INTRODUCTION

Several apparently independent events around the year 1952 formed the nucleus of what is now almost half a century of operations research in the health services as I have known it. In England, Norman Bailey published “Operational Research in Medicine” in the June 1952 issue of Operational Research Quarterly (Bailey 1952), and almost simultaneously in the Lancet, a paper on appointment systems in outpatient departments (Welch and Bailey 1952). His work was part of an operational research effort supported by the Nuffield Provincial Hospitals Trust that was influential in the development of Britain’s National Health Service. In that same year publication of the Journal of the Operations Research Society was launched, and would soon provide an outlet for communication of similar work in America.

In the United States the Hill-Burton legislation of 1945 to fund innovation, construction, and renovation of hospitals created an extramural research and development program aimed at the provision of technical assistance and guidelines for design, construction, and management of hospitals and health facilities. This created the opportunity for operations research to participate in a multidisciplinary effort that became the nucleus for the soon-to-emerge field of health services research. The development in both intragovernmental and extramural research was led by the Assistant Surgeon General for Hospital and Medical Facilities, Dr. J. R. Haldeman. His vision extended beyond the design and management of the physical infrastructure of facilities to the determination of community needs and resources and the integration of services, concerns that would in time dominate the directions of health services and research centered on them. These events are indicative of the post World War II changes in the role of government in the health services: in Britain the commitment to universal coverage of care, and in America a responsibility for funding of needed medical care facilities in the aftermath of the war and the years of economic depression that preceded it. In both countries the need for support of research and education was recognized and implemented, opening the door to forms of inquiry not widely accessible to the health services in the past.

Closer to home, and also in 1952, Dr. Ellis Johnson, director of the Operations Research Office of the Johns Hopkins University (ORO)—actually the program and staff of the U.S. Army Operations Research Office, administered by the University under contract—authorized the creation of an informal seminar in operations research, conducted on the University campus and organized by an ORO historian, Joseph McCloskey, who edited the collected seminar papers into two volumes entitled Operations Research for Management (McCloskey and Trefethen 1954, McCloskey and Coppinger 1956). The seminar had a dual purpose, first the enlightening of the faculty and students about operations research, which was not a well-known topic in civilian life at that time, and second, searching for an academic home for OR in the departmental structure and curriculum of the University. I recall that a place in engineering was not the first choice of an academic home for much of the ORO staff, with its mix of educational backgrounds—something in the humanities would have been preferable—but it was fortunate that the Dean of Engineering, Robert H. Roy, an articulate and experienced manager, a student of organizational behavior and author of several books on administration, saw in the substance of operations research a complementary element in his already multidisciplinary Department of Industrial Engineering. The relationship between ORO and the School of Engineering was formalized, and in time the name of the department would become Operations Research and Industrial Engineering.

In the Johns Hopkins Medical Institutions in 1952, Russell A. Nelson, M.D., a skilled clinician and administrator, was appointed Director of the Johns Hopkins Hospital while maintaining for a while his position as adjunct lecturer in the Department of Public Health Administration in the School of Hygiene and Public Health, where he had been developing an educational program in hospital administration. In a few years he would become president of the American Hospital Association and would chair the Advisory Committee on Hospital Facilities and Services of the U.S. Public Health Service.

At the time all this was taking place, I was a graduate student in Dean Roy’s department, and was one of his advisees. I was in the throes of doctoral research and some
intense study of probability and stochastic processes, an area that had been woefully absent from my earlier formal education. Incidentally, the only place in the University where teaching of stochastic processes, including waiting line or queueing problems, could be found in those days was in the School of Hygiene and Public Health in the Department of Biostatistics, founded by a renowned epidemiologist and statistician, Lowell Reed, who had retired some time before my arrival. He would play a momentary but significant role in my activity in hospital operations research.

Except for my thesis advisor, Dean Roy, with whom I developed a deep lifelong friendship, I had not met any of those mentioned above until the appearance of ORO staff on campus, with the invitation to participate in their seminar and to join ORO as a consultant and later as part-time staff. However, by 1956 a chain of events brought me into involvement with all of them. By then I had completed my doctoral program, had been appointed assistant professor in operations research and industrial engineering, was teaching a course in queuing theory, and was still involved with ORO in its Intelligence Division. There had been some interchange between ORO staff members and individual medical school faculty about extension of OR into the Johns Hopkins Medical Institutions, but no formal programmatic activity had come to fruition.

