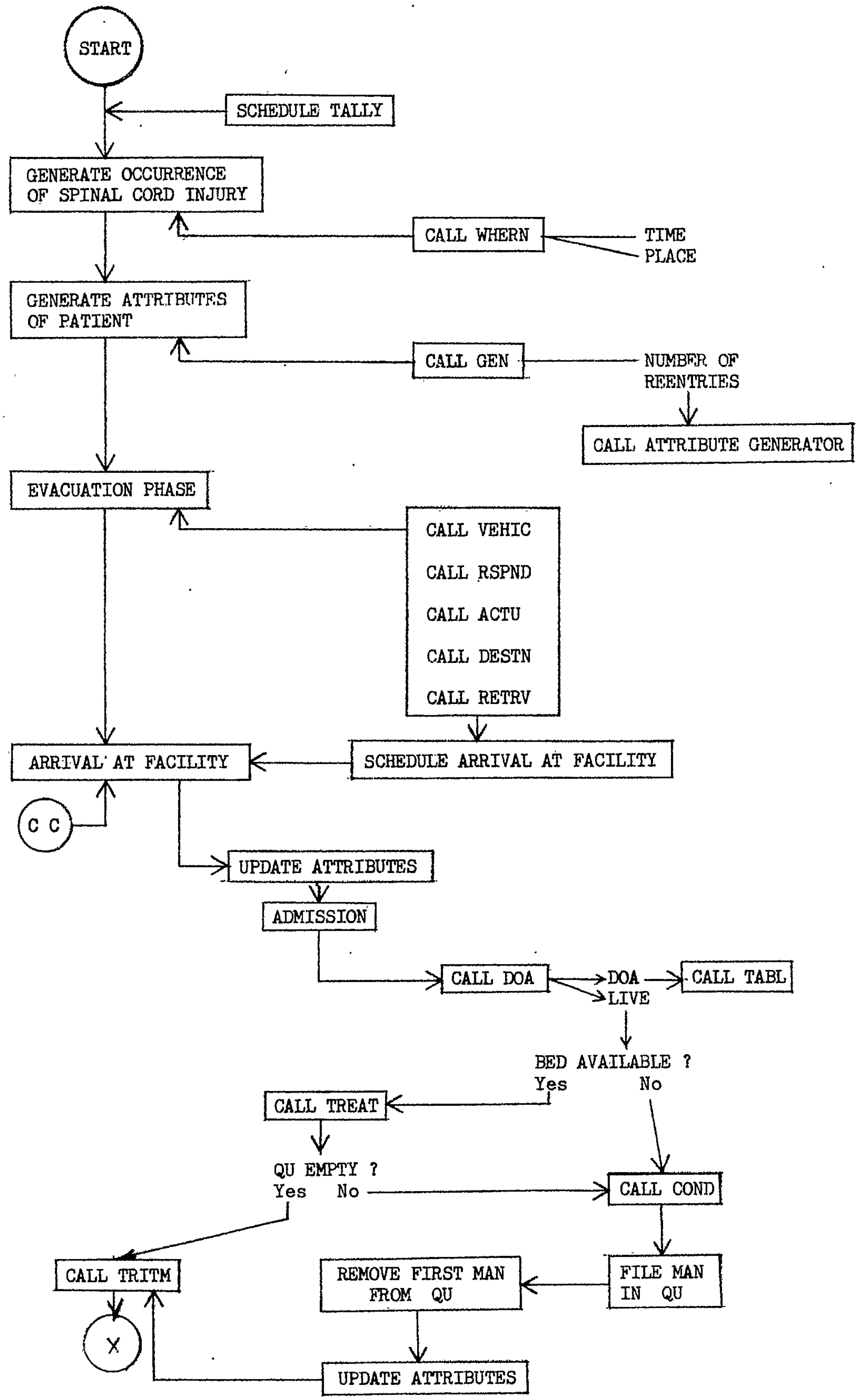
FLOW CHART FOR A COMPUTER PROGRAM TO SIMULATE SPINAL CORD REHABILITATION SYSTEM FOR CHICAGO

