

## OBSERVATIONS ON WARTIME ANESTHESIA \* †

Major F. W. CLEMENT AND Capt. C. K. ELDER  
*Medical Corps, Army of the United States*

THE opening of any hospital under wartime conditions is bound to be attended by numerous difficulties requiring frequent innovations and substitutions designed to meet the various needs or problems as they arise. There will not be available the abundance of supplies and equipment to which one has become accustomed during civilian practice. In view of these circumstances we were doubtless fortunate to have available from the start, such anesthetic agents and methods as ether, sodium pentothal, spinal and regional block.

Spinal anesthesia was the method most frequently employed as the majority of the operations were for abdominal, rectal or orthopedic conditions. The methods employed, however, were not necessarily those of choice but were dictated by circumstances.

In order to mobilize the one medical anesthetist it became necessary to train hospital corpsmen in observing and charting blood pressure levels, respiration, pulse rates and status of capillary circulation. It has been gratifying to observe the close attention and minute observation given the patients by these hospital corpsmen. It has also been instructive to see how quickly some of them acquired an essential grasp of the physiology of spinal anesthesia and of impending circulatory failure. To give corpsmen a working standard, it was found useful to employ the rule that if a falling systolic pressure crossed a rising pulse rate (at about 100), oxygen should be administered and the medical anesthetist notified.

If oxygen was not readily available, the patients were instructed to hyperventilate the lungs at intervals of two to five minutes during the surgical procedures. It was possible to train two corpsmen to administer ether acceptably by the open drop method and barbiturates intravenously. Guedel's Inhalation Anesthesia was found most useful as a text.

Time did not permit a formal series of lectures. The corpsmen obtained what knowledge they could during actual work. Two of them borrowed textbooks, and by virtue of special interest and ability, rapidly acquired a practical working background. The experience gained showed that it is possible in an emergency to train nonmedical personnel

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to carry out elementary procedures of anesthesia. Fortunately, complications of anesthesia were few or this impression might not be so favorable.

A considerable percentage (20.6 per cent) of cases was performed with regional block anesthesia, partly because the anesthetized patient could be supervised by corpsmen. Metycaine, when available, was the drug of choice. It was preferred to procaine because of the former's prolonged action, and its stability in prefabricated bulk solutions. All solutions for local anesthesia were used at body temperature and in strengths ranging from 0.5 per cent to 1.5 per cent for nerve blocking. Epinephrine, 1:260,000, was employed as a vasoconstrictor.

The only complications encountered following local anesthesia were severe tissue reactions occurring at the zone of infiltration in three cases of circumcision. The technic followed was that outlined by Lundy for circumcision (1). All three patients were anesthetized on the same morning, with the same type of solution and by the same anesthetist. In attempting to analyze possible factors involved, it seemed most probable that an excessive amount of epinephrine was used in the effort to prolong anesthesia. Eight drops in 100 cc. of 1 per cent metycaine was employed. Thereafter, the amount of epinephrine was limited to 3 drops in 100 cc. of solution when circumcision was to be performed. No further difficulty was encountered, but it was evident that the duration of anesthesia was shortened by the change.

Regional block anesthesia was used chiefly for the following procedures: operations on fingers, toes, hands and feet, ligation of varicose veins in Scarpa's triangle, operations for hydroceles, varicoceles, hemorrhoids, plastic procedures and surgical procedures on the abdominal wall.

Heavy solution of nupercaine (1:200), injected with the patient in the sitting position, proved highly useful for rectal operations and afforded profound sacral anesthesia of long duration with no circulatory disturbances. Occasionally it was noted that syncope developed when the patient was in the upright position during the five minutes allowed for fixation of the anesthetic agent. The syncope probably was the result of orthostatic hypotension or apprehension. It was easily corrected by having the patient lie down. Most of the surgeons preferred the Kraske or Buie position for rectal operations. It was found that extension of anesthesia did not occur after patients were placed in either position if the full period for fixation had been observed.