Meanwhile, there had been problems in the top leadership of the University, with resignation of the President and search for a replacement. While the search was underway an interim president was needed, someone known and deeply respected. The former chairman of Biostatistics, Lowell Reed, who had also been Vice-President of the Johns Hopkins Medical Institutions, was persuaded to come out of retirement to fill the role of interim president. As I heard the story, during his tenure Dr. Reed professed bewilderment and concern over the complexity of the University structure, with the presence of external research entities, affiliated by contract with government agencies in a pattern reminiscent of the University’s role in World War II, engaged in highly classified work, located off campus, and operating with little formal involvement in the central activities of the traditional Johns Hopkins institutions. He called a meeting of the deans, the directors of the affiliated research agencies, and he invited the Director of the Johns Hopkins Hospital for something of a dog and pony show, I was told later, in which all of those gathered described the mission, scope, and activities of their programs. After the presentations they were asked to explore ways in which new collaborative efforts could be brought about.

Russell Nelson pointed out some similarities he perceived between the problems of military operations and those of a hospital, the timely deployment of scarce resources to meet a critical and partly uncontrollable demand. He noted that in the past there had been some sporadic and independent studies of several aspects of hospital operations by graduate students and faculty of the University, but that the authors of the study reports, having no permanent relationship to the hospital, did not remain on the scene to participate in the implementation and evaluation of any recommendations they may have made. In some cases the studies had been upsetting to the hospital staff and had not produced lasting results. He proposed that, just as ORO was in effect a permanent research and advisory organization for the Army, there should be an on-site operations research group in the hospital, attached to the Office of the Director, providing continuity from research on problem areas through recommendation, implementation, and evaluation of results. From the discussions that followed a decision emerged that a Division of Operations Research be created on the Hospital Director’s staff, and that I should be asked to head the division, drawing upon interested colleagues from other elements of the Johns Hopkins institutions, including the Operations Research Office. After interviews and consideration of the challenges that would lie ahead, I accepted the opportunity, with great interest in the developments taking place in health care and with the naive notion that I would be able to do what was needed in the hospital while carrying a teaching load in the academic divisions across town and still maintaining ties with the ORO in its Chevy Chase offices.

I reported to the hospital on July 1, 1956, and after some first-day introductions to staff in the medical institutions, I was given an office in the original Victorian building dating from the 1800s, a large cavernous room with no one else in sight. I remember sitting there alone for a while, but aware that around me outside the office there were thousands of sick people in beds in the wards, and many more outpatients coming for care during the day. There were many thousands of patient/nurse/doctor transactions and decisions a day, each carried out for the most part independently of the others. They were all involved, to use a familiar OR term, in a game against nature, a malevolent side of nature. What did operations research have to offer that?

**HOSPITAL DAYS**

From early meetings with the director and staff members, several broad problem areas emerged: problems of shortages of critical personnel, mainly nurses; the daily problem of congestion in the outpatient clinics, where patients often endured long waits before receiving professional attention; an issue of outsourcing of materials and services by an institution traditionally self-sufficient in nearly all respects; and over it all, finding the appropriate role of the hospital in meeting the needs of the surrounding community, where health care needs were great and social change was in the wind.

Of the areas of hospital operations in need of study the most immediate and overriding was the chronic, intermittent shortage of nurses in the hospital wards, severe enough to close sections of the hospital from time to time. The Nursing Department had taken several steps toward management of the problem: first the appointment of a
senior nurse to a position of Assistant Director for Methods Improvement, second the creation of a training program for nursing aides to carry some of the burden of the registered nurses. The difficulty of delegating tasks to the lesser-skilled aides formed part of the nursing administration problem, one that was exacerbated by annual turnover rates approaching 100%.

To examine the problems a team was created, consisting of the newly appointed Assistant Director for Methods Improvement in the Nursing Department, the Director of the OR Division, and two OR graduate students, plus ad hoc involvement of other nursing staff and administration, including the Director of Materials Management. From visual observation of daily activities on a 30-bed medical nursing unit it was apparent that the severest demand on nursing time and attention came, as would be expected, from the sickest and most dependent patients, but also that the number of intensive care patients, as they came to be called, varied greatly from day to day and ward to ward. A decision was made to perform round-the-clock observations in one of the wards of the Medical Service, noting the amount of care by type of staff for each patient, measured in units of time, while simultaneously recording each patient’s characteristics in terms of activities of daily living, severity of illness, and mental state. The distribution of hours of direct care per patient per day proved to be multimodal, with one concentration of very ill patients receiving two to three hours of direct care, a group of nearly self-sufficient patients at the other extreme receiving around a half hour of care per day, and with the largest number in between, averaging an aggregate of an hour of daily direct care.

