AVAILABILITY AND UTILIZATION OF NEW MEDICAL TECHNOLOGY IN MEXICO: RESULTS OF A NATIONAL STUDY[1]

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A study of 17 important medical innovations has been conducted in Mexico for the purpose of learning more about how new medical technologies are being used and how existing patterns of use might be improved. The article that follows describes the study, which could serve as a model for similar studies in other countries, and its results.

Introduction

In recent years, questions have arisen concerning the large increases observed in the cost of medical care services and the role those costs play in improving human health. In fact, however, knowledge is lacking regarding the benefits of many new medical technologies; and so it is important to study the utilization of such technologies in clinical practice and, on the basis of the findings, to promote application of the most useful ones and encourage elimination of those with doubtful value *(1-5)*.

Of course, such study presupposes a comprehensive definition of the medical technology involved that takes into account the wide range of supplies, equipment, drugs, and procedures used in patient care as well as the capital investment and personnel organization involved, since all of these things come together in the practice of medicine *(1, 6)*. In this vein, it is possible to consider all medical technology as being either emerging technology, established technology, or new technology. Emerging technology includes all procedures that are still in the applied research stage and for which the results of clinical trials are not available. Established technology includes techniques and procedures that are already widely used in medical practice. And new technology (the subject of this article) includes technology that has passed through the first stage of being confirmed as to safety and efficacy, but which has not yet come into widespread use within the health system *(7)*.

To study new technologies, it is necessary to posit questions about the benefits produced by their increased use and about possible long-term consequences. Other matters that should be examined include their costs, their impact upon the organization and provision of medical care, and their social implications *(7)*. In this regard, the need to allocate resources among alternative health programs

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makes it essential to know about new technologies in order to assess the benefits that will accrue from the alternative programs. Such resource allocation decisions are particularly crucial for public institutions and prepaid service systems, since their resources are limited and they may even be experiencing close to zero growth. One way in which the "output" of alternative programs can be summarized for decision-making purposes is to perform a cost-effectiveness analysis, a process that permits at least part of the program's estimated benefits to be expressed in terms of the operating resources required *(8, 8a, 9)*.

As the foregoing suggests, evaluation of new medical technology is crucial to the process of health service planning. This is especially so because acquisition, implementation, and maintenance of technological innovations usually demands a high financial outlay *(10, 11)*. It is therefore necessary to study the nature of the technological activities involved, and to give greatest attention to those that occur most frequently and whose interruption would produce the most serious consequences. It is also important to consider such technologies' yields in terms of their impact on priority health problems—because the use of new medical technology, like that of any other resource, should be governed by its relevance to health problems of importance within the population served *(12–13)*.

In recent years there have been numerous references in the literature to worldwide dissemination of new medical technology *(5, 8a, 14–16)*. In this vein, representatives of developing countries discussed the problems they face in modernizing health services at a 1982 conference held at the Institute for Health Policy in Milwood, Virginia *(17)*. The problem areas they identified included inadequate budgets for the purchase of expensive equipment and imported materials; lack of appropriate infrastructure; great regional variations in socioeconomic conditions within a given country; shortages of personnel trained in the new technologies; and the difficulties involved in assigning the correct priority to highly technical services within an overall plan for improving the population's health. From the statements made at this meeting, it was apparent that, generally speaking, questions related to medical technology were just starting to be formulated, and it could be expected that some time would be needed for solutions to appear *(17)*.

New Technology in the Mexican Health System

Availability of New Medical Technology

Concerned about the complex of problems posed by new medical technology, the University Center for Educational Health Technology (CEUTES) of the National Autonomous University of Mexico (UNAM) carried out a project supported by Mexico's National Council of Science and Technology *(Consejo Nacional de Ciencia y Tecnología)*. This project sought to provide a basic description of the current conditions governing the use of a series of technological resources in Mexican medicine *(18, 19)*. The first phase of this CEUTES project consisted of a national survey designed to locate places where 17 recent technological innovations of major importance were installed. The 17 technological innovations selected for inclusion in the survey are listed in Table 1. As can be seen, these were placed in one of three broad categories depending on whether they were essentially diagnostic technologies (procedures performed to determine the existence or nature of a condition or disease process), therapeutic technologies (performing actions intended to cure the patient or eliminate disease-associated disability), or maintenance technologies (procedures intended to mitigate disability associated with a chronic disease or to sustain the patient during the critical stage of a disease until his condition improves or some other treatment becomes feasible) *(9, 20, 21)*.

The survey directed at locating facilities where these technologies existed was carried

Table 1. New medical technologies selected for inclusion in the national CEUTES survey.

