

American Society of Anesthesiologists Rovenstine Lecture—1976:

Anesthesia and Surgical Care

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One Surgeon's Introduction to Anesthesia

The nature of the anesthesia experience is a major determinant in the quality of surgical care. It is my purpose here to examine manpower in these two professions, so closely intertwined, and to develop some first estimates of national and regional manpower norms and ratios for surgical and anesthesia personnel. Such estimates, however tentative, may be useful at a time when the analysis of health manpower and the delivery of surgical and anesthesia care are at the forefront of our national thinking. Methods, concepts, or ratios developed here may stimulate others, better qualified than I, to explore further the interrelationship of our two professions. Before embarking on these data, a personal word is in order.

I want to thank the American Society of Anesthesiologists for the honor of presenting this annual lectureship to celebrate the memory of the late Dr. Emery Andrew Rovenstine (1895-1960), for many years Professor and Head of the Department at the New York University-Bellevue Medical Center. To many scholars, he was one of our first truly academic anesthesiologists. He had been a resident of Dr. Ralph M. Waters in Wisconsin, and he himself made many contributions to anesthesiology, all of which improved the care of surgical patients.¹⁻⁴ He was particularly instrumental in the development and use of cyclopropane, an agent we now look upon as hazardous. Yet, at the time that Dr. Rovenstine worked on this anesthetic (about 1934), anesthesiology sorely needed some way out of the "Valley of the

Shadow" of ether and chloroform, in which it had wandered for almost 90 years.

From Rovenstine's development of cyclopropane came an increasing interest in other possible inhalation agents, and their initial use. At the same time he was working on improved anatomic methods for conduction anesthesia. This development of regional techniques was one of his major contributions to anesthesiology, a trend in which he followed the footsteps of his surgical predecessor in the field, Dr. William S. Halsted, who had introduced local anesthesia by nerve block with cocaine. Many surgeons came to study with Rovenstine; surgeons and anesthesiologists joined in the further development of regional block for major intracavitary surgery. To understand this one must realize that in the 1930's, before the development of endotracheal intubation, there were still severe hazards involved with the inhalation agents, hazards that are a rarity today. Dr. Rovenstine explored, and was among the first to perfect, regional block for major thoracic surgery.

Dr. Rovenstine was also deeply concerned with standards for training in anesthesiology and the organizational relationships between anesthesiologists and surgeons. In 1940, he published "The Economics of an Anesthesia Service in a Large Municipal Hospital," a work that bears study today.¹ It was my pleasure to meet Dr. Rovenstine on one occasion, at a meeting of The Society of Clinical Surgery at Bellevue Hospital, with Dr. John Mulholland. Dr. Rovenstine showed both his work and his techniques, as well as his characteristic warmth, charm, and hospitality.

My own inspiration in anesthesiology has arisen from the three men with whom I have worked most closely throughout my life.

The late Dr. Henry K. Beecher, long a member of this Society, taught me anesthesia, if such is an appropriate term for the humble learning process of a young surgical "pup" starting his internship. In later years Dr. Beecher took a keen interest in my

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work as one of the younger members of the attending staff at Massachusetts General Hospital, where I had the pleasure of working intimately with him for ten years both in clinical work and in research. He was a remarkable individual who made many contributions, not the least of which was his last: a heightened awareness of the ethical problems concerned with experimentation in human subjects.⁵

The second influence in my knowledge of anesthesia was Dr. William S. Derrick, now of Houston, Texas, for several years the Chief Anesthesiologist of the Department of Surgery at the Peter Bent Brigham Hospital. Although the Brigham had enjoyed scholarly physician anesthesia under Dr. Walter Boothby 30 years before,⁶ there had been a long period of unsupervised anesthesia; this had an adverse impact on the development of both thoracic and cardiac surgery at the Brigham. Dr. Derrick reversed this trend and showed a constant devotion to the problems of his patients and his surgical colleagues.

To continue on this personal note for a moment, Dr. Leroy D. Vandam, the man with whom I have worked closely for more than a quarter of a century, is the third of my anesthesiology colleagues. Dr. Vandam's work on hazards of spinal anesthesia and his work on visceral sensation and its effect on the circulation must be regarded as major advances. But his great contribution has been the establishment of a superb academic department with its key emphasis on the human factor of patient contact, follow up, and student inspiration, and his conviction that anesthesiology is a very humanistic aspect of the practice of medicine, in addition to its well known features as handmaiden to the surgical patient, and applied pharmacology. In addition, Dr. Vandam as Editor of ANESTHESIOLOGY made a major contribution to the art and science of the practice of anesthesia by making this journal a first-rate and respected scientific publication.

Dr. Vandam's Division was part of our Department of surgery until 1970. Although I had always regarded anesthesiology as a part of surgery, I came to recognize and accept, even if I did not welcome, the advent of a new era in which anesthesiology has been separated in its university organization from surgery, from medicine and from pharmacology.

All three of these men established an indelible imprint of the relationship of anesthesia to surgical care and their inseparable mission in the care of the sick.

The Image of the Profession

Dr. Rovenstine might have been surprised by, and possibly disapproved of, the current devotion of

scholars to the sphere of sociology and economics of medicine; but the concern was no stranger to him. During World War II there was a period of remarkable expansion of surgery, of the scope of surgery, and after the war an ever-widening distribution of surgeons. At this time Dr. Rovenstine recognized the need to clarify anesthesiology-surgery relations and the essentially institutional nature of the practice of anesthesia. He wrote⁷:

The anesthesia service functions as a unit in hospital care, not as an individual practicing in a hospital. It cannot be denied that few people go to an anesthetist for anesthesia today. They simply go to a hospital. . . . This situation, except in some few isolated instances, has been tolerated with polite indifference or welcomed by the public, the profession, and hospital administration. . . .

He indicated that this situation may appear undesirable to those whose view of medical practice worships the conventional tradition of solo private fee-for-service practice based on an individual office. He sensed that this value judgment might not apply to anesthesia. He continued:

. . . principles defended by medicine are tenable so long as their ultimate objective is to improve the quality of medical care for the ultimate benefit of the sick.

In his view the institutional base for anesthesia was no disgrace; indeed it was essential to its maximum public service.

In recognizing the institutional obligation of anesthesiology, Dr. Rovenstine was giving early recognition to a phenomenon that is now shared to a remarkable extent by three other important branches of our profession: radiology, pathology, and rehabilitation medicine. These are four branches of medicine without which the physician, surgeon, and pediatrician could not practice. Their importance is unquestioned. It is not surprising that they are based on the public institution required for their practice.

These four branches of our profession all share certain characteristics. They require a hospital for their practice. Second, they are areas of medical work in which the referral of the patient is from other physicians and patient contact is episodic. Although both of these might seem to be negative factors, or undesirable in the eyes of those who view medicine only in a conventional framework, these very qualities make these fields of work among the most demanding of any in medicine.

Finally, these four professions (anesthesiology, radiology, pathology, and rehabilitation medicine) are often established as distinct hospital departments. They operate within what might be termed a monopoly of practice in the care of patients within that hospital. It is a rarity for a surgeon operating in hospital A to seek the assistance of a full-time

anesthesiologist from hospital B. We are apt to forget that the same thing often applies to surgery. The neurologist in hospital A who seeks operation will consult the neurosurgeon of hospital A rather than a more distant colleague from hospital B.