The idea of classification of patients by level of dependency or severity of need for care was not new, but its description and quantification contributed to our understanding of the dynamics of patient/nurse interaction in the acute hospital. Had the fraction of patients in each mode of the distribution of level of intensity of care remained stable, generalized staffing levels would have been possible, but that was not the case. Over a period of several months, the number of intensive care patients fluctuated between 2 and 15, giving wide swings in the hours of direct patient care needed. The set of descriptors used in the research project to identify the intensive care patients was easily adapted to a daily patient classification protocol, which could be used with paper-and-pencil algorithms to compute nurse staff hours required; and some supplies, such as bed linens, where need was correlated with intensity of care. The application of the patient classification procedure late in the afternoon proved to be a good predictor of need for the following day and useful to nursing administration for daily allocation of resources. Aided by the involvement of the nursing member of the team, the system was implemented, and proved beneficial in a number of ways. Morale on the ward was improved by the rational scheduling of staff and supply to meet needs as they varied from day to day; administrators had concrete evidence for decision for allocation of resources, and the operations researchers were gratified to see a case where an understanding of stochastic processes led the staff of an organization subject to random demand for its services to develop management systems compatible with the nature of their situation. It was further gratifying to see the daily number of intensive care patients, arriving randomly and independently into what was in effect an infinite channel queue, closely follow a Poisson distribution just as the math said it should. The system of patient classification and variable staffing was deployed throughout the medical inpatient services and was reported in both the hospital and operations research literatures (Connor et al. 1960, Flagle 1960, 1962). The system involved daily nursing staff assignments by the Director of Medical Nursing Services; and staffing models were developed to assist in this, notably by Harvey Wolfe, who later headed health OR activities at the University of Pittsburgh (Wolfe and Young 1965).

By this time, the hospital OR Division had been joined by several staff members of the ORO: John Young, who would become the Assistant Director of the Division and second chairman of the as-yet-to-be-formed ORSA Health Applications Section, and John Moss, who later headed OR activities in the Social Security Administration and the Office of the Surgeon General. In addition we were strengthened by the participation of Eliezer Naddor from our parent OR department, who brought our first efforts in application of computers to clinical records, and Rodger Parker, a mathematician who collaborated with Thomas Lincoln, a pathologist and pioneer in medical informatics, in studies of statistical decision theory in screening and diagnosis (Lincoln and Parker 1967).

As they had been invited to do, some colleagues in the hospital administration and medical staff proposed situations or problems to be studied by the OR Division. The physician administrator of the pediatric clinics, where several hundred young patients came each day, described the daily experience of clinic congestion and delay. Most of the young patients were brought to the outpatient services by an adult in the morning and passed through a series of procedures before being examined by a clinician for definitive treatment. They were first seen by a steering physician for direction to quarantine or the appropriate clinic, then to a business office to establish the degree of financial eligibility, then to a cashier, then to an aide for temperature and weight measurement, then to definitive medical care. To our eyes the system was a series of single-channel queues, each with a waiting line, fine for an automobile assembly line but not appropriate for the randomly variable tasks needed for hospital patients. We simulated the clinic, assuming that some of the intermediate steps between the steering physician and the ultimate caregiver could be combined into one, with each staff person trained and equipped to perform all the needed operations, giving three parallel service channels instead of three in series. The results of the simulation were sufficiently impressive in reducing the number of children and parents in the modeled clinic and
the delays in reaching their ultimate care provider that the clinic itself was reorganized for a demonstration that validated the simulation. The demonstrated system remained in place and was replicated in other outpatient clinics on the general principle that the assembly-line paradigm was inappropriate where performance times were highly variable and patient arrival times were uncertain, and that a more versatile staff manning parallel lines of patient flow could speed the patient’s path to definitive care (Gabrielson et al. 1962, Flagle, Huggins, and Roy 1960).

