EMERGENCY PAEDIATRIC ANAESTHESIA*

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THE anaesthetic management of the child with a full stomach, admitted for emergency surgery, presents a major problem. We are faced with maintaining an unobstructed airway against a potential hazard lurking in the stomach of almost every accident case. Statistics prove that we are frequently unsuccessful. In obstetrical anaesthesia, a similar problem exists. Merrill and Hingson (1) made a comprehensive survey of the major hospitals of the United States between 1945 and 1949, reporting 67 aspiration deaths, these being 2 per cent of the total maternal deaths. Wylie and Morton (2), reporting recently in the British journal *Anaesthesia*, list 43 deaths due to aspiration. Although this suggests the magnitude of the problem, everyone is aware that the majority of these cases are not reported at all. There is the additional factor of postoperative morbidity to be considered.

I would like to discuss this important, but often disregarded subject under several main headings: (1) Factors predisposing to gastric retention and vomiting; (2) Anaesthetic level associated with vomiting; (3) Types of vomiting and aspiration; (4) The pathological picture in aspiration deaths; (5) The conduct of anaesthesia and prophylaxis; (6) Treatment of patients with aspirated vomitus.

FACTORS PREDISPOSING TO VOMITING

Best and Taylor (3) state the normal emptying time of the stomach to be three to four and a half hours. In children, the digestive processes usually stop at the time of shock or trauma. This is the result of circulatory collapse causing generalized body depression including gastric atony (4). It is therefore imperative not to be lulled into a false sense of security by physiological norms. In accident or emergency surgery, we assume the stomach to be full unless there is positive evidence that food has not been taken for the past eight hours. With the superimposed factor of emotional stress, this period may well be increased to twelve hours or longer.

The anaesthesiologist controls two of the most important of these predisposing factors—premedication and anaesthetic agent combined with mode of administration. A judicious selection and wise administration with regard to physiological and pharmacological values will largely govern the success or failure of this hazardous procedure. The agents and mode of administration will be discussed later. With regard to premedication, barbiturates allay fear, do not stimulate the vomiting centre, and cause little delay in gastric emptying time. Morphine and its derivatives are contra-indicated as they stimulate the vomiting centre and decrease gastric motility. Demerol causes little stimulation of the vomiting centre and delays gastric emptying only slightly. Atropine may cause some stimulation of the vomiting centre and may decrease gastric motility. However, its use as an emergency premedicant is justified by its parasympathomimetic protection against barbiturate spasm, and by its drying effect on pharyngeal secretions. These factors

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are vital in such cases for smooth rapid inductions and uncomplicated intubations. For these reasons, at the Hospital for Sick Children we favour atropine, demerol, and barbiturates in sedating emergency patients. A basic schedule for atropine dosage has been placed in the emergency department of our hospital for routine administration by the nursing staff. This provides adequate doses at proper time intervals to allow our emergency surgery to proceed without delays. We utilize atropine in relatively large doses according to the following schedule: 10-15 lb. (1-6 mos.)—Gr. 1/400; 15-30 lb. (6 mos.-2 yrs.)—Gr. 1/300; 30-60 lb. (2-6 yrs.)—Gr. 1/150; over 60 lb.—Gr. 1/100. Although other preoperative drugs are ordered as desired by members of the anaesthetic staff, we feel that a relatively smooth induction is assured by the administration of atropine.

In addition to the predisposing factors of shock and trauma and those controlled by the anaesthesiologist, a third group of specific disease states may lead to gastric retention and vomiting of a more mechanical nature: pyloric stenosis, intestinal obstruction, and peritoneal inflammation.

ANAESTHETIC LEVEL ASSOCIATED WITH VOMITING

Awareness of the danger area of vomiting will guide us in attempting to pass speedily and smoothly through this level and maintain our course at a deeper plane through the duration of anaesthesia. This danger area of spontaneous vomiting is located at the lower level of Stage 2. It is further enhanced by pharyngeal reflexes which are present through plane 1, Stage 3. The sensitivity of the vomiting centre also remains through plane 1 of Stage 3. Obstructive vomiting will occur at any depth, as it is a mechanical problem. Lundy (5) has stated that on emergence from Stage 3, vomiting appears immediately after swallowing. Swallowing occurs during the lightest anaesthesia of Stage 3 and vomiting during the deepest of Stage 2. Warning signs of vomiting are shallow respiration, pallor, weak pulse, and contracted pupils. These are warning signals that a deeper level of anaesthesia is required.

