# Appendix C.—Veterans Administration Procurement and the Market for Medical Equipment[1]

This appendix describes and analyzes the ways that Veterans Administration (VA) procurement of medical equipment affects and is affected by conditions of demand and supply in the markets for X-ray equipment, computed tomography (CT) scanning equipment, digital imaging equipment, nuclear diagnostic equipment, nuclear magnetic resonance (NMR) and positron emission tomography (PET) scanning devices, ultrasound diagnostic equipment, patient monitoring and electroencephalograph (EEG) and electrocardiography (ECG) equipment, and hemodialysis equipment. The discussion encompasses the ways procurement policies of the VA affect the prices and products that are offered and the practices of private buyers. Manufacturers' comments on VA procurement are also summarized.

This study is based on data available through the VA Marketing Center (VAMKC) about its procurement. Although important national market structure data exist, most are available only in the form of 4-digit SIC codes, which are too broad a classification for the analysis here.[2] In fact, all types of equipment examined in this study fall within a single 4-digit SIC code, SIC 3693, electromedical and electrotherapeutics equipment.

Some Bureau of Census data are available in the finer 5-digit and 7-digit codes, but they suffer from several problems: First, data are withheld at these levels because of Bureau requirements to maintain confidentiality of individual firms' data; second, some important structural data are not reported at all at these levels of analysis; and third, there begin to be severe problems in the data reliability of plants that produce many products.

Private proprietary sources of data are not bound by the same confidentiality requirements as the Bureau of the Census, but they tend to be incomplete and are frequently inconsistent (3).

Because of VAMKC contractual reporting requirements, however, the characteristics of specific equipment markets can be reconstructed, including information on product market concentration, market shares of individual firms, and market share instability. (When findings are reported here, care has been taken to ensure their confidentiality.) In addition, data gleaned from interviews with manufacturers' representatives have been analyzed along with VAMKC data for a fuller interpretation.

## Diagnostic X= Ray Equipment

X-rays are a highly penetrating form of electromagnetic radiation of much higher frequency than visible light. They are generated in evacuated glass bulbs called X-ray tubes that contain two electrodes, an anode and a cathode. High voltage applied between the two electrodes causes electrons to flow from the cathode to the anode, and X-rays are produced as the electrons strike the anode. Since substances vary in their opacity to X-rays, X-rays that have passed through a body can provide information on its internal structure (63). In standard radiography, X-rays that have passed through the body strike a sensitive photographic film, and the resulting picture reflects the structures through which the X-rays have passed. A conventional radiograph is effectively a shadowgraph, a projection of the X-ray absorption of a three-dimensional body onto a two-dimensional detector. (Standard X-rays are also called "projection X-rays.") In fluoroscope, the detector is a fluorescent screen rather than photographic film. In modern fluoroscope, X-rays are detected by a phosphor surface next to the surface of a photoemitter, to intensify the image. The final image can be viewed directly or camera recorded.

Conventional radiography provides excellent spatial resolution but rather poor contrast resolution. In other words, objects of different opacity to X-rays than surrounding material are quite distinct in X-ray images, but it is difficult to discern even a large target object if its opacity to X-rays does not differ significantly from that of surrounding material. As a result, except in regions of low absorption, namely the chest, breast, and extremities, conventional radiography is unsuited for characterizing soft-tissue detail (75).

### General Demand Characteristics

Supplies v. Equipment Costs.—Annual expenditures on X-ray film and other supplies depend on how much X-ray equipment is used. In a large hospital, the annual cost of supplies can easily be as great as the purchase price of the equipment (21,25). X-ray film, film development chemicals, and other supplies are typically purchased independently of X-ray equipment.

Equipment Purchase Price. -X-ray equipment varies greatly in price depending on its characteristics. A sim-

[1] Based on a paper prepared for OTA by Ralph Bradburd (14).

[2] SIC codes are Standard Industrial Classification codes, which are used by the Bureau of the Census of the Department of Commerce to classify products for the Census of Manufactures, which provides the most comprehensive statistics on medical device industries (see 105).

ple unit may cost as little as $30,000, while the equipment for a fully appointed procedures room may cost well over $1 million. Peripheral equipment is also required, such as developing rooms, viewing equipment, and cabinets for storing X-ray photographs.

**Servicing and Technical Support.**—The need for technical support and servicing of X-ray equipment increases with its complexity. Sophisticated X-ray equipment may require up to 8 weeks for installation and calibration (21). For annual service contracts, manufacturers quoted costs ranging from 5 to 14 percent of equipment purchase costs. Servicing costs and "downtime" of equipment are both important considerations in purchasing, and service availability can support a VA hospital's "brand name justification" for purchasing equipment (which is explained below).

### The VA Market: Demand and Supply

**VA Demand.**—VA X-ray equipment purchases are channeled through the VAMKC'S Radiological and Nuclear Equipment and Supplies Division. The VAMKC negotiates annual contracts with vendors, and when VA medical centers (or other units that purchase through the VAMKC) are authorized to purchase X-ray equipment, the VAMKC places the order, arranges for direct delivery to the medical center, and administers the contract (40).

X-ray equipment accounts for more direct delivery medical equipment capital expenditures than any other single equipment category, and represents a substantial annual budget item. As a proportion of medical equipment expenditures, those for X-ray equipment have been falling, representing 71 percent of total medical equipment expenditures other than through the Federal Supply Schedule (FSS) in 1979, 69.6 percent in 1980, 50.2 percent in 1981, and 46.9 percent in 1982.[3] Yet the corresponding absolute dollar amount in 1982, over $59 million, was larger than that in any of the previous 3 years (131,132).

The VAMKC manages direct delivery purchases of X-ray equipment for a number of Government agencies other than the VA, including the Public Health Service. Even so, the VA accounted for 91.3 percent of VAMKC'S total direct delivery X-ray equipment expenditures in 1979, 78.2 percent in 1980, and 73.8 percent in 1981 (131).

**VA Demand Relative to the National Market.**—The VAMKC appears to be a significant part of the national market for X-ray equipment. The VAMKC requires that vendors disclose total annual sales of the equipment covered in their annual contracts. Although incomplete, the data made available to OTA by the VAMKC indicate that it purchases roughly 5 to 10 percent of the X-ray equipment of companies on annual contract. Companies apparently vary in the proportion of the X-ray equipment sales they make through the VAMKC, for one company below 5 percent, for another over 10 percent (132). For many, but not all companies, the VA is either their largest or one of their largest customers (4,21,25,48,86).

**VAMKC Demand Variability .**-Total expenditures for X-ray equipment orders processed by the VAMKC are highly variable. From 1979 to 1980, they fell by 35.6 percent, and from 1980 to 1981, they fell an additional 37.2 percent. Finally, from 1981 to 1982, they rose by 297.6 percent. The variability of VA demand for X-ray equipment was somewhat greater than that of other agencies that purchase through the VAMKC. VA purchases fell by 44.9 percent from 1979 to 1980, and by 40.8 percent from 1980 to 1981 (131). (Available data do not permit the calculation of the corresponding 1981-82 percentage change. ) Such demand variability is high compared with most American industries (93). Its effect on the market will be discussed below.

**Suppliers to the VA Market.**—Many major manufacturers of X-ray equipment have had VAMKC annual contracts in the past 3 years, including (in alphabetical order) CGR Corp., General Electric Co., General X-ray, H. G. Fischer, Orthopedic Equipment, Philips Medical Systems, Picker International, Raytheon, Siemens Corp., and Xonics Medical Systems. However, this VAMKC market is relatively concentrated: Four firms accounted for almost 95 percent of sales to the VA in 1982 (132). In addition, if vendors are ranked by sales volume for 1979 through 1982, the same four firms are always found at the top, with none moving by more than one rank (131,132).