In another outpatient study, the chief of ophthalmology invited us to join a team consisting of himself, his chief resident, and another member of the faculty to improve outpatient services with the goal of increasing the number of patients seen. He described the ecology of a medical school department, in which the number of faculty is related to the number of interns and residents, which is in turn related to the flow of patients into the clinic and the number of surgical and specialized procedures they require. The clinic had been notorious for patient delays and congestion in the waiting room. As in the nursing study, we proposed a period of observation of patient experiences, mainly a matter of noting time durations between patient arrival and key steps in progression through the clinic. The time line of each patient’s experience was plotted on a Gantt chart, which revealed not only the waiting times experienced, but by looking at vertical cross sections of the chart, the number of patients in the clinic at any time during the day. The charts produced convincing evidence that some patient complaints of losing a day in the clinic were valid. The ophthalmologists on the team proposed two major changes: that a new appointment system be developed, simulating a private practitioner’s office, giving patients appointment times at regular intervals, and also that appointment of a nurse specialist in ophthalmology to do such routine preparation as refraction and test of visual fields be implemented and evaluated. After some patient-flow studies to determine appropriate intervals between appointments, and the training of several nurse specialists, the proposed system was tested, this time not by simulation but by actual implementation in a part of the clinic. Once again the demonstration was sufficiently effective to be left in place, not only for the reduction of waiting times and clinic congestion, but because of its realism in training interns and residents for their future working environments.

Several aspects of the studies described are noteworthy. In each case a physician or nurse with some administrative authority was continuously involved. From the outset none appeared to be threatened by the OR outsider, and all were apparently secure in the knowledge that whatever success the project had was ultimately theirs. Ease of interaction did not always prevail, however, especially in working with middle administrators, some of whom expressed resentment of a part-time outsider’s intrusion into activities they considered their own bailiwick. A case in point was the examination of the advantages of outsourcing of some materials and services, such as prepackaged single-use medical supplies. The problems were viewed as exercises in comparative cost analysis—no arcane terminology and technique needed—something within the range of managerial accounting taught in schools of hospital administration.

It was evident that a closer tie to and identity with hospital and health services administration, and education for it, would have to be developed. The pattern for this had been set by Russell Nelson with the material he had developed earlier in the School of Public Health, and a decision was made to pursue negotiations to resume that activity. Additional justification for ties to the School of Public Health was the number of students from that school showing interest in OR courses—reciprocity for the fact that my most important coursework, in advanced biostatistics including stochastic processes, had been taken in that school. An example of student interest was that of Michel Lechat, a leprologist, later to become Dean of the School of Public Health in the University of Louvain in Belgium, his home country. He arrived from the Congo with reams of data on screening for lepromatous leprosy, and a copy of von Neumann and Morgenstern’s *Theory of Games and Economic Behavior*, with the intention of basing his doctoral research on screening strategies. I worked with him, using a decision-under-uncertainty model in which the sensitivity of screening tests was constrained by capacity of the clinics to deal with large numbers of arrivals in the clinics (Flagle and Lechat 1961).

At some point in the beginning years—the late 1950s—of the OR Division activities, Russell Nelson wrote a series of letters of introduction for me to people in leadership roles in the U.S. Public Health Service. He had become prominent in health affairs at the national level, and at the time our activity began he was also Chairman of the Advisory Committee on Hospital Facilities and Services of the U.S. Public Health Service and a member of the President’s Commission on Health Manpower. The dual purpose of these introductions was to expand my vision of the state of affairs in matters of health care and at the same time to explore the possibilities for grant support. Armed with the letters of introduction, I traveled to Washington and Bethesda to meet the health bureaucracy.

