Changing Trends in the Anesthetic Management of the Child with Cleft Lip-Palate Malformation

Ernest Salanitre, M.D., and Herbert Rackow, M.D.

THE child with cleft lip-palate malformation presents problems specifically related to the nature and site of the lesion. Many of these problems have been discussed by others.[1-7] Few data exist, however, regarding the incidence of the related complications. Most publications on cleft lip-palate surgery make reference only to operative mortality. Early reports showed a mortality of up to 5.9 per cent,[8, 9, 10] while a recent review reported no deaths in 2,635 cases.[11]

This report will present data concerning the incidence of complications which occurred in two groups of children operated during two different periods of time: 1949–53 and 1957–59. These particular intervals of time were selected because they are representative of two distinctly different eras in anesthetic management at the Babies Hospital.

Material

The case records of 409 children, up to the age of 12 years, operated upon for either cleft lip and/or cleft palate at the Columbia-Presbyterian Medical Center, were reviewed for evidence of anesthetic and related complications. Two hundred and thirty-four were operated upon during 1949–53 and 175 in 1957–59. The cases in both groups were consecutive and unselected.

The decision as to whether or not a complication existed was determined either by the recorded observation in the chart, or by interpretation of the data. The definition of complication was necessarily an arbitrary one. However, it included any significant deviation from the normal, expected course of events.

Received from the Department of Anesthesiology, Columbia University, College of Physicians and Surgeons, and the Anesthesiology Service of the Presbyterian Hospital and Babies Hospital, New York 32, New York. Accepted for publication April 10, 1962.

Findings

One hundred and thirty-two of the 409 children had one or more complications. The incidence was 40.5 per cent in the 1949–53 group and 21 per cent in the 1957–59 group (table 1). This difference was of statistical significance as determined by the chi square method ($P < 0.001$). The greater incidence in the 1949–53 group was primarily due to a high rate of complications in the infant group. Table 2 shows that in the 1949–53 group 58 per cent of children up to 12 months of age had at least one complication, as compared to 32 per cent in older children ($P < 0.001$). No significant difference between the two age groups was found in the 1957–59 series ($P > 0.10$).

It was convenient to group the complications into four categories: (1) respiratory, (2) cardiovascular, (3) changes in body temperature, and (4) miscellaneous. Table 3 shows the incidence of complications of each of the categories for the two series. One hundred and ten of the 176 complications were related to respiration or the mechanics of airway maintenance, 86 in the 1949–53 group (36.7 per cent) and 24 in the 1957–59 series (13.7 per cent). The reduced incidence in the latter group was statistically significant ($P < 0.001$). These respiratory difficulties included soft tissue obstruction, accumulation of secretions or blood in the airway, inability to maintain a completely patent airway during operation, problems in laryngoscopy and endotracheal intubation. A common manifestation in all of these difficulties was the presence of cyanosis. Sixty-nine per cent of all the complications in the 1949–53 group were respiratory in character as compared to 47 per cent in the 1957–59 group.

The cardiovascular problems consisted mainly of cardiac arrhythmias, the most serious of which were the bradycardias (rates below

50) associated with acute hypoxia due to acute respiratory difficulties. Six severe bradycardias occurred in the 1949–53 series and four in the 1957–59 group. In this latter group, one child developed an arrhythmia documented electrocardiographically as bursts of ventricular tachycardia. Recovery was uneventful and a subsequent operation was uncomplicated.

No mortality occurred in either series. Cardiac arrest was observed once in the study and occurred in the 1949–53 group. This case, reported by Hanks and Papper,[12] was a 2 month old white male who had a cleft lip repair. Ether-oxygen anesthesia was maintained by nasopharyngeal insufflation. Irregularity of respiration and intermittent periods of cyanosis were noted during the operation. Fifteen minutes prior to the end of the procedure, ether was discontinued and oxygen by insufflation was administered. Three to five minutes after the end of the operation the pulse dropped from 208 to 118, and the respirations, from 40 to 10 per minute. Shortly thereafter, respirations ceased and the pulse became unobtainable. Mouth-to-mouth resuscitation followed by endotracheal intubation and ventilation with 100 per cent oxygen did not improve the situation. Thoracotomy was done and the heart massaged. Spontaneous cardiac rhythm returned in about two minutes after the institution of cardiac massage. Sixty milliliters of whole blood were given because of bleeding from the thoracotomy incision. The patient was discharged on the tenth postoperative day apparently normal. Neurological examination at three months of age was normal and gave no indication of the eventual poor prognosis. Seven year follow-up has revealed the presence of severe psychomotor deficits.