Diagnostic technologies	Therapeutic technologies	Maintenance technologies
Amniocentesis	Cobalt radiotherapy	Coronary care unit
Automated clinical laboratory	Heart surgery	Hemodialysis
Cardiac catheterization	Laser beam therapy	Intensive care unit
Electronic fetal monitoring	Microsurgery	
Fibroscope endoscopy	Organ transplant	
Scanning tomography	Prosthesis implantation	
Scintillography		
Ultrasonography		

out in late 1981 and early 1982. This survey was based on a comprehensive list of private hospitals and clinics outside the Federal District and metropolitan area of Mexico City; private hospitals and clinics within the Federal District and metropolitan area that had over 50 beds, or that had an unknown number of beds, or that devoted themselves to providing diagnostic or other specialized technical services; public hospitals and clinics with over 50 beds in the 20 most populous cities; public hospitals and clinics elsewhere with over 100 beds; and armed forces hospitals and clinics. Psychiatric hospitals and convalescent hospitals were not included. On the basis of this tabulation, a sample of 690 medical facilities was obtained, of which 221 were public and 469 private.

To help determine whether these institutions employed one or more of the 17 technological innovations being studied, a questionnaire was drawn up. This document, which was sent to the director of each facility in November 1981, requested information about the availability of the 17 technologies at the facility, the date of introduction of each technology present, and the number of devices and systems employed. The questionnaire was accompanied by a covering letter and a document that explained the project and provided a detailed description of each of the technologies involved.

A total of 96 questionnaires were completed and returned in response to this initial mailing. A second mailing was then made in January 1982, and this was followed up in some cases by direct requests for the desired information. As a result of this second effort, another 135 completed questionnaires were received, bringing the total number of responses to 231. Because 52 of the questionnaires were returned undelivered in the mail, the base number of facilities approached was taken to be 638, of which the 231 responding represented 36%. Table 2 summarizes the main findings obtained.

Although the information gathered was incomplete, the findings demonstrate that the new medical technologies surveyed—including the most modern—are widely disseminated in Mexico. Moreover, as the table shows, the survey found a total of 803 resources corresponding to the 17 technologies studied. Of these, 477 (59%) were in public health units and 326 (41%) were in private units. In all, 94 public units and 63 private ones were found to possess at least one of the technologies studied.

Regarding geographic distribution, the survey found a majority of the reported resources (468) to be in Mexico's Central Region, with progressively smaller numbers being located in the Northern, Gulf of Mexico, North Pacific, and South Pacific regions (Table 3) *(22)*. Despite this concentration of new technological resources in the Central Region, the data in Table 4 indicate that the Central Region's overall share of those resources (58%) was fairly close to the percentage of the national population (52%) living in

Table 2. Data obtained by the national CEUTES survey regarding the number of public and private health units responding to the survey questionnaire, the number using one or more of the 17 new technologies surveyed, and the number of these new technologies being used by the respondents.

Type of medical unit	No. of health units selected	Units responding		Units with one or more of the resources surveyed	Total No. of surveyed resources found	Average No. of resources per respondent
		No.	%			
Public	214	129	60%	94	477	3.7
Private	424	102	24%	63	326	3.2
Total	628	231	36%	157	803	3.5

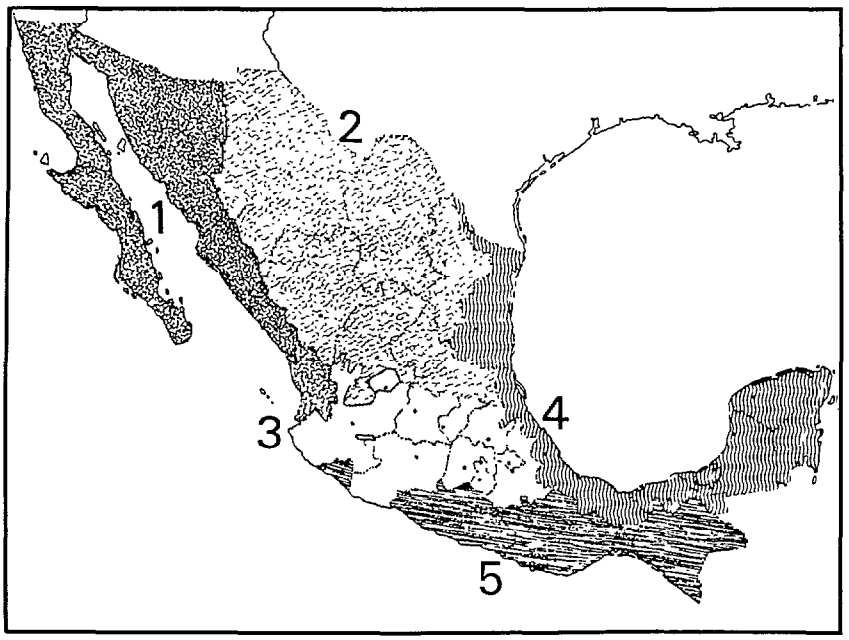
Table 3. Geographic distribution, by region, of the resources embodying the 17 new technologies surveyed, as reported by the survey respondents.