Caudal transsacral block was found effective in patients in the third and fourth decades. This method was employed in 8.7 per cent of all cases. Experience proved it to be a poor choice for routine use in the young vigorous adult. The number of complete and partial failures was annoying. Caudal block alone, using 2 per cent procaine, yielded too high a percentage of partial and complete failures. Caudal block combined with bilateral block of the fifth sacral nerve yielded slightly

better results. Caudal block plus bilateral injection of the second sacral nerve provided uniformly good results in all except the young vigorous adult. In fairness, it must be added that during a busy schedule it was not always possible to allow sufficient time for anesthesia to penetrate large nerve trunks.

Reviewing further, experience gained in the use of abdominal block confirms the impression gained in civilian practice, namely, that un-supplemented block for intra-abdominal surgery is unsatisfactory. The method becomes satisfactory when supplemental anesthetics such as nitrous oxide-oxygen and pentothal, or pentothal alone are administered. The average amount of nitrous oxide and oxygen used was 50 per cent. The average amount of pentothal, when used in combination with nitrous oxide-oxygen, was 0.5 Gm. per hour.

It was learned that the standard technic of costal-iliac block, as described by Labat, for appendectomy can be greatly improved by adding a wall of anesthesia parallel to and below the costal margin (2). This should be extended to the lateral border of the right rectus sheath, and finally an injection into the border of the sheath itself. Labat and others, in describing the technic, apparently failed to consider that the innervation of the operative area often involves at least the ninth intercostal nerve, and it is probably better to extend the zone of anesthesia to include the seventh and eighth intercostal nerves as well.

A surprisingly large number of requests for diagnostic and therapeutic blocks was received. Numerous cases of meralgia paresthetica were encountered, largely occurring in the upper age group tending to obesity. Blocks for circulatory disturbances of both upper and lower extremities were performed in a number of cases. Many patients with radicular pain of sciatic and lumbar plexus origin were treated. Standard paravertebral, sciatic and caudal-sacral blocks were employed (2). The advantages of the posterior approach, advocated by Major Stevens Martin, for injection of the stellate ganglion were apparent over the posterior paravertebral approach.

It has been gratifying to have been able to assist the surgical department in classifying the circulatory disturbances of extremities into vaso-spastic and organic disorders. In several cases of thrombophlebitis developing after operation outstanding results have been obtained by lumbar sympathetic injections of procaine. The results in the cases of long standing were relatively unsatisfactory. It was noticeable that the diagnostic and therapeutic aids offered an over-burdened Department of Surgery enhanced the status of the Department of Anesthesia.

Some interesting speculations are presented on reviewing an extensive series of spinal anesthetics administered during the first six months. The first thought suggested is that spinal anesthesia for abdominal operations seems the method of choice. An outstanding feature has been the peculiar absence of anything other than very minor circulatory failures. This fact stands out in sharp contrast to experi-

ence in civilian practice. In only an extremely small number of military cases was it necessary to use vasoconstrictor drugs or intravenous therapy. The uniformity of age groups and physical fitness of the military offer a reasonable explanation for the marked contrast between civilian and army practice.

Spinal anesthesia was employed in 41.6 per cent of cases. The drugs and technics varied in a bizarre manner from week to week, depending upon the available supply. For example, when a weighting solution was desired, it was found practical to employ the standard 5 per cent intravenous glucose solution as a diluent. Heavy solution of nupercaine, when suitably diluted with either 5 per cent glucose or spinal fluid, served admirably for high abdominal anesthesia. For a limited time ephedrine solutions were made from stock powder, and dispensed from a rubber-stoppered, diaphragm bottle. Ephedrine sulfate was employed routinely in doses of 30 to 40 mg. in all cases of spinal anesthesia. The dose was mixed with the solution used for infiltration at the time of injection. Neosynephrine hydrochloride proved very satisfactory in doses of 0.25 cc., used in the same manner.