TABLE 1. Comparison of Incidence of Total Complications in Children Operated for Cleft Lip-Palate Malformation

	Total Cases	Number of Patients with Complications	Incidence (%)
1949–53	234	95	40.5
1957–59	175	37	21*
Totals	409	132	32

* $P < 0.001$.

TABLE 2. Incidence of Complications in Children Below and Above 1 Year of Age

	1949–53		1957–59	
	Up to 12 Months of Age	Above 12 Months of Age	Up to 12 Months of Age	Above 12 Months of Age
Number of children	79	155	62	113
Number of complications	46	49	15	22
Incidence of complications (per cent)	58*	32	24**	19

* $P < .001$.
** $P > .10$.

Two children, one in each group, required transfusion. One of these was in shock due to blood loss, but responded well to transfusion.

Twenty-nine children had changes in body temperature of more than moderate degree. Six infants less than six months of age, two in the 1949–53 group and four in the 1957–59 group, had postoperative rectal temperatures of below 97° F. The fall in temperature occurred, in every instance, during the course of anesthesia.

Twenty-three children, 16 in 1949–53 and seven in 1957–59, had a rise in body temperature to above 101° F. In two patients, one in each group, the rise occurred during the course of anesthesia and was accompanied by muscular twitchings. Response to cooling measures was prompt and neither child seemed to have neurologic sequelae. In the other 21 children fever developed during the first postoperative day, occasionally on the second day.

TABLE 3. Comparison of Complications in the Four Major Categories

	1949–53 (234 Cases)		1957–59 (175 Cases)	
	Number of Complications	Incidence (%)	Number of Complications	Incidence (%)
1. Respiratory	86	36.7	24	13.7*
2. Cardiovascular	6	2.6	4	2.3
3. Hypothermia	2	0.8	4	2.3
Hyperthermia	16	6.8	7	4.0
4. Miscellaneous	15	6.4	12	6.8
Totals	125		51	

* $P < 0.001$.

In one case this was due to infection at the operative site. Six children had well-documented upper respiratory disease. In 14 patients, ten in the 1949–53 group and four in the 1957–59 series, there seemed to be no obvious cause. Lung infection could not be excluded, since few of the children had postoperative chest films, but there was no clinical evidence for pulmonary disease. One of these children, in the 1949–53 group, had a convulsive episode on the second postoperative day with incomplete recovery, followed by death after one year of custodial care. It is of interest to note that some of the early publications on cleft lip-palate surgery [9, 10, 13] mention the frequent occurrence of postoperative fever associated with some mortality. This complication was known as hyperpyrexia pallida or Ombredanne's syndrome and was originally described in children up to the age of 18 months as consisting of high fever, pallor, tachycardia and tachypnea. Pickerill [14] suggested that the syndrome may have been the result of hemorrhage and hypoxia.

In the miscellaneous category of complications, ether overdose occurred three times in the 1949–53 group and twice in the 1957–59 group. All children recovered without sequelae. Morphine overdose occurred in two patients in the earlier series as compared to one case of overdose in the 1957–59 series. Other complications included prolonged recovery from anesthesia in two children, damage to teeth in six patients, conjunctivitis and corneal abrasion in four cases, an hypoxic anesthetic inhalation mixture in one case. These were spread in equal proportion in both groups of cases.

Cleft lip-palate children seemed to have a relatively large number of operations postponed because of anesthetic difficulties during the induction period. The data showed that one of every 33 scheduled operations of the 1949–53 series was postponed for this reason. There was no cancellation of operation in the 1957–59 group because of induction difficulties. One scheduled case was postponed, however, before induction, because of accidental morphine overdose and a second, during operation, following the onset of bursts of ventricular tachycardia. Both children had uneventful recoveries and were subsequently operated upon without difficulty.

