Bulletin of the

University of Minnesota Hospitals
and
Minnesota Medical Foundation

Baird's Anesthesia In Infants

Volume XX | Friday, May 6, 1949 | Number 26

BULLETIN OF THE
UNIVERSITY OF MINNESOTA HOSPITALS
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I.

UNIVERSITY OF MINNESOTA MEDICAL SCHOOL
CALENDAR OF EVENTS

May 8 - 14, 1949

No. 247

Sunday, May 8

9:00 - 10:30 Surgery Grand Rounds; Station 22, U. H.

10:30 - 11:00 The Effect of Emotion on Blood Counts and Certain Other Constituents; Schuyler Brown; Rm. M-109, U. H.

Monday, May 9

8:00 - Fracture Rounds; A. A. Zierold and Staff; Ward A, Minneapolis General Hospital.

9:00 - 9:50 Roentgenology-Medicine Conference; L. G. Rigler, C. J. Watson and Staff; Todd Amphitheater, U. H.

9:00 - 10:50 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff; M-109, U. H.

10:00 - 12:00 Neurology Rounds; A. B. Baker and Staff; Station 50, U. H.

11:00 - 11:50 Physical Medicine Seminar; Rehabilitation of the Amputee; Glenn Gullickson, Jr.; E-101, U. H.

11:00 - 11:50 Roentgenology-Medicine Conference; Veterans Hospital.

11:00 - 12:00 Cancer Clinic; K. Stenstrom and A. Kremen; Eustis Amphitheater, U. H.

12:00 - 1:00 Physiology Seminar; Potassium Deficiency and Nitrogen Metabolism; Elizabeth G. Frame; 214 M. H.

12:15 - 1:20 Obstetrics and Gynecology Journal Club; Staff Dining Room, U. H.

12:30 - 1:20 Pathology Seminar; Brucellosis Control in Cattle; Harry H. Hoyt; 104 I. A.

12:30 - 1:30 Surgery Problem Case Conference; A. A. Zierold, C. Dennis and Staff; Small Class Room, Minneapolis General Hospital.

1:30 - 2:30 Surgery Grand Rounds; A. A. Zierold, C. Dennis and Staff; Minneapolis General Hospital.

1:30 - 2:30 Pediatric-Neurological Rounds; R. Jensen, A. B. Baker and Staff; U. H.

4:00 - Public Health Seminar; 113 Medical Sciences.

5:00 - 5:50 Clinical Medical Pathologic Conference; Todd Amphitheater, U. H.

5:00 - 6:00 Urology-Roentgenology Conference; D. Creevy and H. M. Stauffer and Staffs; M-109, U. H.

4:00 - Pediatric Seminar; Sulphur Metabolism; Doris Doeden; 6th Fl. W., Child Psychiatry, U. H.

Tuesday, May 10

8:30 - 10:20 Surgery Reading Conference; Small Conference Room, Bldg. I, Veterans Hospital.

9:00 - 9:50 Roentgenology Pediatric Conference; L. G. Rigler, I. McQuarrie and Staff; Todd Amphitheater, U. H.

10:30 - 11:50 Surgical Pathological Conference; Lyle Hay and Robert Hebbel; Veterans Hospital.

12:30 - Pediatric-Surgery Rounds; Sta. I, Minneapolis General Hospital; Drs. Bosma, Wyatt, Chisholm, McNelson and Dennis.

12:30 - 1:20 Pathology Conference; Autopsies; Pathology Staff; 102 I. A.

1:00 - 2:30 X-ray Surgery Conference; Auditorium, Ancker Hospital.

2:00 - 2:50 Dermatology and Syphilology Conference; H. E. Michelson and Staff; Bldg. III, Veterans Hospital.

3:15 - 4:20 Gynecology Chart Conference; J. L. McKelvey and Staff; Station 54, U. H.

3:30 - 4:20 Clinical Pathological Conference; Staff; Veterans Hospital.

4:00 - 5:00 Pediatric Rounds on Wards; I. McQuarrie and Staff; U. H.

4:00 - 5:30 Physiology-Surgery Conference; Starvation and Carcinogenesis; J. King and A. Kremen; Eustis Amphitheater, U. H.

5:00 - 5:50 Urology-Pathological Conference; C. D. Creevy and Staff; Todd Amphitheater, U. H.

5:00 - 6:00 X-ray Conference; Dr. Lipschultz and Staff, Veterans Hospital; Todd Amphitheater, U. H.

Wednesday, May 11

8:00 - 8:50 Surgery Journal Club; O. H. Wangensteen and Staff; M-515, U. H.

8:30 - 9:30 Clinico-Pathological Conference; Auditorium, Ancker Hospital.

8:30 - 10:00 Orthopedic-Roentgenologic Conference; Edward T. Evans, Room 1AW, Veterans Hospital.

8:30 - 12:00 Neurology Rehabilitation and Case Conference; A. B. Baker and Joe R. Brown; Veterans Hospital.

11:00 - 12:00 Pathology-Medicine-Surgery Conference; O. H. Wangensteen, C. J. Watson and Staff; Todd Amphitheater, U. H.

12:00 - 12:50 Radio-Isotope Seminar; Gastric Excretion Studies with Radio-Active Iodine; E. E. Mason; Rm. 212, Hospital Court, Temp. Bldg.