Technology	Resources located in indicated geographic regions:					
	North Pacific	Northern	Central	Gulf of Mexico	South Pacific	Total
Amniocentesis	5	14	27	8	2	56
Automated clinical laboratories	2	15	38	5	0	60
Cardiac catheterization	0	6	19	1	1	27
Electronic fetal monitoring	2	10	24	2	1	39
Fibroscope endoscopy	7	27	46	7	4	91
Scanning tomography	0	6	15	0	0	21
Scintillography	1	11	27	1	0	40
Ultrasonography	2	15	31	2	3	53
Cobalt radiotherapy	1	11	17	1	0	30
Heart surgery	0	6	14	1	2	23
Laser beam therapy	1	6	9	1	0	17
Microsurgery	3	18	38	2	0	61
Organ transplant	1	9	18	0	0	28
Prosthesis implantation	3	17	40	9	1	70
Coronary care units	0	10	20	2	1	33
Hemodialysis	1	12	30	5	0	48
Intensive care units	5	26	55	16	4	106
Total	34 (4%)	219 (27%)	468 (58%)	63 (8%)	19 (2%)	803 (100%)

Table 4. Distribution of the reported technological resources by geographic region, showing the numbers of urban centers served and the approximate percentage of the national population living in each region.

Region	Share of overall No. of new technological resources	Urban centers with one or more resources	Regional share of national population
North Pacific	4%	7	8%
Northern	27%	8	15%
Gulf of Mexico	8%	9	14%
Central	58%	15	52%
South Pacific	3%	3	11%
Total	100%	42	100%

Figure 1. A map of Mexico showing the geographic regions cited in Tables 3, 4, 8, and 9. The numbers on the map refer to the North Pacific Region (1), the Northern Region (2), the Central Region (3), the Gulf of Mexico Region (4), and the South Pacific Region (5).



the Central Region. On the other hand, the Northern Region was found to have a fairly large share of the new technological resources relative to its population, while the other three regions had relatively small shares of these resources relative to their populations *(23)*.

Considering the 17 new technologies by category, there were 334 separate instances in which one of the eight diagnostic technologies was found and the time of its introduction was reported. These technologies are classified in Table 5 according to their year of introduction into the medical units involved and whether the units were public or private. By and large, the numbers introduced per year tended to increase progressively with time—from 12 in 1955–1964 to 83 in 1965–1974, to 239 in 1975–1982. However, different technologies followed different patterns. For instance, as of 1980–1982 the rates of acquisition of scanning tomography and ultrasonography (both of which appeared after 1970) were showing rapid growth, while those of electronic fetal monitoring, fibroscope endoscopy, and scintillography were showing modest gains and the rates of acquisition of amniocentesis and cardiac catheterization appeared to have leveled off.

The periods in which most of the reported therapeutic technologies were introduced are shown in a similar fashion in Table 6. Again, the overall pace of introduction has shown a steady rise—from 18 introductions in 1955–1964, to 60 in 1965–1974, to 115 in 1975–1982. However, growth trends for cobalt radiotherapy, organ transplant, and prosthesis implantation have been irregular and most recently appear to have slackened. Since 1979 heart surgery and laser beam therapy appear to have continued their slow but steady growth. Microsurgery, therefore, is the only technology in this group that has most recently shown sustained rapid expansion.

Table 5. Diagnostic technologies: Periods of introduction by public and private units of the eight diagnostic technologies surveyed. (No time of introduction was cited in 53 of the 387 cases where introduction of one of these technologies was reported, and so these 53 cases have not been included in the data tabulated here.)