In lieu of a special mattress for continuous spinal anesthesia, it was found practical to drop the needle and tubing through a break in the operating table. The tables were covered in two sections with army blankets, leaving the center break uncovered. Continuous spinal anesthesia was reserved for the occasional cases of gastric operations, nephrectomy, or those abdominal cases in which the patients were considered unfavorable risks for conventional spinal methods.

The experience gained in the work with spinal anesthesia strengthens the conviction that the particular drug used for anesthesia is of secondary importance. The extent and profoundness of anesthesia seem to be much more important in determining morbidity and sequelae.

Close observation of the extent of anesthesia secured with various drugs and technics leads to the impression that spinal anesthesia is not as easily controlled as some writers claim. A comparison of the levels of anesthesia after anesthesia became established and those obtaining after operation, emphasizes this fact still further. Often anesthesia extended cephalad as much as eight to ten body segments in an hour's time. Consideration was given the exclusion of possible gravity factors.

A high incidence (9 to 10 per cent) of atelectasis and pulmonary morbidity of all types following spinal anesthesia occurred. All respiratory morbidity after operation was confined to the group having intra-abdominal procedures or operations on the abdominal wall. Thoracic complications were absent following rectal, orthopedic and genito-urinary operations, and in all cases confined to the external genitalia. Several facts may explain this high figure. An abnormally high percentage of upper respiratory infections existed before operation in surgical candidates. For statistical consideration, it may be said that

all abdominal operations were performed with spinal anesthesia. For various reasons adequate postoperative hyperventilation and similar procedures were not always possible. The depressant effects of preoperative sedation must also be considered as a factor.

Several instances of massive atelectasis occurred. One multilobar collapse developed while the abdominal wall was being closed. Immediately at the conclusion of the surgical procedure, the patient was turned on the unaffected side and a dramatic result was obtained by vigorously slapping the chest wall of the affected side. Prompt recovery followed violent expulsive coughing, and in twenty-four hours the chest was entirely normal, and remained so. Suction bronchoscopy after operation was not performed. All other patients with atelectasis recovered rapidly with conservative treatment. Again, this experience is in sharp contrast to that of civilian practice. Atelectasis ordinarily was considered a formidable complication calling for frontal attack.

Pain, nausea and vomiting frequently were the result of mesenteric and visceral traction during spinal anesthesia. These objectionable complications occurred in a high percentage of cases, irrespective of the extent of anesthesia. Supplemental analgesia and sodium pentothal, nitrous oxide-oxygen pentothal or morphine given intravenously obviated the difficulty satisfactorily. In the literature on this subject anatomical explanation is offered that visceral afferent fibers enter the cord as high as the level of the fourth thoracic vertebra (3). One author thinks it not improbable that there are communications as high as the hypothalamus itself (4). On several occasions reactions were noted to visceral tugging when anesthesia was complete to the level of the clavicle. It will be of interest to hear comment from other observers on this problem and methods of control.

It has been routine practice to administer oxygen under high tension, employing a B.L.B. mask to all patients when the anesthesia extended to, or was likely to extend above the sixth thoracic vertebra. When oxygen was not employed, prompt improvement of the capillary circulation resulted following brief periods of voluntary exaggerated breathing by the patient. Hyperventilation in an oxygen enriched atmosphere enhanced this phenomenon. Sluggishness of the capillary circulation was often apparent in the presence of normal blood levels, pulse rates and pulse pressure determinations. It might be advantageous to formulate a mathematical evaluation of the degree of capillary stasis and the relationship to circulatory failure. In civilian practice, capillary stasis was considered a forerunner of circulatory collapse, and was an indication for administration of oxygen, fluids and possibly vasoconstrictor drugs.

A summary of experiences with various methods of spinal anesthesia in a homogenous group emphasizes the comparative safety in the "better than average" risk cases. There were no anesthetic deaths, although anesthetic conditions were far short of ideal at times. The high

incidence of postoperative respiratory morbidity naturally raises the question as to what the percentage of chest complications might have been had gas-oxygen-ether been employed throughout.