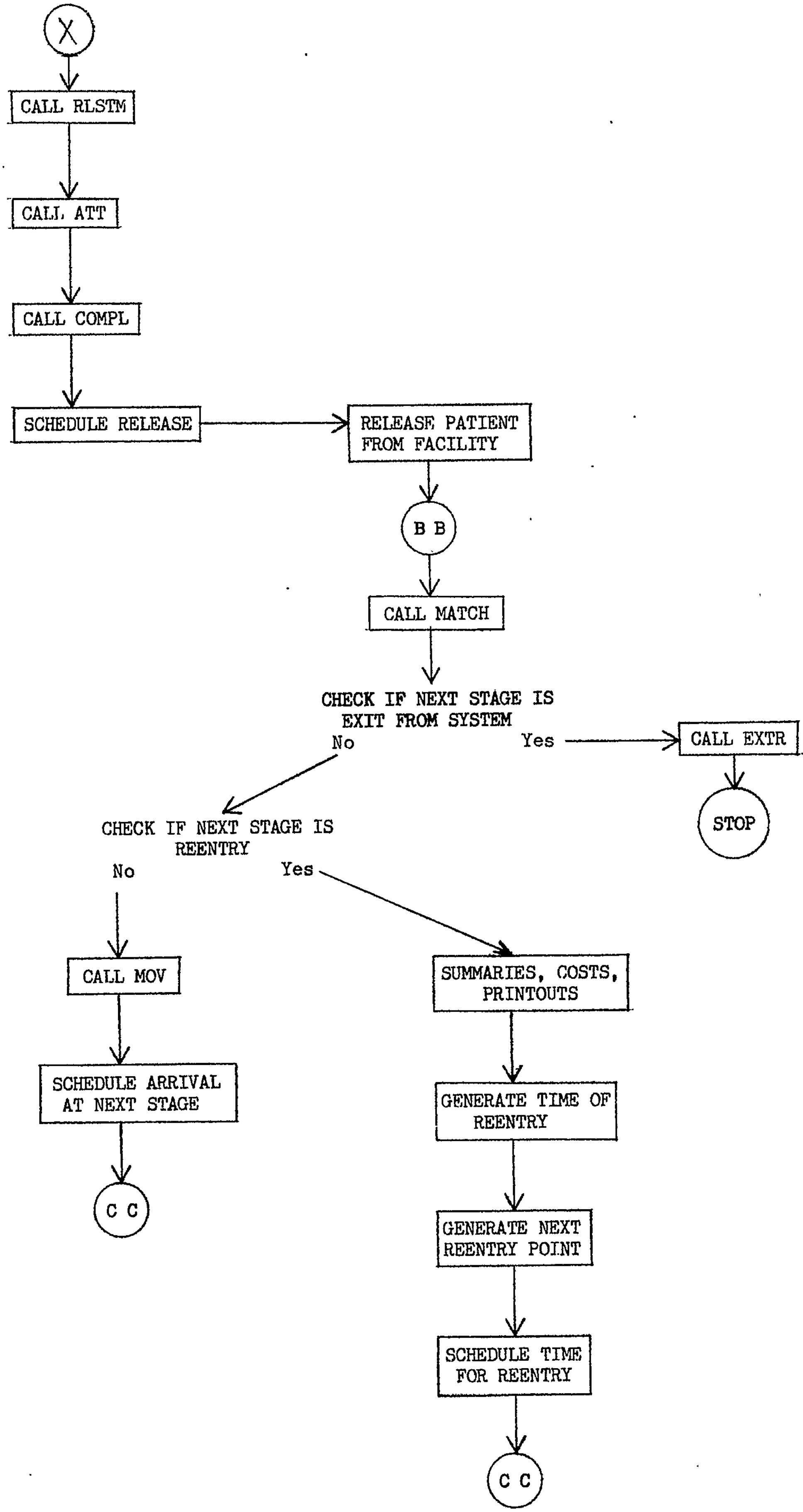
Figure 2




A A
RECORD NEW VALUES FOR NEX, JNOW IN THE STAGE JUST COMPLETED
JNOW(I,K).LE.JPERS(I,K)?
No
Yes
COMPUTE NUMBER OF PATIENTS IN THE QUEUE,NQ(I,K)
RECORD IDENTIFICATION NUMBER OF PATIENT JJ AS JXth ENTRY FOR STAGE(IX,KX)
COMPUTE STATISTICS
GENERATE TNREV(IX,KX,JX)
300 CONTINUE
PRINTOUT
GO TO 7777
No
500 TNEV.GE.TIMSIM ?
Yes
STOP