3:30 - 4:30 Journal Club; Surgery Office, Ancker Hospital.

4:00 - 5:00 Infectious Disease Rounds; Rm. E-101, U. H.

Thursday, May 12

8:15 - 9:00 Roentgenology-Surgical-Pathology Conference; Craig Freeman and H. M. Stauffer; M-109, U. H.

8:30 - 10:20 Surgery Grand Rounds; Lyle Hay and Staff; Veterans Hospital.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; M-109, U. H.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:30 - 11:50 Surgery-Radiology Conference; Daniel Fink and Lyle Hay; Veterans Hospital.

11:00 - 12:00 Cancer Clinic; K. Stenstrom and A. Kremen; Todd Amphitheater, U. H.

11:30 - 12:30 Clinical Pathology Conference; Steven Barron, C. Dennis, George Fahr, A. V. Stoesser and Staffs; Large Class Room, Minneapolis General Hospital.

12:00 - 1:00 Physiological Chemistry Seminar; D-Amino Acids and Biological Activity; R. W. Von Korff; 214 M. H.

1:00 - 1:50 Fracture Conference; A. A. Zierold and Staff; Minneapolis General Hospital.

2:00 - 3:00 Errors Conference; A. A. Zierold, C. Dennis and Staff; Large Class Room, Minneapolis General Hospital.

4:00 - 5:00 Bacteriology and Immunology Seminar; The Mechanisms of Action of Botulinum Toxin; William Hess; 214 M. H.

4:30 - 5:20 Ophthalmology Ward Rounds; Erling W. Hansen and Staff; E-534, U. H.

5:00 - 6:00 X-ray Seminar; Thoracic Surgery Conference; Richard Varco; Todd Amphitheater, U. H.

Friday, May 13

8:30 - 10:00 Neurology Grand Rounds; A. B. Baker and Staff; Station 50, U. H.

9:00 - 9:50 Medicine Grand Rounds; C. J. Watson and Staff; Todd Amphitheater, U.H.

10:00 - 11:50 Medicine Ward Rounds; C. J Watson and Staff; E-221, U. H.

10:30 - 11:20 Medicine Grand Rounds; Staff; Veterans Hospital.

10:30 - 11:50 Otolaryngology Case Studies; L. R. Boies and Staff; Out-Patient Department, U. H.

11:00 - 12:00 Surgery-Pediatric Conference; C. Dennis, O. S. Wyatt, A. V. Stoesser and Staffs; Minneapolis General Hospital.

11:30 - 12:50 University of Minnesota Hospitals General Staff Meeting; Clinical Evaluation of a Long Intestinal Tube of Improved Design; Jacob Strickler and John J. Wild; Powell Hall Amphitheater.

12:00 - 1:00 Surgery Clinical Pathological Conference; Clarence Dennis and Staff; Large Classroom, Minneapolis General Hospital.

1:00 - 1:50 Dermatology and Syphilology; Presentation of Selected Cases of the Week; H. E. Michelson and Staff; W-312, U. H.

1:00 - 3:00 Pathology-Surgery Conference; Auditorium, Ancker Hospital.

1:00 - 2:50 Neurosurgery-Roentgenology Conference; W. T. Peyton, Harold O. Peterson and Staff; Todd Amphitheater, U. H.

4:00 - 5:00 Electrocardiographic Conference; George N. Aagaard; 106 Temp. Bldg., Hospital Court, U. H.

Saturday, May 14

7:45 - 8:50 Orthopedics Conference; Wallace H. Cole and Staff; Station 20, U. H.

8:30 - 9:30 Surgery Conference; Auditorium, Ancker Hospital.

8:00 - 9:00 Pediatric Psychiatric Rounds; Reynold Jensen; 6th Floor, West Wing, U. H.

8:00 - 9:00 Surgery Literature Conference; Clarence Dennis and Staff; Minneapolis General Hospital, Small Classroom.

9:00 - 9:50 Medicine Case Presentation; C. J. Watson and Staff; E-101, U. H.

9:00 - 10:30 Pediatric Grand Rounds; I. McQuarrie and Staff; Eustis Amph., U. H.

9:00 - 11:30 Surgery-Roentgenology Conference; Todd Amphitheater, U. H.

9:00 - 12:00 Psychiatry Conference; Powell Hall Amphitheater.

10:00 - 11:50 Medicine Ward Rounds; C. J. Watson and Staff; E-221, U. H.

10:00 - 12:50 Obstetrics and Gynecology Grand Rounds; J. L. McKelvey and Staff; Station 44, U. H.

11:00 - 12:00 Anatomy Seminar; Monkeys with Induced Female Pseudohermaphroditism, L. J. Wells; Some Effects of Thiouracil upon the Thyroid, Arthur E. Sethre; 226 I. A.

II. PENTOTHAL-CURARE MIXTURE WITH ENDOTRACHEAL N2O AND O2 IN INFANTS

Christine Furman Webster
Frederick H. Van Bergen

Introduction

One of the newer developments in the field of anesthesia is the use of pentothal-curare mixture (Baird's solution) with endotracheal nitrous oxide and oxygen in infants. The literature on the subject is largely limited to the statement that sodium pentothal is contraindicated in the extremes of life. For example, Adriani states, "Do not administer pentothal to children under ten years of age" because "response in children is variable."