Taken alone, these data might indicate lack of competition in the market. However, further data analysis shows that, although rankings by market share have not changed much, the market shares themselves have. In measuring market share changes, the greatest possible sum of the absolute values is 200. This is the value resulting should the market change hands completely, with every firm with any sales in the first period having none in the second and other firms entirely capturing the market. Table C-1 shows the significant annual changes in market shares during the sample period.

There are several possible explanations of the observed volatility in market shares. One is that the

[3]The FSS program is administered by the Office of Federal Supply and Services of the General Services Administration. VAMKC is the commodity manager for this program's Group 65, Medical, Dental, and Veterinary Equipment and Supplies. VAMKC establishes contracts with manufacturers of this equipment under the policy guidance and procurement regulations of the General Services Administration. (This arrangement is discussed further in ch. 5.)

**Table C-l.—Sum of Absolute Values of Annual Percentage Changes in Vendors' VA Marketing Center X-ray Equipment Market Shares, 1979-82**

| | 1979-80 | 1980-81 | 1981-82 |
|---|---|---|---|
| Sum of absolute values...... | 26.4 | 45.8 | 29.3 |
| As a percentage of maximum possible value (200) ... , . . . | 13.2 | 22.9 | 14.6 |

SOURCES: U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Supplies Division, unpublished data, Hines, IL, 1983; and U.S. Veterans Administration, Marketing Center, Radiological and Nuciear Equipment and Supplies Division, unpublished information from vendors' 1982 contracts, Hines, IL, 1983.

individual buyers of X-ray equipment prefer particular companies' products, and it happens that the purchase cycles of these buyers alternate to produce the observed shifts. Although the data do not permit a test of this hypothesis, it seems unlikely. An alternative, and more likely, explanation is that the firms aggressively compete with each other in price or product performance, with the lead in either or both of these dimensions, and hence the market share, changing hands from year to year.

## CT Scanning Devices

CT scanners area form of X-ray equipment. As in standard radiography, X-rays are generated and detected, and the attenuation of the X-rays as they pass through the body provides information about the structures through which they have passed.

In CT scanning, the X-ray beam is passed through a collimator (a device for producing a beam of parallel rays of light or other radiation) that forms the beam into a thin fan in a plane perpendicular to the long axis of the body. On the other side of the body is an array of X-ray detectors. Each of these detectors produces a charge signal proportional to the X-ray energy it absorbs. Signal strength is a function of the attenuation of the X-ray along the path between the detector element and the X-ray source.

To produce a cross-sectional image, depth information is obtained by rotating the source and detector array around the body axis while taking projections of the same section from several hundred different angles. The data from each projection are "digitized" and processed. A series or "stack" of contiguous CT images contains all the data necessary for constructing a variety of quasi-three-dimensional forms (75).

CT scanning devices help overcome two limitations of standard X-ray equipment. First, they allow the diagnostician to obtain a view of a cross-section of the body, as opposed to a projection that provides only information on the total accumulated attenuation of the X-ray beam as it passes from one side of the body to the other. A tumor or lesion directly behind a bone as the body is viewed may not be detectable in a standard X-ray. Also, standard X-ray equipment usually cannot determine the depth of a tumor or lesion, but a cross-sectional view can. In addition, because the detector absorption data are digitized and can be processed, greater contrast resolution is possible (as explained in the discussion of image data processors below). CT scanners are extremely important in detecting tumors, in determining the optimal path for radiation therapy, and in other uses.

### General Demand Characteristics

**Supplies v. Equipment Costs.**—Accurate data are not available on the annual costs of supplies for CT scanners. However, because these scanners are much more expensive than standard X-ray equipment, and because they use digital image recording rather than expensive X-ray film, the cost of their supplies should be smaller relative to equipment costs compared with standard X-ray equipment.

**Equipment Purchase Price.**—The list price of a CT scanning device generally varies between $600,000 and $1,500,000 depending on its manufacturer and characteristics. These prices have begun to fall as the market has matured and the cost of data-processing components has fallen (40).

**Servicing and Technical Support.**—CT scanners are extremely sophisticated equipment and, to perform properly, must be very finely adjusted. (The VA hires an outside consultant, a physicist, to inspect installed CT scanners.) As a result, both technical support and servicing are extremely important. One vendor quoted a price of $85,000 for the annual service contract on a CT scanner with a list price of about $1 million, or about 8.5 percent of the equipment's purchase price (4,25,42,86).

### The VA Market: Demand and Supply

**VA Demand.**—CT scanning devices are purchased through the VAMKC, rather than through the usual FSS, decentralized contracts, or direct delivery programs (all described in ch. 5). Purchases of CT scanners must be approved by the VA Central Office in Washington, DC. The Central Office has ranked VA hospitals by their need for CT scanners. Funds for the scanners are budgeted in the VA Central Office and are provided centrally, not as usual through hospital funds. Purchases are delayed until a sufficient number are possible, so a group purchase can be made with significant savings. The VAMKC then requests bids for equipment meeting its specifications.

In 1982 the VAMKC requested a bid for purchase of 23 CT scanners, 21 for VA hospitals and 2 for the Air Force. The list price for the equipment of the winning bidder was $1,359,000 per unit; the VAMKC procured the equipment at $917,730 per unit. An additional $4.4 million worth of CT scanners were bought in the same year from another company. In 1983, the VAMKC purchased 24 CT scanners through similar bidding. In that year, the list price for the equipment purchased was $1,383,500 per unit; the VAMKC procured the equipment at $829,950 per unit (40).

CT scanners have accounted for a growing proportion of VAMKC-procured equipment costs. In 1979 CT scanners represented 6.1 percent of non-FSS equipment expenditures; in 1980, 13.1 percent; and in 1981, 28.2 percent. In 1982 CT scanners accounted for 20.2 percent of total non-FSS equipment procurement, a somewhat smaller percentage than the year before, but a higher total dollar commitment, $25,512,122 compared to $8,386,270. Since 1980 CT scanners have accounted for more VAMKC procurement dollars than any other category of equipment except X-ray equipment, with most of this CT equipment going to VA hospitals (table C-2). In 1983 VAMKC procurement of CT scanners totaled $19,918,800 (40,132).

**VA Demand Relative to the National Market.**—As mentioned above, CT scanners have not been purchased through the usual VAMKC annual contracts. As a result, there is much less information to estimate the relative importance of VA procurement in the national market. According to a representative of Siemens, the CT market is now about 600 units per year (for all manufacturers), down from 750 per year a few years ago (86). If this number is accurate, VAMKC procurement probably does not account for more than 4 to 5 percent of total national expenditures on CT equipment.

In this market, the VAMKC may also not be some manufacturers' largest account. Nonetheless, the total dollar volume of VAMKC CT procurement—almost $20 million–may be high enough for VAMKC'S procurement practices to influence manufacturers' behavior, if not as much as in other markets.

**Table C-2.—Annual VA Marketing Center Procurement of CT Scanning Equipment, 1979.82**

| | 1979 | 1980 | 1981 | 1982 |
|---|---|---|---|---|
| Total annual CT procurement by VAMKC ($ millions) . . . | $3.2 | $4.5 | $8.4 | $25.5 |
| VA proportion of total VAMKC procurement . . | 100°/0 | 20.70/o | 88.40/o | N.A. |

SOURCES: U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Supplies Division, unpublished data, Hines, IL, 1983; and U.S. Veterans Administration, Marketing Center, Radi. ological and Nuclear Equipment and Supplies Division, unpublished information from vendors' 1982 contracts, Hines, IL, 1983.