Although many anesthesiologists work in several hospitals, and most are on a fee-for-service basis, the institutional responsibility remains clear; each hospital large enough to have an identifiable department or division for anesthesia services tacitly assumes that the head of that unit will be responsible for anesthesia services throughout the hospital.

Because of this hospital-wide responsibility, the anesthesiologist and his department must supply continuous service 365 days and nights a year. If such service is not provided, is of poor quality, or is insufficiently adaptable to the many needs of surgical patients, rectification is usually sought by changing the leadership of the department. This again points out the assumption of hospital-wide responsibility for anesthesia service. Rather than regarding this as an undesirable feature of anesthesiology as a profession, it is my own belief that it should be appreciated as an extremely demanding responsibility, and a form of medical practice placing it at the highest level of public service.

Whether or not a separate professional fee is collected for each service by the physician is immaterial in the social relationship: high-quality care with independent thinking is a feature of practitioners of high standards, whether they are working as solo practitioners, on a group-practice salary (a frequent practice in both surgery and anesthesia) or on institutional salary. The anesthesiologist provides "hospital professional consultant services"; and the fact remains that for most anesthesiologists there is a clear obligation to provide the highest quality of service for all the patients and staff of a single institution.

The management of intensive care, respiratory care, resuscitation, consultation on intractable pain problems, and a variety of additional services enriches and widens the professional activities and intellectual scope of anesthesiology; the institutional relationship is only heightened thereby.

The Relation of Anesthesiology to Surgery

For analysis of professional work in this country, physicians can be conveniently divided into three groups according to their relationships to hospitals as institutions, and the natures of their referral services. The first group, the "Hospital Professional Service Group," includes the four services already mentioned (anesthesiology, radiology, pathology and rehabilitation medicine). These services are primarily based upon individual hospitals, and the patients

are referred to them by other physicians almost exclusively. Second is the "Consultant Group," including surgery and those branches of medicine and pediatrics (*e.g.*, endocrinology, cardiology) that are highly specialized fields, and for which hospitals are essential for practice; referral is both from patients and from other physicians. Third is the "Primary Care Group" or "access physicians" in primary care medicine, often working outside the hospital framework, and providing continuous care to individuals and families over prolonged periods; referral will usually be via other patients.

Among these three categories of physicians, surgery and anesthesiology are more closely intertwined than any other two branches of the medical profession.

I would estimate that 90 to 95 per cent of the work of every anesthesiologist is concerned with the work of a surgeon. The in-hospital operative work of the surgeon is at least 90 per cent involved with the work of an anesthesiologist. The exceptions to the interrelation are those occasions when the anesthesiologist is working on pain problems or respiratory care supervision and those situations in which the surgeon is providing the anesthesia himself, as a regional block.

For this reason, the ratio of surgeons to anesthesiologists and to all others providing anesthesia services is an important number in medical manpower. Recent studies from the anesthesia study groups have added important data in this field, and form the basis of many of my tabulations.⁸⁻¹⁶

There are analogous intertwinings of other pairs of professions in medicine, but none of them quite as close. Psychiatry and neurology have worked closely together for many years, but about 40 years ago they began to diverge in their activities, so that now the closest professional association of neurology is probably with neurosurgery rather than psychiatry.

Pediatrics and pediatric surgery worked very closely together for many years, but as the pediatric surgeon has increasingly developed his own methods of pre- and postoperative care, the pediatrician, while an intimate colleague, is not always involved.

Cardiology and cardiac surgery should ideally be very close in their clinical relationships. Surprisingly, there have been historical examples where cardiac surgery became very prominent in a hospital despite a general lack of interest and collaboration from medicine; fortunately, this has been the exception.

Radiology and radiotherapy present no analogy, since they were always uneasy bedfellows at best, perhaps more siblings than collaborators, now going their separate ways and usually dealing with entirely different patient populations.

The relation of anesthesiology to surgery is, there-

TABLE 1. Manpower Estimates—Anesthesia and Surgery

Line	Cohort and Year	Reference Data
1	American Society of Anesthesiologists (ASA) December 1973 December 1974 December 1975 December 1976 (est.)	12,807 13,450 14,210 (Total) 15,300* 10,033 (active)
2	Residents in anesthesiology Year end 1970 Year end 1971 Year end 1972 Year end 1973 Year end 1974 Year end 1975 Year end 1976	1,408 1,619 1,618 1,820 1,799 1,870 1,950†
3	American Association of Nurse Anesthetists December 1973 December 1974 December 1975 December 1976	(Active) 13,032 (Active) 13,918 (Active) 14,357 (Total) 17,364 14,800 (active)
4	Total anesthesia personnel (TAP) December 1976 (est.)	32,050
5	Board-certified surgeons (BCS) November 1971 December 1975 December 1976 (est.)	46,469 54,996 57,000
6	Surgical residents (RES) (advanced) December 1970 December 1971 December 1972 December 1973 December 1974 December 1976	12,565 13,697 14,102 14,555 14,772 15,100
7	Total surgeons (BCS + RES) Year end 1976 (est.)	72,100

* This figure for total ASA membership includes some categories other than active licensed practitioners, as follows: in advanced residency (2,300), affiliated membership in Canada, foreign countries or in research (1,190), retired (536). The corrected figure for active practitioner members of the ASA is shown in the regional tables and is approximately 10,033.

† This residency listing overlaps with some residents who hold fellowship in the ASA. The estimated figure for total residents in Anesthesiology as of year end 1976 is 2,400.

fore, unique. While this has educational significance, its most important impact lies in public service, in the manpower ratios and ideal doctor mix involved between the two professions.

This relationship is also critical in any evaluation of the workloads and national scopes of the two professions. Whatever developments mandate more surgery also necessitate more anesthetics given. A pioneer student of this topic in surgery, Dr. John P. Bunker, is

quite appropriately himself an anesthesiologist. In 1970, he published an article comparing the United States with the United Kingdom.¹⁷ This was to stimulate a closer consideration of national surgical manpower and workloads. In that paper, Dr. Bunker took the view that the larger number of surgeons per unit population in the United States was responsible for the larger number of surgical operations. Possibly it is unfortunate that he did not give sufficient weight to the facts that there were more physicians of all types in the United States than in Great Britain (at that time approximately 145 active physicians per 100,000 population versus 100 per 100,000 population in the UK) and that all medical services were given in much greater profusion in the United States. As any visitor to British hospitals will testify, this applies equally to coronary care units, well-baby clinics, psychoanalysis, and radiologic examinations. Surgery and anesthesia were, therefore, just one part of a societal or cultural super-utilization of medical services in the United States.

My own involvement in this field began in 1969, with the undertaking by the American Surgical Association and the American College of Surgeons of a National Surgical Study (SOSSUS) that published its summary report in 1975,¹⁸ and whose detailed documentary publication appeared early this year (February 1977).¹⁹

It is from this background that I would like to look at the national distribution of surgeons and anesthesiologists, and particularly to examine the problem of the ratio of the one to the other, and the impact on that ratio of active nurse anesthetists.