It is well known that none of the general anesthetics has been entirely satisfactory for babies. Because pentothal-curare has given such excellent results in adults, our staff felt that it should be evaluated for infants. In the past fourteen months, twenty-seven such anesthetics have been administered here at the University of Minnesota Hospitals. The results have been encouraging.

An infant, anesthetically speaking, is two years old or under and although the anesthetic problems are somewhat the same as those of adults, the margins of error are much smaller. The aim is to achieve and to maintain adequate anesthesia and good relaxation with the minimum physiological disturbance. This series was commenced after careful consideration of the special requirements of infants in regard to anesthesia. I should like to quickly review these requirements to see how well they are met by the commonly used anesthetics as well as by Baird's solution, before discussing our series.

Special Problems of Infant Anesthesia

1. Oxygenation.

Since the infant's metabolic rate (i.e., oxygen consumption/kg.) is nearly twice that of the adult, hypoxia and anoxia quickly become disastrous. With normal respiration atmospheric air (21% O2) is adequate but when the respiration is reduced for any reason, a higher O2 content may be necessary to prevent hypoxia. Experience has shown that 35% O2, as delivered to the patient, will provide the necessary margin of safety. It is evident that any open-drop method which relies upon atmospheric air for oxygen will be inadequate since the gauze mask reduces the oxygen content to about 16%. In the closed system, 35% oxygen can be delivered to the patient only if 50% of the new gases entering the system is pure O2. This is due to the dilution of the new gases by the exhaled gases.

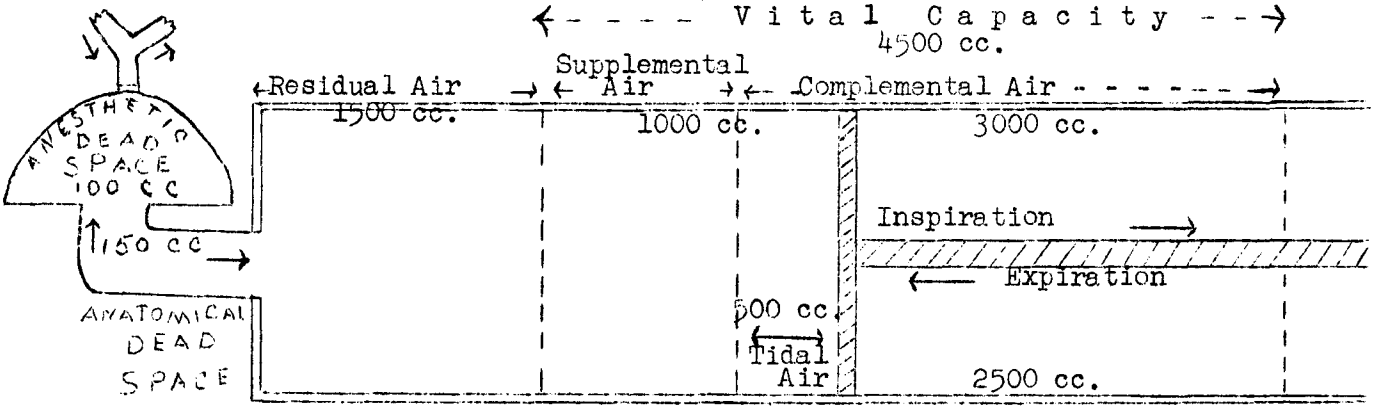
2. Dead Space Air

Anatomical dead space is the volume of the respiratory passage from the nasal orifice to the beginning of the respiratory bronchioles. Air remaining in this space is useless in supplying oxygen to the body, since the oxygen in it does not diffuse rapidly enough into the blood stream. Understanding of the mechanics of respiration is necessary to recognize how vital dead space is in infant anesthesia. This is best illustrated by substituting for the respiratory system, a mechanical system consisting of a cylinder, piston and pipe, as shown in Figure 1.

The piston represents the diaphragm and expandable thoracic cage of a 70 Kg. man. The various cylinder volumes indicated by the dotted lines represent the total air within the alveoli at various phases of respiration. It will be noted that in quiet breathing 500 ccs of gases enter and leave the alveoli with each respiration. This equals the tidal air. Not all of this 500 ccs is fresh air since, at the end of each expiration, the dead space (150 cc.) is filled with alveolar air of about 15% oxygen, and this must be redrawn into the lungs before fresh air containing 21% oxygen reaches the alveoli. If we now add a mask with an additional anesthetic dead

Figure 1

Adult (Scale = 1/3)



space of 100 cc, only 250 ccs of fresh air will reach the lungs per breath. Sixteen respirations per minute allow the lung to extract the average oxygen requirement of 240 ccs of pure 02/min.

It can further be seen from the diagram, that the adult chest with its large vital capacity can meet the stress of additional dead space.

