Anaesthesia History

Evolution of 20th century attitudes to prophylaxis of pulmonary aspiration during anaesthesia

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Purpose: To describe the evolution of aspiration risk identification and prophylactic management during general anaesthesia as presented in the United Kingdom (UK) anaesthesia textbooks published 1900-1998.

Methods: The Cumulated Index Medicus, 1900 - 1997, was searched under the headings: anaesthesia, aspiration, and pneumonia for relevant articles. A classification of features was created using key words and phrases: fasting guidelines, gastric emptying, intestinal obstruction and peritonitis, gastro-oesophageal function, upper oesophageal sphincter, raised intra abdominal pressure, pregnancy, posture and difficult tracheal intubation. Finally, 46 20th century UK anaesthesia text books were studied for the presence or absence of these features.

Results: Throughout the century, intestinal obstruction was a recognized risk factor. Only in the 1940s did some authors mention many of the now known risk factors. Hazards for the pregnant patient were described and in the 1960s the importance of the cricopharyngeus muscle was identified. Prophylactic measures included food and water restriction recommendations, especially in the latter half of the century and gastric lavage and drainage were mentioned throughout the century, as was posture at induction. In the 1950s tracheal intubation began to be routinely recommended. In the 1960s, cricoid pressure appeared and then a burgeoning interest in pharmacological control of gastric content character. Awake tracheal intubation is not always mentioned in 1990-96 textbooks.

Conclusion: The consensus of information in textbooks since 1970 was lacking in the previous part of the century. Current textbooks are fewer and are published less frequently. Their role in contemporary anaesthesia education and update merits review.

Objectif : Décrire, à partir des manuels d'anesthésie publiés au Royaume-Uni de 1900 à 1998, l'évolution de l'identification des risques d'aspiration et des mesures prophylactiques pendant une anesthésie générale.

Méthode : On a examiné l'Index Medicus cumulatif, 1900-1997, selon les rubriques suivantes : anesthésie, aspiration et pneumonie pour trouver des articles pertinents. On a créé une classification des articles selon des mots-clés et des expressions : ligne de conduite concernant le jeûne, évacuation gastrique, obstruction intestinale et péritonite, fonction gastro-oesophagienne, sphincter supérieur de l'oesophage, élévation de la pression intra-abdominale, grossesse, posture et intubation endotrachéale difficile. Finalement, 46 manuels d'anesthésie publiés au 20^e siècle au R-U ont été examinés pour vérifier la présence ou l'absence de ces caractéristiques.

Résultats : Tout au long du siècle, l'obstruction intestinale a été reconnue comme un facteur de risque. C'est dans les années 1940 seulement que certains auteurs mentionnent de nombreux facteurs de risque connus aujourd'hui. Les risques pour les femmes enceintes ont été décrits et, dans les années 1960, l'importance du muscle crico-pharyngien a été identifiée. Les mesures prophylactiques comprenaient, surtout pendant la seconde moitié du siècle, la recommandation de restreindre l'eau et la nourriture, le lavage et le drainage gastriques, mentionnés tout au long du siècle, de même que la posture du patient lors de l'induction. Dans les années 1950, on a commencé à recommander l'intubation endotrachéale comme une pratique courante. Dans les années 1960, la technique de la pression cricoïdienne apparaît et, par la suite, un intérêt croissant pour le contrôle pharmacologique du contenu gastrique. L'intubation endotrachéale chez le patient éveillé n'apparaît pas toujours dans les livres publiés entre 1990 et 1996.

Conclusion : La généralisation des informations qu'on retrouve dans les manuels depuis 1970, était absente auparavant. Les manuels actuels sont moins nombreux et sont publiés moins souvent. Leur rôle dans l'enseignement de l'anesthésie contemporaine et dans la mise à jour mérite une révision.

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THE first documented case of death from aspiration of food, during chloroform anaesthesia was reported in 1862.¹ Vomiting, regurgitation and pulmonary aspiration during general anaesthesia remains an ever present hazard of clinical care.

In 1891, the Section of Therapeutics of the British Medical Association formed a committee to investigate the effects of anaesthetics on humans, safety, techniques of administration and resuscitation.² During 1892, 25,920 case reports were gathered and in 1901, Eastes³ reported the analysis. Among the 35 conclusions of the committee: which had met more than 300 times, was one stating that the phenomena of retching and vomiting were frequently associated with complications and doubtless bore a causal relationship to them. A decade later, it was stated that "anaesthetic fatalities are increasing at an alarming extent",⁴ and an enquiry into the question of deaths resulting from the administration of anaesthetics, presented to Parliament by the command of His Majesty (Edward VII) in 1910, clearly stated "there is an increasing number of deaths under anaesthetics and some of them are preventable."⁵ Tragedies due to pulmonary aspiration occurred at that time and continued to be reported in medical journals. Thus at the start of the 20th century, pulmonary aspiration had been identified as a complication of general anaesthesia. The intent of this study is to describe the evolution of aspiration risk identification and prophylactic management during general anaesthesia; as presented in the United Kingdom (UK) anaesthesia textbooks published 1900-1998.