<u>PROCESS FLOW CHART OF SIMSCRIPT SIMULATION OF MRSCICS EVALUATION SYSTEM</u>

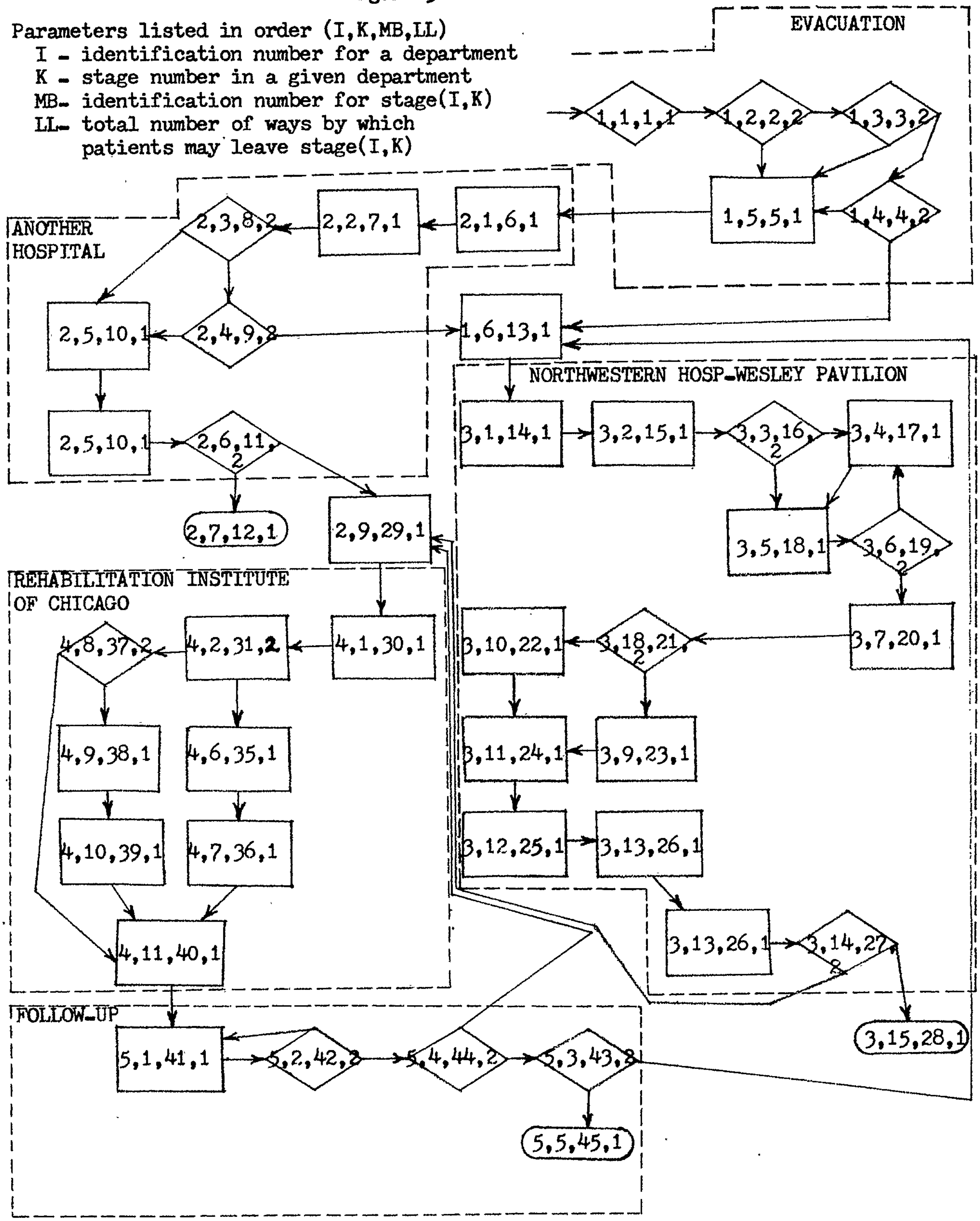



X
CALL RLSTM
CALL ATT
CALL COMPL
SCHEDULE RELEASE
RELEASE PATIENT FROM FACILITY
B B
CALL MATCH
CHECK IF NEXT STAGE IS EXIT FROM SYSTEM
No
Yes
CALL EXTR
STOP
CHECK IF NEXT STAGE IS REENTRY
No
Yes
CALL MOV
SCHEDULE ARRIVAL AT NEXT STAGE
C C
SUMMARIES, COSTS, PRINTOUTS
GENERATE TIME OF REENTRY
GENERATE NEXT REENTRY POINT
SCHEDULE TIME FOR REENTRY
C C

PATIENT FLOW CHART FOR
THE MIDWEST REGIONAL SPINAL CORD INJURY CARE SYSTEM
INDICATING STRUCTURAL PARAMETERS USED IN SIMULATION

Figure 3

Parameters listed in order (I,K,MB,LL)
- I - identification number for a department
- K - stage number in a given department
- MB- identification number for stage(I,K)
- LL- total number of ways by which patients may leave stage(I,K)



SIMULATION MODULE STRUCTURE

Figure 4