Figure 2

Newborn. (Scale = 1/2)

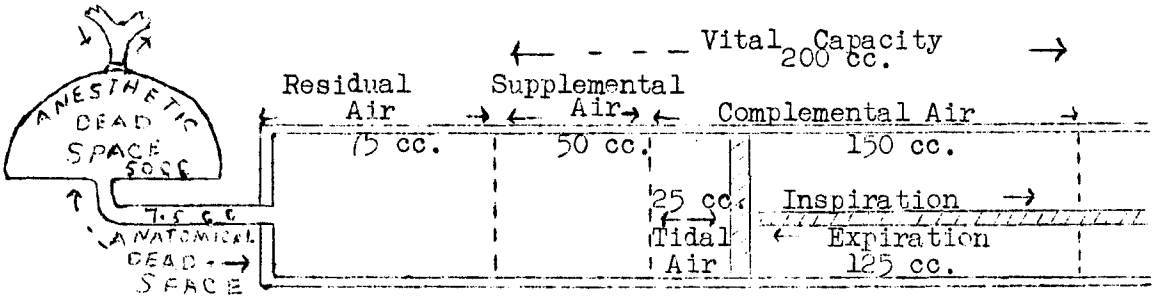


Figure 2 illustrates the markedly reduced lung volume dealt with in infants. It will be noted that these figures are approximately 1/20 of those of the adult, which corresponds with the ratio of weights and represents the newborn. The increased metabolic rate found in infants is made up for by an increased respiratory rate. However, the anesthetic dead space cannot be proportionately decreased, even with the smallest mask of 50 ccs. It is seen immediately that the dead space is now more than double the resting tidal volume; and the infant must respire 40% of his total vital capacity to get a normal volume of oxygen into his lungs. This soon exhausts the patient unless oxygen tension is markedly increased, respiration augmented (assisted respiration by means of intermittent manual compression of the breathing bag) and the total dead space reduced by endotracheal intubation. Intubation reduces the anatomical dead space from 8 to 4 ccs. and the anesthetic dead space as compared to a mask from 50 to 30 ccs - a total of 24 ccs which is equal to one tidal volume.

3. Patent Airway

A patent airway is the next thing to consider since the muscles of the infant

are weak and laryngeal spasm common. That is why endotracheal intubation, or at least being prepared to intubate, is a necessity.

4. Carbon Dioxide Clearance

Carbon dioxide clearance is closely associated with what has already been discussed. Rebreathing of dead space air produces a carbon-dioxide excess which quickly results in acidosis in infants, partly because the actual amounts of electrolytes in their bodies are small, and partly because, in the newborn, renal function is somewhat reduced. Carbon dioxide clearance is handled by a combination of two methods. Most of the time a closed circle system is employed with a fresh double canister of soda lime to absorb the carbon dioxide and augmented respiration is maintained. For brief periods a modification of the Ayre's system of massive overflow with a semi-closed system may be used where the carbon dioxide is flushed out.

5. Respiratory Rate

Respiratory rate in infants is labile, varying in the newborn from 22 to 100/min. even at rest. A rapid rate will soon exhaust the little patient and reduce the carbon dioxide content of the blood; too slow a rate will lead to hypoxia and increased carbon dioxide retention. Respiration is affected by barbiturates, the belladonna drugs, opiates, acidosis, hypoxia and many anesthetic agents. We control these variations for the most part with a closed system and augmented respirations.

6. Vomiting

Vomiting is a serious complication of anesthesia. Uncorrected, it leads to dehydration and electrolytic imbalance, both of which the infant tolerates poorly. A loss of fluids equalling seven per cent of the body weight is serious dehydration at any age, and where the patient weighs only a few pounds, the actual amount in ccs. becomes very small before he is in grave condition. The concomitant loss of electrolytes is equally dangerous. Of more immediate concern to the anesthetist is the danger of aspiration with the possible resulting aspiration pneumonia, atelectasis or even asphyxiation.

7. Acidosis and Alkalosis

Acidosis and alkalosis have been touched upon under other headings, but I should like to enlarge upon them. Adriani states that "Acidosis accompanied most general anesthesia." This is due partly to the anesthetic agent, especially the volatile vapors, which produce fixed acids, decreased respiratory minute volume, and the inadequate clearance of carbon-dioxide. Dehydration and other metabolic upsets may also be factors. Alkalosis results from hyperventilation or the administration of excess alkali. With the blood volume of infants only 6% of their body weight, the amount of natural buffer solution is small so that uncompensated conditions occur easily.

8. Duration of Anesthesia

Duration of anesthesia is the next consideration. All anesthetics affect metabolism to some extent, so that a short duration is something for which to strive. Then, too, the sooner after operation the reflexes return, particularly the cough reflex, the safer. It also facilitates the early resumption of oral intake.

9. Induction

A rapid, pleasant induction does not need to be enlarged upon.

Problems of circulation, relaxation, inflammability and explosiveness are important, but are much the same for all ages.