The domain of anaesthesia textbooks from the UK was chosen because of its availability and, importantly, early anaesthesia textbooks outlining such subject matter originated exclusively from the United Kingdom.

Methods

The Cumulated Index Medicus published during this century was searched manually under the headings anaesthesia, aspiration, and pneumonia for relevant articles. The keywords and phrases used are shown in Table I. These were read and a classification for recording the presence or absence of salient features of the subject appearing in the textbooks was created (Tables II, III). This classification was validated by finding that those salient features were included in textbooks published during 1990-96 and were absent during the decade 1900-09 publications.

Finally, the 46 anaesthesia textbooks published during this century available at the Wellcome Institute for the History of Medicine, London, England and the

John Scott Medical Sciences Library, University of Alberta were searched to discover the presence of items in the classification. This involved reading several chapters because in early texts, and sometimes even in modern multi-authored ones, the index is an unreliable guide to items of content believed of little importance by the compiler.

Results

Aspiration risk factors

FOOD AND DRINK INTAKE

During the first four decades, scant attention was paid to this topic. However, after 1960, a delay of five to six hours following solid food was commonly recommended though such a delay was known to be unreliable for emergency cases. Increasingly, the wide variety of factors influencing gastric emptying was appreciated and the impossibility of infallibly predicting whether or not a patient's stomach was empty. Thus, advice focused on the role of gastric intake control, aspiration and lavage prior to surgery in high risk cases. Recently, access to fluids up to two hours before surgery has been recommended for elective cases. (Table IV)

GASTRIC EMPTYING DRUG EFFECT AND TRAUMA

In the fourth decade gastric stasis, dilatation, and toxæmia were sometimes mentioned and by the sixth decade began appearing additional information regarding gastric contents, its consistency, quantity, osmotic pressure and osmotic pressure. There were cautionary comments regarding trauma patients and the effect of narcotics. Reduced motility had a role as did sclerodermic change and other pathology in the oesophagus.

INTESTINAL OBSTRUCTION DISTENSION, PERITONITIS

Throughout the century intestinal obstruction has been specifically identified as a cause of pulmonary aspiration, a potentially lethal hazard that in early decades was the only threat to the lungs mentioned. Pyloric stenosis was similarly recognized as a hazard at an early stage.

GASTRO-OESOPHAGEAL JUNCTION DYSFUNCTION: DRUGS OR PATHOLOGY

Pharmacological effects on these or the symptoms and signs manifested preoperatively by their malfunction were virtually ignored until mid-century when their importance began to be generally and consistently appreciated, particularly with reference to general anaesthesia for obstetrics.

TABLE I Keywords used for the information searches

Aspiration
Anaesthesia
Anaesthesia fatality
Childbirth
Cricoid pressure
Caesarean section
Fasting time
Gastric emptying
Gastro-oesophageal junction
Gastric pH
Gastric lavage
Gastric drainage
Intestinal obstruction/distension
Intra-abdominal pressure
Obstetrics
Posture
Protective reflexes
Regurgitation
Tracheal intubation
Upper oesophageal function
Vomiting

RAISED INTRA-ABDOMINAL PRESSURE, PREGNANCY, POSTURE

Pulmonary aspiration as a complication of obstetrical anaesthesia was not mentioned during the first four decades though in some instances other aspects of anaesthesia for obstetrics, especially uterine effects, were discussed at length. However, starting in the 1940s aspiration became an extremely important consideration.

COMPLICATED TRACHEAL INTUBATION

The depressant effect of anaesthesia on protective airway reflexes had long been recognized and thus the

need for as brief a period as possible between their removal and insertion of an endotracheal tube. Additionally, events that might stimulate vomiting or facilitate passive regurgitation had to be avoided. Implicit in this is the importance of factors that could cause intubation to take longer than usual, thus increasing the risk for the patient. However only in the present decade have the signs of a potentially difficult tracheal intubation been consistently presented as factors to be considered when identifying the risks of aspiration for a patient.

Pulmonary aspiration prophylaxis

The incidence of factors presented as attempts to prevent pulmonary aspiration or attenuate its effects are summarized (Table II).

Gastric content control

FOOD AND DRINK RESTRICTION

Advice for the management of elective surgery patients during the first half of the century was very vague, but later, though more details were provided, consensus was absent. (Table IV) The recent trend has been toward a freer access to clear fluids during the preoperative period.