**PUBLIC HEALTH SERVICE DAYS**

Upon visiting the staff of the Hill Burton program, I found considerable interest in our work and applied for and received grant support for expanding the work on facilities and staffing of the hospital nursing units, and also for continuing study of administrative procedures in outpatient care. Our project on nurse staffing caught the attention of Assistant Surgeon General Haldeman for its relevance to an intramural project he was organizing around one of the experimental hospitals in the Hill Burton Program. The experimental facility was designed on the principle called Progressive Patient Care, the concept that patients in an episode of hospitalization typically progress from conditions calling for intensive treatments to a less demanding
state, labeled routine care, to nearly well states not requiring the continuous presence of a skilled nurse and capable of participating in their own care—self-care. The relevance of this concept to the problem of hospital-bed shortage was that it relieved the typical hospital nursing unit of the burden of severe and unpredictable demands of urgently dependent patients by placing them in a specially equipped intensive care unit staffed with the most experienced nurses. At the same time, patients on the intermediate or routine-care floors, upon convalescence to a condition no longer requiring the skilled nursing constant supervision could be moved to simpler facilities under hospital responsibility—a self-care unit. The rationale—the hope—was that with the intensive care patients removed from the area of routine-care beds, and the removal of self-care patients freeing up beds for legitimately routine-care patients, the overall capacity of the hospital would be increased and patients would be cared for in facilities and by staff appropriate to their needs. Both the quality and cost concerns would be eased and access to care increased. To demonstrate the feasibility of the idea, the Manchester (Connecticut) Memorial Hospital had built an intensive care unit within the hospital, adjacent to the recovery room, and had bought residences contiguous to its property and had equipped and staffed them for self-care. The role of the USPHS intramural research team was to evaluate the demonstration of the progression of patients through the stages of care and recovery, and, if warranted, to prepare guidelines for diffusion of progressive patient care in other settings. The parallels were obvious between our three-way classification of intensity of care for medical ward patients at Johns Hopkins, where resources were allocated in place, and the Manchester system where patients were moved to the location most capable of providing their level of need.

I was invited to join the USPHS intramural team as a consultant to transfer some of the formal Hopkins procedures for patient classification to augment the intuitive ones used at Manchester. One dividend of the Manchester experience: I had arranged for John Moss of ORO to work with the intramural team. He would later head an OR Group in the Social Security Administration, and in the mid-1960s an OR team in the U.S. Office of the Surgeon General. Our work at Manchester produced a Public Health Service Guideline containing a patient classification protocol and method for estimating bed needs in progressive care, which found its way into the literature on progressive patient care (Flagle et al. 1963). A major outcome of the Manchester experiment was that intensive care units were successful and have proliferated. The incorporation of self-care—or continuing care, or long-term care—while successful at Manchester, did not proliferate. The culture of the voluntary hospital in those days did not see its concerns beyond rendering acute care and maintaining a set of referral resources. Nevertheless, the topic of extended or self-care or long-term care continued as a major interest of the health services at large, and for us brought on a near replication of our inpatient nursing studies—with added complications—in long-term care institutions (Jones et al. 1974).

The interests of Dr. Haldeman in the experimental progressive patient care transcended the operational aspects of the concept. He saw the hospital-operated self-care units as the beginning of an integrated health service, a continuum of care responsible for patients beyond the hospital’s doors. This was seen as an essential aspect of quality of patient care, a rational and timely passage of patients to resources best suited to their conditions.

Association with Dr. Haldeman and his colleagues on the Manchester project led to an appointment to the Hospital and Health Facilities Study Section, the 12-member non-governmental group charged with merit review of extramural grant proposals. The three-year stint on the study section was laborious, with as many as 50 proposals to review before each meeting, about a fourth of them approved and the remainder subjected to the difficult task of explaining the reasons for disapproval and suggesting ways to improve a resubmission, occasionally with a recommended site visit for face-to-face critical discussions of an investigator’s work. It was in this environment that researchers became known to each other. I learned that I was not alone in bringing the substance and principles of OR to the health services. To name a few, Daniel Howland at Ohio State had developed a system model for a hospital in which the doctor/patient/triad was seen as an element of a cybernetic process in which signals (signs and symptoms) from the patient were sensed by the care providers (Howland 1963). The accuracy and timeliness of sensing and response were measures of quality of care. William Pierskalla’s work in inventory-control aspects of blood banking appeared (Pierskalla and Roach 1973). John Thompson, coming down from Yale for a Hopkins short course on operations research and visiting our hospital projects, developed a new aspect of patient severity classification. Whereas we had made daily classification for the purpose of daily allocation of resources, Thompson and his colleague, Robert Fetter, looked at resource consumption over total episodes of hospitalization related to diagnosis. Although intended as a means of identifying outliers in length of stay for a diagnosis, their Diagnosis Related Groups (DRGs) proved to be adaptable to per-case reimbursement and were adopted for this purpose, becoming one of the most significant contributions of OR techniques to the changing character of health services in the 1960s (Fetter et al. 1976).