Technology	Type of medical facility	Period of introduction						Total
		1955-59	1960-64	1965-69	1970-74	1975-79	1980-82[a]	
Amniocentesis	Public	1	1	3	6	17	4	32
	Private	0	1	1	5	7	2	16
	Total	1	2	4	11	24	6	48
Automated clinical laboratories	Public	0	2	2	6	13	8	31
	Private	0	0	2	6	8	6	22
	Total	0	2	4	12	21	14	53
Cardiac catheterization	Public	0	4	1	1	7	2	15
	Private	0	0	1	5	1	1	8
	Total	0	4	2	6	8	3	23
Electronic fetal monitoring	Public	0	0	0	6	6	6	18
	Private	0	0	1	2	9	3	15
	Total	0	0	1	8	15	9	33
Fibroscope endoscopy	Public	0	1	1	10	22	18	52
	Private	0	0	2	6	13	3	24
	Total	0	1	3	16	35	21	76
Scanning tomography	Public	0	0	0	0	3	9	12
	Private	0	0	0	0	3	6	9
	Total	0	0	0	0	6	15	21
Scintillography	Public	1	1	3	3	4	4	16
	Private	0	0	0	7	6	5	18
	Total	1	1	3	10	10	9	34
Ultrasonography	Public	0	0	0	1	10	16	27
	Private	0	0	0	2	8	9	19
	Total	0	0	0	3	18	25	46
Total		2	10	17	66	137	102	334

[a]Does not include data beyond June 1982.

Regarding the three maintenance technologies surveyed (Table 7), the overall pace of their introduction likewise showed steady growth—from four introductions in 1955-1964, to 53 in 1965-1974, to 104 in 1975-1982.

Utilization of New Medical Technologies

The second phase of the CEUTES investigation, performed in July and August of 1982, sought to determine how the 17 subject technologies were being used. To that end an interview questionnaire was drafted on which information was recorded regarding the use of these resources, with particular emphasis on (1) their introduction into the medical facility; (2) their general pattern of utilization; (3) the equipment, materials, and costs involved; and (4) the personnel responsible for applying the technology in question. Each questionnaire had a covering sheet for recording general data on the medical care unit involved—including its date of establishment, number of beds, the volume of patient care provided, and the medical care and ancillary services provided.

The information furnished by the initial survey (on the availability of medical technol-

Table 6. Therapeutic technologies: Periods of introduction by public and private units of the six therapeutic technologies surveyed. (No time of introduction was cited in 36 of the 229 cases where introduction of one of these technologies was reported, and so these 36 cases have not been included in the data tabulated here.)

Technology	Type of medical facility	Period of introduction						Total
		1955–59	1960–64	1965–69	1970–74	1975–79	1980–82[a]	
Cobalt radiotherapy	Public	0	3	0	6	1	1	12
	Private	0	2	3	3	3	2	13
	Total	1	5	3	9	4	3	25
Heart surgery	Public	0	2	1	3	3	4	13
	Private	0	0	1	2	3	0	6
	Total	0	2	2	5	6	4	19
Laser beam therapy	Public	0	0	1	1	2	7	11
	Private	0	0	0	1	3	1	5
	Total	0	0	1	2	5	8	16
Microsurgery	Public	0	0	2	4	12	17	35
	Private	0	2	0	5	9	3	19
	Total	0	2	2	9	21	20	54
Organ transplant	Public	0	0	3	3	7	3	16
	Private	0	0	0	1	9	0	10
	Total	0	0	3	4	16	3	26
Prosthesis implantation	Public	1	3	1	10	15	4	34
	Private	2	2	1	8	6	0	19
	Total	3	5	2	18	21	4	53
Total		4	14	13	47	73	42	193

[a]Does not include data beyond June 1982.

Table 7. Maintenance technologies: Periods of introduction by public and private units of the three maintenance technologies surveyed. (No time of introduction was cited in 26 of the 187 cases where introduction of one of these technologies was reported, and so these 26 cases have not been included in the data tabulated here.)

Technology	Type of medical facility	Period of introduction						Total
		1955–59	1960–64	1965–69	1970–74	1975–79	1980–82[a]	
Coronary care units	Public	0	0	1	2	7	5	15
	Private	0	0	2	7	4	3	16
	Total	0	0	3	9	11	8	31
Hemodialysis	Public	1	1	2	4	10	5	23
	Private	0	0	1	5	11	1	18
	Total	1	1	3	9	21	6	41
Intensive care units	Public	0	2	3	14	35	12	66
	Private	0	0	2	10	8	3	23
	Total	0	2	5	24	43	15	89
Total		1	3	11	42	75	29	161

[a]Does not include data beyond June 1982.

ogy) was used to determine the areas to be visited and the units where interviews should be scheduled. In all, 74 units were selected, these amounting to 47% of the 157 units reporting possession of the 17 study technologies. In making this selection, a ratio of public to private units (42 public:32 private) was maintained that was fairly similar to that of the units originally reporting possession of a study technology (94 public:63 private).

