

and returning toward the preoperative values during the second week. This significant study has suggested to us the necessity of noting the effect of surgical anesthesia alone on the subtidal lung volume before factors incidental to surgical manipulation enter the picture. . . . A group of 17 preoperative surgical cases from the general surgical and gynecological services of the New Haven Hospital was selected. When the choice of anesthesia was known to be basal avertin, the past respiratory history of each case was carefully reviewed; any patient having recent or chronic symptoms was rejected, as was any subject with abnormal physical findings in the chest.

“A reduction in subtidal lung volume occurred in 14 of 17 subjects following the administration of avertin (tribromethanol) in basal anaesthetic doses. In the remaining 3, anaesthesia was incomplete. The maximum decrease was observed in the neighborhood of thirty minutes following administration of the drug when the circulating blood concentration of the drug is known to be highest. The probable cause of this decrease is considered to be a diminution in muscle tone, with a consequent disturbance of the normal balance between the elastic lung and the supporting musculature of the thorax and abdomen. Other evidences of respiratory depression are found.” 8 references.

J. C. M. C.

ALLEN, F. M.: *Reduced Temperatures in Surgery. I. Surgery of Limbs.* Am. J. Surg. 52: 225-237 (May) 1941.

“For about ten years I have been trying to make an experimental approach to the problem of diabetic gangrene, and have carried out the observations at intervals whenever the existing obstacles could be circum-

vented. . . . Prevailing conditions seem to warrant a general outline of ideas and methods, though the work is still in progress and more detailed reports will be published elsewhere. Some statements made here briefly or doubtfully may be subject to correction or amplification with larger experience. . . . In order to study conditions of inadequate circulation, observations were made on tissues deprived of all blood supply by a tourniquet. The essential finding was that the modification of local metabolism by temperature enormously influenced the survival, from a few hours or even minutes at elevated temperatures to fifty-four hours at a temperature near freezing. No attempt was made to attain a maximum time limit, but the preservation of isolated tissues for weeks and months in the icebox is familiar; and if technical difficulties were overcome, it seems possible that attached limbs might be kept bloodless for very considerable periods and then restored to usefulness. It is noteworthy that during fifty-four or more hours of refrigeration the blood does not clot, the vessels do not suffer damage resulting in subsequent thrombosis and the skin and other tissues remain fresh and intact. Paralyses and other nerve injuries are either prevented or minimized by cold. The investigation properly included systemic shock, since this has relations with diabetic surgery on one hand and with diabetic coma on the other. Both primary and secondary shock are abolished by suitably low temperature. . . .

“Correct application of the tourniquet is one of the important details. Empirical judgment has thus far been the only guide for the degree of tension, which should be the least that will positively stop all blood flow. . . . The first clinical employment copied the procedure used in animals, by having the patient sitting up or propped up

at a sufficient angle to allow the leg to be immersed in ice water to a level about one inch above the tourniquet. . . . Next, weaker patients were allowed to lie with only a slight elevation of the head of the bed, and with the protection of a rubber sheet, the leg or thigh was placed on a layer of ice and covered completely with cracked ice. To obviate inconvenience and mess, a third step has been taken by using ice bags. The thinnest and most flexible pure-gum bags should be used, and three to five teaspoonfuls of salt added to each. . . . A preliminary morphine hypodermic or other sedative may be helpful on account of nervousness in some patients, but as far as anesthesia is concerned no drugs are required.

"Tests of the refrigeration should be made by occasionally inserting an ordinary laboratory thermometer between the various ice bags and the skin. Readings slightly above or below 5 C. assure the desired combination of adequate chilling and safety against actual freezing. . . . The time required for complete through-and-through anesthesia varies with the depth of tissue. It may possibly be as short as one hour for an emaciated shin or as long as five hours for a rather thick thigh. If it is not possible to cut the sciatic nerve at mid thigh without attracting the notice of the conscious patient and without any change in pulse or blood pressure, there has been something wrong in the method of preparation. This physiological blocking of nerve conduction by reduction of temperature has some evident advantages over drugs employed either locally or systematically for this purpose. . . . Refrigeration introduces the fundamentally new conception of anesthesia of protoplasm. . . . For the first time the surgeon has the opportunity of working in a bloodless and shockless field. Such details as duration and extent of dissection are wholly

immaterial; all that matters is the condition left after completion. Shock is nonexistent except for the (usually slight) degree of it which may develop from the tissue injury remaining after the wound is finally closed and the temperature is raised to allow the protoplasm to resume its functions. . . . It is assumed that the tourniquet has been placed at the lowest level which will permit of preparing a sterile operative field and also not impede the sawing of the bone or other procedures. In the operating room the limb is removed from its nest of ice bags and the sterilization and operation completed as usual. No extraordinary haste is demanded, because the chilled tissues remain cold during an ample time for an ordinary operation. A rise of temperature does not affect the anesthesia, which is still thoroughly maintained by anoxia, but it is inimical to the perfect preservation of tissues and avoidance of subsequent shock. If saline solution is to be used for sponging or other local purposes, it should be iced. For any particularly long operation the limb may be kept on a bed of ice bags. Contrary to usual custom, the cooler the atmosphere of the operating room the better, and there is even the possibility that for operations lasting one to several hours the windows might be opened in winter or artificial cooling provided in summer. When all is in readiness for closure of the wound, the tourniquet is released. Circulation returns promptly, in a degree proportioned to the existing arterial supply, and bleeding points can be caught and ligated. The anesthesia then continues at least long enough for convenient completion of suturing. . . .

