The Evolution of Medical Practice Network Computer Systems: Lessons From Two Regional Projects

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The use of the computer in office practice is slowly gaining acceptance within the medical profession. Beginning with sporadic use of computers in individual physicians' offices, attempts have gradually been made to link individual office practices together to form regional computerized networks. Many medical schools—Medical College of Virginia, Michigan State University, University of Rochester, University of South Carolina, University of Washington, Dartmouth Medical School, and the University of Colorado—have attempted to establish networks, some more successfully than others. In general, networks that have formed around academic medical centers have evolved from a combination of interests held by medical school faculty as well as community physicians; therefore, a wide variety of factors have led to the formation of these medical school based networks. Some of the key factors in network formation to be discussed are shown in Figure 1.

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Factors Responsible for Establishing Networks

Research and Education

Most medical care is delivered by primary care physicians practicing alone or in small- to medium-sized group practices.[1,2] Until recently, however, there were few hard data available to describe primary care practice. A strong motivation, therefore, for the formation of networks was to describe quantitatively primary care practice. The landmark publication on the diagnostic content of family practice by Marsland, Wood, and Mayo came from an early network developed by the Medical College of Virginia.[3]

Because there is great variability in treatment process and costs of care,[4] a second driving force favoring network formation is to compare differences in the treatment process and to relate these to variations in outcomes and costs among different types of providers, practices, or regions. One strong interest among the charter members of the Dartmouth Primary Care Cooperative Information Project (COOP) was to find out, for example, whether differences in clinicians' approaches to managing hypertension led to different levels of blood pressure control.[5]

Most medical research is done by specialists in

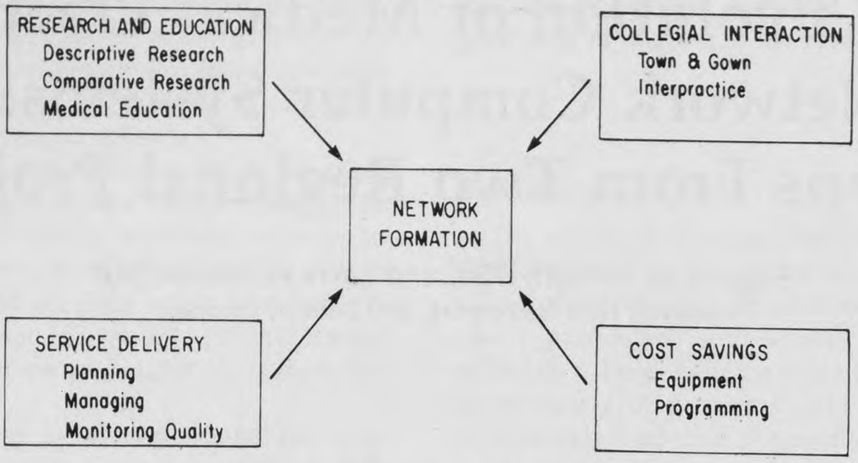

Figure 1. Factors triggering network formation

urban academic medical centers, while most care is delivered by generalists in community practice. There are limitations, therefore, in attempting to apply the results from research performed in academic centers to what actually takes place in the community because of differences in physicians, patients, and setting.[6] A third factor that sparked network formation was the desire to do clinical research in mainstream practices.

The work of academicians involves education as well as research. Information networks were formed to advance the education mission of primary care residencies and predoctoral clerkships. Networks have been used by faculty to document students' clinical experience and by community physicians to assess their continuing education needs.[7,8]

Service Delivery

Community physicians and practice managers often view networks as vehicles for improving service delivery. Information generated by networks can be used to plan services, manage practices, and monitor quality of care. For example, networks can produce age-sex and diagnostic registers on the population served, which can then be used to plan new services and to estimate manpower needs. The network can be used to document productivity, revenues, and expenses among all practices, information that can help in managing the practice. The network can also be used to monitor the quality of care delivered in an individual practice or across all the practices.[9]

Collegial Interaction

Networks can do much to foster professional interaction. The town-gown divisions that often separate medical center faculty from community physicians can be bridged by establishing a network that produces information useful to both groups. Also, primary care physicians, especially those in rural areas, often feel professionally isolated. The drive for constructive interaction between medical school faculty and community physicians, plus the need for more professional stimulation among community physicians, contributes to interest in network formation.