Vomiting which follows retching, during which the breath is held, is particularly dangerous. The masseter muscles are in firm spasm so that the mouth cannot be opened. The vomitus fills the pharynx and is drawn into the trachea and lungs by the first deep post-retching inspiration.

The actual mechanism of vomiting may be accomplished either by the co-ordinated actions of the muscles of the stomach, oesophagus, and abdominal wall or by the antiperistaltic movements of the intestine. The nervous control (6) is by afferent impulses arising in the stomach or other viscera, or from almost any region of the body, and travelling by the sympathetic and vagus systems to the vomiting centre in the medulla near the dorsal nucleus of the vagus. The efferent fibres are contained chiefly in the phrenics, vagi, sympathetics, the spinal nerves to the abdominal muscles, and the cranial nerves to the muscles of the pharynx, and palate.

TYPES OF VOMITING AND ASPIRATION

This is essentially a classification of degree, with immediate or delayed visible signs (7).

1. Vomiting and aspiration of solid food lodging in the larynx, trachea, or

bronchi may produce total obstruction and death by suffocation. If the obstruction is only partial, the typical picture of obstructive atelectasis is found.

2. An asthmatic type of chemical pneumonitis may result from aspiration of liquid vomitus; clinically cyanosis, tachycardia dyspnoea, and wheezing are observed. If death occurs, it is due to cardiac failure and pulmonary oedema.

3. There is an insidious type known as "silent" regurgitation and aspiration. Adriani (8) in a series of 926 elective operations disclosed a regurgitation incidence of 14 per cent and aspiration incidence of 7 per cent. The incidence appeared to be unrelated to drugs used or operation performed. It was increased by stormier inductions, difficult endotracheal anaesthesia, and gastric retention or distension. In this series of cases the risk of pneumonitis was negligible if careful endotracheal suctioning was practised and antibiotic therapy instituted. In emergency surgery, there is danger of an equally insidious but more massive aspiration leading to a more severe pneumonitis. Such patients may recover from their anaesthesia with a pain in the chest, blood-tinged sputum, cyanosis, tachycardia, and hyperpnoea.

4. Special mention should be made of the specific type of vomiting observed in cases with intestinal obstruction. A large aspiration may result, in which the patient drowns, or a slow insidious type as mentioned above may occur. Such complications are reduced to a minimum by gastric lavage, leaving the Levine tube in place, associated with endotracheal anaesthesia. In infants about to undergo the Ramstedt operation for pyloric stenosis, we do a preoperative gastric aspiration routinely, usually obtaining large amounts of secretions and undigested feedings. A Levine tube is left *in situ* during the actual operation, for further drainage.

The route followed by this aspirated material depends on the bronchial configuration; right-sided passage is favoured (9). The most frequent site is the apical branch of the lower lobe with the patient lying on the back. With the patient in the lateral position, the most common site is the subapical posterior and axillary portions of the upper lobe.

PATHOLOGICAL PICTURE IN ASPIRATION DEATHS

The post-mortem examination reveals no atelectasis because of the presence of aspirated material and bronchial exudates. The lungs are increased in weight. The gastric contents cause a chemical breakdown of the blood, making it much darker in colour. There is hyperaemia of the bronchial tree and gastric dilatation. Microscopically, the alveolar spaces reveal capillaries engorged with erythrocytes and edema and particles of undigested food. Marked desquamation has usually occurred along the lining of the bronchial tree.

CONDUCT OF ANAESTHESIA

The procedure followed at the Hospital for Sick Children is as follows:

1. The time interval between the last food eaten and the proposed operation will govern the anaesthetic technique to be employed. A careful history is taken from the parent, and if the child is old enough, from the child as well, to determine how long before the accident or acute illness food was taken. Information from both these sources is of equal importance—the parent will

disclose the home menu while the child will often reveal outside snacks. Such data are recorded routinely on every emergency anaesthetic chart by our nursing staff in spaces marked "nature of last nourishment" and "time." Our anaesthetic staff usually rechecks this important information. A positive history warns us to take every precaution and alerts us as to the nature, type, and amount of vomiting to expect in the postoperative period. Although a negative history offers us some assurance, it is wise to be extremely guarded in such cases with children.