Pentothal sodium was used both as an anesthetic agent and to supplement the actions of other agents previously administered. Morphine and atropine, or hyoscyne was the routine premedicant given forty-five minutes to one hour before operation. The strength of the pentothal solution employed varied from 2.5 per cent to 5 per cent. In the more prolonged cases, oxygen was administered with a B.L.B. mask. Laryngospasm or other complications were not encountered, nor was it found necessary to administer metrazol, coramine or similar analeptics during the anesthesia. Pentothal was employed as the anesthetic agent for such operations as incision and drainage of abscesses, removal of packing from wounds, cystoscopy and dental extractions.

Pentothal sodium was useful in supplementing the action of spinal and regional anesthesia. During abdominal section the patients not infrequently complained of pain caused by traction on the mesentery. In such cases a few cubic centimeters of sodium pentothal was found to be adequate to relieve all discomfort. A combination of pentothal and nitrous oxide-oxygen was used for some full-mouth dental extractions. Following the injection of pentothal, blind nasal intubation was done. The resultant coughing was controlled by the nasal administration of gas-oxygen under slight positive pressure. The resulting narcosis was smooth and satisfactory.

Pentothal was used also as an adjunct to block, plus gas-oxygen anesthesia, and proved satisfactory. Pentothal sodium was employed in approximately 3 per cent of cases, and pentothal sodium as a supplement in 1 per cent of all cases.

*Inhalation Anesthesia:* Gas machine equipment consisted of three McKesson machines of the combined nargraph and absorber types. Nitrous oxide in D and F size cylinders was used in combination with commercial oxygen. Cyclopropane, even if available, would have been contraindicated because of the explosive hazard of static discharges. The removal of a woolen blanket from a patient would result in a very marked discharge of such charges. To reduce this hazard when using the gas-oxygen-ether sequence, the closed method was employed. Otherwise, no particular antistatic methods were employed.

Nitrous oxide-oxygen without ether was given in 29.3 per cent of the total anesthetics in two months. (Positive pressure technic with fractional rebreathing was used.) The remainder was made up of nitrous oxide-oxygen plus ether (2.8 per cent of cases) or gas supplement to block and spinal, or in combination with pentothal sodium. The first group receiving gas-oxygen alone included orthopedic procedures, operations on the shoulder, knee, extremities, and for osteomyelitis; also thyroidectomy, operations for hernia, pilonidal cyst, varicose veins, dental extractions, skin graft, maxillary sinus and miscellaneous opera-

tions such as incision and drainage of abscesses, removal of cysts and tumors, rectal dilatation, and so forth.

The second group in which gas-oxygen-ether was employed comprised nephrectomy, cholecystectomy, appendectomy and operations for ruptured gastric ulcer. The closed or carbon dioxide absorption method was used, plus frequent use of the endotracheal catheter. Routine premedication consisted of a barbiturate such as nembutal, seconal sodium or sodium amytal by mouth, plus morphine  $\frac{1}{8}$  grain, and atropine or hyoscine  $\frac{1}{50}$  grain hypodermically, given one hour before operation.

Contrary to expectations it was found that heavy premedication was not imperative for these vigorous patients whose age ranged between twenty and thirty years. The premedication was usually sufficient to assist in rapid and easy attainment of the desired level of anesthesia. One factor involved may well be that the young men now entering the armed forces are, as a rule, nonalcoholic. A recent survey showed that about 50 per cent of the present day soldiers may be classed as teetotalers. (So perhaps that era known as prohibition was not entirely devoid of good results.)

It is also interesting to note that following inhalation anesthesia, postoperative pulmonary complications and other sequela did not occur.

TABLE  
TYPE OF ANESTHESIA ADMINISTERED

	Per cent
Spinal.....	41.6
Caudal.....	8.7
Local.....	20.6
Pentothal.....	4
Open ether.....	1.4
Nitrous oxide-oxygen.....	29.3
Nitrous oxide-oxygen-ether.....	2.8

} 2 months'  
period

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