Cost Savings

Individual practices that want a better medical information system sometimes favor development of a network to save money and share risk. Group purchasing of hardware and software can reduce costs, and the financial outlay for software development and maintenance can be shared among practices. In addition, networks may be in a position to attract grant funds, revenues from schools, or contributions from professional organizations that could not be tapped by individual practices.

Problems and Prospects

The potential of office practice networks to contribute to research, education, service delivery, collegial interaction, and cost effectiveness is enormous. Because of this potential, the interest in networks continues to rise. Nevertheless, there are many problems that threaten to keep networks from reaching their potential. The obstacles spring from several sources: (1) man—those who plan, use, and maintain the system, (2) machines—technical characteristics of the hardware and software, and (3) money—the direct and indirect cost of starting and operating a network. Those who wish to begin or join computerized networks should know about the potential for multiple positive applications and, at the same time, be aware of the major pitfalls.

Description of COOP Project and FMIS

This article describes two networks, the Primary Care Cooperative Information Project (COOP) based at Dartmouth Medical School, and the Family Medicine Information System (FMIS) located in Colorado, as case studies that highlight the major lessons learned and offers recommendations for future developers of computerized networks.

Goals

COOP: The goal of the COOP is to enable medical school faculty and community-based primary care practices to work together voluntarily to provide high-quality health care in a cost-effective manner. The basic tools for reaching this goal are (1) a computerized network that links all member practices, (2) practice management consulting, and (3) collaborative, practice-based research. The tools are used to promote clinical cost effectiveness and medical education.

FMIS: The Family Medicine Information System was created to support the major goal of the Mountains/Plains Outreach Program to develop a support system for primary health care providers in rural areas. FMIS was designed to be a medical data base management system including modules for patient accounts, practice analysis, and patient management. The family medicine residencies in Colorado and Wyoming quickly adopted FMIS, recognizing its usefulness in curriculum planning, evaluation, administration, patient education, resident and student teaching, and primary care research.

Setting

COOP: COOP was formed in 1977 with a nucleus of 14 practices in northern New England. A voluntary organization, COOP is directed by a board of governors who are community physicians elected by the practices. It has grown to include (as of 1984) 47 practices in Maine, New Hampshire, and Vermont. Twenty-five sites are private practices, and 22 are community-sponsored health centers. The practices are solo and small-group practices, staffed by approximately 90 physicians and 27 physicians' assistants and nurse practitioners and are the primary source of care for over 100,000 patients, who make 28,000 visits per month.

FMIS: FMIS became operational in September 1976 at the A.F. Williams Family Medicine Center, University of Colorado School of Medicine in Denver. A total of eight family medicine residencies and 14 family practices in urban or rural areas have participated in the network, as shown in Table 1.

Design of Information Network

COOP and FMIS adopted the following design specifications: (1) capture a core minimum clinical and management data set that contributes to a cross-practice data base, (2) fit into the regular office routine for collecting data that is needed

Table 1. Participation in Family Medicine Information System: 1979-1983

Year	Number of Patients	Number of Visits
1978-1979	36,384	102,721
1979-1980	51,848	145,402
1980-1981	56,133	160,699
1981-1982	47,356	138,819
1982-1983	17,867	50,619

for billing on each encounter, (3) offer individual practices clinical, managerial, and educational applications, and (4) be priced at a cost that can be afforded by primary care practices.

COOP: Practices in the COOP network can choose to use any one of three alternative methods to tie into the network: (1) service bureau, (2) microprocessor, or (3) microcomputer.

The service bureau approach to networking was the first one attempted by the COOP, and it has been operational since 1979. Most practices continue to use the service bureau method described previously.[10] The service bureau uses patient encounter forms that are completed by practice staff on all patient contacts occurring in all locations. The encounter forms are mailed to Dartmouth for data entry, verification, report generation, and storage. The core data set for the cross-practice data base is "spun-off" from the billing process, which continues to be done manually by the practices using pegboard systems that utilize specially designed encounter forms to capture core data.