**VAMKC Demand Variability .**—VAMKC procurement of CT scanning devices has fluctuated from year to year, but much of this fluctuation seems more appropriately characterized as growth rather than demand instability, certainly in the period from 1979 to 1982. 111 any case, given that VAMKC procurement is a small fraction of the national market, a drop in VAMKC orders, such as available data indicated for fiscal year 1983 (from 25 to 24 scanners), is unlikely to have an impact on manufacturers.

**Suppliers to the VA Market.**—A number of major companies produce CT scanning equipment, including CGR, General Electric Co., Picker International, and Siemens. Since 1979 the VAMKC has purchased CT equipment from General Electric, Pfizer, and Picker International (Pfizer has since left the CT market) and some equipment from Technicare, a subsidiary of Johnson & Johnson, for use with CT equipment. In 1982 a number of companies responded to the VAMKC request for technical proposals to supply CT equipment. Only two of those companies' proposals met the necessary technical specifications. Those two companies were then issued an invitation for bid. Of the two companies that received an invitation for bid, only one company's product passed the testing for specifications, and that company received the contract. (There was a second round of bidding in 1982, with different specification requirements, to replace five CT units purchased in 1979. ) In 1983 three companies submitted technical proposals that met specification requirements; those three companies received an invitation for bid. One of the three companies' products did not pass testing, and the contract was given to the lower of the two remaining bids. Thus, in both 1982 and 1983, one firm received either all or most of the orders (40).

It is difficult to say whether the number of potential CT equipment suppliers to the VA market will increase or decrease in the next few years. As the market matures, it is likely that some firms now active will exit the market. On the other hand, it is likely that the equipment of more of the firms remaining will meet VAMKC specifications. Thus, it is hard to predict whether competition in the VA market will increase or decrease.

## Digital Image Processing Equipment

Digital image processing is a technology that reconstructs and enhances images based on data stored electronically in digital form, The system is perhaps best explained by comparing it with the technologies it is replacing. In traditional projection radiography, for example, the X-rays passing through the subject strike an X-ray sensitive photographic film. The chemicals on the film are exposed (i. e., darkened) at particular locations depending on the attenuation of X-ray beams as they pass through the subject on their way from their source to the film. In a digitized projection X-ray system, the photographic film is replaced by a grid of electronic detectors that transmit their data on X-ray exposure to a computer, where the data are recorded in digital form. These recorded data can then be processed in a variety of ways and used in reconstructing images. (The familiar computer-printed pictures of the Mona Lisa and Snoopy are examples of image production from digital data, though these computer programs are vastly less sophisticated than those used in medical imaging. )

In digital fluoroscope, a photoemitter is connected to an image-intensifying system, which creates a video signal that is digitized, stored, and processed. A television monitor driven by a digital display controller then converts the processed information into displayed brightness (75).

Digital image processing offers a number of important advantages over standard radiographic and fluoroscopic techniques and is being applied to ultrasound techniques as well. Notably, this processing can vary the brightness and contrast of a picture so a diagnostician can focus on particular features. As mentioned in the discussion of X-ray equipment, contrast resolution is a problem in standard radiographic techniques, Because the film must record a wide range of X-ray attenuation occurring between the source and the detector, it is often difficult if not impossible to distinguish two objects similarly opaque to X-rays in an X-ray photograph. The advantage of digital image processing is that signals representing a narrow range of X-ray attenuation can be processed to obtain high contrast. This enhancement is like that of a medical thermometer compared to an outdoor thermometer. The outdoor thermometer must record temperatures anywhere from –30o to over 100° F, a very wide range; a medical thermometer can be more sensitive since it only covers a range from 94° to 108° F, Similarly, one may adapt a digital image to focus on a narrow range more sensitively.

There are other advantages of digital image processing as well. It can also be used for edge enhancement and to increase the clarity of the X-ray image. Its greater sensitivity makes possible less X-ray exposure, and the time diagnosis takes is also reduced by eliminating the time-consuming step of film development.

One of the most important medical applications of digital image processing is in angiography (103). In angiography, a catheter is threaded through a vein or artery until properly positioned and a dye that is opaque to X-rays is injected. Subsequent X-rays of the injected region highlight the blood vessel passages, revealing arterial blockages, constrictions, and other signs of atherosclerotic disease. Angiography requires minor surgery, however, and is not without risk; an average of 2 in 1,000 patients die from complications (77).

Digital image processing substantially reduces the risks of angiocardiography and arteriography. In either procedure, dyes injected into the bloodstream begin to diffuse through the bloodstream, and using standard X-ray techniques this meant that dye had to be injected very close to the location of interest, requiring invasive surgery. Digital image processing, however, can enhance the information about the flow of dye. The new techniques can sense far lower amounts of dye than standard equipment, which allows the dye to be injected in peripheral veins. Very revealing images of interior structures can be created using digital subtraction. First, an X-ray image of an area is taken before injecting the dye and the pattern obtained is stored on computer disks or tapes. Then the dye, usually iodine, is injected, and as the dye passes through the area's arteries, a television monitor displays a pattern representing the difference, point for point, between the images before and after injection. In this way, a much less cluttered picture is created (58).

Another important advantage of digital image processing is that its operating costs are much lower than those of standard radiography. It does not require expensive X-ray film, the annual costs of which can be as great as the capital cost of standard radiographic equipment. Also, because images are stored on such media as magnetic tape or disks in very little space, the large storage facilities now required are no longer needed (25,37). In addition, the diagnostician can retrieve stored X-rays almost instantly from a computer terminal.

Because of the enormous and rapidly growing advantages of digital imaging, the markets for radiographic and fluoroscopic equipment are now unstable. One manufacturer's representative predicted that the entire imaging market could be captured by digital imaging within 5 years (25).

### The VA Market: Demand and Supply

**VA Demand.**—In discussing VA demand for digital image processing equipment, it is necessary to distinguish between such equipment that is an integral part of an X-ray system and that called "digital add-on" equipment, which is appended to an existing system to "digitize" it. It is difficult to determine the extent of total VAMKC procurement of digital image processing equipment from available VAMKC documents. The available documents indicate that in 1982 the VA purchased $342,261 worth of digital radiography equipment and $438,900 worth of digital fluoroscope equipment, for a total of $781,161, or just slightly more than 0.6 percent of the total VAMKC non-FSS expenditures for medical equipment. However, an unknown part of the expenditures for "X-ray equipment" may actually represent such imaging equipment purchased as part of a system (132). In this discussion we will focus on VAMKC procurement of digital "add-on" equipment.

**The Problem of Mixed Systems.**—Perhaps the most important feature of the market for digital add-on equipment is the problem of putting together the products of different companies into a coherent system. VAMKC procurement personnel and manufacturers' representatives indicate their concern about assigning responsibility for equipment breakdowns, particularly during the warranty period. They fear that when a system does not function properly, each of the companies will place the blame on a component produced by the others. In addition, there is the problem of coordinating the delivery of mixed systems, and especially, of determining which manufacturer is responsible for connecting the components. Finally, there are the issues of service costs and the larger discounts typically offered when the VAMKC purchases an entire system from one manufacturer (40).