In the earlier series many agents and techniques were used. Induction agents included ethyl chloride, nitrous oxide, chloroform, ethylene, cyclopropane, diethyl ether, divinyl ether, intravenous thiopental, rectal thiopental and rectal Avertin. Anesthesia was maintained, in the most part, with diethyl ether and nitrous oxide using one of several techniques. In 43 per cent of the children anesthesia was conducted by insufflation technique, usually via nasopharyngeal or oropharyngeal catheters, occasionally by endotracheal catheter. Forty-seven per cent were given endotracheal anesthesia by either nasal or oral tubes using a nonrebreathing valve system or, rarely, Ayre's "T"-tube. It was customary to give nasoendotracheal anesthesia for palate surgery and orotracheal anesthesia for lip procedures. In 10 per cent of the cases, the method of anesthesia was either local infiltration or unknown.

In the 1957–59 group 98 per cent of the patients were given endotracheal anesthesia. Ninety-one per cent of these had their tracheas intubated with sterile endotracheal tubes via the oral route. In this more recent series, insufflation anesthesia was rarely used and nasotracheal intubation was limited to a few cases early in the series. There were fewer agents used in this group. They will be discussed more fully later.

Discussion

The large number of anesthetic complications observed in the cleft lip-palate children may be attributed to several factors. The most important of these is the distorted oral anatomy caused by the cleft lesion itself and which often results in impairment of the airway. This may be further compounded by the presence of other congenital anomalies of the mouth and pharynx. The association of other congenital defects with cleft malformation has been reported to be 4.9 per cent in one series [15] and as high as 20 per cent in another series.[7] Those anomalies which could have a bearing upon the anesthetic management of these children include: microstomia, macroglossia, nasal deformity, Klippel-Feil syndrome (congenital fusion of cervical vertebrae), Pierre-Robin's syndrome (cleft palate, hypoplasia of the

mandible, glossoptosis) and cardiovascular lesions. The impairment of the airway by the cleft itself, and in some cases the concomitant presence of one of the associated defects, may explain the relatively large number of respiratory complications in both groups. The high rate of postponements of operation in the 1949–53 group probably reflects insufficient awareness of the difficulty of the anatomical problems, at that time. Although the incidence of respiratory complications was significantly reduced and no postponements occurred in the 1957–59 group, a relatively high incidence of complications still occurred.

The size and age of the patient must also play an important role. The greater susceptibility of the child to dehydration, his responses to changes in environmental temperature, the relative instability of the infant's thermo-regulatory mechanisms and the differences in laryngeal anatomy as compared to the adult may also contribute to the number of complications. In addition to these anatomic and physiologic considerations, the small size of the patient presents problems related to the anesthetic equipment. It was not uncommon, in the earlier group, to see a makeshift adaptation of adult equipment which was not only cumbersome, but often unphysiologic. This lack of well-designed pediatric anesthetic equipment must also have contributed to the overall difficulties.

The reduction in the incidence of anesthetic complications, the relative diminution of respiratory difficulties and the absence of postponements of operation due to induction complications in the 1957–59 group were the result of a more careful application of the principles of sound anesthetic and surgical management to the problems of infants and children.

Present Regime

Because of the known susceptibility of these children to upper respiratory infection, they are hospitalized two–three days prior to operation for observation. Any suspicion that the child has a respiratory infection is an indication for postponement of operation. The cleft lip-palate children also tend to have relatively low hemoglobin levels, possibly due to nutritional deficiencies.[2] The anemia may set the stage for a clinically significant hypoxia, if even a minor ventilatory difficulty occurs during anesthesia.

The question of what constitutes a reasonable minimal preoperative hemoglobin level in this necessary, but essentially elective, operation is not easy to answer. We have agreed to accept 10 Gm. of hemoglobin per 100 ml. of blood as a minimal hemoglobin value for elective operation. The basis for the selection of this particular value is somewhat arbitrary, but this decision has appeared wise with increasing clinical experience. Guest, Brown and Wing [16] stated that "at any age hemoglobin values below 10 Gm./100 ml. can be assumed to indicate a degree of anemia ranging from moderate to severe." Elvehjem, Peterson and Mendenhall [17] pointed out that only 10 per cent of a series of clinically normal children at one year of age had a hemoglobin of less than 10 Gm./100 ml. Merritt and Davidson [18] gave a figure of 12.6 Gm./100 ml. for the mean hemoglobin value during the first year of life, with a standard deviation of 1.3; using these data, 10 Gm./100 ml. of hemoglobin would represent the lower end of the 95 per cent confidence limits.