Manpower Data

In table 1 are shown manpower estimates for anesthesia and surgery. Wherever possible, these have been updated to December 1976 or January 1977.† The information about residents in anesthesiology is provided by publications of the ASA, as further checked in the AMA "Distribution of Physicians" for the years shown.²⁰ The term "total anesthesia personnel (TAP)" in table 1 refers to the sum total of American Society of Anesthesiologists membership plus their residents in training,‡ plus the active practicing

† The author is indebted to Mr. William Marinko, Associate Executive Secretary of the American Society of Anesthesiologists, for providing data and checking over tabulations; to Mrs. Josephine Heimler, Associate Director, The American Association of Nurse Anesthetists, likewise for providing data and checking tabulations in nurse anesthesia. The author is also indebted to Dr. Richard Kitz, Dr. Richmond Ament, and Dr. Leroy D. Vandam for reviewing some of the personnel tabulations and data. The opinions expressed and interpretations offered are those of the author.

‡ In the tabulations beyond table 1, trainees are omitted.

membership of the American Association of Nurse Anesthetists.

The data on Board-certified surgeons have been corrected for death and retirement, and updated by extrapolation of prior curves to year-end 1976. These are the best estimates currently available to the author. The data have been corrected for "double-boarding." That is, when a surgeon has registered as having two Board certifications he is nonetheless enumerated as a single individual. The information about surgical residents in advanced years of training is from the AMA "Distribution of Physicians" for year-end as shown.²⁰ These data have likewise been updated by curve extrapolation, providing an estimate for the year-end 1976 of 15,100 surgical residents in advanced years of training. By "advanced years of training" is meant individuals beyond first year after medical school, enrolled in surgical residency programs. The AMA, over recent years, has published two sets of data on numbers of residents. The mid-year listing in the "Directory of Approved Residents" is based on reports from Program Directors; the year-end data published in "Distribution of Physicians" regularly show a lower number, providing the basis for the data included here.

The term "total surgeons" refers to Board-certified surgeons plus their residents in advanced years of training. This takes note of the fact that residents in advanced years of training are responsible for carrying an important fraction of the national surgical workload. In table 1 no effort is made to enumerate the total number of persons who carry out surgical operations (including approximately 10,000 individuals in general practice, 10,000 noncredentialed surgeons, and approximately 10,000 internists, pediatricians or radiologists who carry out procedures in the operating room from time to time). The operations performed by the latter, including those done by internists (such as endoscopy) or radiologists (radium insertion), often require the administration of an anesthetic. To be all-inclusive, analysis of anesthesia workloads would require detailed local and regional records to determine what fraction of the total work of nurse anesthetists or anesthesiologists is concerned with this latter group of noncredentialed surgeons. As shown by the studies of Nickerson,²¹ about 75–95 per cent of the surgical procedures in this country (corrected for magnitude of procedure) are carried out by Board-certified surgeons working with their residents in advanced years of training. In obstetrics, the figure is far lower; estimates suggest that in parts of the country more than 50 per cent of the obstetrical deliveries are carried out by non-Board-certified surgeons, obstetricians or gynecologists; it has been estimated that only 15 per cent of the obstetrical deliveries in this

country are attended by physician anesthesiologists (personal communication, Dr. R. Ament).

The SSSUS Report was completed in the autumn of 1974, and published in the summer of 1975. Based on data for year-end 1974, the total number of Board-certified surgeons plus their residents was estimated at 64,000–66,000. These data, updated two additional years to 1976, show 72,100 in the credentialed cohort of surgeons and their residents in advanced years of training. The ratio of Board-certified surgeons to population has increased approximately 4.5 per cent per year in the last four years.

The number of surgical residents has also increased, approximately 2,000 more residents being enrolled in non-federal programs in 1975 (year-end) than at year-end 1969. As shown in table 1, the membership of the ASA has also increased during this time, estimated to be an increase of about 6 per cent per year in the population ratio. In both instances "population ratio" refers to the ratio of persons enumerated to the total population they serve. This is most readily expressed as number of physicians per 100,000 population.

The data for nurse anesthetists as shown in table 1 may be criticized because they do not include nurses in training; opinions differ as to what extent nurse trainees provide an important component in the national workload of nurse anesthetists. The omission is probably not misleading in evaluating the total number of active working nurse anesthetists. Data regarding the number of nurses in the training schools are readily obtainable from the AANA.

Table 2 shows relationships between groups of surgeons and collaborating groups of anesthesia personnel, as derived from table 1. The data are self-explanatory. It is evident from tables 1 and 2 that the relative proportions of residents in relation to credentialed practitioners are about the same for surgery and anesthesiology. In surgical postgraduate programs the fraction of foreign medical graduates (FMG) is estimated to be approximately 18–22 per cent at the present time. In anesthesiology, numbers of FMG in residency training programs have ranged from 45 to 55 per cent of total enrolled residents.

In table 3 are shown regional data for the distribution of the membership of the American Society of Anesthesiologists. Population data are based on the 1970–75 curve updated to January 1977.

It is evident that the national distribution ratio for anesthesiologists (members of the ASA) is approximately 4.64 anesthesiologists per 100,000 population. As is the case with many other medical and surgical specialties, the distributional ratios are highest in the northeast and mid-Atlantic states and on the Pacific coast (5.5 to 6.9 per 100,000). The east north-central (middlewestern urban states) and the mountain states

TABLE 2. National Manpower Ratios—Anesthesia and Surgery—Based on Best Estimates for December 1976 (Table 1)

Line	Ratio	Ref Table 1	Abbrev.	Table 1 (Abs.)	Ratio
1	Board-certified surgeons and residents to total anesthesia personnel	$\frac{\text{Line 7}}{\text{Line 4}}$	$\frac{\text{BCS} + \text{SR}}{\text{TAP}}$	$\frac{72,100}{32,050}$	2.25
2	Board-certified surgeons to American Society of Anesthesiologists (active)	$\frac{\text{Line 5}}{\text{Line 1}}$	$\frac{\text{BCS}}{\text{ASA}}$	$\frac{57,000}{10,000^*}$	5.70
3	Surgical residents to anesthesia residents	$\frac{\text{Line 6}}{\text{Line 2}}$	$\frac{\text{SR}}{\text{AR}}$	$\frac{15,100}{2,400}$	6.29
4	American Society of Anesthesiologists to American Association of Nurse Anesthetists	$\frac{\text{Line 1}}{\text{Line 3}}$	$\frac{\text{ASA}}{\text{AANA}}$	$\frac{10,000}{14,800}$	0.67
5	Board-certified surgeons plus residents to American Society of Anesthesiologists and residents	$\frac{\text{Line 7}}{\text{Lines 1 \& 2}}$	$\frac{\text{BCS} + \text{R}}{\text{ASA} + \text{R}}$	$\frac{72,100}{17,250}$	4.17

* This figure for total ASA membership includes some categories other than active licensed practitioners, as follows: in advanced residency (2,300), affiliated membership in Canada, foreign coun-

occupy an intermediate position, around 4.5 per 100,000. The south Atlantic, east south-central, west south-central and west north-central areas have the lowest distributional ratios (3.0 to 3.9 per 100,000).

