ANESTHESIA FOR MEN WOUNDED IN BATTLE

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ADVANCES IN SURGERY in the 30 years since the start of World War I have in a number of cases been made possible by progress in the field of anesthesia. This progress has required acceptance of the view that surgery acceptable by the standards of 1945, cannot be achieved if anesthesia equipment and technics and personnel are limited to those of 1914. An attempt will be made here to sift out the anesthesia procedures found to be practicable under the circumstances of warfare and necessary for the best military surgery, surgery unrestricted by anesthesia.

Intravenous anesthesia, sodium pentothal, has had its first significant trial in military medicine in the present conflict. The technic is admirably suited to the needs of warfare; but the extravagant statements made for and against it, above all its newness in military medicine, all suggest the desirability of a fuller discussion of this agent, than of the others employed. This has been undertaken.

This report is based upon experience in the Mediterranean Theater of Operations. It has been made possible by the wholehearted coöperation of the anesthetists of the Theater.

ANESTHESIA AGENTS AND TECHNICS IN THE COMBAT ZONE

Some Limiting Factors

A number of factors here are of enough importance to limit considerably one's freedom of choice. *Mobility of equipment and availability of supplies:* Even the 400 bed evacuation hospitals on occasion have to dispose of their patients, tear down their equipment, move many miles over difficult, congested roads, set-up and be ready to receive patients about 24 hours after the first notification of the move. The rough handling inevitable if such speed is to be obtained means that complicated gas machines often become so battered that they leak and lose their serviceability. The premium to be placed on simple durable equipment is evident. The problems arising from interruption of supply and constantly changing supply routes soon convinces the most enthusiastic anesthetist that he had better get along, if need be, with a few agents that can be transported by hand* or administered by improvised equip-

* It must be recognized that for some types of surgery a satisfactory survival rate cannot be obtained unless a closed anesthesia apparatus is provided which will permit the administration of positive pressure anesthesia, notably in open thoracic surgery. As a result of the coöperation of the Surgeon-General, 50 of the small transportable anesthesia outfits described by Beecher (an easily transportable apparatus for anesthesia with or without compressed oxygen, War Medicine 2, 602, 1942) were obtained and tried out. The

ment. These are adequate reasons for the frequent limitation of anesthesia agents in the forward zone to ether, sodium pentothal and procaine hydrochloride. *Problems of personnel* will be discussed in more detail later, but it can be mentioned, in passing, here that they, too, offer some arguments for this simplification. Observe, for example, the section on personnel, where it is pointed out that a third of the Theater's physician "specialists" in anesthesia had had only three months or less special training.

While it was necessary to press into service a good many men who had had little special preparation in anesthesia, these men have rendered a superb service in which earnest application to the job to be done has gone far to override limited training in the field.

PREPARATION OF THE PATIENTS FOR SURGERY

This is an important matter and has been discussed in detail elsewhere.[1] It is customary in a report of this kind to discuss preanesthetic medication. This has been done so frequently by various writers in the past little more needs to be said on the subject. In the opinion of the writer, based upon first-hand experience on the Cassino front and at the Anzio Beachhead, the seriously wounded need very little preanesthetic medication. The use of morphine had better in most cases be avoided, except when needed for the relief of severe pain. As pointed out elsewhere,[2] when the peripheral circulation is poor as in chilled or shocked patients, morphine previously administered may or may not have been absorbed from subcutaneous deposits. With resuscitation and later with the peripheral vasodilation associated with ether anesthesia, the injections of morphine may be rapidly taken up into the blood and poisoning appear. In any case, the use of morphine is not necessary as a routine in these patients. Atropin is important to cut down the flow of mucus under ether and also as described in the section on pentothal anesthesia.

Intratracheal intubation under general anesthesia is desirable for intracranial, maxillofacial, thoracic (pleural involvement) and abdominal surgery and in other cases where the position of the patient makes it difficult to maintain a good air-way, and finally when the operation promises to exceed an hour or so.