These 74 units were situated in 12 cities—as compared to 42 in which the original 157 units were found. The names and geographic regions of these 12 cities are as follows:

City	Region
Hermosillo	North Pacific
Chihuahua	Northern
Monterrey	Northern
San Luis Potosí	Northern
Torreón	Northern
Federal District	Central
Guadalajara	Central
León	Central
Puebla	Central
Mérida	Gulf of Mexico
Vera Cruz	Gulf of Mexico
Acapulco	South Pacific

A total of 228 interviews were scheduled with people at the 74 units. Naturally, however, the number of interviews scheduled for any particular one of the 17 study technologies varied, because not all the study technologies were present in each of the chosen units.

In July and August 1982, 208 interviews (91% of the total scheduled) were conducted. As Table 8 shows, these included 57 in the Federal District (Mexico City) and 151 elsewhere. Of the remaining 20 interviews that had been scheduled, 17 did not take place because there was no informant present at the time of the visit, and in three cases the technology reported to have existed at the unit was not in fact present. In all, interviews were conducted at 73 health units, 41 of which were public and 32 private.

Table 9 shows the numbers of interviews conducted with regard to each of the 17 technologies studied. As these data indicate, it was possible to conduct interviews about all the study technologies in the selected cities of the Central and Northern regions. In contrast, such interviews could not be conducted for many of the technologies in the selected cities of the other regions, because the initial survey did not succeed in locating health units with these resources.

The findings of this phase of the study showed that the new medical technology being investigated was being used to solve some of the health care problems in the hospitals and clinics of Mexico's major cities. In addition, evidence was obtained that justifies a certain amount of optimism about the future use of technological innovations in Mexican medicine. For one thing, substantial partici-

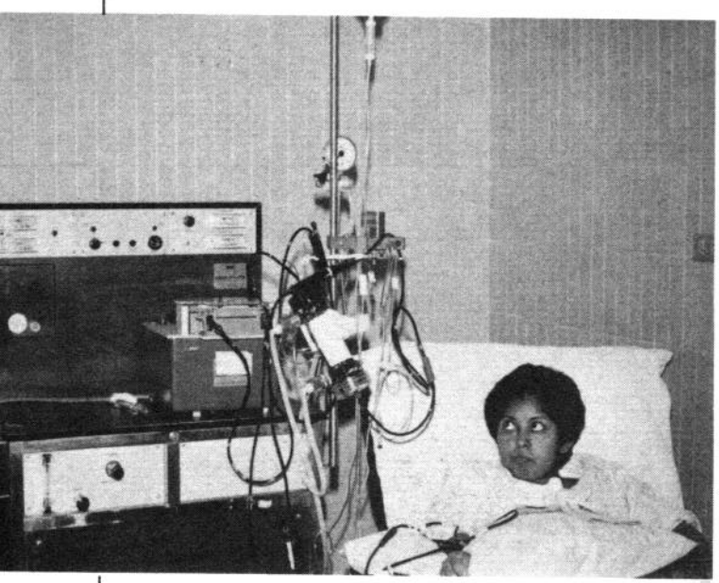
Table 8. A record of the interviews conducted at units with one or more of the study technologies, showing the units' geographic distribution and whether they were public or private.

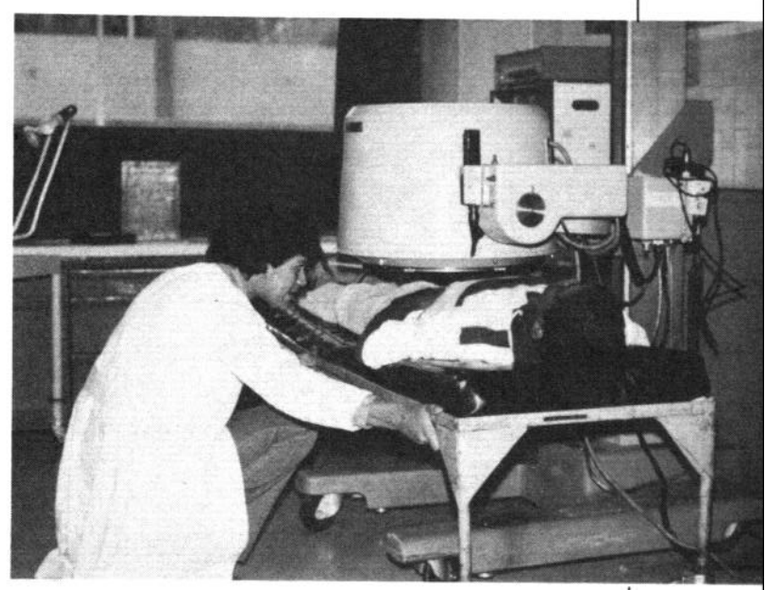
Geographic region	No. of cities	No. of units			No. of interviews at:		
		Public	Private	Total	Public units	Private units	All units
North Pacific	1	2	1	3	8	2	10
Northern	4	11	10	21	42	32	74
Central	4	21	17	38	60	36	96
Mexico City	*1*	*14*	*9*	*23*	*38*	*19*	*57*
Other	*3*	*7*	*8*	*15*	*22*	*17*	*39*
Gulf of Mexico	2	5	2	7	19	2	21
South Pacific	1	2	2	4	5	2	7
Total	12	41	32	73	134	74	208