In table 4 are shown the regional distribution of

TABLE 3. American Society of Anesthesiologists, January 1977 Regional Estimates

Region	Active	Population ($\times 10^6$)	Ratio Active per 100,000 Population
Northeast	844	12.3	6.86
Mid-Atlantic	2,051	37.3	5.49
S. Atlantic	1,348	34.7	3.88
E. S. central	408	13.7	2.98
E. N. central	1,865	41.0	4.55
W. S. central	760	21.4	3.55
W. N. central	596	16.7	3.57
Mountain	479	10.0	4.79
Pacific	1,682	29.0	5.80
TOTAL	10,033	216.1	4.64

TABLE 4. American Association of Nurse Anesthetists and Total Anesthesia Personnel, January 1977, Regional

Region	Active	Population ($\times 10^6$)	Ratio Active per 100,000 Population	TAP*	TAP/Population
Northeast	750	12.3	6.09	1,594	12.95
Mid-Atlantic	2,359	37.3	6.32	4,410	11.82
S. Atlantic	2,633	34.7	7.59	3,971	11.44
E. S. central	1,127	13.7	8.22	1,535	11.20
E. N. central	2,400	41.0	5.85	4,265	10.40
W. S. central	1,763	21.4	8.23	2,523	11.78
W. N. central	1,807	16.7	10.8	2,403	14.38
Mountain	594	10.0	5.94	1,173	11.73
Pacific	1,222	29.0	4.21	2,904	10.01
TOTAL	14,655	216.1	7.02	25,138	11.74

* TAP (total anesthesia personnel) refers to anesthesiologists plus nurse anesthetists, omitting trainees in both categories, and based on active United States members of ASA only.

tries or in research (1,190), retired (536). The corrected figure for active practitioner members of the ASA is shown in the regional tables and is approximately 10,000.

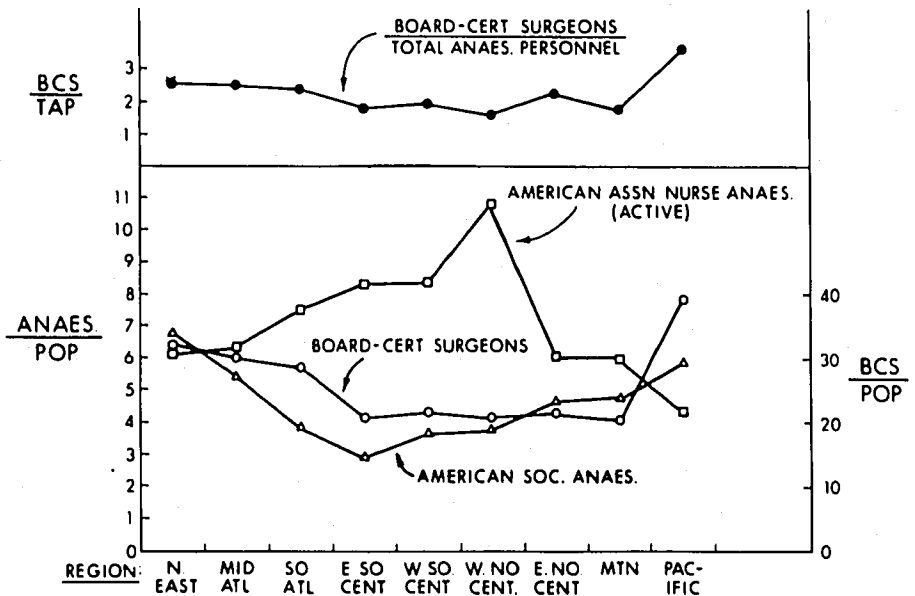
nurse anesthetists and some estimates of total anesthesia personnel (TAP). The latter figure for total anesthesia personnel is the sum of ASA members plus nurse anesthetists, omitting residents (for whom we do not have regional distributional data). Population figures are the same as those in table 3.

The national mean population ratio for active anesthesia nurses is 7.02 per 100,000, while the highest distributional patterns of nurse anesthetists relative to population are to be found in the west north-central, east south-central and south Atlantic areas (8–10 per 100,000). These are precisely the areas that have the thinnest distributions of membership of the ASA. As shown in figure 1, the two distribution curves demonstrate a reciprocal relationship. This is most clear-cut in the west north-central area of the country, where the AANA distribution is at its highest (approaching 10 nurse anesthetists per 100,000 population) and the ASA membership is in its lowest range (3.6 anesthesiologists per 100,000 population).

The ratio of total anesthesia personnel (referring again to ASA plus AANA but excluding residents) to the population is shown in the right-hand column of table 4. It is almost constant throughout the country. The two exceptions, departing from a general level of 10.5–11.8 total anesthesia personnel per 100,000 population, are the west north-central and northeast areas, in which the ratios are quite high because of the abundance of nurse anesthetists. In general, where nurse anesthetists predominate in an area the total anesthesia personnel ratios are the highest.

The regional data in tables 3, 4 and 5 do not include trainees; the inclusion of trainees would not be expected to alter the configuration of the distribution curves, because in both anesthesiology and nurse anesthesia, the trainees are most abundantly distributed

FIG. 1. Regional data for anesthesiologists, nurse anesthetists, and Board-certified surgeons (BCS), and ratio of total anesthesia personnel (TAP) to population. It is evident that anesthesiologists and Board-certified surgeons are relatively less numerous in certain areas of the country, generally in the rural midwest and southeast. In these areas, nurse anesthetists are more numerous. The resulting curve for total anesthesia personnel, and the relations of this group both to surgeons and to population, are rather constant throughout the country.



where there is the greatest concentration of qualified practitioners and teachers.

In table 5 are shown some estimates for regional ratios of Board-certified surgeons to total anesthesia personnel. As shown in table 2 the national average for Board-certified surgeons plus residents in training to total anesthesia personnel was 2.25 to 1. It is evident that this ratio becomes higher in the northeast and Pacific areas and lower in the west north-central, east south-central and mountain states. Considering the large variations in populations and in the locations of large metropolitan centers, and heavy industry, as well as the several categories of personnel concerned, it is remarkable that the variation around the mean of 2.25 is not very great.

Responsibility for the administration of anesthetics in the United States is currently being shared in a way that shows marked regional differences in the relative proportions of physicians to nurse anesthetists; at the same time, the United States has achieved a remarkable uniformity in distribution of total anesthesia personnel in relation to both surgeons and population (fig 2).

There is an analogy here to the distribution of surgeons themselves as displayed in the SOSSUS Report: while there does seem to be some regional inequity, it is ironed out to some extent when the distribution of surgeons is related to the distribution of available hospital beds.

By the same token, the wide availability of service facilities and the need for collaboration among surgeons, anesthesiologists, and the total personnel of each hospital have produced a rather even national distribution (fig. 2). Inequities are more directly re-

lated to regional availability of health care facilities than to any other single factor. These facilities are at their lowest distribution in the south Atlantic and east south-central areas. It is this factor—lack of facilities—that is responsible for what often manifests as a major inequity in personnel distribution. If the patients are there and hospitals present and equipped to care for them, then surgeons will enter practice and anesthesiologists with them.

Sex differences within the anesthesia personnel are notable. Most of the members of the ASA are men. Most of the members of the AANA have been women.[§] Any analysis of the provision of anesthesia services must take into account this disparate sex distribution.

It appears to the intuitive judgment of many per-

§ Recent reports suggest that as of early 1977, as many as 23 per cent of active practicing nurse anesthetists were men (personal communication from Mrs. Heimler).