Comparison of Anesthetics

Table 1

Anesthetic	Oxygen Supply	Dead Space	Vomiting	Acid-Base Balance
VINE - O Drop	poor	very poor	very poor	acidosis
THENE Vapor	good	poor *1	very poor	acidosis
ETHYL O Drop	poor	very poor	very poor	acidosis
ETHER Vapor	good	poor *1	very poor	acidosis
CYCLOPROPANE	good	good if tubed	fair	minimal acidosis
NITROUS OXIDE	50% good	poor *2	good	good
PENTOTHAL	good	good if tubed	good	alkalosis *3
RECTAL ANESTHESIA	good if 02 added	poor with mask *2	good	minimal acidosis
REGIONAL *4	good	good	good	minimal alkalosis
BAIRD'S N20,02 & TUBE	good	good	good	minimal alkalosis

Table 2

Anesthetic	Promptness of Recovery	Depth of Surgery	Length of Surgery	CO2 CLEARANCE
VINE - O Drop	good	good	limited	poor
THENE Vapor	good	good	limited	poor *1
ETHYL O Drop	poor	good	good	poor
ETHER Vapor	poor	good	good	poor *1
CYCLOPROPANE	good	good	good	good
NITROUS OXIDE	good	poor	good	good
PENTOTHAL	fair	good	limited	good
RECTAL ANESTHESIA	variable	poor	variable	fair
REGIONAL *4	good	good	good	good
BAIRD'S N20,02 & TUBE	good	good	good	good

Table 3

Anesthetic	Relax-ation	Resp. Rate	Speed of Induction	Cardiovascular Condition
VINE - O Drop	good	increased	good	good
THENE Vapor	good	increased	good	good
ETHYL O Drop	good	increased	poor	good
ETHER Vapor	good	increased	poor	good
CYCLOPROPANE	fair	slight increase	good	pos.Bradycardia & Arrythmias
NITROUS OXIDE	poor	unchanged	good	good
PENTOTHAL	poor	slight increase	good	May drop blood pressure
RECTAL ANESTHESIA	poor	decreased	poor	May drop heart rate and blood pressure
REGIONAL *4	good	increased	good	Epinephrine increases Blood pressure and heart rate
BAIRD'S N20,02 & TUBE	good	augmented as desired	good	May drop blood pressure slightly

Notes on Tables 1, 2 & 3:

*1 Augmented breathing is dangerous. *2 Too weak an anesthetic for intubation.

*3 More pentothal required when unsupplemented by other agents.

*4 Difficult because of patient's lack of cooperation.

Much of these tables is self-explanatory, but I should like to amplify a few points. Since the cough and laryngeal reflexes are not obtunded until Stage III, plane 2, such a depth is necessary for intubation, and the anesthetic must be sufficiently potent to attain it. Nitrous oxide with sufficient oxygen, and rectal anesthesia are too weak for this purpose. Augmented respiration is dangerous with both ethyl and vinyl ethers, since the concentration in the alveoli may rapidly become so great as to cause cardiac arrest. These tables would suggest that Baird's solution is a good choice of anesthetics for these infants. It was probably considerations along this line which prompted Dr. Baird, et al, to write, as far back as April 1947, "It (pentothal-curare mixture with nitrous-oxide and oxygen endotracheally) is adaptable to all types of surgery and to all age groups."

Disadvantages to Pentothal-Curare Mixture with Endotracheal Nitrous Oxide and Oxygen in Infants

1. A reliable intravenous puncture must be made and maintained. In infants, this means, almost always, a pre-operative "cut-down". However, this has been only a minor objection since the pediatricians have usually already done this procedure for the sake of intravenous therapy.

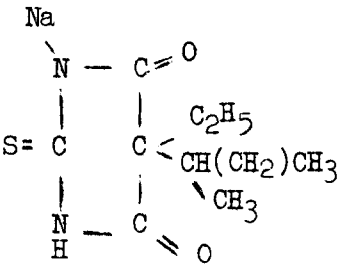
2. Trauma is always possible during intubation, and the tube may be the cause of irritation. Although, theoretically, hemorrhage, aspiration of blood and laryngeal edema from these sources is to be considered; empirically, only laryngeal edema has occurred and that only to a minimal degree.

3. A trained physician anesthesiologist is required. This is a good principle anyway for major infant surgery.

4. Endotracheal intubation should be limited to procedures lasting more than a few minutes, or where posture demands it. . In very short cases, a mask may be used, always keeping an endotracheal tube handy in case of an emergency.

Chemistry and Pharmacology

Pentothal is an ultra-short barbiturate with the formula



It is a potent hypnotic, but lacks analgesic power and does not produce muscular relaxation; nor does it affect the vomiting center, the liver, kidneys, heart, total blood carbon dioxide, bleeding and coagulation time or the white blood cells. As a consequence of its active parasympathomimetic effects, it increases the laryngeal reflex, constricts the bronchioles, dilates the spleen, depresses smooth muscle of blood vessels and is prone to produce a fall in blood pressure. Pentothal moderately decreases minute respiratory volume and intracranial pressure. Destruction occurs largely in the liver, but there is a cumulative action since one of its degradation products is pentobarbital.

Curare is an alkaloid mixture of several drugs with the formulae $C_{19}H_{26}N_2O$, $C_{19}H_{25}N_2O$ and $C_{19}H_{21}NO_4$. The d-tubocurarine Chloride form has two phenol groups and is isolated from the plant chondrodendron tomentosum. Probably by raising the threshold to acetylcholine, it depresses the myoneural junction. Hemodynamic disturbance is minimal other than a mild hyperglycemia. Its function is muscular relaxation. Scott Smith was given large doses of this drug to the point of prolonged respiratory arrest and, in spite of complete paralysis of all skeletal muscles, remained fully conscious with unimpaired sensation. The diaphragm is the last muscle to be affected. It produces no appreciable change in smooth or cardiac muscles. Curare is partially destroyed by the liver and is excreted by the kidneys.