While preparation of badly wounded patients for surgery should include check on the availability of a bronchoscope, the *routine* use of this, even in open thoracic cases, is undesirable for the following reasons: The air-way

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manufacture of these is relatively simple and rapid and the use of critical materials rests at a minimum. Light (14 lbs. boxed), simple, and durable, having few parts there is little to get out of order and few opportunities for leaks. The apparatus takes up little space in crowded operating tents and is easily transportable by hand. Its safe use is much more easily and quickly mastered by inexperienced anesthetists than is true of the more complex apparatus provided. Use of the apparatus in the combat zone established that it was adequate for the most complicated types of thoracic surgery, as well as for any inhalation anesthesia. The apparatus is also readily available for oxygen therapy or artificial respiration.

should, if necessary, be kept clean by means of frequent aspiration of the trachea through a catheter. Use of the bronchoscope at the end of operation involves one of three things, all undesirable: If the bronchoscope is to be introduced at this time either the anesthesia must be maintained at a deep level for an undesirably long time, or it must be deepened with possible harm to the patient at the end of a trying operation when the condition of the patient may be poor, or topical anesthesia must be used. In this case, if the patient vomits on recovery from the general anesthesia he is almost certain to aspirate vomitus through his locally anesthetized air-way.

TABLE I

SAMPLE DISTRIBUTION OF ANESTHETICS FOUND IN FORWARD AND REAR AREAS

(Based on Tunisian and Sicilian Campaigns, from June to September, 1943. Compare with Table II)

Area	Percentages are Based upon the Following Number of Cases	Inhalation (Ether Chiefly)	Intravenous (Sodium Pentothal)	Spinal (Procaine HCl Chiefly)	Local (Procaine HCl Chiefly)
Forward: Field Hospitals Evacuation Hospitals	1,104	18.0%	53.2%	19.8%	9.0%
Rear: Station Hospitals General Hospitals	5,279	14.3%	27.7%	38.2%	19.7%

TABLE II

SAMPLE DISTRIBUTION OF ANESTHETICS CURRENTLY FOUND IN FORWARD AND REAR AREAS

(Collected January through August, 1944, for comparison with Table I)

Area	Percentages are Based upon this Number of Cases	Inhalation				Intravenous (Sodium Pentothal)	Spinal	Local		Regional	
		Open Ether	Closed Ether*	Nitrous Oxide	Chloroform		All 3	Chiefly Procaine HCl		Avertin Basal	Combined†
Forward: Field Hospitals Evacuation Hospitals	10,734	11.6%	8.7% (20.3%)			62.6%‡	3.0%	13.4%	0.7%		
Rear: Station Hospitals General Hospitals	9,180	2.6%	5.9% (8.8%)	0.2%	0.1%	48.1%	15.0%	20.4%	2.2%	0.1%	5.4%

* Includes those with nitrous oxide induction.

† Agents are listed as "combined" when two or more agents are both used for prolonged anesthesia. This classification does not include brief induction of one agent by another, nor "basal avertin."

‡ In the forward area, the use of sodium pentothal is almost entirely limited to the evacuation hospitals. It is rarely used in the field hospitals where the nontransportable type of patient is cared for. It provides for practically all of the anesthesia for major cases in field hospitals.

INHALATION ANESTHESIA

Ethyl chloride or *chloroform* have been used so infrequently in this Theater (for incidence of use, see Tables II and III) as to merit little comment. It has been suggested that chloroform in small ampoules be used by

nonmedical personnel to overcome wounded manic individuals in burning tanks so that they might more easily be removed through the narrow escape hatch. So far as the writer knows the agent has not been used for this purpose in this Theater. With the other agents now available it is difficult to find any legitimate anesthetic use for chloroform, except in the rare circumstances where sodium pentothal, nitrous oxide, or local procaine are not adequate and when use of a noninflammable agent is imperative. The effects of the agent are such that there can be even less excuse for using it in men wounded in battle than in nontraumatic civilian practice where the agent has been