TABLE 5. Regional Ratios: Board-certified Surgeons (BCS) and Total Anesthesia Personnel (TAP)

Region	BCS/Population	TAP/Population	BCS/TAP
Northeast	33.5	12.95	2.59
Mid-Atlantic	30.3	11.82	2.56
S. Atlantic	27.5	11.44	2.40
E. S. central	20.6	11.20	1.83
E. N. central	22.0	10.40	2.11
W. S. central	23.1	11.78	1.96
W. N. central	21.7	14.38	1.51
Mountain	20.2	11.73	1.72
Pacific	36.7	10.01	3.67
Mean	26.2	11.74	2.26

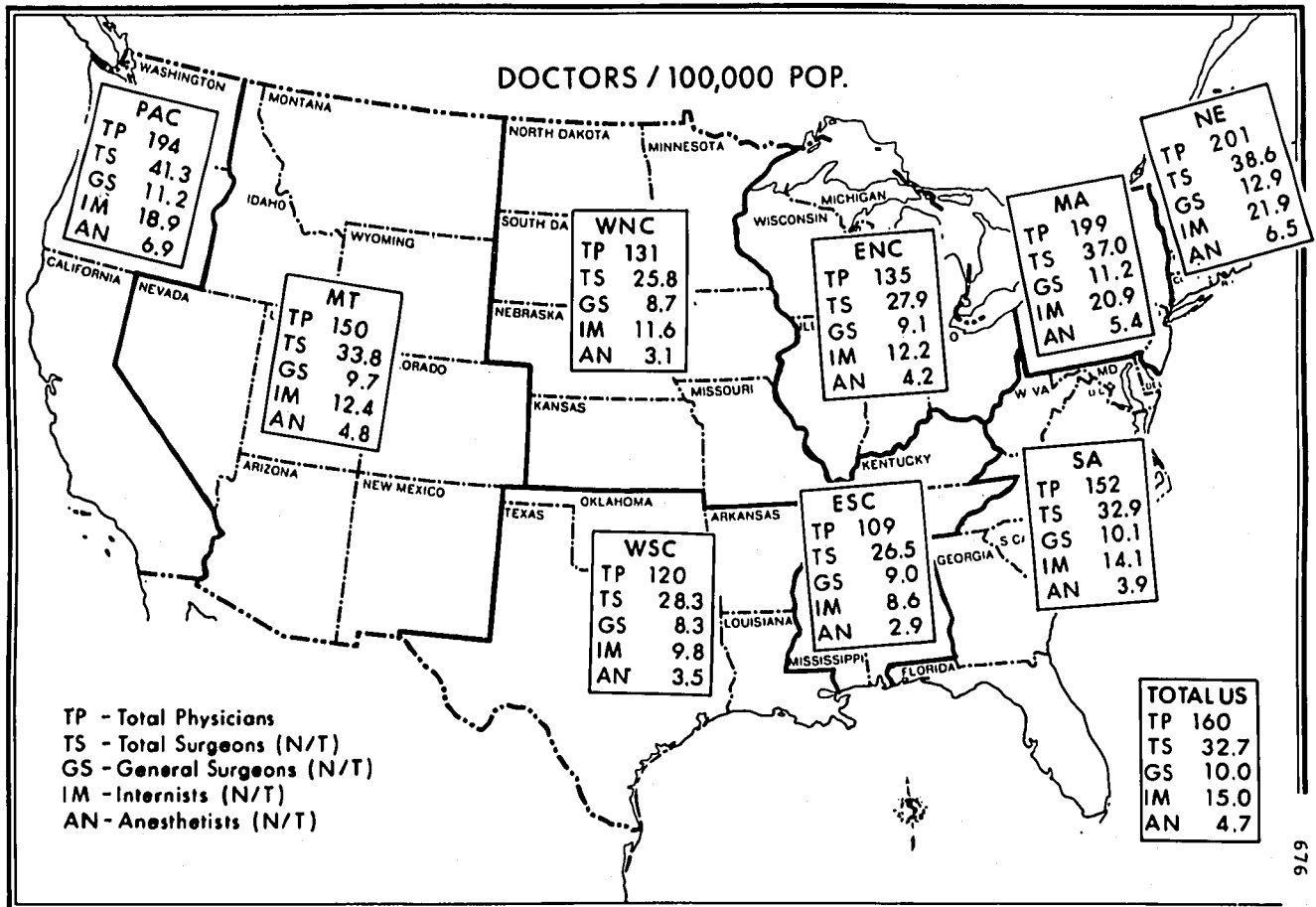


Fig. 2. Physicians per 100,000 population (adapted from SOSSUS Long Form Report¹⁰ with permission of the Editor). Figures are shown for total physicians, total surgeons, general surgeons, internists, and anesthesiologists per 100,000 population for the nine major census districts. In the right lower corner are the totals for the United States. The abbreviation N/T signifies "not in training." The figure for anesthesiologists is based on the American Society for Anesthesiologists' data for 1972-73. Distributional aspects are described in the text.

sons concerned with this field that future recruitment policy will gradually, over the coming decades, even out some of the inequities by attracting more men into nurse anesthesia and more women into anesthesiology.

In table 6 are shown estimates for the numbers of anesthetics administered by nurses and by physicians according to numbers of hospital beds and according to year by recent decade.¹¹ These data are helpful in understanding the relative preponderance of nurse anesthetists in certain areas of the country that are predominately rural and agricultural, even though large cities with medical centers are also included. In rural areas small hospitals predominate. In hospitals that have fewer than 100 beds approximately 65 per cent of all anesthetics are given by nurses. In the larger hospitals this figure decreases to about 42 per cent and physician-administered anesthesia becomes predominant (fig. 4). In the large metropolitan areas of the northeast, and the Pacific coast and the

east north-central areas of the country, physician-administered anesthesia predominates. There is also a relation here to the average size of hospitals, which is larger in the metropolitan area.

Manpower Contrasts and International Comparisons

Should an effort be made to effect a large increase in the number of anesthesiologists or nurse anesthetists in this country? There certainly are no data to suggest that any portion of this country experiences a limitation in delivery of surgical services because of the limitation in availability of anesthesia personnel. Despite this national generalization, there are focal areas where one may discover by casual conversation or anecdote that surgeons express the desire to have more anesthesiologists available.

In conjunction with the SOSSUS questionnaire, it was possible to assess the opinions of surgeons about the relative abundances of other specialists.²² The

questionnaire returns (with the responses numbering about 5,700) showed that only 10 per cent of the respondents considered that there was a shortage of radiologists, whereas 77 per cent thought that the number of radiologists was about correct and 7 per cent considered that there was an excess; 6 per cent expressed no opinion.

The position with respect to anesthesiology was quite different. Of 5,730 respondents who addressed themselves to this question, 41 per cent believed that there was a shortage of anesthesiologists in their area, whereas only 51 per cent believed that it was "about right." Only 3 per cent experienced an excess, 4 per cent having no opinion. This position with respect to anesthesiology, makes a contrast not only with radiology, as mentioned above, but also with pathology. With respect to pathology, 5,697 respondents addressed the question of abundance; 11 per cent indicated a shortage of pathologists, 77 per cent experiencing a distribution that was "about right," 4 per cent an excess, and 9 per cent no opinion.

From this brief excerpt of information from an article to which the reader is referred for details,²² it is evident that almost half the surgeons responding felt that there was a relative shortage of anesthesiologists. Although this cannot in any sense be considered a universal or final consensus, the sample was large and carefully selected and stratified by strict statistical techniques. It did indeed show that more surgeons perceive a shortage of anesthesia services than perceive shortages in the hospital-related fields of radiology and pathology.