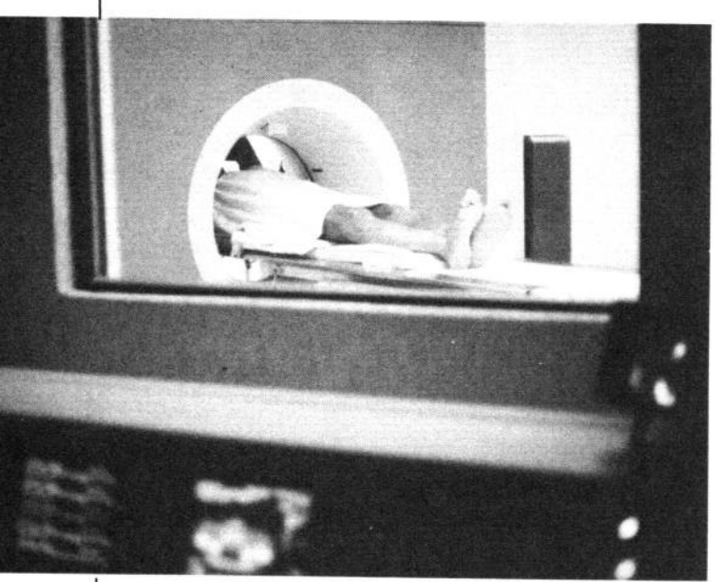
Table 9. The numbers of interviews conducted about each of the 17 study technologies, by type of technology, location of the health unit, and whether the health unit was public or private.

	No. of interviews conducted at public and private units in different regions																	
	North Pacific Region			Northern Region			Central Region			Gulf of Mexico Region			South Pacific Region			Total (all regions)		
Technology	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total	Public	Private	Total
Diagnostic technologies:																		
Amniocentesis	—	—	—	3	1	4	3	2	5	2	—	2	1	—	1	9	3	12
Automated clinical laboratories	—	—	—	3	2	5	2	2	4	1	—	1	—	—	—	6	4	10
Cardiac catheterization	—	—	—	1	2	3	3	2	5	—	—	—	—	—	—	4	4	8
Electronic fetal monitoring	1	—	1	2	2	4	4	2	6	—	—	—	—	—	—	7	4	11
Fibroscope endoscopy	2	—	2	3	2	5	5	2	7	2	1	3	1	1	2	13	6	19
Scanning tomography	—	—	—	2	3	5	4	3	7	—	—	—	—	—	—	6	6	12
Scintillography	—	1	1	3	2	5	2	3	5	1	—	1	—	—	—	6	6	12
Ultrasonography	1	—	1	4	3	7	5	2	7	2	—	2	—	—	—	12	5	17
Subtotal	4	1	5	21	17	38	28	18	46	8	1	9	2	1	3	63	38	101
Therapeutic technologies:																		
Cobalt radiotherapy	—	1	1	1	1	2	4	2	6	—	—	—	—	—	—	5	4	9
Heart surgery	—	—	—	2	1	3	3	1	4	—	—	—	1	—	1	6	2	8
Laser beam therapy	—	—	—	1	2	3	3	1	4	1	—	1	—	—	—	5	3	8
Microsurgery	1	—	1	2	2	4	4	3	7	—	—	—	—	—	—	7	5	12
Organ transplant	—	1	1	2	2	4	3	1	4	—	—	—	—	—	—	6	3	9
Prosthesis implantation	1	—	1	3	2	5	2	4	6	3	1	4	—	—	—	9	7	16
Subtotal	2	2	4	11	10	21	19	12	31	4	1	5	1	—	1	37	25	62
Maintenance technologies:																		
Coronary care units	—	—	—	3	1	4	2	4	6	2	—	2	—	—	—	7	5	12
Hemodialysis	1	—	1	3	2	5	5	1	6	3	—	3	—	—	—	12	3	15
Intensive care units	—	—	—	4	2	6	6	1	7	2	—	2	2	1	3	14	4	18
Subtotal	1	—	1	10	5	15	13	6	19	7	—	7	2	1	3	33	12	45
Total	7	3	10	42	32	74	60	36	96	19	2	21	5	2	7	133	75	208

Four of the technological innovations surveyed: (1) hemodialysis, (2) scintillography, (3) scanning tomography, and (4) a coronary care unit.







pation in the study was obtained from personnel responsible for the technologies involved. That in itself represents an important achievement, since at the beginning a number of people had expressed the opinion that a study of this kind, based on surveys within health care units, would meet with little success.