Nitrous oxide is an analgesic at a concentration of 40% or more, is not al-

tered within the body and has little or no physiological effects without anoxia.

The combination of these drugs leads to a decreased amount of pentothal required for the same stage of anesthesia as when it is used alone. Dr. Baird wrote in 1947, "It is our belief that the combined agents in the amounts required alter the normal physiology less than any other type of general anesthesia." This anesthetic combination has the added advantage of being non-explosive.

Procedure

The infants are prepared by the pediatrics department and are sent to the operating room in as good a physiological state as time will permit. They have corrected anemia by whole blood transfusions; dehydration by a solution of 1/3 saline and 2/3 5% glucose in distilled water. This will usually restore the acid-base balance as well, but a 5% Butler's solution may also be used. A "cut-down" using polythene tubing has been performed and fluids are dripping when the patient arrives for surgery.

Food and fluids have been withheld for at least four hours. Preoperative medication of small amounts of morphine sulfate and scopolamine are given one hour before surgery. Dr. Knight has a schedule of doses according to age and weight; the younger ones receiving only scopolamine. Head injuries receive codeine rather than morphine.

After the patient has been immobilized, the induction is started using Baird's pentothal-curare mixture. This solution contains 25 mgs. of pentothal and 5 units of d-tubocurarine chloride per cc. A 5 cc Leur-lok syringe, containing this mixture, is attached to the straight arm of a 3-way stopcock which, in turn, is attached to the "cut-down" tubing; and half cc doses are administered every 3 minutes until the patient falls to sleep. Then 100% oxygen is started by mask. Thus the patient's blood and alveoli are saturated so that small breaks in respiration do not produce hypoxia. The Baird's solution is continued at the same rate of $\frac{1}{2}$ cc per 3 minutes until the breathing is almost entirely diaphragmatic. Intubation is now performed using a Magill oral tube #00, 0 or 1 and 10.5 to 12 cm. in length. The largest diameter that can easily be inserted is used so that there will be a minimum of respiratory resistance due to it. Cyanosis should never be tolerated. The mask can be reapplied and oxygen given at any time with the intubation attempted again if necessary. When this procedure is completed, the tube is connected to the inhaler tubings and assisted respiration is initiated, supplying nitrous oxide and oxygen flowing at the rate each of 500 ccs per minute. A semi-closed system is used employing fresh soda lime for carbon dioxide removal. Very little additional Baird's solution is needed, but half cc increments are added as required, never oftener than at 3-minute intervals. It is discontinued well before the termination of surgery, the procedure being continued on nitrous oxide and oxygen. Upon completion, the nitrous oxide is washed out of the patient's lungs by hyperventilation with oxygen and helium. When the reflexes have returned, the tube is removed, after the mouth pharynx and trachea have been thoroughly suctioned. During surgery, the 1/3 saline 2/3 5% glucose solution has been very slowly dripping to keep the needle open, and there has been as accurate a replacement of blood loss as possible.

Cases

In this series of 27 cases there have been no fatalities or serious complications due to anesthesia. The age range has been from 5 weeks to 34 months with the average 16.4 months. Pentothal-curare varied from $2\frac{1}{2}$ to 15.0 ccs with the average 7.9 ccs. The duration of anesthesia was from 15 minutes to 4 hours and 50 minutes with the average 2 hours and 3 minutes. If these last figures are corrected for the 3 cases in which the endotracheal tube was at hand but not used and a mask employed instead, the time varies from 40 minutes to 4

hours and 50 minutes with an average of 2 hours and 14 minutes. Most of this surgery was major.

The following tables give the general information regarding the type of case, age of the patient, length of anesthesia, and amount of pentothal-curare given.

Table 1

Neurosurgery

Case	Operation	Age	Anes.time	P-C	Remarks
1	Expl. Craniotomy	6 mo.	2 hours 0min.	13 cc	Satisfactory
2	Expl. Craniotomy	7	1 55	15	Satisfactory
3	Cautery Choroid Plexus	6	2 15	6	Satisfactory
4	Subdural hematoma	7	1 20	3.5	Operation disc. * Note 1
5	Elevation Skull Fracture	23	- 40	9.5	Satisfactory
6	Repair Meningocele	14	1 35	9	Satisfactory
7	Expl. Laminectomy & Biopsy	24	2 40	11	Satisfactory
8	Expl. Carniotomy	7	2 -	$4\frac{1}{4}$	Satisfactory
	Average	11.8mo	1 hour 35 min.	8.9 cc	

Table 2

Abdominal Surgery

Case	Operation	Age	Anes.Time	P-C	Remarks
1	Plastic Repair C.B.D.	5 mo	3 hours 10 min	7 cc	Satisfactory
2	Repair Cong Atresia CBD	5	3 55	4	Post-op Satisfactory Died 8 day- cirrhosis
3	Closure Colostomy	18	3 -	9	Satisfactory - 1st op. of 2 with PC
4	Repair incisional hernia	28	1 50	$13\frac{1}{2}$	"Very satisfactory" mask
5	Expl. Laparotomy-abscess	27	2 35	13	Satisfactory
6	Expl. Laparotomy-abscess	14	1 25	6	Satisfactory
	Average	16.1mo.	2 hour 4 min.	8 3/4 cc	