TABLE III

SAMPLE DISTRIBUTION OF ANESTHETICS FOUND IN FORWARD AND REAR AREAS

These data overlap those of Tables I and II as far as time of collection goes, and show transition between early and current (Table II) practices. They are included here because they are based upon a larger volume of material than are Tables I and II

Area	Percentages are Based upon this Number of Cases	Inhalation: Open Ether	Inhalation: Closed Ether*	Inhalation: Nitrous Oxide	Inhalation: Ethyl Chl.	Inhalation: Chloroform	Intravenous (Sodium Pentothal)	Spinal: All 3	Local: Procaine HCl	Regional: Chiefly	Avertin Basal	Combined†
Forward:	19,464	9.7%	7.2%	0.2%	0.02%		62.3%	6.0%	13.0%	1.3%	0	0.4%
Field Hospitals			(17.1%)									
Evacuation Hospitals												
Rear:	21,598	2.9%	6.5%	0.7%	0.2%	0.04%	38.3%	23.3%	19.8%	4.6%	0.1%	3.7%
Station Hospitals			(10.3%)									
General Hospitals												

* Includes those with nitrous oxide induction.

† Agents are listed as "combined" when two or more agents are both used for prolonged anesthesia. This does not include brief induction of one agent by another, nor "basal avertin".

adequately discredited for many years. Ethyl chloride, because of its easy transportability and rapid transient action, has had a little use as an inducing agent or for use to dull the pain of brief procedures.

Cyclopropane or *ethylene* have not been issued to the American Army in this Theater.

Nitrous oxide, when available, is useful for minor surgical procedures (painful changes of dressings), supplement of other forms of anesthesia (notably 50 per cent nitrous oxide with 50 per cent oxygen to add to the effect of sodium pentothal) and induction of ether anesthesia. While nitrous oxide is useful its value by no means ranks with that of the important three: ether, sodium pentothal, and procaine hydrochloride. The straight induction of ether is remarkably easy and apparently not unpleasant in the badly wounded, whether by open-drop or better by closed machine with oxygen. The use of nitrous oxide is convenient when available but is not indispensable.

Ether is the choice in the seriously wounded. This is true whether the seriousness of the wounds depends upon widespread tissue destruction, pene-

tration of important body cavities or is due to severe hemorrhage through otherwise trivial wounds. When surgery must be undertaken in patients in shock or when shock is impending, it has been clearly demonstrated that ether is the best tolerated of any of the available agents. Ether is now so widely recognized as the most desirable agent for use in the seriously wounded, its corresponding merit is evident for patients who are less badly off. It provides for practically all of the anesthesia for major cases in field hospitals.

Early practice in the Theater was to use ether too little. The 2 per cent increase (cf. Tables I and II) in the forward hospitals in the use of ether over the past year is of doubtful significance. Not adequately shown by the type of table presented is the increased use of ether in the numerically relatively small but surgically important group that includes wounds of the abdomen, the thorax and compound fractures of the femur.

INTRAVENOUS ANESTHESIA

Perhaps the best way to approach the problem will be deliberately to reverse the usual order of discussion and present first some of the end-results* of the use of this agent as found in the survey of September, 1943, as contrasted with the survey made a year later (September, 1944), for this approach will make clear the reasons for some of the decisions made regarding this anesthetic agent.

Background.—At the time of the first survey, September, 1943, deaths from sodium pentothal were so common, not only as shown in the sample data in Table VI but throughout the Theater, both before and after this survey, that the question was raised of abandoning the agent. Moreover, experience here was then in line with reports arising from use of the agent at Pearl Harbor. But examination of the deaths that had occurred here indicated that two correctable factors were present: (a) Its frequent use by completely inexperienced individuals. ("You need only to be able to hit a vein to be an anesthetist these days"); and (b) its use in cases where actually contraindicated. Because of the unquestionable advantages of the agent in warfare, the decision was made to continue its use, at the same time taking measures to correct (a) and (b).