In the context of peer review of the large number of grant proposals submitted, it became apparent in the late 1950s that the scope of research had moved beyond matters of facilities design and management to broader matters of organization in the spectrum of health care: to concerns for access to care, cost of care, and quality of care. To encompass the growing range of interests and disciplines involved, the name of the merit review group, by its own instigation, was changed to the Health Services Research Study Section. It was largely through the efforts of Dr. Haldeman and the Division of Nursing member on the intramural research
team, Dr. Faye Abdellah, that funding for multidisciplinary health services research was expanded.

Throughout all of the changes of the late 1950s, Dr. Haldeman maintained a strong interest in the efforts to achieve integration of community health services, the quest for continuity of care centered in the community hospital. He became aware of related activities in England, where as part of the research accompanying implementation of the National Health Service, Dr. Thomas McQuown had designed an integrated health care community in Birmingham, supported by the Nuffield Provincial Hospitals Trust. I had visited the Trust in 1959, and met with the Secretary of the Trust, Gordon McLachlan, where we reviewed the status of operational research in both countries. Mr. McLachlan spoke of plans for a Trust-sponsored conference on the topic at Oxford in the following year for the purpose of reviewing studies underway, current problems in development of the National Health Service, and definition of the role of operational research in addressing the problems. The meeting took place in December 1960. Dr. Haldeman and I, along with Dr. Cecil Sheps, the Chairman of our Study Section, were there as invited observer/participants. The problems set forth were somewhat like our own: aged facilities neglected through years of economic depression and war, awareness of increasing demand for outpatient services, a paradox of long waiting lists for hospital admission in the face of low overall occupancy levels, a shortage of nurses, the estimation of community health care needs as a basis for future construction of hospital beds, and communication among care providers. Norman Bailey spoke on calculating the scale of inpatient accommodations, a topic that somehow embraced all the others. Demographic analyses within defined regions or catchment areas were needed, estimates of frequency of admissions, anticipated distributions of length of stay, and achievable levels of occupancy were all factors to be taken into account. The last named, the experience of low occupancy rates, was peculiar to the British tradition. Patients were cared for outside the hospital by physician practitioners who did not have privileges for hospital practice, and would be taken over by physician consultants upon admission to hospital, a break in continuity of care. Within the hospital, groups of beds were allocated to individual consultants, making it possible for beds in one consultant’s area to be empty while another’s was full with patients waiting to be admitted, a situation calling for applied stochastic analysis. Following the Oxford Conference a series of exchanges brought Bailey to Johns Hopkins for a term; we both taught in the annual program Statistics in the Health Sciences at Stanford in 1962, where I gave an introductory course in OR. Later on Bailey joined the World Health Organization in Geneva, where he made many contributions not only to OR projects, but also in the mathematics of epidemiology, including an early warning of the magnitude of the eventual epidemic of AIDS in Africa.

It was during the Stanford program that I met Dr. Morris Collen, one of the founding physicians of the Kaiser Permanente medical plan and, as an electrical engineer by earlier training, a pioneer in the development of computer-based information systems, which he had incorporated into Kaiser’s multiphasic screening clinic. He brought up a problem faced by many applicants to the USPHS for research support—that those projects containing development and demonstration aspects needed to have a component of formal evaluation in their proposals. He recognized that much of operations research was a decision process based on an evaluation of alternative courses of action and that it should play a role in emerging developments in medical technology, particularly in medical information systems. I was aware of a growing distinction within the health services research activities between research projects devoted to knowledge acquisition and those that developed and applied new organizational or physical systems calling for evaluative research. The distinction was sufficiently strong to bring about creation of a new Health Systems Study Section, with operations research as a topic within its scope. To appreciate its impact on the field of operations research in health care, some of the dramatic events of the times must be recalled.