Table 3

EENT

Case	Operation	Age	Anes.Time	P-C	Remarks
1	Bronchoscopy & Trach.	27 mo.	2 hours min.	4cc	Died Post.Op.*Note 2
2	Iridectomy & Discission	24	- 20	$3\frac{1}{2}$	Satisfactory
3	" "	24	- 45	10	" (Pt #2,3, & 4 the
4	Removal of suture	24	- 15	$3\frac{1}{4}$	" mask. same)
5	Wiring Mand. & maxilla	24	2 10	$7\frac{1}{2}$	" (Pt #5 & 6 the same)
6	Rewiring " "	24	1 30	10	"
	Average	24.6mo.	1 hour 9 min.	$6\frac{1}{4}$ cc	

Table 4

Miscellaneous

Case	Operation	Age	Anes. Time	P-C	Remarks
1	Agenisis of Lung	5 wk	4hours 50min	2½cc	Good recovery*Note 3
2	Excision Hygroma of Neck	5 mo	3 -	4 1/8	Final hour on cyclopropane because Bl.P. dropped from 160 to 120. Results good.
3	Multiple Dental Fillings	34	2 10	8	Nasal Trach.Tube, no "cut-down". Satisfact.
4	Ureteral Catheterization	18	1 -	5	Mask. Same pt. as obd.#3. Satisfactory
5	Ureteral sigmoidostomy left	6	2 5	7½	Slight overdose, condition good
6	Excison Sarcoma of cheek	22	3 45	13½	"Very satisfactory"
7	Incis. & Drainage Abscess RLQ	30	1 15	12	Satisfactory
	Average	16.6mo	2 hours 40min.	7.5 cc.	

Note 1. Case 4 of neurosurgery. Kinking of the endotracheal tube in this case occurred so that the patient became quite cyanotic and the operation was discontinued. The following week the craniotomy was performed under local and the patient went home in good condition.

Note 2. Case 1 of EENT. This patient came to surgery with a history of having aspirated a foreign body. Cyanosis and dyspnea were present even though she was receiving oxygen. Bronchoscopy was performed under local with oxygen. When the foreign body could not be removed, a tracheotomy was performed. This, too, was started under local anesthesia, but was changed to Baird's with an oral endotracheal tube. When the pentothal was given, the patient temporarily stopped breathing, which resulted in an increased cyanosis. Positive oxygen was given. Upon completion of the tracheotomy, a tube was inserted and oxygen was supplied through it. The infant was responding when she left the operating room, but died the next day of complications incident to the foreign body.

Note 3. Case 1 of Miscellaneous. This was the first case of the series and the technique was not yet well worked out. The patient was a 5-week old male weighing 3300 grams, who was brought to surgery in a very cyanotic state in spite of receiving oxygen. On entering the left chest an ephysematous upper lobe was found with total atelectasis of the lower and lingular lobes. Positive pressure and massage corrected the atelectasis and the operation was completed in 55 minutes. The patient was in good condition except that he showed no attempt toward spontaneous respiration. Various analeptics were tried without effect. Artificial respiration via the breathing bag and endotracheal tube was maintained for the next 3 hours and 45 minutes, at the end of which time he was breathing satisfactorily. When returned to the ward, he was in good condition and responding. The pentothal-curare had been given more frequently than a half a cc. every 3 minutes, and probably it had backed up in the tubing. However, this case seems to illustrate several points. In spite of overdosage with Baird's solution, so long as artificial respiration was maintained, the infant emerged without ill-effects even though he had been a poor risk patient. Second, analeptics were without avail. Third, although the endotracheal tube was in place for almost 5 hours, it did not produce laryngeal edema.

Note 4. Several private cases have been done by our staff using pentothal-curare with endotracheal nitrous oxide and oxygen in infants at other hospitals in the Twin Cities. They include a Blaloch

and a repair of a tracheo-esophageal fistula. All have been satisfactory.

Summary

1. A series of 27 cases of pentothal-curare mixture with endotracheal nitrous oxide and oxygen anesthesia in infants was reported.