"The guiding principle of postoperative management is to reduce the temperature to whatever extent may be necessary but to raise it as fast and as far as may be safe. In cases with an adequate blood supply, there is no objec-

tion to letting the stump return immediately to normal body temperature. . . . Instead of the usual alternatives of prompt primary union or a breakdown followed by granulation, the surgeon encounters a new phenomenon, namely, a wound healing strictly per primam but requiring a multiple of the usual time. . . . The absence of coagulation in the ligated refrigerated limbs of animals is presumably due not so much to an inhibition of the clotting process as to the preservation of the vessel walls by cold. As bacterial activity is also prevented or retarded, the danger of thrombosis should theoretically be avoided or minimized. . . .

"Following thigh amputations there is still a perceptible depletion of strength. The experience to date gives the impression that this debility is decidedly reduced by refrigeration as compared with former methods, but it may still be a source of danger to extremely feeble patients. On the other hand, with properly managed lower leg amputations this after-shock approaches the vanishing point. . . . As diabetic gangrene furnished the starting point of this research, it should be discussed in a little more detail. . . . Retention of a hopelessly infected leg may mean certain death, while amputation often carries extreme risk from shock alone or from lowering of resistance to a beginning systemic infection. . . .

"The existing situation today is that in the most desperate cases surgeons customarily take the risk of a high amputation or else let the patient die as inoperable. It is clear that refrigeration offers an alternative, and the use of a tourniquet can add all the advantages of operation without the shock. The simple packing in ice will often transform both local and general conditions and may check pain and the advance of sepsis for perhaps several days. When necessary, the tourniquet

can give a still more decisive result, obviating the need of morphine and the waste of time and strength in preparing for operation. If applied promptly by anybody on the resident staff, it will within a few hours permit of amputation without an anesthetic and with minimal shock. If the condition is so extreme as to make any operation inadvisable, the limb can be left for a few days or can be harmlessly amputated or disarticulated anywhere below the tourniquet in order to reduce the mass to be kept refrigerated. The time for the finished amputation can then be selected according to the patient's strength. It is important to warn that when a tourniquet has been in place for one to several days, it must never be removed or allowed to slip. An excessively rapid and fatal intoxication may result. At the proper time another tourniquet may be applied a few inches above the original one, and after the few hours necessary for anesthesia the amputation may be performed a little above the original tourniquet. . . .

"Refrigeration is applicable to other conditions not handicapped by senility and arteriosclerosis. One of the strongest reasons for presenting the subject at this time is its apparent value for war wounds. Industrial accidents furnish a more continuous supply of similar cases. . . . A large number of both military and industrial wounds consists in mutilations of limbs, and to these the results of animal experiments are clearly applicable as follows: . . . In warm weather ice is often available or can be specially provided. In cold weather only precautions against actual freezing of parts may be needed. The chilling is so simple that it can be carried out by any reasonably intelligent nonmedical persons. . . . A tourniquet is often needed to stop hemorrhage, and it sometimes remains in place for several hours pending surgi-

cal treatment. Histotoxins are produced in proportion to the mass of asphyxiated tissue and the duration of the asphyxia, and they are poured into the circulation upon removal of the tourniquet. . . . Efficient chilling prevents this shock effect largely or entirely, and also wards off local gangrene when the tourniquet is retained for an excessive length of time. . . . The transportation of wounded persons can be made entirely painless as far as limb injuries are concerned. There is probably better preservation of strength and resistance than with large doses of sedatives. . . . The wounded may arrive at a hospital after several hours, ready for immediate operation without any additional anesthetic. . . .

"Mere external icing is inadequate for prolonged through-and-through chilling of thick limbs, notably the human thigh, and internal parts near the tourniquet may still be warm enough for gradual toxin formation or even necrosis. Appropriate precautions should therefore be taken, even to the extent of amputation, if a tourniquet has been in position perhaps for eighteen hours or longer. . . . When any parts are potentially infected, perhaps by being macerated with dirt and foreign material, refrigeration serves the important purpose of holding everything in abeyance. . . . The preservation of tissue together with suitable temperature reductions in the post-operative care, should facilitate conservative and reparative operations and aid in avoiding amputations and crippling. The chief difficulty will perhaps consist in persuading surgeons that a refrigerated limb, no matter how cadaveric it may appear, actually retains vitality so as to offer the above stated advantages; and that therefore one of the most revolutionary achievements of this method may be hoped for in the field of military and emergency surgery. . . .

"Every new method must have its value tested, its limitations defined and its technic developed before it can receive an established status. . . . There is as yet no proof that it can reduce the statistical mortality from diabetic gangrene, that it is superior to other operative methods in cases permitting of free choice, or that there may not be some harmful results of the drastic chilling in contrast to the usual careful conservation of tissue warmth. Furthermore, the technic is still primitive, so that the best beneficial effects cannot yet be realized while harmful effects may be magnified. For all these reasons the first trials may properly be limited to cases regarded as desperate or inoperable, and this experience may serve as a guide to any wider adoption. Fundamental studies are the principal need, in order that undue enthusiasm over a spectacular novelty may not be followed by disillusionment which may obscure any real value of the method." 12 references.

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ARNOLD, L. E.: *Analgesia in Obstetrics: An Analysis of 500 Consecutive Cases*. Texas State J. Med. **37**: 211-215 (July) 1941.

"A survey of the current literature reveals that most of the papers on obstetric analgesia attempt to prove the efficacy of some particular drug. In this paper six different drugs or combinations of drugs have been studied with complete impartiality. Both the analgesic effect upon the mother and the narcotizing effect upon the infant have been carefully analyzed and graded. This series is truly consecutive in that no cases have been thrown out to improve statistics. . . . An effort was made to eliminate the human error factor in estimating clinical results. This was done by placing all observations and interpretations on a purely