As a result of these complications, the VAMKC strongly prefers to purchase complete X-ray systems rather than purchase their components from different manufacturers. When the VAMKC does purchase digital add-on equipment, it prefers to purchase this equipment from the same manufacturer that produced the system (40). This preference probably reduces the number of vendors to the VA market, which may increase the costs of the digital add-on equipment. Available documentation does not indicate if the impact of this preference is significant, and if it is, whether or not the above-mentioned difficulties with mixed systems still make the preference for avoiding mixed systems the most cost-effective strategy.

**Suppliers to the VA Market.** -There are probably 30 or 40 manufacturers of digital image processing equipment today (37). However, many of them produce only add-on equipment, and thus, for the reasons discussed above, may have some difficulty selling their products through VAMKC. In 1982 the VAMKC purchased digital image processing equipment from only two companies (132).

## Nuclear Diagnostic Equipment

In diagnostic nuclear medicine, pharmaceuticals tagged with a gamma-ray-emitting isotope are administered to a patient. The steady-state or dynamic distribution of the isotope in the body is then determined by an imaging system. The most common imaging system is the "gamma camera, " which produces a projection image. It is also possible to combine cross-sectional techniques and isotope imaging in emission computed tomography, in which one or many gamma cameras rotate around the patient and collect and store data for many projection images. Techniques like those used in CT are then used to create cross-sectional images.

Diagnostic nuclear medicine has a number of medical uses. It requires only a low radiation dose and is particularly suited to the study of cardiac dynamics and to whole-body imaging, which can determine the extent of certain diseases (75). Nuclear medical equipment is commonly used in diagnosing thyroid dysfunction, using a radioisotope of iodine as the tracer.

### The VA Market: Supply and Demand

**VA Demand.**—The VA and several other agencies purchase nuclear medical equipment through the direct delivery program of the VAMKC'S Radiological and Nuclear Equipment and Supplies Division. Nuclear medical equipment accounts for a variable but significant part of total annual VAMKC medical equipment procurement expenditures. In 1979 it accounted for 19 percent of total non-FSS equipment expenditures; in 1980, 12.5 percent; in 1981, 18.1 percent; and in 1982, 6.6 percent. Total expenditures for nuclear medical equipment were $10 million in 1979, $4.3 million in 1980, $5.4 million in 1981, and $8.3 million in 1982 (131,132).

The VAMKC manages direct delivery purchases of nuclear diagnostic equipment for a number of agencies, including the VA, Public Health Service, Army, Navy, Air Force, and other Government agencies. It appears that the VA is not always the largest buyer of nuclear medical equipment through the VAMKC, In 1979 the VA accounted for 81.2 percent of total expenditures on nuclear medical equipment; by 1980 it accounted for only 49 percent of the expenditures, though it was still the largest buyer; and in 1981 the VA accounted for only 32.4 percent of expenditures, buying less than the Army (131). There is no breakdown of equipment purchases by agency in 1982 or 1983.

**VAMKC Procurement Relative to the National Market.**—VAMKC procurement of nuclear medical equipment accounts for a moderately significant part of the national market. In 1982 VAMKC procurement totaled about $8.3 million. Based on the data that nuclear medical equipment vendors must provide the VAMKC, it would appear that VAMKC procurement in that year accounted for approximately 7 percent of these vendors' nuclear medical equipment sales (with a range from about 5 to 10 percent) (132),

VAMKC Demand Variability .—VAMKC procurement of nuclear medical equipment has fluctuated from year to year (see table C-3). The variability of nuclear medical equipment expenditures is not as great as those for X-ray equipment, but it is significant.

Suppliers to the VA Market.—Companies with VAMKC annual contracts in the past 3 years include (in alphabetical order) Elscint, Inc.; General Electric Co.; MEDX, Inc.; Picker International; Raytheon; Siemens; Technicare; and Toshiba Medical Systems, All major manufacturers appear to have an annual contract with the VAMKC.

It is difficult to assess the competitiveness of the nuclear medical equipment market. The four firms with the largest market shares in 1982 accounted for almost 95 percent of VAMKC procurement, and the pattern is similar in earlier years for which data are available. With such high market concentration, the firms are likely to recognize their mutual dependence, and vigorous price rivalry would not be expected.

However, other factors operating in the nuclear medical equipment market suggest that this simple structural measure may underestimate true competitiveness. First, in this market there is very rapid technological change. In such situations, firms tend to compete very vigorously in both product development and pricing (78). Second, there have been notable changes in the rankings of the top four firms in the VAMKC market (table C-4).

Not only have the rankings of the firms shifted, but as table C-5 shows, so have their market shares. (If the firms were quite close to each other in market shares, there could be significant movement in the firms' rankings without significant shifts in market shares. ) Again, the greatest possible sum of the absolute values of market share changes is 200. The data in table C-S suggest that firms are competing with each other for market share, although, as discussed in the section on X-ray equipment, other explanations are possible.

The market concentration and market share data point to opposite conclusions about competition in this market. It is impossible, given available data, to assess pricing rivalry in the VAMKC nuclear medical equipment market. However, though it may be difficult to assess the static efficiency of this market, the pace of technological change and improvement in product performance are consistent with high dynamic efficiency.

**Table C-3.—Annual Percentage Change in VA Marketing Center Procurement of Nuclear Medical Equipment, 1979-82**

| | 1979-80 | 1980-81 | 1981-82 |
|---|---|---|---|
| Total. . . . . . . . . . . . . . . . . . . | -57.50/0 | +25.9Y0 | +54.80/0 |
| VA only . . . . . . . . . . . . . . . . . | -74.3°/0 | –16.7°/0 | N.A. |

SOURCE: U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Suppiies Division, unpublished data, Hines, IL, 1983; and U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Supplies Dlvlsion, unpublished information from vendors' 1982 contracts, Hines, IL, 1983.

**Table C.4.—Changes in Rankings of Four Largest Sellers of Nuclear Medical Equipment Through the VA Marketing Center, 1979-82**

| *1979* | *1980* | *1981* | *1982* |
|---|---|---|---|
| A | B | B | D |
| | A | D | A |
| ~ | C | A | C |
| D | D | C | B |

NOTE: The firm with the largest 1979 VA market share is identified as Firm A, that with the second largest 1979 market share Firm B, etc.

SOURCES: U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Supplies Division, unpublished data, Hines, IL, 1983; and U.S. Veterans Administration, Marketing Center, Radiological and Nuclear Equipment and Supplies Division, unpublished information from vendors' 1982 contracts, Hines, IL, 1983.

**Table C.5.—Sum of Absolute Values of Year-to-Year Percentage Changes in Vendors' VA Marketing Center Nuclear Medical Equipment Market Shares, 1979.82**

| | 1979-80 | 1980-81 | 1981-82 |
|---|---|---|---|
| Sum of absolute values. . . . . . | 14.1 | 40.5 | 35.4 |
| As a percent of maximum possible value (200) . . . . . . . | 7.0% | 20.30/o | 17.7% |

SOURCES: U.S. Veterans Administration, Marketing Cater, Radiological and Nuclear Equipment and supplies Division, unpublisheci data. Hines. IL, 1983; and U.S. Veterans Administration, Marketing 'Cente~: Radiological and Nuclear Equipment and Supplies Division, unpublished information from vendors' 1982 contracts, Hines, IL, 1983,

## NMR Devices

NMR, or as it is also known, magnetic resonance imaging (MRI), is based on the principle that information can be gathered on the composition of tissue through its response to powerful magnetic fields. The basic tool of NMR is an immense and extremely powerful doughnut-shaped magnet that can enclose the patient's entire body. When subjected to magnetic fields, hydrogen nuclei within the patient's body align themselves in parallel ranks, spinning like tops, and wobbling or "processing," as tops do, around their axes of spin. The patient is then irradiated with a short electromagnetic pulse, which pushes the spinning nuclei over on their sides. When the pulse subsides, the nuclei return to their positions, reradiating in the process some of the energy they had absorbed. Sensitive receivers pick up this electromagnetic echo. The information about the tissue comes from the timing and intensity of the signal, which depend on the amount of fat or water in a tissue and the type of motion of the nuclei. Computers then analyze the signals and display a cross-sectional image of the area studied (1). The techniques used for developing a cross-sectional image are essentially the same as those used in CT scanners, through digital data processing.