Preoperative medication consists of a belladonna drug, often combined with a barbiturate in the older children, less frequently with a narcotic. Scopolamine is generally used for the inhibition of secretions. Infants up to the age of 3–4 months usually receive only a belladonna drug for premedication. Older children are given a barbiturate, most often secobarbital, in doses of 1 mg. per pound of body weight up to 60 pounds of weight. Narcotics are rarely used because the consequent depression of respiration prolongs the induction of inhalation anesthesia and delays postoperative awakening.

Included as an integral part of the preoperative medication are orders concerning feeding and hydration. Usually normal feeding is allowed up to eight hours prior to the estimated time of premedication. Water is not only permitted, but offered to the child up to four hours before premedication; infants who are still taking a bottle are offered glucose-water four hours before medication.

The present anesthetic management (and that of the 1957–59 series) differs in some im-

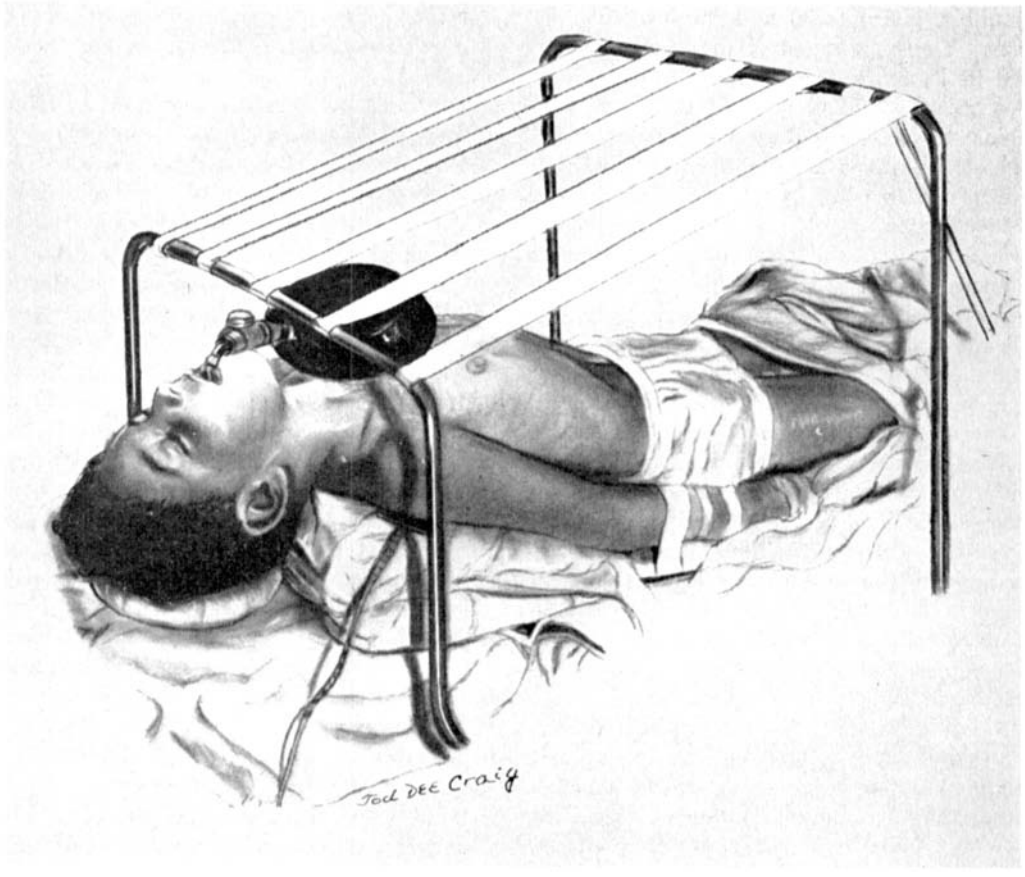

FIGURE 1.