The simplicity with which pentothal anesthesia can be made available, particularly the compactness and the simplicity of the necessary equipment, the ease with which smooth induction can be produced even by the inexperienced, the usual prompt awakening of the patient, the infrequency of unpleasant after effects, the number of cases an inexperienced man can "get

* In Tables V and VI, and occasionally here in the text, the phrase "death rate" has been used for brevity. This has been placed in quotation marks to give it a special significance. Obviously one cannot speak of rate in a precise mathematical sense when, as in Table VI, two deaths occurred in 11,000 cases; yet a year previously, in a quarter as many cases, three times as many deaths had occurred. This 12-fold difference indicates that a real change for the better had taken place. So the data will be set down in this way to suggest order of magnitude, nothing more.

away with" even though his actual death rate may be unreasonably high in comparison with what it should be—all of these factors have tended to outweigh the fact that pentothal is a powerful tool, that overdosage is not always easy to overcome, that sodium pentothal's use is incompatible with certain types of injury, and that its fatal dose varies extremely widely from one patient to another.

TABLE IV

DISTRIBUTION OF SURGERY IN THE TWO AREAS

Area	Percentages are Based upon this Number of Cases	Chief Region Requiring Surgery: Extremities	Abdomen	Inguinal Hernia	Thorax	Central Nervous System	Misc. (Major)	Misc. (Minor)	Ear, Nose, Throat
Forward: Field Hospitals Evacuation Hospitals	9,199	28.0%	7.0%	0.5%	3.1%	1.7%	2.8%	56.3%	0.6%
Rear: Station Hospitals General Hospitals	11,261	13.4%	6.5%	1.6%	0.8%	1.4%	2.9%	71.4%	2.1%

TABLE V

TO COMPARE TOTAL ANESTHESIA "DEATH RATE" OF SEPTEMBER, 1943, WITH THAT OF SEPTEMBER, 1944

Time of Survey	Number of Institutions Included in Survey	Total Number of Anesthesias in the Sample	Total Number of Anesthesia Deaths*	Over-all Anesthesia "Death Rate" (Round Numbers)
September, 1943.....	12	7,650	8	1:1,000
September, 1944.....	10	19,914	4	1:5,000

* What constitutes an anesthesia death can in most cases be argued over. Cases were described as "anesthesia deaths" in this study when they occurred without adequate explanation in the condition of the patient or in the surgery involved and followed a pattern known to be characteristic of the given agent. In several of these cases, death occurred unexpectedly either before surgery had started or very soon after its beginning. The same criteria were used in the two surveys made a year apart.

Notes on the Use of Sodium Pentothal.—While the action of this agent cannot be discussed in detail here, those employing it should, for safety, be aware that among other effects pentothal (as do all barbiturates) destroys the sensitivity of the respiratory center[3] to its normal chief stimulus, carbon dioxide. Under full pentothal anesthesia the body has to make use of a supplementary mechanism in order to keep respiration going. To maintain it, a shift is made from the normal driving action of carbon dioxide acting on the respiratory center to the action of anoxia on the chemoreceptors, chiefly the carotid mechanisms in the neck. Anoxia will stimulate respiration just as powerfully under deep pentothal anesthesia as it will under light anesthesia. Thus, the uninformed anesthetist may believe that respiratory stimulation under pentothal means that the patient is waking up, whereas, it may simply mean that the patient is not getting enough oxygen. A wrong interpretation, here, leading to the further administration of sodium pentothal, has probably caused deaths. In other words, the true depth of pentothal anesthesia may be impossible to determine when the oxygen content of the blood is low. For safety, certainly whenever the operation exceeds a half-

hour, oxygen ought always to be administered with pentothal, for, when the patient's oxygenation is normal, the character of the respiration is a helpful guide as to the depth of anesthesia. When the patient's oxygenation is below normal the character of the respiration may be fatally misleading.