The advantage of NMR is that, unlike CT scanners, NMR does not expose the patient to X-rays. NMR may prove useful in diagnosing cancer and in detecting brain abnormalities and possibly heart damage (56).

### Demand and Supply

NMR (or MRI) devices have only recently received approval of the Food and Drug Administration (FDA), and thus are only beginning to be sold commercially. Their cost is expected to be roughly that of CT scanning devices (56) or perhaps higher (86). According to a recent estimate, by August 1984, 93 NMR units were installed within the United States (84). It is widely believed that NMR's potential market is extremely large. One manufacturer's representative estimated that the NMR national market maybe as large as $250 million to $300 million a year within 2 or 3 years (42). Given the size of the potential market for NMR devices, a number of manufacturers have entered the field, including General Electric, Philips, Picker, and Technicare.

Through fiscal year 1983 only one NMR device had been procured through the VAMKC, one for a clinical evaluation. This procurement is unlikely to affect the market significantly. Performance specifications were drawn up for the purchase, but they *were* based on those of available products, and so should not have affected product development (40).

Because NMR's use in medicine is so new and has so recently received FDA approval for clinical use, the market is in its youth. However, NMR will likely have a significant market within a few years. It would clearly be in the public interest for the VAMKC to begin planning its NMR procurement policies.

## PET Devices

PET is another technique for cross-sectional imaging. It is unique in producing images of chemical activity within the body, such as local metabolism. In PET, positron-emitting isotopes of biologically significant atoms—e.g., oxygen, nitrogen, or carbon—are produced using a cyclotron. These isotopes are then attached, or "tagged," to a physiologically active material, such as glucose, and administered to the patient. Finally, a scanner determines the postinjection distribution of the isotope, the information being processed like that in a CT scan to produce a two-dimensional image. The image is significant because the distribution of the isotope reflects the distribution, and therefore the utilization, of the metabolize (75).

### Demand and Supply

PET has attracted attention in the popular press for its potential in diagnosing metabolic disorders, brain abnormalities, and cancer. It would appear to be a way of observing abnormalities in body chemistry, with great medical potential.

At present, however, there does not appear to be a significant market developing for PET scanners. In part, this probably reflects the expense of PET, perhaps $1 million for the PET scanner itself and as much as another $2.5 million for a cyclotron to produce the radioactive isotopes (1).

The VA has purchased two PET scanning devices and apparently has no immediate plans to purchase more, so VAMKC procurement practices have most likely not affected whatever market this product has. It is uncertain whether a market for PET will develop later, but at the moment PET does not appear to be an important issue for procurement planners.

## Ultrasound Diagnostic Equipment

Ultrasound is generally defined as vibrations between 20 kHz and 30 MHz. The sound frequencies used for most diagnostic purposes range from 1 to 12 MHz. Such ultrahigh frequencies are produced by piezoelectric transducers that convert electrical energy to vibratory mechanical energy (sound). After a short sound burst, the transducer circuitry is switched to act as a receiver for returning sound or echoes, and for each pulse of sound emitted the reflectivity of tissue along the line of sound transmission is measured. The returning echo is converted to an electrical signal that is processed and stored in digital form.

In traditional ultrasound the echoes are displayed on an oscilloscope, with the intensity of each echo represented by a correspondingly bright spot on the screen. The position of the echo is displayed in the X-Y plane depending on the position of the transducer and the transit time of the acoustic pulse. In *more* modern ultrasound equipment, the digitized information can be processed with digital image processing to obtain a better picture of the target object. Moving the sound beam through the tissues by moving the trans-

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ducer is termed scanning. Using scanning techniques, a series of parallel or orthogonal tomograms, which are images of a slice or plane, can be assembled into a three-dimensional image of an organ.

Ultrasound is extremely useful in diagnosing heart disease and in detecting abnormalities of the liver, kidneys, gallbladder, and lymph nodes in the abdomen (72). It also has the very important attraction of employing nonionizing radiation at low power levels; no harmful effects have been found in humans in almost 30 years of clinical application (72). However, ultrasound has limitations. It requires a soft-tissue path between the transducer and the region of study; intervening bone, air, or dense fat attenuates and distorts the sound (60,72). In addition, ultrasound cannot effectively penetrate deep into tissue (about 22 cm is now the practical limit) and thus cannot effectively analyze problems in blood vessels or other parts deep within the body (77).

### General Demand Characteristics

**Supplies v. Equipment Costs.**—Ultrasound equipment is relatively inexpensive to operate. Costs of supplies and expendable are modest, perhaps at most one-fifth or one-sixth of the equipment's purchase price, according to one industry source (60).

**Equipment Purchase Price.**—Ultrasound equipment varies substantially in price depending on a system's capabilities. A system typically costs between $40,000 and $120,000, in the middle range for the diagnostic medical equipment discussed here.

**Servicing and Technical Support.**—Servicing and technical support are important to the proper functioning of ultrasound equipment. Manufacturers will frequently provide training in these areas to customers' personnel, and service availability is one of the important factors affecting VA procurement of ultrasound equipment (60,85).

### The VA Market: Demand and Supply

**VA Demand.** -Ultrasound equipment has been purchased through the VAMKC'S direct delivery program since April 1983. Prior to that it was purchased through decentralized contracts. From March 1, 1980, to February 1981, such ultrasound procurement totaled $6.84 million; from March 1,1982, to March 31,1983, VAMKC procurement of ultrasound equipment totaled about $11.5 million; in 1983 it is expected to be about $5 million (85).

Differences in contract, fiscal, and calendar years make it impossible to calculate the proportion of non-FSS medical equipment expenditures accounted for by ultrasound equipment. The $11.5 million spent on ultrasound equipment in the 1982 contract year is equal to about 9 percent of total VAMKC direct delivery equipment procurement costs in the 1982 Government fiscal year. The 1980 contract year ultrasound procurement of $6.84 million is equal to about 20 percent of 1980 fiscal year direct delivery equipment procurement costs, although it was not included in the direct delivery program at the time. The figure for 1983 is likely to be much smaller, perhaps 5 to 10 percent (85,131,132). Exact data are not available, but according to the VAMKC contract specialist for ultrasound, the VA accounts for about 60 percent of total VAMKC procurement of ultrasound equipment, with the Army, Air Force, and Public Health Service accounting for most of the rest (85).

**VA Demand Relative to the National Market.**-The VA accounts for a very small proportion of the national demand for ultrasound equipment. Several sources estimated that national sales of ultrasound equipment in 1982 were about $400 million (60,74). Assuming VA procurement to be 60 percent of VAMKC procurement, VA expenditures represent not even 2 percent of the national market; VAMKC procurement altogether was probably not more than 3 percent. National sales of ultrasound equipment are expected to be less in 1983 than in 1982, about $285 million. However, VAMKC ultrasound procurement is expected to fall even more, to about $5 million, or less than 2 percent of the market. Although VAMKC procurement may account for a larger proportion of some vendors' sales than this, no vendor indicated on its annual contract that VAMKC procurement accounted for more than 5 percent of the company's ultrasound equipment sales (85).