2. All non-urgent operations, falling into an elective category, are postponed until the following day or until an adequate time interval has elapsed.

3. Whenever possible, local or regional anaesthesia is employed. The use of these methods is relatively restricted in children.

4. I should like to stress, particularly, the importance of the preparation of equipment. This should be ready in every detail, prior to induction, to meet each emergency without catastrophic delay. It includes an operating table readily adjustable to Trendelenburg position, proper suction apparatus of a metal pharyngeal type and rubber nasal type, anaesthetic machine with adequately filled tanks, intravenous or liquid anaesthetic agents and relaxants in complete readiness, airways of proper size, laryngoscope and several endotracheal tubes with connectors attached, adhesive strapping, dental mouth gag, and readily available bronchoscope.

5. The question of mechanical stimulation to initiate vomiting, and gastric lavage to remove stomach contents before inducing anaesthesia, are controversial subjects. We prefer not to employ these techniques. If we do, they are accomplished by insertion of a finger or metal suction into the throat or by the passage of a large stomach tube. This may accomplish the purpose partially but should not lull the anaesthetist into a false sense of security, as solid material may remain. Furthermore, it may initiate a severe psychological disturbance, leading to a stormy induction, with the residual food being vomited in the "danger area."

6. With children whose veins are accessible, we prefer to administer pentothal combined with a relaxant to accomplish smooth, rapid induction. Venipuncture may be accomplished in very small children by use of hypo needles. A 2½ per cent sodium pentothal solution is utilized with 2 mgm. syncurine added to the 20 cc. syringe. One cc. of this mixture is administered per 5 lb. of body weight. Succinylcholine 1 mgm. per 4 lb. may be given to facilitate rapid intubation. The syncurine is a valuable adjuvant in preventing bucking and gastric disturbances and allowing stabilization of the anaesthetic. We prefer to use a snugly fitting endotracheal tube, quickly selecting the proper size among several prepared on our anaesthetic table. The teeth are kept apart by means of a dental mouth gag, so that if vomiting does occur food particles may be removed readily by the fingers and liquid material easily aspirated by suction apparatus. A bite block or airway prevents easy access to the pharynx. It is important that the endotracheal tube be fastened firmly in place, particularly in operative procedures about the face. Liquid solutions used to prepare the surgical area will loosen ordinary adhesive tape, allowing dangerous accidental extubation. This may be obviated by utilizing a water-proof adhesive, such as Sleek®, or by fastening nasotracheal tubes to the external nares and orotracheal tubes to the lip margins by silk sutures.

Maintenance of anaesthesia is accomplished by further doses of intravenous agents as required—nitrous oxide, oxygen, and trilene—utilizing a partial or non-rebreathing technique. We favour this method particularly for fractures in our fluoroscopic room. If there is no explosion hazard and a circle filter machine of proper size is available, cyclopropane may be substituted either for induction or for maintenance.

7. In smaller children, where venipuncture is impossible, induction is accomplished in the lateral Trendelenburg position using vinethene and ether and our best psychological approach. When plane 2 of stage 3 is reached, the patient is placed in the supine position and a snugly fitting endotracheal tube is introduced. The anaesthetic is maintained by ether, nitrous oxide, oxygen, and trilene by the partial rebreathing or non-rebreathing techniques.

The anaesthetic agents mentioned above have no deleterious action on the vomiting centre—there is no stimulation with nitrous oxide, vinethene, and sodium pentothal, and depression occurs with cyclopropane and ether.

8. For recovery the patients are placed again in the lateral Trendelenburg position. The endotracheal tube is left in place, fastened securely by adhesive. The pharynx is kept accessible for manual removal of solid particles and suction removal of liquids by the dental mouth gag. This position is maintained until the cough reflex has returned sufficiently to provide effective control by the patient of any vomited material. The patient is taken back to the recovery room or ward by the anaesthetist. Full instructions are issued to the nurse in charge regarding the state of consciousness and postoperative care.