Beyond that, the opinions recorded during the survey came from personnel at both the operational and management levels, so that different types of views were sampled regarding use of the various technologies. Within this context, it is also noteworthy that the interview subjects generally expressed a favorable attitude toward review of the use being made of the technologies involved.

Finally, by means of the survey a directory was obtained of professionals (chiefly physicians) who have been trained to take charge of the 17 study technologies. These professionals constitute a valuable group of experts who could play an important role in any program of activities designed to ensure rational use of new medical technology.

The survey also revealed a number of problems. In many cases the study technologies were not being used to best advantage; and, in general, utilization of the technologies was hampered by obstacles to effective technology transfer, by administrative and operational problems, and by failure to apply appropriate clinical criteria in using the technology.

Regarding technology transfer, many deficiencies were noted in the decision-making processes that led to acquisition of the resources. In the case of public health care units, equipment was generally purchased and allocated at the initiative of the central institutional decision-making level, without consulting the receiving unit's managers or operations personnel.

In private health care units the decision to purchase equipment was generally taken by the medical director, or by a small group of doctors, without any formal evaluation of the equipment's usefulness or cost-effectiveness. In more than one case the equipment was received through donation, and import permits were not always obtained.

At the same time, it was noted that some health units—both public and private—carried out their services with obsolete equipment, or kept the same models in use for periods of over a decade. Even more surprising, in some cases the equipment had remained in storage for months or years, suffering minor or major damage that later affected its use. These start-up problems could be traced to several causes: inadequate infrastructure facilities in the unit, delays in procuring essential supplies and accessories, and problems finding trained support personnel or personnel able to assume responsibility for the resource's operation.

Regarding administrative problems, deficiencies in management of materials and equipment were noted that caused the equipment to be out of action repeatedly, days or weeks at a time, for lack of basic supplies. (Many of these supplies, such as contrast materials and hemodialysis packages, were imported.)

It was also noted that maintenance and calibration of instruments were sporadic and costly, and that contracts covering these tasks were lacking in many cases. Commonly, maintenance took the form of seeking help in an emergency, so that it had to be provided urgently and at even higher cost. Closely related to these problems were upkeep budgets too small to support maintenance consistent with rational operation of the resource. The combination of these factors resulted in substantial underutilization of the equipment.

Finally, regarding application of appropriate clinical criteria, it was noted that in some cases the indications for using the technology differed from one unit to another. This suggests that the clinical criteria varied, and that programs of continuing medical education were not succeeding in keeping knowledge of the technology up to date. This deficiency was evident in the performance of a number of diagnostic procedures without consistent standards.

Discussion and Conclusions

Availability of New Technologies

At the time the study was performed, the precise share of general health services being provided by the public and private health sectors was not known, there being a lack of specific data on this matter. However, one source indicated in 1977 that 77% of all hospital beds subject to the census that year were in public health care units and 23% were in private units *(24)*.

As already mentioned, our initial survey on availability of new technology in Mexican medical practice indicated that 41% of the study technologies recorded by the survey were in private sector units; this would suggest more available technology per bed in the private than in the public sector. However, the survey also found that the public sector had more equipment per unit. It was therefore not possible to determine from the data which sector, public or private, was the best equipped with the new technologies surveyed.

It might be assumed that some relationship exists between a given geographic region's total population and the technological resources available within it. Accordingly, a comparison was drawn between each region's share of technology, as revealed by the survey, and that region's population. The survey found that while the study technologies existed in 42 of the cities surveyed, the data indicated differences among the country's five geographic regions regarding the ratio of technology to population. Specifically, the Northern and Central regions clearly had more technological resources relative to their populations than did the other three regions. It is not known whether the differences in resource distribution that were recorded by the survey reflected the true situation or were due to some extraneous factor affecting compilation of the data. However, the information obtained appears to be reasonable, suggesting a distribution of medical technology similar to the distribution of industrial activity and general economic activity, which are concentrated in the Central Region (mainly the Federal District and Guadalajara) and in certain other important development centers (chiefly Monterrey and Chihuahua, two cities of the Northern Region).