**VAMKC Demand Variability** .-VAMKC ultrasound procurement expenditures vary substantially from year to year. The decline from contract year 1982 to contract year 1983, for example, is expected to be greater than 55 percent. More than half the manufacturers' representatives interviewed indicated that VAMKC demand variability is greater than that of most private customers (55,60,74,87).

**Suppliers to the VA Market.** -The capital requirements to enter the ultrasound market are smaller than for many other kinds of diagnostic medical equipment, and many small companies have entered the market in recent years. This is reflected in the VAMKC market, where more than 15 companies will have annual contracts this year (85).

Although some companies do specialize in particular ultrasound applications (abdominal, cardiac, etc. ) there appears to be substantial competition in the market. In contrast to the VAMKC'S procurement of other kinds of medical equipment discussed here, its procurement of ultrasound equipment is very evenly distributed among the vendors on contract. The four vendors with the largest shares of the VAMKC market accounted for only slightly more than half of the VAMKC market in 1982; sales of the vendors ranked seventh and eighth totaled almost as much as those of the vendor with the largest share; and even the low-ranked vendors accounted for significant shares of the VAMKC market (85). Consistent with this low market concentration, the relative ease of entry into the market, and the industry's very rapid technological change, the ultrasound equipment market was described by the VAMKC contract specialist as "fiercely competitive" (85).

## Electromedical Equipment

The 5-digit SIC category Electromedical Equipment (SIC Code 36932) includes a wide variety of diagnostic, therapeutic, and patient monitoring equipment. In this discussion, VA procurement of electrocardiograph (ECG), electroencephalograph (EEG), and patient monitoring equipment is examined.

In electrocardiography, electrodes attached to the chest and extremities measure changes in the electrical potential of the body's surface, which are associated with the electrical activity accompanying the action of the heart. Thus, such measurements can detect heart abnormalities. In electroencephalograph, electrodes attached just under the scalp detect electrical activity in the brain. EEG recordings are used in diagnosing epilepsy, stroke, tumors, and other brain abnormalities. ECG and EEG recordings were originally made on paper rolls (63), but digital recording techniques are replacing the old recordings, so that ECG and EEG equipment can easily be used in patient monitoring as well as diagnosis.

Patient monitoring equipment is used to monitor parameters reflecting a patient's medical condition, such as blood pressure, pulse, brainwave activity, temperature, and respiration. Modern patient monitoring equipment is based on semiconductor chip technology, and often incorporates microcomputer components. Patient monitoring equipment varies in complexity and cost, from stand-alone units that monitor one or a few functions for a single patient to central station systems that can monitor a wide range of physiological indicators for a very large number of patients and transmit the data for display to a single location, such as a nurses' station (20).

### General Demand Characteristics

**Equipment Purchase Price.**—Stand-alone EEG, ECG, and patient monitoring units range from $2,000 to $16,000, while systems can cost anywhere from $20,000 to several hundred thousand dollars depending on their size and complexity (20).

**Servicing and Technical Support**.—According to an industry source, most EEG, ECG, and patient monitoring equipment does not require much servicing, and the annual cost of a full-service contract is about 5 to 10 percent of the equipment's purchase price.

### The VA Market: Demand and Supply

**VA Demand**.-Patient monitoring systems are purchased through the VAMKC direct delivery program; stand-alone monitoring units and EEG and ECG equipment are purchased through the FSS program.

In July 1982 the responsibility for procurement of patient monitoring systems was transferred within the VAMKC. Unfortunately, the procurement data were not similarly transferred, and it was not possible to construct a historical series for this kind of equipment. In addition, according to VAMKC personnel, FSS procurement data for stand-alone EEG, ECG, and patient monitoring equipment are also not readily available for 1981 and 1982 (49).

FSS procurement of such stand-alone equipment during the first three quarters of the 1983 contract year (beginning August 1982) totaled $4.6 million (49). Assuming that this figure can be extrapolated for the year (multiplying it by four-thirds), annual FSS procurement during the contract year should be about $6.2 million.

In fiscal year 1982 (beginning October 1981), VAMKC procurement of patient monitoring systems under the direct delivery program totaled $12.2 million, which suggests that expenditures for such systems are about twice those for stand-alone equipment. In the same year, procurement of patient monitoring systems represented close to 10 percent of total equipment procurement under the direct delivery system (132). The lack of data makes it impossible to calculate corresponding figures for earlier years.

**VAMKC Procurement Relative to the National Market.**—According to one industry source, the national market for patient monitoring systems is about $220 million, and that for stand-alone EEG, ECG, and patient monitoring units about $100 million (20). If the VAMKC figures of $6 million for stand-alone equipment purchases and $12 million for monitoring system purchases are in fact representative, then VAMKC procurement accounts for about 5 to 6 percent of national sales for both categories of equipment, Because the data are incomplete, and because VAMKC procurement of other medical equipment varies greatly from year to year, it is best to consider these estimates as rough ones.

**Suppliers to the VA Market.**—Although a number of firms produce patient monitoring equipment, the VAMKC market is dominated by a few large firms. In fiscal year 1982, the four firms with the largest shares of VAMKC direct delivery procurement accounted for close to 95 percent of such procurement, and a single firm accounted for much of the 95 percent (132). The national market for patient monitoring equipment is also highly concentrated. Some companies appear to have a much higher share of the VAMKC direct delivery market than they do of the national market, while for other companies the reverse is true. Based on information in 1982 annual contracts, one vendor's share of the direct delivery market was only 7 percent of its share of the national market, while another vendor's direct delivery market share was almost seven times as large as its nationaI market share. This is a puzzling phenomenon, and to understand it would require a closer investigation than is possible here; however, since it may reflect some positive or negative feature of procurement rather than chance, it may warrant further study.[4] It was not possible, given available date, to calculate the market concentration of the FSS patient monitoring equipment market.

Despite the apparent market concentration and the existence of a dominant firm, Hewlett-Packard, both the VAMKC and industry sources characterized the firms in the patient monitoring equipment market as very competitive (20,47,49,92).

## Hemodialysis Equipment

Dialysis is the transfer of solute (a dissolved substance) across a semipermeable membrane. Hemodialysis, through "artificial kidney" machines, is dialysis to purify the blood of people whose kidneys have partly or completely ceased to function. In such machines, blood is circulated on one side of a semipermeable membrane while a special dialysis fluid is circulated on the other. The dialysis solution must closely match the chemical composition of the blood. Metabolic waste products, such as urea and creatinine, diffuse through the membrane into the dialysis fluid and are discarded, while substances needed by the body (e.g., sodium chloride) are prevented from diffusing by including the same substances in the dialysis fluid (63).

### The VA Market: Demand and Supply

**VA Demand.** -Manufacturers contract with the FSS division of the VAMKC to provide hemodialysis equipment and supplies to Government agencies at specified prices. These prices, along with product descriptions, provide the supply schedules that VA hospitals and other Government agencies use to order equipment and supplies directly. Most schedules are so-called multiple award schedules, specifying several different vendors' versions of an item so that buyers can choose among them. Multiple award schedules are governed by a most favored customer clause (described later below). Less frequently, the FSS program awards contracts through competitive bidding and makes a single award (47).

The VA spends a relatively modest sum *on* hemodialysis equipment relative to its expenditures on hemodialysis disposable and supplies. One manufacturer estimated that in the national market equipment costs are onlys to 8 percent of total dialysis costs, with disposable, consumables and personnel costs accounting for the remainder (17).