TABLE VI

TO COMPARE PENTOTHAL "DEATH RATE" OF SEPTEMBER, 1943, WITH THAT OF SEPTEMBER, 1944

Time of Survey	Number of Institutions Included in Survey	Total Number of Pentothal Anesthesias in Sample	Total Number of Pentothal Deaths	Over-all Pentothal "Death Rate" (Round Numbers)
September, 1943.....	12	2,672	6	1:450
September, 1944.....	10	11,136	2	1:5,500

TABLE VII

ALTHOUGH GREAT IMPROVEMENT HAS BEEN MADE IN ANESTHESIA "DEATH RATE" THIS HAS NOT BEEN AT THE EXPENSE OF ABANDONING PENTOTHAL, RATHER ITS USE HAS INCREASED

	Forward Field and Evacuation Hospitals		Rear Station and General Hospitals	
Time of Survey	Number	% of Total	Number	% of Total
September, 1943.....	2,500	53%	1,462	28%
September, 1944.....	6,721	62%	4,415	48%*

* This great increase is in large part to be explained by the adoption of the practice of secondary suture of wounds. Pentothal approaches the ideal anesthetic for this procedure.

Not only does the respiratory center lose its sensitivity to carbon dioxide under full pentothal anesthesia, but under such circumstances carbon dioxide becomes a true depressant. It is clear that the use of carbon dioxide to stimulate respiration depressed by too much pentothal is contraindicated.

Acceptable practice in the employment of sodium pentothal includes the use of 2.5 per cent solution, routine administration of oxygen, and frequent observation of pulse and blood pressure during anesthesia. In general, pentothal anesthesia is not the best choice for operations that will exceed a half to three-quarters of an hour in duration. If the duration of a given operation unexpectedly turns out to be longer than this, it is almost always well to shift to ether anesthesia.

It is probable that the course of pentothal anesthesia can be considerably influenced by the *preanesthetic medication.* There are many controversies concerning this. Morphine may or may not be used. Very likely preliminary morphine can lessen the total quantity of pentothal needed for a given procedure. Whether or not too high a price may be paid for this advantage is not certain at this time. (Does morphine heighten the activity of the occasionally troublesome laryngeal reflexes? Does morphine in reasonable dose play a part in the long depressions sometimes encountered following the use of pentothal?—*etc.*). It has been demonstrated that the supplement of pentothal anesthesia by inhalation of 50 per cent nitrous oxide with 50 per cent oxygen can reduce the dose of sodium pentothal required, probably a better means of accomplishing the desired end than by use of morphine.

Of considerably more importance than morphine in preliminary medication for pentothal anesthesia is atropin. Its purpose is to minimize vagal reflexes. Atropin 0.6 mg. (gr. 1/100), subcutaneously, should be given about one hour preceding induction of pentothal anesthesia, with half the dose of atropin repeated intravenously just before anesthesia is started. During periods of heavy admission of patients, there will not be time for the above and atropin 0.6 mg. (gr. 1/100) intravenously, about 10 minutes preceding anesthesia is satisfactory. (In the presence of severe tachycardia atropin is avoided). When laryngeal spasm occurs during pentothal anesthesia, atropin, 0.6 mg. (gr. 1/100), should be given intravenously as soon as possible, even though the same dose has been administered in preanesthetic medication shortly before this.

The Clinical Choice of Pentothal Anesthesia.—Changes here, effected over the Theater as a whole, have been of great importance in the reduction of the frequency of death under pentothal anesthesia (Table VI).

Sodium pentothal is of proven value in military medicine, of that we can be certain. Equally certain it is that the choice of pentothal is unwise, in the long run, in the presence of certain injuries:

(A) When the patient is suffering from morphine overdose avoid the use of sodium pentothal.

(B) When shock is present, or when shock is anticipated, avoid pentothal anesthesia. This should also be the case whenever the intake or distribution of oxygen is impaired or even jeopardized. The agent should rarely if ever be used when penetrating wounds of the thorax or the abdomen, or compound fractures of the femur are present. Severe hemorrhage, even when from otherwise trivial wounds, contraindicates pentothal anesthesia. Ether is the choice when these conditions are present.