portant aspects from the management of the 1949–53 group. It is our present policy to give oral endotracheal anesthesia to all children who undergo cleft lip-palate operations. Induction of anesthesia is accomplished by the open hose gravity method using either cyclopropane-oxygen or halothane-nitrous oxide-oxygen at high flows. Open drop divinyl ether and diethyl ether with oxygen added under the mask may also be used in suitable cases. Upon loss of consciousness one of the three following methods is employed: (1) open drop diethyl ether with oxygen added under the mask; (2) diethyl ether-nitrous oxide-oxygen in a nonrebreathing system, or (3) halothane-nitrous oxide-oxygen in a nonrebreathing system. The child is brought to a level of anesthesia suitable for endotracheal intubation. In a very few cases intramuscular succinylcholine, 1½–2 mg. per pound of body weight, has been used to facilitate intubation. In general, however, because of the airway problems in these children, it is considered desirable to preserve spontaneous breathing at all times and relaxants are not used. After the insertion of the endotracheal tube, anesthesia is maintained with light diethyl ether-nitrous oxide or halothane-nitrous oxide via a nonrebreathing valve, or, occasionally, an Ayre's "T"-tube. Some of the nonrebreathing valves used include Digby-Leigh, Fink and Frumin valves.

Intravenous infusions are started in all children in whom venipuncture is possible. In the very young child and infant, in whom the placement of a reliable percutaneous intravenous needle may be difficult or impossible, the insertion of a catheter by venous cut-down is desirable. Although the indications for venous cut-down seem to be clear, namely, the greater susceptibility of the younger child to dehydration and the failure to perform a successful percutaneous venipuncture, there are other

means which can be used to provide fluids, but they are distinctly less valuable than venous cut-down. These methods include active efforts to ensure preoperative hydration, the use of minimal premedication so that postoperative sleep is not prolonged, the avoidance of narcotics which may accentuate nausea and vomiting, the use of anesthetic agents, such as halothane, which are less likely to delay postoperative awakening, the use of hypodermoclysis and early and intensive efforts at postoperative oral hydration.

In certain instances there can be no compromise regarding the placement of an intravenous catheter. When preoperative dehydration is suspected, surgical procedures of longer duration than one hour contemplated, amount of blood loss unpredictable, or rising body temperature during the operation observed, intravenous fluids should be started without delay.

The infusion bottle should not contain a volume of fluid more than one-third of the estimated 24-hour fluid requirement. This arbitrary limit will help avoid the hazards of over-hydration.[19] The infusion itself may be either 5 per cent dextrose in water or a mixture of one-third normal saline and two-thirds of 5 per cent dextrose in water. Blood replacement rarely has been necessary in these children.

An important part in the anesthetic management of these patients is the proper positioning of the child on the operating table. Two problems which have always existed in cleft lip-palate surgery have been the relative difficulty of airway control because of the operative site and the envelopment of the child by drapes, thus impeding observation of the