Regarding the years when services provided by the study technologies were introduced, there appears to have been a progressive increase in the rate of their introduction in each succeeding five-year period from 1955 to 1979. This growth trend also appears to have persisted up to 1982, the last year covered in the survey. In part, these findings merely reflect the years in which the various study technologies were developed and disseminated around the world. On the other hand, they also reflect the dynamics of factors influencing innovation within the public and private sectors of the Mexican health system. Thus, the adoption of the study technologies in large numbers in the later part of the study period could be ascribed partly to their greater availability on the worldwide commercial market, and partly to an increasing acquisition of medical equipment over time that paralleled heavy investment in other capital goods that prevailed in Mexico during the 1960s and 1970s.

Comments and Recommendations

It might be supposed that acquisition of new technologies by health units would continue throughout the mid-1980s at the same rapid rate as it did previously. However, the serious economic crisis that Mexico has faced since early 1982 makes this seem unlikely. It is more likely that the trend toward acquisition of expensive equipment, as typified by complex medical technology, will change. Such a change would show up as a leveling-off or decline of acquisitions relative to preceding years. And since technological development appears to have proceeded in a more or less similar fashion in the public and the private health sectors, this change could logically be expected to occur within both sectors.

Several other comments seem appropriate on the basis of the survey data. For one thing, the new medical technology possessed by both health sectors, public and private, represents a substantial capital investment; yet the survey results indicate that such technology is still not available to the extent needed and is not well distributed. This is especially unfortunate in view of the fact that Mexico's current economic situation reduces the prospects that the rate of technology acquisition will be maintained.

It should also be mentioned that a number of measures have been taken recently to coordinate public health sector services, and that proposals have been made for integrating these services *(25)*. It seems clear that actions taken to implement these latter proposals would have to be based on regionalization of all public sector health resources, including advanced technology; and any movement in this direction could be expected to focus attention on the need for a properly balanced distribution of technological resources—both among Mexico's various regions and within its different health care levels. In order to plan for the greater access to technology that this implies, it would be necessary to have a complete register of all resources available in both the public and the private sectors.

The work discussed here was not concerned with proposing particular approaches for utilizing new medical technology, nor did it attempt to determine what might be the ideal technological configuration for a given health service. Rather, it sought first to learn about the context within which the Mexican health system uses technological resources and second to pave the way for considering both the advantages and general problems associated with advances in medical technology in Mexico. By way of contributing toward this latter goal, it appears appropriate to make a number of general recommendations concerning measures urgently needed to improve utilization of new medical technology. In particular, our work to date indicates that action should be taken:

1) to establish formal evaluation procedures for rational acquisition of new medical equipment, and to assess the extent to which these criteria are valid for the public and private sectors;

2) to maintain an up-to-date national register of new technological resources possessed by Mexican health units and of the personnel who manage those resources;

3) to design and implement programs of continuing medical education concerning the benefits and limitations of new technology;

4) to design a national program of studies and continuing education for support personnel concerning the operation and maintenance of health technology resources;

5) to carry out economic and operational studies on the use of new technology in Mexican medicine.

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SUMMARY

In Mexico, as in other countries, there exist important health problems which must be resolved in hospitals with the aid of modern medical technology. Health care authorities should devote special attention to this matter, since a wide range of complex new technologies have been introduced in recent years, and precise assessment of their availability and usefulness is needed.

The establishment of a data base regarding the use being made of these technologies is a first step toward their supervision and control. Because this kind of information is scarce in Mexico, the University Center for Educational Technology in Health of the National Autonomous University of Mexico (CEUTES-UNAM) conducted a study designed to provide information about patterns of use of 17 new medical technologies within the Mexican health system.

The initial part of the study documented the existence of some 803 health resources corresponding to these 17 medical technologies. The services in question were distributed among 157 hospitals and clinics (94 public and 63 private institutions) located in 42 cities. Of Mexico's five geographic regions, the Central Region was found to possess about half the technology involved (468 of the reported resources), followed by the Northern Region with 219 resources, the Gulf of Mexico Region with 63, the North Pacific Region with 34, and the South Pacific Region with 19.

A second, subsequent part of the study indicated that the technologies examined were being used to solve a portion of the medical care problems in hospitals and clinics of major Mexican cities, and that there was a general willingness on the part of the responsible personnel to review the utilization being made of these resources. However, the results also indicated that application of these technologies was not optimal, major obstacles being posed by a variety of technology transfer problems, administrative and operational problems, and inadequate use of clinical criteria. By way of contributing to further consideration of these matters, the authors present a list of general recommendations for rationalizing the acquisition and use of new medical technology in Mexico.

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