(C) Sodium pentothal is a dangerous agent to use when cervical inflammation is present. Many deaths have occurred during surgery here. Apparently, inflammation in the region of the carotid bodies and sinuses causes sensitization of reflexes arising there. These may account for the notorious incidence of sudden death under such circumstances. Since pentothal (and other barbiturates) are not very effective in depressing these reflexes its choice should be avoided in most cases of this kind. Rarely, as in cases where compound fractures of the face may also be present and make inhalation anesthesia difficult sodium pentothal is sometimes the reasonable choice for the surgery of cervical abscess. When this is to be undertaken, the following precautions are to be observed: (1) Use heavy atropinization in the preanesthetic medication. (2) No surgery is to begin in cases with irritable carotid sinus until at least ten minutes following induction of pentothal anesthesia. (3) Avoid pressure on the carotids. If feasible, block them with local anesthesia.

(D) Sodium pentothal is not a good choice of anesthetic to make when

gas gangrene is present, for the toxins elaborated in this disease produce severe circulatory damage. Such damage contraindicates use of the agent.*

So far, groups of cases have been discussed where pentothal anesthesia is contraindicated. In the following, the use of pentothal may at times be debatable; but it is usually unwise:

(A) In general, pentothal should be avoided when the operative position or procedure may interfere with the air-way or make artificial respiration difficult, as in operations that must be carried out in the face-down position, or in operations on maxillofacial injuries involving the air-way. If local anesthesia is inadequate, often the case, ether can be used, preferably with intratracheal intubation.

(B) While skillful (or lucky) anesthetists may often get away with the use of pentothal as the chief anesthetic agent for intracranial surgery, its employment here is usually unwise for the following reasons: (1) Such operations are long.† Pentothal anesthesia is best limited to short, half-hour, procedures. (2) Neurosurgical operations are usually associated with great blood loss, often a liter or more by actual measurement. Extensive blood loss contraindicates the use of sodium pentothal. (3) Sodium pentothal often unexpectedly causes respiratory depression and anoxia. Anoxia produces immediate swelling of the brain and may make an intracranial procedure difficult or impossible. The hiccoughing, laryngeal spasm, and straining occasionally encountered under this agent or during recovery from it are particularly undesirable in intracranial surgery. Local procaine or ether is the best available choice in most of these cases.

(C) Experience with severe burns appears to show that such patients tolerate pentothal anesthesia poorly. Why this is so is not clear. (Perhaps the rather poor tolerance of these patients for pentothal is to be explained as a result of the great reduction of circulating blood volume in burns, with consequent circulatory impairment, in this respect like the effect of hemorrhage, known to contraindicate pentothal.)

The great field where pentothal has proved its value in military medicine, is in providing anesthesia, when relaxation is not needed, for short (half-hour) procedures in men in good general condition.

LOCAL AND REGIONAL BLOCK ANESTHESIA

These are accomplished chiefly with *procaine hydrochloride* (*pontocaine*

* While it is true that the skin temperature of an extremity rises under anesthesia with sodium pentothal, this may be the result of an effect on arteriovenous anastomoses, and does not necessarily imply a better cellular oxygen supply. Polderman, McCarrell and Beecher (The Effect of Anesthesia on Lymph Flow. Jour. Pharmacol. and Exper. Therap., **78**, 400, 1943) have shown that the lymph flow is greatly reduced by barbiturate anesthesia, in comparison with local or ether anesthesia. This can be construed as evidence that tissue oxygen supply is impaired by barbiturate anesthesia, certainly to be avoided in gas gangrene.

† Twenty typical craniotomies performed in the combat zone required on the average 109±11 minutes (not including anesthesia induction time).

or *cocaine* for topical anesthesia) for neurosurgical, some maxillofacial and for minor surgical procedures. Peritoneal block under direct vision is useful for improving abdominal wall relaxation under light ether anesthesia. Because of the usual multiplicity of wounds in a given individual, regional block procedures are often of little value in the combat zone. Notable exceptions here are paravertebral or intercostal blocks for controlling chest wall pain and sympathetic blocks when the circulation of an extremity is impaired.