9. With regard to very minor procedures such as myringotomies, incision and drainage of abscesses, and greenstick fractures, we favour an analgesic technique with vinethene or nitrous oxide and trilene without intubation.

TREATMENT OF ASPIRATIONS

The patient is placed in as steep a Trendelenburg position as possible to facilitate gravity drainage of material. Immediate bronchoscopy is imperative to save the patient's life if a major obstruction has occurred. In such an exigency, this becomes the direct responsibility of the attending anaesthetist. Oxygen may be administered through the side arm of the bronchoscope during and following this procedure, for resuscitative purposes. The bronchi are cleared of all offending material, with the bronchoscope remaining in place until reflexes have returned, the general condition is satisfactory, and oxygenation adequate. During the recovery phase chest expansion is encouraged by frequent movement, coughing, and hyperventilation. Antibiotics are administered during the postoperative period. The patient remains in a Trendelenburg position with the administration of oxygen as required.

SUMMARY

Emergency paediatric anaesthesia has been discussed with particular reference to the child with a full stomach.

1. The various factors influencing gastric retention and vomiting have been mentioned.

2. The depths of anaesthesia associated with vomiting and its neurogenic control have been outlined.

3. The various types of aspiration and routes followed by such material under anaesthesia have been discussed.

4. A short outline of the pathological picture of the lungs following aspiration deaths has been presented.

5. Particular emphasis has been placed on the conduct of such anaesthesia as practised at the Hospital for Sick Children.

RÉSUMÉ

L'anesthésie d'un enfant qui n'est pas à jeun qu'on admet pour chirurgie d'urgence présente un problème majeur.

Bien qu'il soit admis que l'estomac se vide en 3 à 4 heures et demie, les processus digestifs chez les enfants ordinairement s'arrêtent au moment du choc ou du traumatisme. C'est pourquoi, il ne faut pas s'illusionner par un faux sentiment de sécurité basé sur les normes physiologiques. Dans la chirurgie traumatique ou d'urgence nous prenons comme acquis que l'estomac est rempli à moins qu'il y ait preuve certaine qu'il n'a eu aucune ingestion d'aliments durant les dernières huit heures.

La prémedication, les agents anesthésiques et les techniques peuvent influencer les vomissements chez ces enfants. On favorise l'emploi des barbituriques et du Démérol parce qu'ils diminuent l'appréhension et n'excitent pas habituellement le centre du vomissement. Ils ne prolongent pas non plus, ou du moins très peu, le temps nécessaire à l'estomac pour se vider. La morphine et ses dérivés sont contre indiqués. Bien que l'atropine peut stimuler légèrement le centre du vomissement, son emploi se justifie par ses effets parasympholytiques qui sont nécessaires pour une induction rapide et facile et une intubation sans complication.

Quand l'anamnèse suggère que l'estomac est plein, toute intervention élective ou non urgente devrait être remise à plus tard ou faite sous anesthésie régionale si possible. S'il est nécessaire d'employer l'anesthésie générale, la technique préférée employée au "Hospital for Sick Children" de Toronto, consiste en une induction rapide employant un mélange de pentothal et de Syncurine (2 mgm. de Syncurine dans 20 cc. avec 2½% de pentothal—1 cc. par 5 lb. de poids). La Succinylcholine en dose de 1 mgm. par 4 lb. peut être donnée pour faciliter l'intubation qu'on fait rapidement utilisant un tube endotracheal de diamètre adéquat. On maintient la bouche ouverte au moyen d'un instrument de façon à avoir accès facilement au pharynx en cas de vomissement. Une fois l'intubation faite, l'anesthésie est maintenue par un mélange de protoxyde d'azote avec oxygène et trichlorethylene en ajoutant s'il est nécessaire des doses d'agents intraveineux.

À la période du réveil, le tube endotracheal est laissé en place et le patient est placé en position latérale avec tête basse jusqu'à ce que le reflexe de la toux s'est rétabli suffisamment pour permettre au malade un contrôle suffisant de tout matériel vomit. Le traitement de l'aspiration de vomissements se fait par bronchoscopie immédiate.

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