In this regard, it might be helpful to compare figures for the United States with those for other countries. For detailed data, not presented here in the interest of brevity, the reader is referred to Volume I of the "Long Form Report" of the Surgical Services Study (SOSSUS),¹⁹ where international comparisons of physician manpower shown by tabulation and charts are presented (page 759 *et seq.*). In figure 3 is

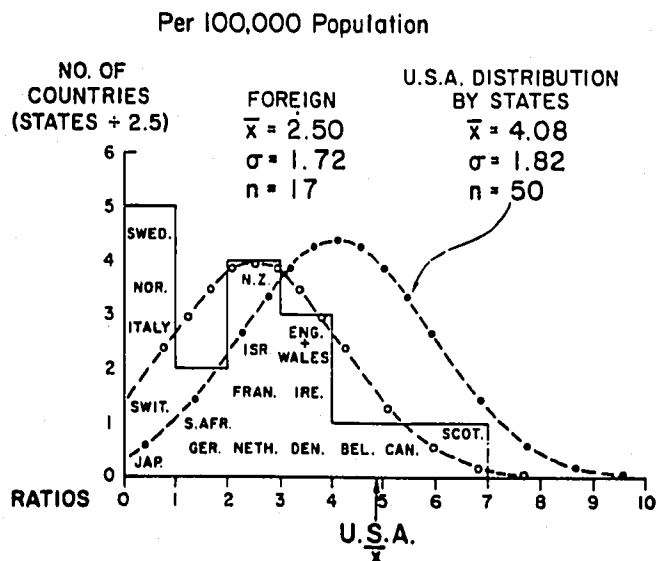


FIG. 3. Frequency distribution curve for anesthesiologists in foreign countries compared with the United States (adapted from SOSSUS Long Form Report¹⁹ with permission of the Editor).

shown an abstract of some of these data, presented graphically.

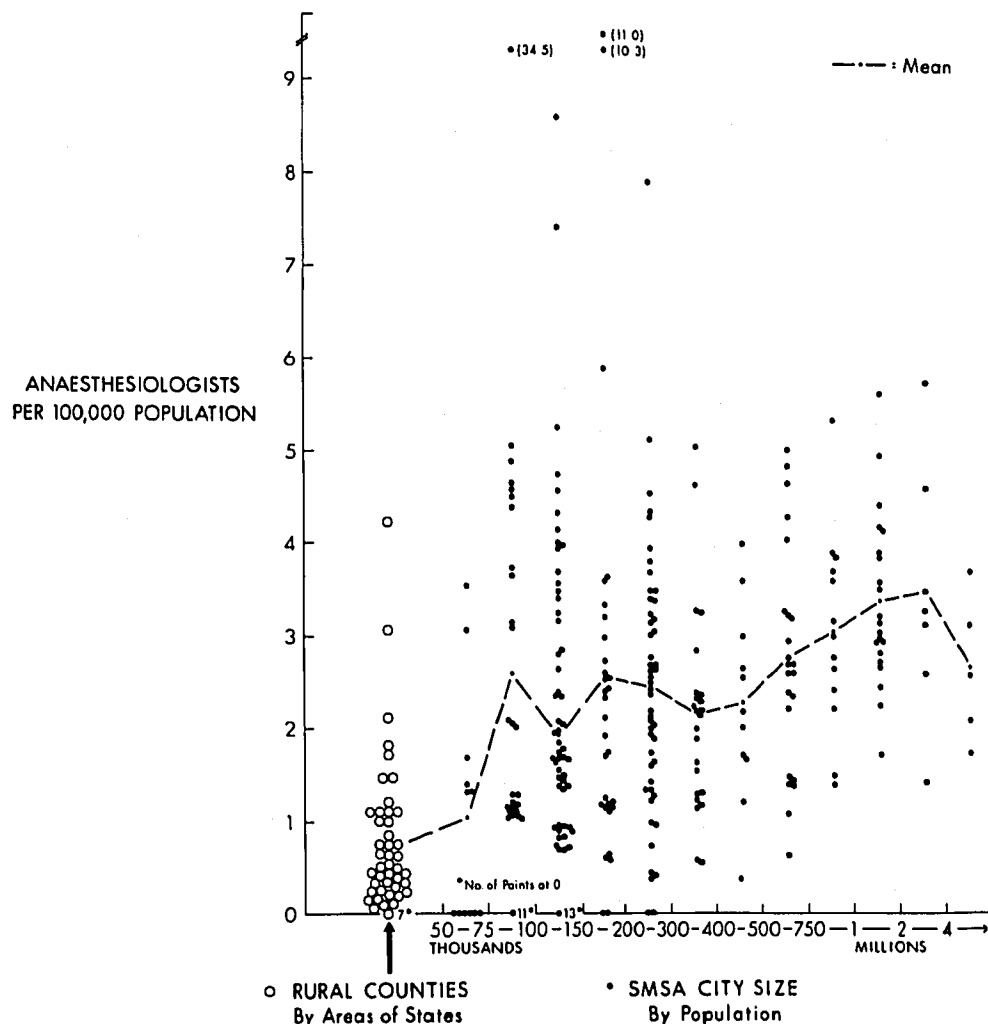
It is evident that certain of the western European or English-speaking countries (Scotland, Canada, England, Wales, New Zealand, Belgium, Denmark, Netherlands, France, Ireland, and Israel) enumerate anesthesiologists much as do the United States manpower data. That is, they enumerate them as physicians, showing distributional data of 2.5 to 6.5 anesthesiologists per 100,000 population. Although this is a wide range, it is evident from figure 3 that the mean is about 4 anesthesiologists per 100,000 population. In both instances the standard deviations are large, there is much overlap between the United States and some foreign countries, and the differences cannot be considered significant.

There is a second group of countries, including South Africa, Germany, and Spain, in which the enumeration is intermediate, showing slightly less than 2 physician anesthetists per 100,000 population.

Then there is a third group, including Sweden, Norway, Italy, Switzerland, and Japan, in which the figure is so low (less than 1 per 100,000 population) that one must assume that the manpower data base is entirely different or that most of the anesthesia episodes are administered by nurse anesthetists, not enumerated. From this evidence one would suggest that the proportion of anesthesiologists in this country is adequate as compared with other countries; when to that number is added the information about nurse anesthetists reported in this paper, it becomes evident that our total anesthesia personnel availability is as great as or greater than those of comparable countries.

TABLE 6. Anesthesia Services by Hospital Size and Decade

	Beds				Years		
	0-49	50-99	100-249	250+	1955	1965	1971
Anesthesiologists (per cent)	11	16.6	35	47.5	18	39	38.3
Nurses (AANA) (per cent)	67	65	50.4	42.6	34	45	48.5
Other physicians (per cent)	16	14	11	7.3	27	11	9.7
Other nurses (per cent)	5	4	3	2	19	3	2.8
Miscellaneous or other (per cent)	0.6	0.5	0.6	0.7	2	1	0.6



Trends

ACCREDITATION AND CREDENTIALING

The data from the recent decades show the gradual emergence of the anesthesiologist, from administering 18 per cent to administering almost 40 per cent of anesthetics. The fraction given by nurses accredited by AANA has likewise increased (table 6).[¶] By contrast, anesthetic administrations by other physicians and other nurses without these qualifications and credentials have declined markedly. The trend to national credentialing for anesthesia services is thus becoming strong and incontrovertible. This is a national trend in all fields of medicine, and it is particularly important in surgery, wherein Board certification increasingly dominates the credential process for staff appointment.

¶ There is a possibility of double-listing here, some AANA cases listed as given by nurse anesthetists having been supervised by ASA physicians.