The distributed microprocessor/host computer design was the second strategy for networking tested by the COOP. Three practices use this method to contribute to the cross-practice data base. Each practice has an office microprocessor in which patient encounter data are entered. The microprocessor stores each day's worth of encounter data. During the night, the host computer automatically calls the practice's microprocessor to (1) receive all the information stored during the prior day, and (2) update the information stored in the microprocessor's memory concerning patients' outstanding balances. This system not only gathers COOP's core data set but also automates the billing function, since billing is done in a central location based on information stored in the host computer.

A third method COOP is currently testing to facilitate networking is the free-standing microcomputer system. Two practices are using microcomputers for billing, clinical applications, and entering data for the cross-practice data base. Two others use microcomputers to contribute to the network's data base and for such other nonbilling applications as word processing. The core data from the microcomputer sites are stored on disks, which are mailed to Dartmouth and entered into the host computer.

FMIS: FMIS was designed in 1975 and 1976 as a distributed network in which each practice has its own terminal linked by dedicated telephone lines to a central computer in Denver. A service bureau approach was used temporarily by some practices before going on line. Thus, computer operations were standardized and maintained at one location with little capital expense for an individual practice. However, there is little flexibility for individual practices, and the cost of dedicated telephone lines is a substantial recurring expense. A detailed description of FMIS has been previously published.[11]

Uses: Data Elements, Feedback Reports, and General Applications

COOP: COOP uses an encounter form to collect core information on patient contacts. This form documents which provider saw what patient, for what condition, at what cost. A special revenue and expense reporting form, compatible with data required by the Internal Revenue Service, is completed periodically. The encounter form and expense reporting form make up the core data base (clinical, management, and financial) that is used to produce monthly, quarterly, and annual feedback reports on clinical and management topics and to generate diagnostic indices and age-sex registers. Practices are encouraged to make special requests for feedback or reports of special concern to them. The feedback reports and cross-practice data base are used for multiple applications including patient care, practice management, quality assurance, planning, cost containment, medical education, health services research, and clinical research.

FMIS: FMIS uses a family information sheet to collect patient registration data and an encounter form to collect information about each patient visit. The data collected by these two forms and a description of standard monthly, quarterly, and annual reports with examples of their applications have been published previously.[11]

Costs

Estimating actual costs of networks is very difficult. There are costs specific to each practice that can vary with efficiency, location, volume of work, and level of information system use. There are also the costs of networking: communication, aggregation and manipulation of data, leadership for the network, and the actual use of the network as a tool. Sometimes prices become confused with costs.

COOP: The aim has been to develop a network that collects clinical and financial data at reasonable cost. The three alternative systems available to COOP practices in the network have different associated costs. The ongoing, direct cost per encounter for the service bureau system is approximately $0.42 per encounter: $0.21 for data entry and verification, $0.11 for data processing, and $0.10 for personnel. For the physician who averages 400 patient visits per month, the charge would be $168 per month.

The costs for the microprocessor and microcomputer options are structured differently. The total costs incurred by both the COOP project and individual practices combined amount to $0.60 per encounter or $240 per physician per month for the microprocessor approach. The comparable figures for the microcomputer options are $0.49 per encounter or $197 per physician per month.

FMIS: The initial pricing structure for FMIS assumed first that in-kind contributions would be available from the computer service bureau and that use of the full system would be encouraged by not charging directly for standard reports or special studies. When development was completed and grant support associated with it was discontinued, a significant source of revenue was lost. Simultaneously, most of the practices recognized that they wanted to use only parts of the system and did not want to pay for anything else. Thus, a new pricing structure was developed that made clear the substantial costs of maintaining a family-oriented, person-oriented, medical data base management system.

At 1978 volumes and with grant support for development, the estimated costs for FMIS (including staff time and forms) were $1.05 per encounter for a 70-patients-per-day practice in Denver, and $1.17 per day for the same practice outside Denver. Likewise, the cost of FMIS to a 35-patients-per-day practice in Denver was estimated at $1.36 and $1.61 outside Denver. Four years later, substantial strides had been made with microcomputers and grant funding for FMIS development concluded. A new pricing structure was developed for FMIS that accurately reflected costs. Simultaneously, several practices discontinued the system. The price per encounter rose to approximately $2.25.