The decade of the 1960s brought a flood of health-related legislation that began with the election of John F. Kennedy and amplified in the Lyndon Johnson years of the Great Society. The Hill Burton Program was followed by passage of the Comprehensive Health Planning Act, which strengthened Public Health Departments at state and community levels in their pursuit of measuring and meeting needs across all health services. Under the management of the National Institutes of Health, the Regional Medical Programs were created, concentrating on major diseases—initially heart disease, stroke, and cancer. The intent was to bring medical knowledge from the laboratory and academic medical center to community and rural health providers—developing such terms as primary care by community physicians and clinics, secondary care in community hospitals, and tertiary care in the large, medical-school-affiliated hospitals—a disease-based classification bearing some similarity to the progressive patient-care concept and the idea of integrated care across the spectrum of need. The most significant legislation of all, the passage of Titles 18 and 19 of the Social Security Act in 1966, creating Medicare for care of the elderly and Medicaid for care of the indigent, altered American health care in the most profound way. The federal government had accepted financial responsibility for care of large segments of the population in addition to the earlier responsibility for construction of facilities under the Hill Burton Act. The effect was also profound on health services research and operations research. For one thing, economists began to appear in droves, concerned with the scope of coverage and the effects of deductibles and copayments on overall cost to government. There was a double-edged concern over medical technology and its changing contribution to the cost of care or its possible reduction of costs through increased productivity. Information technology became of special interest in its role in administration
of government-related programs. There was a legend that as the time approached for implementation of Medicare, the health service agencies braced themselves for a deluge of patients, but received instead a deluge of paper.

During this period, I had served on both the Health Services Research Study Section and the Health Systems Research Study Section, had site-visited a number of early projects in application of computers to medical care in such areas as computer-aided diagnosis, automated patient records, automated monitoring systems, medical imaging and nuclear medicine, and management information systems. An issue that arose consistently was the role of government in supporting the development of equipment of high commercial potential and undemonstrated impact on quality and outcomes of care. The position taken was to support demonstrations and evaluations of technologies, in several cases with intermediate site visits by Study Section teams. In the midst of this, a decision was made in the Office of the Surgeon General to create a position of Special Assistant to the Surgeon General for Applied Health Technology, a position with two major charges, first to develop policy on dealing with the federal role in high-cost technologies. The problem was complicated by the fact that there were already developmental projects in the Public Health Service including, for example, a government laboratory on the cutting edge of automated remote interpretation of electrocardiograms in competition with similar private sector interests. The second responsibility was to assist the OSG in structuring the authorized National Center for Health Services Research and Development. It was anticipated that much of the funding of the Center would come from the splintered research funds in the budgets of other agencies in the Public Health Service. I was invited to be the Assistant to the Surgeon General for the year 1967–1968, and was granted sabbatical leave from Johns Hopkins for the purpose.

At the time, the OSG was located on the National Institutes of Health campus in Bethesda. My office was located near that of the Assistant Surgeon General for Program Planning and Evaluation, Dr. William Kissick, who had had a hand in creating my position, and down the hall from John Moss and his Operations Research Group. From the point of view of the jobs that needed to be done, the timing of the appointment could not have been better. There were a number of key technologies to be evaluated under federal grants that would be administered by the new Center for R&D, scheduled to begin its activities in mid-1968. In most other respects the timing was difficult. The Vietnam War and its devastating effect on the Great Society efforts was cause for demoralization. The assassination of Martin Luther King occurred that year and all but shut down normal life in Washington. The Office of the Surgeon General was under attack by the Assistant Secretary, who assumed most of the authority of the Surgeon General in that year. Nevertheless, a working policy on support of technological development emerged, following a dictum of Adam Smith, that beyond the role of government to defend the country against outside threats and to maintain internal order, there was a responsibility to support those activities that were for the good of the people that would not be of profit for an individual or group to pursue. It was not difficult to identify those technologies with high commercial potential and also of potential benefit to the people. These could be the objects of federally supported demonstration and evaluation.

On the matter of organization of the National Center for Health Services Research and Development (HSR&D), the funds for its establishment were mustered, and the Center opened on schedule in the midst of major reorganization of the Department of HEW. From the point of view of the operations research community, a very positive development took place during the year. Two energetic members of ORSA, John Hall and George Chacko, visited my office to discuss the idea of forming a working group on health OR within ORSA. We reviewed the roster of members engaged in the health services and saw a sufficient number to pursue the subject. From those discussions the Health Application Section of ORSA was formed. I was its first chairman and must say that I cannot remember a group so eager for action. Whereas papers had appeared in small numbers at ORSA meetings, a series of organized symposia were held, culminating in a joint meeting with ORSA, TIMS, and the Institute of Industrial Engineers. Fortunately, the remarkable set of papers from the symposium, a definitive description of OR in health to that time, were collected, edited, and published (Shuman et al. 1975). I remained active in the Health Application Section into the late 1970s, but must remind myself that my presence in the OSG during John Hall’s tenure as Secretary of the Health Technology Study Section and George Chacko’s active OR involvement in the Washington area was a fortunate coincidence, and at that time, my professional society activities had already been shifting to population-based studies in public health and with that to the fields that have become medical informatics and technology assessment.