FIG. 4. Community-size distribution of Board-certified anesthesiologists, based on data from the 50 states. Left (*open circles*), data for rural counties, with the mean for each state. Right, populations of urban centers (SMSA), by increasing size. Each dot represents the population ratio for anesthesiologists in one city. The dotted line is drawn through the arithmetic mean for each group of cities in the population bracket. Anesthesiologists show a slight trend towards a more urban/metropolitan distribution. This trend is small, however, compared with the steeply rising slope for internists plotted in the same manner.¹⁹ Surgeons show a slightly flatter slope, indicating a somewhat more even distribution in the smaller communities. The reader is referred to the SOSSUS Long Form Report¹⁹ for similar charts of community-size distributions of various specialists. The data shown here have not previously been published.

Such a trend in credentialing in both anesthesiology and surgery appears to the author to be not only socially desirable but historically inevitable. The public expects, and the professions will provide evidence of, training, achievement and meeting of standards by those who provide public services that are both important to health and hazardous when poorly carried out. These criteria apply to both anesthesia and surgery. It seems evident that in the future, hospitals will move towards increasing strictness of credentialing in both these fields. It is my own hope that this credentialing will continue to be carried out through the private sector rather than by the government. An overview of the problem of credentialing as well as the possible government harassment through the Federal Trade Commission has recently been presented.²³ Sociologists and legislators frequently ask for "proof" of superiority, which is difficult to acquire in a society where a credentialed group already predominates numerically and takes on most of the more difficult problems. As mentioned in the article referred to above,²³

methods of credentialing and standards of excellence should always be improved, rather than devoting extensive research to seeking direct statistical proof of the superior performance of credentialed people.

PREDICTORS OF THE POPULATION RATIO

When professional personnel must pass through a distinct qualification episode ("entry gate") before starting practice, a predictive method can be evolved to express their future number relative to the population. The event of Board certification or ASA membership qualification constitutes just such an entry gate, where counting can be very accurate. This accurate count in surgery is referred to as the "Board-certification rate," *i.e.*, the number of new persons Board certified per year. When this number is related to the age group distribution of the practitioners of the population, and the death and retirement rates, it is possible to make future projections as to the numbers of those persons who will be alive and in active practice over the next two or three decades. The Bureau of the Census supplies future population forecasts which, though they have been undergoing some downward modification in recent years, are the most reliable we have.

The mathematical model and computer application for converting Board-certification rates into predictions of physicians per population over coming decades are shown in detail in the Long Form Report of SOSSUS.¹⁹ Because very few surgeons remain in practice beyond the fourth year without Board certification (providing they have progressed and graduated from an accredited residency), such predictions are reliable within the limits of population variables.**

** The number of highly trained surgical specialists entering practice without any intent of achieving Board certification is, in my opinion, low at this time and declining. Some disagree with this view. It appears that the statistical data currently at hand suggest that entry into major surgical responsibility is becoming increasingly confined to those with Board certification, and it is noteworthy that in the residency questionnaire of SOSSUS^{18,19} more than 96 per cent of all residents responding, including those in municipal tax-supported hospitals as well as university hospitals, indicated that they intended to become Board certified after the completion of their residency.

Such predictions of population ratio (*i.e.*, the number of physicians per 100,000 population) cannot be regional because the populations of regions and the internal migration of physicians within this country are too unpredictable. The recent growth of population in the "sun-belt" southwestern states has been accompanied by an increase in the total number of surgeons, anesthesiologists and training facilities that would scarcely have been predicted 20 years ago. Population ratio forecasts that we have made are, therefore, national rather than regional.

On that basis, the growth of surgery and anesthesiology can be predicted within the confidence limits of Board-certification rates and the data on age-group distributions. Specifically, Board-certifi-

Similar growth rates for other branches of the medical profession are currently under study. It appears that internal medicine, radiology, and pathology are all growing much more rapidly than they did in the previous 30 years, and the same is true of primary care medicine, however one wishes to define that entity.

Data for anesthesiology are much more difficult to derive or predict, because some members of the American Society of Anesthesiologists are not Board certified and remain so in fully accredited positions, but without Board certification. It would be my prediction that Board certification will become a stricter credentialing criterion for anesthesiology in the future, as previously mentioned. Data for the growth of the AANA cohort are reasonably secure because of firm data describing the number in training, and the rather fixed fraction of the activity/inactivity ratio reported by the AANA.¹¹

FOREIGN MEDICAL GRADUATES

Uncertainty on the anesthesiology side relates also to the large number of foreign medical graduates in training programs. The Health Manpower Assistance Act of 1976 could decrease participation of foreign medical graduates in clinical training programs drastically. Were this to occur, there would be a sudden decrease in the number of anesthesiologists entering practice in the United States over the next 20 years.

Such federal legislation is prone to modification either by outright amendment or by changes in federal regulations by which the law is administered. It would, therefore, be unwise to make firm predictions; better to emphasize the uncertainty as to the number of anesthesiologists entering practice with Board certification in the next 20 years.

fication rates for the ten surgical specialties have grown from 2,985 in 1968 to 3,478 in 1974, uncorrected for double-boarding. The double-boarding correction reduces the figure by 12–18 per cent, depending upon the number of individuals Board-certified in thoracic surgery in any given year; the data for 1975–76 show the same continued slope of modest increase, approximating 2 per cent per year. This is in sharp contrast to the growth of the Board-certification rate in anesthesiology, which has doubled since its 1968 figure of 311, to 608 in 1975; some of the imbalance in training rates between the two fields is evidently being rectified. It is notable that certain other fields, especially internal medicine and radiology, also show brisk growth rates at this time.

Despite the modest growth in surgical Board certification, it is evident that the surgical profession is still growing faster than the population. Based on year-end 1975, it appears that the cohort of Board-certified surgeons is growing at about 5 per cent per year, while the population grows at 0.5–0.62 per cent per year. As mentioned previously, the corrected growth rate for the ratio of Board-certified surgeons in practice to the population has been about 4.5 per cent per year since 1970.

The large number of foreign medical graduates in anesthesiology training program in this country reflects the tendency of United States medical graduates (USMG) to enter other fields. The increasingly large number of women entering medicine in this country deserves a comment in this connection, and increasing class size suggests the possibility that more USMG's will enter anesthesiology.

WOMEN IN ANESTHESIOLOGY; MEN IN NURSE ANESTHESIA

At the present time many medical schools in the country are enrolling as many as 33 per cent women in the first year. The national average currently is estimated to be 20 per cent. The question, therefore, arises as to what fields women will select for their careers in medicine as they become available in American medicine in large numbers for the first time. The record is so brief as to make analyses unreliable. It seems evident that more women will enter surgery in this country than has been the case in Great Britain, where many women have graduated from medical school over the past 35 or 40 years.

At the same time, there are certain fields that are well adapted for women in medicine because they do not involve prolonged commitment to individual patient care. This aspect makes it a little easier for the young mother to drop out of clinical practice for a few years, if needed, during childbearing and infant upbringing. Anesthesiology is one of those fields, along with pathology, radiology, rehabilitation medicine, research of all types, and positions in postgraduate teaching.