2. Special problems of infant anesthesia were presented.

3. A comparison of anesthetics in reference to these problems was made.

4. Disadvantages of pentothal-curare with endotracheal nitrous oxide and oxygen were listed.

5. The chemistry and pharmacology of the drugs employed were discussed.

6. The procedure for this anesthetic was described.

7. Case listings were given with comments.

References

1. Adriani, J.
The Chemistry of Anesthesia,
Springfield, Chas. C.Thomas, Ed.2,
355, '47.
2. Adriani, J.
The Pharmacology of Anesthetic Drugs.
Ed. 2, Springfield, Chas. C. Thomas,
'47.
3. Adriani, J.
Techniques and Procedures of Anesthesia.
Springfield, Chas. C.Thomas, 172, '47.
4. Baird, J. W.
Pentothal-Curare Mixture.
Anesthesiol.8:75 (Jan.) '47.
5. Baird, J. W., Johnson, W. R. and Van Bergen, F. H.
Pentothal-Curare Solution: A Preliminary Report and Analysis of Its Use in 160 Cases.
Anesthesiol.9:141, (Mar.) '48.
6. Best, C. H., Taylor, N. B.
The Physiological Basis of Medical Practice.
4th Ed., Balti., the Williams and Wilkins Co., 17 and 293 and 510, '45.
7. Bieter, R. N., Wright, H. N.
The Minn. Pharmacology Outline.
University Bookstores, U of Minn., 2, '47.
8. Grob, D., Lilienthal, J. L., Jr., and Harvey, A. M.
On Certain Vascular Effects of Curare in Man: The Histamine Reaction.
Bull. Johns Hopkins Hosp. 80:6:299 (June) '47.
9. Harroun, P., Beckert, F. E., and Fisher, C. W.
The Physiological Effects of Curare and its Use as an Adjunct to Anesthesia.
Surg.Gyn.& Obst.84, 491 (Apr.) '47.
10. Hemingway, A.
Outline of Lectures on Respiration.
U of Minn. '47.
11. Holt, L. E., McIntosh, R.
Diseases of Infancy and Childhood.
11th ed.,N.Y., D. Appleton-Century & Co., 230, '39.
12. Johnson, W. R.
Curare in Anesthesia. Staff Mtg. Bull. U. of Minn. Hosp.,XVIII,45 (May) '47.
13. Knight, R. T.
Combined Use of Sodium Pentothal. Intocostin (Curare) & Nitrous Oxide.
The Canad.M.A.J. 55, 356, '46.
14. Leigh, D., Belton, K.
Pediatric Anesthesia.
N.Y., Macmillan Co., '48.
15. Lomas, W. E.
Intravenous Anesthesia.
Surg.Staff Sem.,Mpls. Vet. Hosp., III, ¢, (Sept.) '47.
16. McIntyre, A. R.
Curare. - 1946.
17. Nelson, W. E.
Textbook of Ped. 4th ed., Phila., W.B.Saunders Co., 163, '48.
18. Smith, S.M., Brown, H.O., Toman, J. E.P.,Goodman, L.S.
The Lack of Cereral Effects of d-Tubocurarine, Anes. 8:1 (Jan.) '47.
19. Smith, S.M.
The Use of Curare in Infants and Children.
Anesthesiology 8:176 (Mar.) '47.
20. Starling, E. H.
Principles of Human Physiology.
Ed.7, Philadelphia, Lea & Febiger, 965, '36.
21. Van Bergen, F. H.
Pentothal-Curare Mixture with Endotracheal Nitrous Oxide and Oxygen in Infants.
Post-grad.Anes.Lect., (Feb.) '49.

III. MEDICAL SCHOOL NEWS

Faculty News

Dr. Joe R. Brown has announced that he has accepted a position as a member of the Department of Neurology at the Mayo Clinic. Dr. Brown will leave to assume his new post on July 1 of this year. He will hold the rank of Associate Professor in the Mayo Foundation.

Dr. Halvor O. Halvorson, Professor of Bacteriology and Director of the Hormel Institute at Austin, has announced that he has accepted a position as Chairman of the Department of Bacteriology at the University of Illinois. Dr. Halvorson has been a member of the faculty of the University of Minnesota since 1922 and has been particularly active in the investigation of microbial physiology and industrial bacteriology. Dr. Halvorson will begin his new work in Champaign, Illinois, on September 1 of next year.

Miss Myrtle E. Kitchell, instructor in nursing education, has accepted a position as Director of the School of Nursing at the University of Iowa at Iowa City.

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New Minn. Medical Foundation Members

Dalmon V. Boardman, M.D., Winona
Anthony S. Berlin, M.D., Hallock
A. E. Magnuson, Wheaton
Hamlin Mattson, M.D., 837 Medical Arts Bldg., Minneapolis
Joseph F. Bicek, M.D., 814 Lowry Medical Arts Bldg., St. Paul
H. J. Setzer, M.D., 1604 Randolph Ave., St. Paul
Silas C. Andersen, M.D., 418 LaSalle Bldg., Minneapolis
Ludvig Lima, Jr., M.D., Montevideo

Biographical Briefs -- Internist

Cecil James Watson was born in Minneapolis. His father was a physician and was active in the practice of eye, ear, nose, and throat in this city. His freshman year in Medical School was spent at the University of Michigan. However, he received the remainder of his undergraduate medical training at the University of Minnesota and was awarded his B.S. degree in 1923 and his M.D. in 1926. He received an M.S. in pathology in 1925 and wrote his thesis on the subject, "Periarteritis Nodosa."

He served the Minneapolis General Hospital as Pathologist and Director of Laboratories from 1926-28. In 1928 he received his PhD. in Pathology. Dr. Watson then moved to Minot, North Dakota, where he joined the staff of the Northwest Clinic and served that group and Trinity Hospital as Pathologist and Director of Laboratories. During the two years spent here, he was also active in the clinic in the practice of internal medicine.

Dr. Watson left for Europe in 1930 and spent two years in research and postgraduate study in Munich. Here he worked under Dr. Hans Fisher and Dr. Friedrich Mueller. During his second year in Europe, he was a fellow of the National Research Council.

In 1932 he returned to the University of Minnesota and to Minneapolis General Hospital as a medical fellow. At that time, he took charge of the course in clinical microscopy and chemistry. Returning to the University Hospital, promotion followed promotion and 1936 found Dr. Watson as Associate Professor of Medicine and Director of the Division of Internal Medicine. In 1940 he became Professor of Medicine, and in 1943 Chairman of the Department of Medicine.