SCHOOL OF PUBLIC HEALTH DAYS

As the events in the narrative above on my OR-related experiences in the U.S. Public Health Service were taking place, my central activities and obligations remained in the University and Hospital. By the early 1960s it was clear that I would have to make a choice of principal affiliation, a choice between the School of Engineering—my roots—where I had become Professor of Operations Research, or the Johns Hopkins Medical Institutions and the world of health services around it, where most of my efforts had become centered. Events in both alternatives helped ease the pain of decision. In the School of Engineering the teaching of operations research had become increasingly theoretical, and would soon be absorbed into a new department of mathematical sciences. Students coming to the
medical institutions for their research studies found themselves torn between the demands of their academic department and the total involvement expected of anyone who worked in the often troubled world of the health services. At the same time, the analytical capabilities of faculty in the School of Public Health were continually increasing. A new chairman in the Department of Public Health Administration, Dr. John Hume, was expanding the faculty to include economics, the behavioral sciences, and management. This was the department in which Russell Nelson had begun to develop hospital administration in the early 1950s. In a meeting with Dr. Hume involving Dean Roy and Dr. Nelson, we discussed the potential of adding operations research to the disciplines in public health administration, pointing out that there were an increasing number of students from public health involved in OR studies, and conversely a number of OR students taking courses in public health. The upshot of the meeting was an invitation to have a joint appointment as Professor of Operations Research in the School of Public Health, with the strong request that it be my principal appointment with responsibility for strengthening the department in the area of the management sciences.

Thus began a rewarding association of almost thirty-eight years now, a professor emeritus for almost as long as I had been a professor. For much of that time I headed a Division of Operations Research in the Department and was involved in the evolution of OR applications in comprehensive health planning, coordination of health services, health technology assessment, and evaluation of a number of health-related programs, including a revisiting of some of the earlier topics in hospital operations. Public health is essentially an international affair. Students to the School of Public Health have come from all over the world and there have been many opportunities to visit them in their native habitats: co-chairing a Seminar on Operational Research in Bucharest (World Health Organization, 1971, organized by the European Office of WHO), and meetings in Peru and Costa Rica as a member of the WHO/PAHO Advisory Committee on Medical Research.

We were fortunate to receive a training grant from the National Institute of Mental Health entitled “Operations Research in Mental Health,” which enabled us to keep a steady flow of talented students into the OR program. OR graduates have filled many positions in the health services: Two have become vice presidents of the Johns Hopkins Hospital and one a departmental administrator. The Chair of the Department of Health Policy and Management—a name transmogrified from the original Public Health Administration—is Dr. Donald Steinwachs, one of the early operations research Ph.D.s from the engineering program.

In an activity I had intended to be my swan song, I submitted a proposal to the National Library of Medicine (NLM) to review the status of operations research and health services research in the medical literature. I was given a visiting scholar office there to be close to the library’s resources. I had worked earlier with Donald Lindberg, the Director of NLM, on a project to develop content and classification for full-text literature retrieval. In the midst of my work for NLM, the Agency for Health Care Policy and Research (AHCPR) was created, with its purpose to produce medical outcomes studies and clinical practice guidelines, with a mandate to establish interagency agreements with NLM to enhance the literature and to create a National Information Center for Health Services Research (Flagle and Cahn 1992). My swan song lasted another four years, and I like to think that to some extent, as result of it, the new journal of the INFORMS Health Applications Section, Health Care Management Science, is in Medline. Its contents bear much resemblance to the earlier work in the field, grounded in observation at the clinical level, expanded by models that give insight into the impact of operations at the institutional and organizational level, and extending the insights, where possible, to societal and global concerns.

In preparing these reminiscences I have had to search for and review numerous old references, not to mention memories. In each of the activities recalled, not only in the health services but also in the broad OR family, in the end what clings to mind are the people involved—the individuals more so than the events—and the opportunities to have made purposeful friendships with colleagues around the world. I think especially of a few, gifted in leadership and vision: Lowell Reed, Robert Roy, Ellis Johnson, Russell Nelson, John Hume—all of them gone now. Had they not been where they were at the turning points in my narrative, none of this might have happened at all.

REFERENCES