TABLE VIII

EVACUATION HOSPITALS

Hospital	Capacity Listed	Number of Patients at Time of Survey	Fluctuation in Number of Operations Per Day at Time of Survey	Anesthetists				
				M.D.	Nurse	Auxiliary Surg. GP.	Corps Men	Miscellaneous
"A"	750	800	25–100	1	2	0	4 plus 3 more on 2nd call	7 tables in day 4 tables at night
"B"	400	600	25–120	2	3	3	2	6 tables day and night
"C"	750		50–100	1	4	4	2	8 tables day and night
				(1 physician and 5 nurses care for 50-case days; the 100-case days require the addition of 4 auxiliary surgical group anesthetists)				
"D"	400	550	60–138	2	4	4	1	
				(See above re-addition of auxiliary surgical group anesthetists)				
"E"	400	500	50–125 (with 6 internists—2 auxiliary teams)	1	4		0	
				(125-case days require the addition of 6 internists and 2 auxiliary surgical anesthetists)				
"F"	750	400	80–120 (1 dentist—4 internists)	1	4	0	0	6-8 tables 24-hours day
				(The 120-case days require the added help of 1 dentist and 4 internists as anesthetists)				

SPINAL ANESTHESIA

The 20 per cent incidence of spinal anesthesia found in forward hospitals in the survey of September, 1943 (Table I) fell remarkably down to 3 per cent (Table II) a year later, and reflects the widespread realization and acceptance of the clearly demonstrated fact that spinal anesthesia is usually a poor choice for use in recently wounded men: The condition of the circulation, already precarious, too often deteriorates rapidly under spinal anesthesia. It is almost never acceptable for the initial surgery of battle casualties. This is of course true for the surgery of fresh trauma wherever it occurs. The current 3 per cent figure referred to as found in the forward zone represents, in considerable part, use of the technic for emergency appendicectomy and other conditions unrelated to warfare. Only occasionally can one find in this Theater an experienced surgeon, or anesthetist, who will now recommend the use of spinal in even the lightly, but freshly, wounded. This represents a striking change over the situation existing a year and a half previously.

TYPE OF SURGERY INVOLVED

An intelligent interpretation of anesthesia data requires that some key be given to the nature of the surgery involved. Such data have been presented in Table IV. Special groups, for example the Second Auxiliary Surgical Group, having a wide experience of forward surgery, particularly of non-transportable, field hospital patients, finds a higher incidence in certain categories than shown in Table IV. Major Lawrence M. Shefts has kindly supplied the writer with the following figures from his study of the files of the group referred to: In 15,925 cases, 1,628 (10.2 per cent) were classified as abdominal injuries, 1,502 (9.4 per cent) as chest cases with pleural involvement, and 508 (3.8 per cent) as thoraco-abdominal. The 1,628 cases listed as abdominal contain some "negative explorations"; so, as Major Shefts points out, the thoracic cases may be said to be as frequent as abdominal in this organization's experience. The combined total of chest and thoraco-abdominal cases exceeds abdominal alone.

PERSONNEL

The beginning of the present war found the country with too small a number of trained anesthetists and the Army Medical Corps, reflecting as it does a cross-section of American medical practice, shows this same shortage. For example in this Theater, of the men listed in the personnel files as "specialists in anesthesia," just 10 per cent have been certified by the American Board of Anesthesiology. Of the physician anesthetists in the Theater, 20 per cent had had no anesthesia training, except that obtained incidentally during surgical or rotating internships and a further 15 per cent had had only one to three months training in anesthesia.

The total number of physicians available for assignment to anesthesia was so small as to require the widespread use of nurse anesthetists for ether and sodium pentothal anesthesia. In a few cases corps men were needed and used to supplement the anesthesia staff in the forward areas. These men worked under close supervision.