Lessons Learned

The evolution of medical-school-based networks has taught many important lessons, which are set forth below. Some have been enjoyable, others more difficult.

1. Distributed data systems in primary care are, in fact, powerful tools for education, particularly in terms of curricula development and evaluation of training programs. Such systems require and merit financial and ideological support from academia.

2. Interest in networks is often high among

physicians new in practice. Enthusiasm may wane over a two- to three-year period; however, as "coping with practice" emerges as the physician's top priority, networks must be realistic about how much they can expect from practitioners.

3. The linkage of data collection to billing operations assures completeness of data collection, but at a price, including limitations on data collected and potential for inaccuracy (eg, diagnostic coding).

4. Although technology is available to meet the needs of medical practice networks, interpersonal relationships among practitioners using a system, the providers of the system, and the users of the system's outputs are at least as important as system design.

5. Networking requires skills in administration, research and development, and marketing. Networks do not just happen, nor do they sustain themselves in the absence of dedicated resources.

6. Members of a network participate for different reasons, but the primary purpose of the network must be clear and acceptable to all participants. There is a propensity on the part of those who sell the computers, those who use them, and those who interpret the results to develop unrealistic expectations.

7. There is a tendency to become confused about two sets of problems: (1) the adequacy, or lack thereof, of the data system, and (2) the users' and developers' abilities to use it effectively.

8. Information management is expensive. The building and maintaining of a data base in a readable and usable form, with the flexibility to cross-link all variables, require work and money. The incremental return on investment may often seem small for the physician. (What are two special reports or two studies per year worth in time, work, and money?)

9. Frustration in the network tends to be expressed through arguments over coding systems, who is paying for what, and feelings of "why are my interests the only ones being neglected?"

Recommendations for Future Development of Computerized Networks

Based on the experiences with COOP and FMIS, the following recommendations are offered to those who may have an interest in developing their own computerized medical network.

If a network aims to involve full-time physicians, it must be recognized that the primary business of a practice is patient care and profit. Additional uses of the information system must be budgeted for separately or accomplished "invisibly." Information management merits specific budgeting by residencies and practices.

There is no style of computerization that is appropriate for every office. Some will desire markedly interactive systems, while others will want as much distance as possible from the computer. Expect technology to continue to change, and be flexible in pursuing the information necessary to understand primary care and improve practice.

Everyone using the network needs a sense of ownership in the system. The availability of the network does not mean that it will be used. Data themselves do not constitute information; information requires thinking and the development of ideas, tasks that may resist arbitrary time lines.

Be absolutely clear about the purpose of the network from the beginning. Assign responsibilities for key functions and the information system to such particular groups as the vendor, academic institution, and practices.

Link office information systems to continuing medical education and to prospective audit, and thereby directly influence patient management as it occurs in office practice.

Avoid invention of coding schemes unique to one system; build as much as possible on existing taxonomies.

Networks may prove to be especially important in the assessment of primary care. The issue of norm-setting—inherent in the collection and publication of large data sets—must be recognized and interpreted in some manner.

National primary care groups should establish a task force charged to produce recommendations concerning archiving of data from practice networks.

Anticipate new demands from practices for information management if prospective reimbursement strategies are applied to office settings. Such developments may encourage the use of data base management systems to secure dollars for the physician.

Build financial self-sufficiency into network planning and operation from the start. This planning will help strike the right balance between value of the network and money spent.

Conclusions

Experience shows that community physicians in various regions welcome the opportunity to join a network. New groups are coalescing in New Jersey, Missouri, and Minnesota. It is possible to integrate data collection for multipurpose information networks into each individual practice's record-keeping system. This strategy provides an efficient means for the practice to contribute a core data set on all visits to the network without creating major new work.

The problems inherent in developing and managing networks are matched by their potential to contribute to improved inpatient care, medical education, and primary care research.

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Colorado FMIS

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