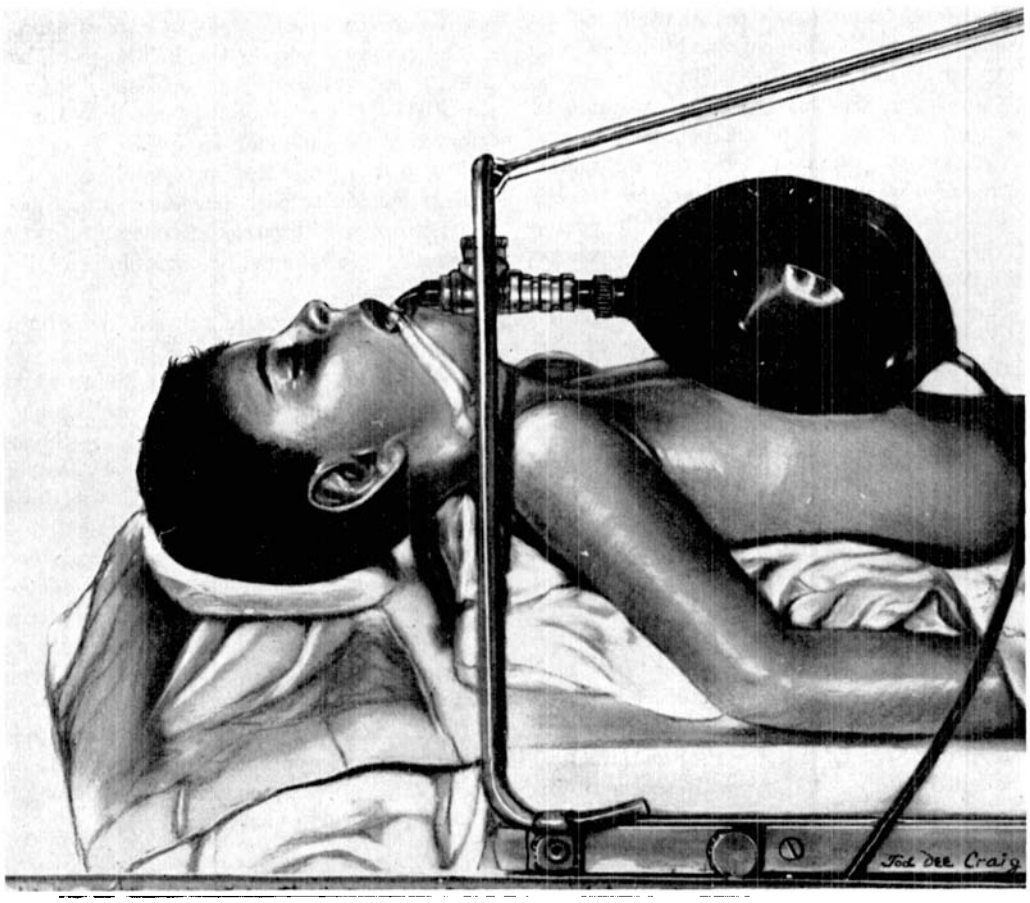

FIGURE 2.

patient and setting the stage for heat retention and possible convulsions. Figures 1 and 2 illustrate the method that has evolved to minimize some of the problems of patient accessibility. Similar methods have been described in the literature.[1, 5] The extension of the head must be maximal for palate surgery, less so for lip procedures. The surgeon stands at the head of the table for both types of operations. The positioning of the head in extension must be done carefully to avoid injury to the cervical vertebrae and spinal cord.

Each child is put in a Croupette immediately after the operation. The atmosphere of the Croupette is composed of a cold oxygen-air-water mist. All children remain in this atmosphere for several hours. If signs of tracheitis appear, treatment in the Croupette is continued. Should the tracheitis be severe or persistent a cortisone preparation and/or antibiotics are considered. Even with the most careful technique, signs of tracheitis occasionally occur. Unrecognized trauma may be the most obvious cause. One may speculate, however, that the extreme extension of the head or a pre-existing subclinical respiratory infection may be a contributing factor. No data were available regarding the number of children who developed sub-glottic edema in the 1949–53 group, but there were no clinically evident cases in the 1957–59 group.

The infrequent occurrence of hypothermia in the infants of both series (table 1) has made unnecessary the taking of routine measures for its prevention. This low incidence may be the result of several factors: (1) the avoidance of skeletal muscle relaxants, (2) the short duration of the surgical procedure, and (3) the fact that none of the major body cavities were open.

The best of anesthetic and surgical managements cannot completely eliminate the problems created by the mutual sharing of the patient's airway by surgeon and anesthesiologist. Only an understanding of each other's requirements can minimize these difficulties. With proper placement, the oral endotracheal tube need rarely interfere with the performance of the operation. On the other hand, the surgeon must accept a certain limitation in maneuverability of his instruments and must also be constantly aware that the endotracheal tube, which is under his direct vision, should not be disturbed without due consultation. The profits in patient welfare reaped from the methods described outweigh any minor difficulty in accessibility to the operative field. The use of these techniques in this clinic for the past four years has proven most satisfactory. The importance of using specifically designed pediatric anesthetic apparatus cannot be over-emphasized.

Summary and Conclusion

Two groups of children, undergoing cleft lip-palate surgery were compared as to anesthetic complications and anesthetic management. Although the 1957–59 group showed an encouraging diminution in complication rate, the incidence remained relatively high. The reasons are: the abnormal oral anatomy resulting from the cleft lesion itself, the small size of the patient, and the sharing of the operative site by anesthesiologist and surgeon.

The improvement in the incidence of both overall and respiratory complication rates in the 1957–59 group of patients may be attributed to the following factors:

(1) A more critical preoperative evaluation of the child, with particular attention to signs of upper respiratory infection and a strict adherence to a minimal hemoglobin level of 10 Gm./100 ml.

(2) Special efforts to prevent dehydration during the preoperative period.

(3) Effective control of the patient's airway by the use of oral endotracheal intubation.

(4) Positioning of the patient on the operating table such that the airway can be reached rapidly and conveniently, the drapes can be so placed as to allow the patient to be observed properly and measures for body cooling or warming readily instituted if needed.