According to the FSS Solicitation for Offers for 1984, estimated expenditures for hemodialysis equipment for 1984, which are based on actual 1983 expenditures, are slightly under $650,000 (129), or about one-half of 1 percent of total annual VAMKC equipment procurement expenditures. This figure seems unrealistically low. At approximately $7,000 per machine (the price quoted by two manufacturers), the VA would have purchased only 93 machines. However, the VA now has about 1,900 machines in use, and the average machine is replaced afters years; this implies a 20-percent turnover rate (17) and thus that the VA should be buying about 400 machines annually. In estimates of the VA's importance in the national market, it will be assumed that a normal annual procurement is between 10 and 20 percent of stock or 200 to 400 hemodialysis machines per year. If this is the case, then annual expenditures on hemodialysis equipment are between 1 and 2 percent of total annual medical equipment procurement.

**VA Demand Relative to the National Market.**—There are approximately 25,000 hemodialysis machines in use in the United States today; of these, about 1,900, or 7.6 percent, are in use in VA installations.

The market for new machines is a function of depreciation and obsolescence of existing equipment and the growth of new facilities. More than one manufacturer estimated that the size of the national market was about 4,000 to 5,000 machines per year at an average unit price of between $7, 000 and $8,000, or between $28 million and $40 million (17,73). If FSS procurement of hemodialysis equipment is roughly propor-

[4] One possible explanation is that VA hospitals are generally larger, university-affiliated hospitals. Certain vendors do better in this select market than they do elsewhere (10).

tional to its share of dialysis equipment now in use, then it should account for about 7 to 8 percent of the national market. It is probably safe to say that FSS procurement represents between 5 and 10 percent of the national market.

Suppliers to the VA Market .—The national market for hemodialysis equipment is highly concentrated; the three largest companies account for about 90 percent of total market sales, and only five firms account for virtually all the national sales. Data are not available to calculate manufacturers' market shares of the VAMKC FSS market, but sales in this market appear as highly concentrated as in the national market (17,73,135).

## Analysis and Implications for Policy

### The Importance of VA Procurement in the National Market

The VA's proportion of the national market for medical equipment, considered in isolation, is a misleading measure of the market leverage that the VA exerts. VA procurement is channeled through the VAMKC, which also acts as contract negotiator and administrator for the Public Health Service, the armed services, and other Government agencies. The combined procurement of all these groups, then, determines the buying power of the VA. As a result, the rest of this discussion will consider all VAMKC procurement, rather than its procurement for the VA alone.

VAMKC procurement accounts for a significant, but not overwhelming, proportion of the national market for most types of equipment examined in this appendix; in some of the markets, the VA proportion is very modest. Based on data in VAMKC annual contracts, VAMKC procurement accounts for 5 to 10 percent of the national markets for X-ray, nuclear diagnostic, and hemodialysis equipment, about 5 percent of the national market for EEG, ECG, and patient monitoring equipment, 3 percent of the national market for CT scanning equipment, and 1 to 2 percent of the ultrasound equipment market. The VAMKC share of the national market for digital image processing equipment is uncertain, but most likely is very small (40,131,132). Thus, although the dollar amounts of VAMKC procurement may be significant, and vendors are certainly anxious to maintain their VAMKC market share, VAMKC procurement does not dominate any market examined here.

### Conditions of Supply

Numerous structural characteristics of the market can be said to shape observed market outcomes (78), but only a few of the most important will be discussed here.

### Barriers to Entry

For some of the equipment categories examined, particularly CT scanners and radiographic and nuclear diagnostic systems, the capital requirements of the market appear to preclude the entry of small firms. The servicing and technical support of some products are so important that the firms that cannot offer well-organized nationwide support suffer a severe disadvantage.

Of course, all these markets are not entirely closed to small firms. There is enormous technological change occurring in almost all the markets examined, much of it in computer applications to diagnostic medicine, and in software rather than hardware. In such markets, a small firm can succeed if it finds a niche. (On the basis of reports of mergers and acquisitions, the result of that success is often being purchased at an attractive price by a larger firm in the medical equipment market. )

### Market Concentration

Market concentration, the proportion of sales accounted for by the largest sellers in a particular market, is quite high in almost all the medical equipment markets examined here. In the VAMKC markets for X-ray, nuclear diagnostic, patient monitoring, and hemodialysis equipment, the four largest firms in each class accounted for 90 to 95 percent of procurement expenditures within their classes. Procurement of CT scanners has been based on competitive bids, and the same firm won the contract in both major bids. Only in the market for ultrasound equipment are VAMKC procurement expenditures spread more evenly over a large number of companies, Generally, such high market concentration is associated with a lack of high pricing rivalry, but it is not clear that this is the case for the industries examined here.

### Market Share Instability

High market concentration can sometimes be a misleading indicator of firms' conduct in the market. In both the X-ray and nuclear diagnostic equipment VAMKC markets, market share instability suggests that rivalry among the firms is greater than would be predicted on the basis of market concentration.

### Summary of Competitive Conditions

Although the medical equipment markets examined in this appendix certainly do not conform to the picture of perfectly competitive markets, the volatility of market shares and the very rapid pace of technological change suggest that these markets still function competitively. In a few cases, rivalry may be based more on product performance than price. Two of the VAMKC markets, for ultrasound diagnostic and patient monitoring equipment (the first of which is highly concentrated and the second not), were both described by VAMKC personnel as extremely competitive (49).

### The Impact of VAMKC Procurement on Vendor Pricing

The impact of VAMKC procurement on market outcome depends not only on supply conditions and the level of VAMKC procurement, but also on the procedures and policies that govern VAMKC procurement, the most important of which are analyzed below.

Brand Name Justification .-When a VA hospital is authorized to buy equipment, the VAMKC forwards to the hospital a list of suppliers on contract whose equipment meets the specifications of the purchase order, ranked by order of cost. By regulation, the hospital is required to buy from the least-cost supplier unless it can justify purchasing from a different source (e.g., service availability). This requirement is called brand name justification. Because suppliers are anxious to maintain their share of the VAMKC market, the requirement almost certainly lowers prices.

Firm Fixed Price Clause.—Under the terms of a VAMKC contract, suppliers cannot increase prices during the contract year. Furthermore, if they lower the price at any time during the year, the lower price holds for the remainder of the year. The firm fixed price clause may or may not result in lower procurement costs. Suppliers offer temporary price discounts in the private market to promote their products. Normally, promotional offers would probably be extended to the VAMKC as well, but because of the firm fixed price clause, suppliers are reluctant to make them. Even the requirement that prices not be increased during a contract year has indeterminate effects on procurement costs. While the requirement does protect those who buy through the VAMKC from price increases, suppliers may charge a higher price at the start to ensure a profit. Altogether, it is extremely difficult to determine the net effect of the firm fixed price clause.

Public Disclosure Requirements. -By law, the public has access to VAMKC procurement prices for medical equipment. Both theoretical and empirical evidence support the view that this results in higher procurement costs for the VAMKC. First, a firm's benefits from cutting its price are in part a function of the so-called retaliation lag, the length of time before rivals learn of the price cut and cut their own prices in response. Price disclosure requirements reduce the retaliation lag, and therefore discourage price cutting in the VAMKC market. Because other buyers of medical equipment also have access to the price data, the VAMKC price may be the private buyer's target in pricing negotiations, which can also inhibit price cutting in the VAMKC market. Finally, suppliers of X-ray, nuclear medical, patient monitoring, and hemodialysis equipment have stated that the prices offered to the VAMKC are higher because of the contract disclosure requirement. Some suppliers said the disclosure requirement did not affect pricing in their markets, for the reason that pricing information was widely available from other sources.