The perception of sex—femininity or masculinity—as having any particular features adapted to one profession as opposed to another is unfashionable at this time, and is often viewed with a sense of criticism or sex chauvinism by certain activist groups. Despite the desire to avoid discussion of the matter, the fact remains that some fields of professional work in medicine are well adapted to the needs of the woman practitioner to raise a family and enjoy the privileges of motherhood. As already mentioned, the large number of women in nurse anesthesia is a historical circumstance relating to the fact that most nurses in the United States have been women over the past century. Nonetheless, their activity in nurse anesthesia demonstrates clearly that some features of the career in anesthesia services are well adapted to the life-style of women. It would therefore seem so obvious as to be scarcely worthy of argument that improved recruitment of women into anesthesiology, and men into nurse anesthesia, would help to improve the balance

and career opportunities for both sexes in both aspects of this important professional service.

THE PHYSICIAN'S ASSISTANT OR ALLIED HEALTH PERSONNEL IN ANESTHESIA

The current trend to evolve a new professional group—the physician's assistant in anesthesia—often recruiting large numbers of men into training programs, seems in part to be a response to the preponderance of women in nurse anesthesia, and, for some male enrollees, the greater attractiveness of a predominantly male cohort. The physician's assistant is perceived as an individual who has learned the administration of anesthetics at the technician level, but somehow works in a manner distinct from nurse anesthesia. Men have predominated in the technical fields of inhalation therapy and respiratory management. This provides another track or professional activity for men, many of whom have completed a college education. Some have been unable to achieve admission to medical school. The respiratory therapist as a member of the health team, without the M.D. degree, has thus become an established and effective feature of many of the larger hospitals and urban centers. In many hospitals this service is directed by the Chief of Anesthesia.

In anesthesiology itself, the definition of "physician's assistant" or "allied health personnel" has not been agreed upon. Historically, the nurse anesthetist has always appeared to represent the very prototype of the relation between physician and assistant: a highly trained, technically expert person who has worked in close collaboration with the anesthesiologist. It seems self-evident that it is to the advantage of all aspects of anesthesia care in this country to avoid a further subdivision of non-physician anesthetists according to sex, or according to new training programs, or based on the presence or absence of a nursing diploma or degree. The nurse anesthetist has ideally functioned as a physician's assistant.

In my opinion there is nothing to gain by the growth and designation of a new third or fourth cohort of credentialed individuals to work with anesthesiologists. It would seem preferable to strengthen the current relationship, whereby the status of AANA membership is clearly recognized and members of the AANA carry approximately 50 per cent of the workload of American anesthesia services. Jurisdictional division or political pressures to modify or divide this group would not seem to be in the public interest or to lead to improved patient care.

This matter is of great moment and deserves wide discussion now, because new federal regulations,

drawn up as part of new legislation, could threaten the status of the nurse anesthetist through the granting of some sort of privilege or categorical identification to a group of physician assistants in anesthesia who would receive an alternative training program and who would not be a part of the AANA activity. The political process in the United States is particularly sensitive to strong lobbying pressure from new splinter groups of old professions or from dissatisfied minorities who perceive themselves as being excluded from established groups.

The role of the physician's assistant in surgery is still not clear; to many observers of the subject there appears to be waning enthusiasm for that personnel category, and a general sense of failure to define a wide national role, even though certain specific categories (emergency ward assistants, orthopedic assistants) may prove to be viable and enduring career patterns.

By sharp contrast, the role of the nurse anesthetist has not been in question; it has been neither insecure nor indefinable. It has grown in strength and scope; many schools of nurse anesthesia have recently been strengthened or enlarged.

In summary, then, trends in anesthesia suggest an increased emphasis on accreditation and credentialing both in anesthesiology and in nurse anesthesia, a gradual levelling out of the disparity of sex roles, a possible decline in anesthesiology trainees with forthcoming limitation in FMG, and the growing importance of maintaining and strengthening the cohort of nurse anesthetists as the prototype "physician's assistant" in anesthesia without dividing this group by new jurisdictional disputes or accreditation definitions.

The large increase in USMG during the past decades will produce a "wave" of increased numbers of postgraduate trainees (interns and residents) in all fields over the next ten years. The decrease in anesthesiology trainees threatened by federal intervention in FMG immigration may be modified by the greatly increased number of USMG entering several fields; recent Board-certification trends in anesthesiology provide a base for expectation that more USMG will enter anesthesiology in the next decade.

Summary and Conclusions

1. Anesthesiology and surgery constitute two of the most closely interrelated branches of the medical profession. The manpower relationships between the two are, therefore, important both in the delivery of professional services in the United States, and in any manpower planning that may be undertaken.

2. The manpower data in this article arise from

many sources. We are indebted to the American Society of Anesthesiologists and the American Association of Nurse Anesthetists for information updated to late 1976 or 1977. Standardization of terminology and increased accuracy of manpower reporting in all aspects of the health professions are objectives sought by all workers in this field.

3. The ratio of Board-certified surgeons plus their residents in advanced years of training to total anesthesia personnel is approximately 2.25 to 1, nationwide. The ratio of Board-certified surgeons in practice to active fellows of the American Society of Anesthesiologists is about 5.7 to 1. Data suggest that the growth of anesthesiology is proceeding at a more rapid rate than is that of the total of Board-certified surgeons. Recent trends in Board-certification rates in the two fields corroborate this; Board certification in surgery is growing at about 2 per cent per year, while in anesthesiology the figure has almost doubled over the last eight years.

4. The active ASA membership shows a population ratio of about 4.6 per 100,000 population, the active membership of the American Association of Nurse Anesthetists, about 7.0 per 100,000 population. Nationally, the total of anesthesia personnel of both categories (omitting trainees) is about 11 per 100,000 population. A comparable figure for Board-certified surgeons is about 26-28 per 100,000.

5. Anesthesiologists are most numerous in the northeastern, northwestern, and eastern midwest parts of the country. Nurse anesthetists are more common in other parts of the country, especially in the west north-central district. By this distributional circumstance, an equity has been achieved whereby the ratio of total anesthesia personnel to population is quite constant across regions of the country, as is the numerical ratio of total anesthesia personnel to Board-certified surgeons.

6. Anesthesiologists are more numerous and give a larger proportion of anesthesia in the larger hospitals and in larger cities, whereas nurse anesthetists predominate in smaller hospitals and more rural areas.

7. Comparison with foreign countries shows that the United States figure for anesthesiologists is in the same range as but slightly higher than those for comparable countries.

8. There is a recent trend towards increased formality of credentialing in both anesthesiology and nurse anesthesia, with a marked diminution over recent decades in the total number of anesthesia administered by other persons.

9. There are more foreign medical graduates in anesthesiology training in the United States than there

are in surgical training, relative to total trainees. The impact of the Health Manpower Assistance Act of 1976 could be severe in terms of decreases in anesthesiology trainees and a sharp decline in the number of anesthesiologists entering practice, over the next decade.

10. Most anesthesiologists are men, a historic circumstance relating to the high proportion of men graduating from American medical schools. Most nurse anesthetists are women, likewise a historical circumstance relating to the history of nursing in this country. It appears evident that anesthesiology is one of the fields of activity that is well adapted to the special needs of women in medicine; a desirable trend—which appears to be on its way to realization—would be for a larger number of women in anesthesiology and a larger number of men in nurse anesthesia.

11. The recent trend to establish training schools and paraprofessional groups identified as “physician’s assistants” or “allied health personnel” could have an adverse impact on the present equilibrium in American anesthesia services. It would appear desirable to stabilize the present relationship between anesthesiologist and nurse anesthetist, rather than challenging this long-standing relation by the establishment of new professional categories that will generate jurisdictional disputes among groups of nonphysician anesthetists.

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