(5) Prophylactic treatment of the potential sequelae of endotracheal intubation by the postoperative use of a suitable cold, humid environment.

(6) Increased experience of the anesthesiologist with this type of patient.

(7) The application of modern principles of sound anesthetic management.

This work was supported in part by N. Y. C. Health Research Council Grant U-1059 and in part by U.S.P.H.S. Grant H-3041.

References

1. Davies, R. M., and Danks, S.: Anaesthetic care in cleft lip and palate surgery, Anaesthesia **8**: 275, 1953.
2. Norris, W., and Saunders, R. C. O.: Anesthesia for repair of cleft lip and cleft palate, Brit. J. Anaesth. **27**: 597, 1955.
3. Leigh, M. D., and Kester, H. A.: Endotracheal anesthesia for operations on cleft lip and cleft palate, ANESTHESIOLOGY **9**: 32, 1948.
4. Deming, M. van N.: Agents and techniques for induction of anesthesia in infants and children, Anesth. Analg. **31**: 113, 1952.
5. Smith, R. E.: Anesthesia for Infants and Children. St. Louis, C. V. Mosby Co., 1959.
6. Eckenhoff, J. E.: Some anatomic considerations of the infant larynx influencing endotracheal anesthesia, ANESTHESIOLOGY **12**: 401, 1951.
7. Holdsworth, W. G.: Cleft Lip and Palate, ed. 2. London, William Heineman, Ltd., 1957.
8. Lane, W. A.: The treatment of cleft palate, Proc. Roy. Soc. Med. **4**: 169, 1911.
9. Veau, V.: Bec de Lievre. Paris, Masson et Cie., 1938.
10. Krarup, T.: Some reflections on post-operative hyperthermia, Acta Otolaryng. (Suppl. 51) 219, 1944.
11. MacCollum, D. W., and Richardson, S. O.: Management of the patient with cleft lip and cleft palate, Pediatrics **20**: 573, 1957.
12. Hanks, E., and Papper, E. M.: Cardiac resuscitation, New York J. Med. **51**: 1801, 1951.
13. Ombredanne, L., and Armingeat, J.: Le syndrome paleur et hyperthermie chez les nourrissons opérés, Presse Med. **37**: 1345, 1929.
14. Pickerill, H. P.: Ombredanne's syndrome: hyperpyrexia pallida, New Zeal. Med. J. **50**: 51, 1951.
15. Fogh-Andersen, P.: Inheritance of Harelip and Cleft Palate. Copenhagen, Nyt Nordisk Foriag, 1942.
16. Guest, G. M., Brown, E. W., and Wing, M.: Erythrocytes and hemoglobin of the blood in infancy and childhood, Amer. J. Dis. Child. **56**: 529, 1938.
17. Elvehjem, C. A., Peterson, W. H., and Mendenhall, D. R.: Hemoglobin content of the blood of infants, Amer. J. Dis. Child. **46**: 105, 1933.
18. Merritt, K. K., and Davidson, L. T.: The blood during the first year of life, Amer. J. Dis. Child. **46**: 990, 1933.
19. Crawford, J. D., and Dadge, P. R.: Complications of fluid therapy in patients with neurological disease, Ped. Clin. N. Amer. **6**: 257, 1959.

STILLBORN RESUSCITATION Certain requisites should be observed before attempting cardiorespiratory resuscitation of a stillborn infant: (1) A trained staff with proper equipment must be on hand in the delivery room. (2) A rapid examination must show the infant to be mature with no evidence of major birth trauma or congenital anomalies. (3) There should be no background of prolonged intrauterine asphyxia or severe systemic disease. (4) Good fetal heart sounds must be heard in the five-to-ten minute period preceding delivery. Closed-chest cardiac massage is the method of choice, and this is performed by exerting mild to moderate pressure with two fingers (index and middle) to compress the middle third of the sternum at a rate of about 100 per minute. Cardiac resuscitation must be combined with ventilatory resuscitation. The nasopharynx and oropharynx should be quickly suctioned, an airway established, and ventilation begun. Endotracheal intubation is usually indicated, and through the tube the tracheobronchial tree can be washed intermittently between several ventilations by using 2–3 cc. of saline followed by immediate suction until the return is clear. (*Surks, S. N., and Ladner, W.: Closed-Chest Cardiac Massage in the Stillborn, J.A.M.A. 180: 328 (Apr. 28) 1962.*)