No Volume Commitment.—Having a contract with the VAMKC does not imply any contractual volume commitment in procurement. For two equipment categories, X-ray equipment and nuclear diagnostic equip ment, volume commitment does not appear to be an important consideration. For the other equipment categories examined here, volume is a major influence on pricing.

There are two likely reasons why volume commitment would be unimportant in some industries and very important in others. First, when equipment is purchased from stock, and is fairly standardized, a volume commitment can reduce manufacturing costs that can be passed on to the buyer, but not when the equipment is custom made. Second, the effects of volume commitments seem to depend on whether equipment is expensive or inexpensive. When equipment is inexpensive, the costs of preparing contracts and marketing are higher relative to the purchase price of the equipment. In this situation, the savings that come with volume commitment are more significant. Some suppliers indicated that they might lower their prices by 5 to 10 percent in exchange for a volume commitment. One supplier in the ultrasound market, stated that a purchase of even IS to 20 units would suffice for a larger price discount than is now offered the VAMKC.

Most Favored Customer Clause. -Under the terms of a VAMKC contract, suppliers are prohibited from selling their equipment under a "like contract" to any private buyer at a price lower than that offered the VAMKC. If a lower price is offered to a private buyer, this price must be given to the VAMKC for the rest of the contract year. This stipulation helps ensure that the VAMKC'S clients benefit from any vendor competition in the private market, Although the strictness with which the most favored customer clause is interpreted varies from one equipment category to the next, it almost certainly reduces VAMKC equipment procurement costs. *In* **a** few markets, private buyers are offered lower prices than the VAMKC **when they make contractual volume commitments, on the grounds that these are not "like contracts, " and the effect of the clause is obviously less in those markets. The most favored customer clause can greatly influence private buyers, as discussed below.**

**Informal Procedures. -VAMKC personnel said they were reluctant in practice to purchase mixed medical equipment systems, those in which items of different manufacturers are interconnected. The most important reason for this is the difficulty of assigning financial responsibility for repairs under warranty, in addition to that of determining responsibility for actually making the interconnections. Unfortunately, this VA policy may practically eliminate many smaller companies in procurement, causing higher initial procurement costs. The reluctance to purchase mixed systems is based on experience, but the value of this policy should be reviewed periodically.**

## The Impact of VAMKC Procurement on Vendor R&D

**In contrast to prosthetic devices, which veterans may have special needs for and the VA has actively developed and procures with great leverage, the categories of medical equipment examined here are ones that the VA and VAMKC affect relatively little. Of the various VAMKC procurement mechanisms that could influence vendors' research and product development, only three seem to exert any significant impact, and of the three, one type is rather indirect.**

**Specifications. -The VAMKC can and does influence product development through specifications. These are often developed from industry standards or based on the characteristics of products already on the market. To maintain their share of the VAMKC market, firms must produce equipment that satisfies the specifications, and some vendors in the markets for X-ray equipment, nuclear diagnostic equipment, CT scanning devices, and patient monitoring equipment stated that they altered their products to meet the requirements (though most of these equipment modifications are incremental changes in performance, not fundamental improvements in product design). Different manufacturers' products have different strengths.** It is **a great advantage for a manufacturer to have VAMKC equipment specifications "written to its own machine, " as discussed below.**

**Product Evaluations.—The VAMKC'S Testing and Evaluation Staff evaluates some medical equipment and supply items and makes the results available to the public. According to the director of this program, these results are heavily used** (66). It is impossible to quantify the effect of this program on manufacturers' development activities, though no doubt there is some.

Indirect Effects.—Within the limitations determined by its shares of the various medical equipment markets, VAMKC procurement can encourage manufacturers' R&D to the extent that it embraces new technologies. For the most part, vendors characterized VAMKC procurement as moderately progressive **in this regard. The VAMKC has a policy of not purchasing equipment that is not commercially available and already in clinical use. Thus, VAMKC procurement is not "state of the art" in most instances. However, the fact that most VA installations do attempt to have up-to-date equipment probably has some small positive impact on the profitability, and therefore the extent, of manufacturers' R&D.**

## Effects of VAMKC Procurement on Private Buyers

**VAMKC procurement practices may affect private buyers of medical equipment in several ways. The most important of these are its information on product evaluations and prices, and the most favored customer clause.**

**Product Evaluation Information.—As mentioned above, the product evaluation information produced by the VAMKC'S Testing and Evaluation Staff is extensively used. It must be assumed that the availability of such information leads to better informed medical equipment procurement by private buyers.**

**Availability of Price Information.—There is clear evidence that the price information available from VAMKC annual contracts and bids has sometimes influenced private buyers of medical equipment. A procurement director for a large, private, centrally managed hospital group stated that in one case, he "insisted on a better deal because the VA got a better deal. " At the very least, the VAMKC price may be the target for private buyers of medical equipment.**

**Most Favored Customer Clause. -In contrast to the effects of available product evaluation and price information, the most favored customer clause increases the prices that private buyers must pay for medical equipment. Interviews with both vendors and buyers indicated that the clause affects prices of X-ray, nuclear diagnostic, ultrasonic, patient monitoring, and CT scanning equipment. One private buyer indicated that the most favored customer clause was a "major**

problem" for him. Even when vendors offer lower prices to buyers who make volume commitments, the effect of the VAMKC is still felt.

The most favored customer clause limits price discounting in the private market. For this reason, although the stipulation may lower VAMKC procurement expenditures, it may actually raise Federal health care expenditures through its effect on the equipment and supply costs of private providers of health care. The Federal Government's role in financing health care extends far beyond the agencies that procure medical equipment and supplies through the VAMKC, and if the most favored customer clause increases equipment costs for private buyers who are reimbursed on the basis of costs, it could increase rather than decrease total Federal health care expenditures.

## Manufacturers' Views of VAMKC Procurement

Manufacturers generally demonstrate a positive view of VAMKC procurement. Other than the failure to make volume commitments, which was discussed "above, only three issues were identified as clearly problematic: contract documentation requirements, the delay in processing procurement orders, and the problem of "tailored specifications. "

Contract Documentation Requirements. -Contract documentation was the major complaint of many vendors, especially those of less expensive products, for whom documentation costs are more significant relative to equipment purchase prices. Documentation may also be a greater source of dissatisfaction among smaller firms because larger firms are more likely to have employees specializing in Government accounts. Several manufacturers suggested that the VAMKC maintain a central computer file for contract documentation and simply have vendors update the file when necessary, rather than supply full documentation repeatedly.

Delay in Processing Orders.—The time required for the VAMKC to process orders was a major source of irritation for some manufacturers. Apparently, the delays are important only for firms that normally sell their equipment from stock. When manufacturers produce equipment to order, the order typically becomes part of the order backlog (unless the market is extremely slack). In this situation, the time necessary for processing the order is absorbed easily and does not cause problems. When equipment is sold from stock, however, the order can usually be filled immediately, and, as a result, the bureaucratic delay is a major irritation. It is not clear what can be done to alleviate this problem, except perhaps to computerize the procurement process more.

Tailored Specifications. -As mentioned above, different manufacturers' products tend to have different areas of strength. When equipment specifications are written to the specifications of a particular manufacturer's product, essentially as "tailored specifications, " other manufacturers are at a distinct disadvantage in the VAMKC market. A number of manufacturers from a variety of equipment markets complained of this problem, suggesting that it warrants greater attention from VAMKC personnel. If specification requirements can be prepared with attention to their impact on the number of vendors able to compete, procurement costs may be reduced without significant sacrifice in quality of care.