Possibly more than any other single unpreventable factor the constant shortage of trained anesthetists was responsible for delay or threatened delay in carrying out needed surgery. While instances when shortage of anesthetists has seriously slowed down the flow of patients to surgery are relatively few, this was a constant and uncomfortable threat to those responsible for the care of the patients. That serious shortage was not more common was due to the voluntary aid of dentists, the assignment of internists to anesthesia duties and most important, the constant training of nurses in this work. Four general hospitals were employed for this purpose where courses up to three months were given, depending upon how long the students could be spared from their respective units. This was in addition to training given throughout the Theater in each unit for the training of its own members. The general hospitals, having more minor cases, were better suited than the forward installations for such supervised training.

The following tables (VI, VII, VIII) give typical sample data showing the personnel used in relationship to the load in various installations. An important group not represented in the tables is that of the field hospitals, these (for nontransportable patients), with their 100 bed capacity per platoon, usually are staffed with four mobile surgical auxiliary teams each of which includes an anesthetist, in most cases a physician. Two operating tables can be used day and night. Sometimes three or four operating tables are used at one time in a single platoon, but this number only for short intervals.

TABLE IX

STATION HOSPITALS

Hospital	Capacity Listed	Number of Patients at Time of Survey	Aver. No. Operations Per Day at Time of Survey	Number of Nurse Anesthetists	Miscellaneous Anesthetists
"A"	250	348	3	1	Surgeons give spinals. One physician on part-time anesthesia duty
"B"	500	250	5	1	A part-time physician anesthetist also has a ward
"C"	500	400	4	2	
"D"	500		3	1	3 surgeons assist with anesthesia part-time
"E"	500	389	6.5	0	Medical officers take turns
"F"	250	490	15	3	
"G"	500	625	4.5	0	1 full-time physician anesthetist. 4 surgeons cover anesthesia on a part-time basis

TABLE X

GENERAL HOSPITALS

Hospital	Capacity Listed	Number of Patients at Time of Surgery	Aver. No. Operations Per Day at Time of Survey	Physician Anesthetists	Nurse Anesthetists	Miscellaneous
"A"	1,500	900	10	1	2	2 anesthesia utility men help out with apparatus (do not give anesthesia)
"B"	1,500	1,700	50	1	6	
"C"	1,500		25	1	3	
"D"	1,500	1,000	10	1	2	1-2 internists help when needed
"E'	1,500	950	13	1	3	

As a working principle it is always better to give the ablest anesthetists assignment in the combat zone. Unquestionably, it is here that the greatest demands are made on native intelligence, judgment, resourcefulness and technical ability. Often in practice, however, this principle could not be put into operation, because of the association of outstanding men with affiliated units having their origin in various schools or hospitals. These men could not be readily transferred. In several instances their unusual abilities were utilized for training anesthetists to be sent to the forward areas. It is probably true that the surgery undertaken in the rear (station and general hospitals) requires at least as much judgment, skill and training as that of the forward

zone, but the anesthetist's skill is certainly more heavily taxed in the forward region than in the rear.

SUMMARY AND CONCLUSIONS

In the prolonged campaigns that have been carried out in the Mediterranean Theater of Operations, ether has clearly emerged as the anesthetic agent of choice for use in the seriously wounded. Its corresponding merit in the less trying cases is evident.

Acceptance of the limitations of sodium pentothal, that is, avoidance of its use in recently badly wounded men and employment of it when relaxation is not needed, for relatively short procedures in men in good general condition, has made possible great reduction in the death rate attributable to the agent. At the same time its use has been increased. This demonstration, made possible by the anesthetists and surgeons of the Theater, constitutes a milestone in military medicine; for the agent, sodium pentothal, has been employed in warfare, its limitations for this purpose clearly defined, and on this basis the death rate reduced to a small fraction of what it had been. Sodium pentothal, thus, takes rank with ether and procaine (novocaine) as one of the three most important anesthetic agents for use in military medicine.

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