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A. PLANNING TELEMEDICINE SYSTEMS

The following report summarizes research submitted to the Department of Electrical Engineering on August 14, 1972, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

The shortage and maldistribution of primary-care physicians in the face of growing demand for care motivate exploration of new care-delivery concepts. Telemedicine, the practice of medicine by a physician who is physically remote from his patients, is one promising response which seeks to exploit the use of physician-assistant personnel and communications technology. This thesis develops quantitative methods useful for systematic planning and evaluation of telemedicine systems.

Experience with physician-assistant personnel and with prototype telemedicine systems is reviewed. Important unresolved issues in telemedicine planning are identified, and the use of queueing theoretic techniques in resolving these issues is indicated. A telemedicine system can be viewed as a special case of the "hierarchical queueing network." Approximate analysis of the hierarchical queueing network yields predictions of telemedicine operational behavior in terms of patient waiting times, queue lengths, personnel utilization rates, response times to requests for remote-physician consultation, the maximum number of assistants that one doctor can supervise, and the maximum patient capacity of a system. Analysis is carried out for three alternative operating disciplines governing access to remote consultation, and it is shown that choice of operating discipline can strongly influence system performance. The approximate analytical results are verified and extended by use of a computer program that simulates the operation of a telemedicine network.

Several hypothetical case studies illustrate application of the queueing models to important planning problems. Conditions are explored under which telemedicine offers greater promptness of care than conventional patient transportation. The costs and performance of telemedicine as a "physician expander" are investigated. Operational criteria are developed under which television communication is cost-justified vis-à-vis telephone. The applicability of these techniques to planning telemedicine systems for other clinical environments is noted. Finally, it is pointed out that the analysis of the hierarchical queueing network can be of use in planning many nonmedical systems that share this common structure with telemedicine.

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