MODIFICATION OF GASTRIC CONTENTS PH

This possibility was not described until 1971 when preoperative antacids were advised. In 1980 histamine blockers and metoclopramide were added. A further addition in 1995 was the use of proton pump inhibitors.

TABLE II Definition of risk factors

	<i>Decadal Number of Books</i>	<i>Food & Drink Intake</i>	<i>Gastric Emptying, Drug Effect & Trauma</i>	<i>Gastric Emptying, Disease Effect</i>	<i>Intestinal Obstruction Distension Peritonitis</i>	<i>Gastro- oesophageal Junction Dysfunction. Drugs or Pathology</i>	<i>Upper Oesophageal (crico- pharyngeal) Dysfunction</i>	<i>Raised Intra abdominal Pressure Pregnancy Posture</i>	<i>Complicated tracheal intubation</i>
1900-09	6	2	0	0	3	0	0	0	0
1910-19	5	0	0	0	3	1	0	0	0
1920-29	6	1	0	0	5	0	0	0	0
1930-39	6	0	0	0	2	0	0	0	0
1940-49	9	4	2	4	8	2	0	3	0
1950-59	2	2	1	1	2	0	0	1	0
1960-69	3	3	3	3	3	2	2	3	0
1970-79	2	2	2	2	2	2	2	2	0
1980-89	4	4	4	4	4	4	4	4	1
1990-96	3	3	3	3	3	3	3		

The incidence of aspiration risk factors occurring in decadal groups of textbooks studied

TABLE III Pulmonary aspiration prophylaxis

Decade Books n	Food & Water Restrict	Antacids	Gastric Content Control			Gastric Drainage Lavage	Gastric Isolation	Posture	Induction Characteristics		
			Histamine Blockers	Meto- Clo- pramide	Proton Pump Inhib				Cricoid Pressure	Tracheal Intubation	Awake Tracheal Intubation
1900-09	6	2	0	0	0	3	0	3	0	0	0
1910-19	5	0	0	0	0	2	1	3	0	1	0
1920-29	6	1	0	0	0	4	1	5	0	2	0
1930-39	6	0	0	0	0	3	0	3	0	1	0
1940-49	9	1	0	0	0	6	0	6	0	2	0
1950-59	2	1	0	0	0	1	0	1	0	2	0
1960-69	3	3	0	0	0	0	0	3	1	3	0
1970-79	2	2	2	0	0	2	0	2	2	2	0
1980-89	4	4	4	4	0	4	0	3	4	4	1
1990-96	3	3	3	3	2	3	0	1	3	3	1

The incidence of aspiration prophylaxis topics occurring in decadal groups of textbooks studied

GASTRIC DRAINAGE OR LAVAGE

These manoeuvres had been advocated in most textbooks since the beginning of the century though the general effect on the well being of very sick patients, and technical imperfections, were believed to restrict its use. The unfortunate psycho-physiological effects on the patient could be ameliorated by delaying passage of the tube until anaesthesia caused sufficient insensitivity but few authors proposed this.

GASTRIC ISOLATION

The insertion of an inflatable balloon into the stomach that could be then drawn up to block the oesophageal gastric junction had brief mention in textbooks during the period 1914-22.

Induction characteristics

POSTURE

In the early part of the century, those authors who addressed the matter were concerned with the anaesthetist's ready access to the mouth and the convenience of a patient who could take advantage of any remaining protective reflexes to clear his throat. Thus the head was often tilted to one side with it and shoulders rather high. The mouth might be kept open with a prop or gag. By 1930, a head-down tilt had its advocates. However, by 1966, practitioners were offered three options: (i) a head-down tilt with the patient in a lateral position. (ii) a 40° head-up tilt. (iii) supine combined with cricoid pressure. The choice was gradually reduced and, in 1980, reliance was primarily on a supine posture with cricoid pressure, a judicious choice of an awake intubation; a "rapid sequence" induction of general anaesthesia, or a regional anaesthetic with or without intubation.

CRICOID PRESSURE

Since 1966 cricoid pressure has been advised, consistently, as part of a prophylactic plan against tracheo-pulmonary contamination by gastric contents though more recently its fallibility and inconvenience in some circumstances have been identified.

TRACHEAL INTUBATION

Intratracheal insufflation was advocated in 1914 and again in 1922 primarily to facilitate airway management. The dual purpose of tracheal intubation was recognised with the development of cuffed endotracheal tubes. However, though endotracheal placement of a cuffed tube was included in books of 1923, 1930 and 1944, the technique was not consistently advocated by every author until 1960 and subsequently.

AWAKE TRACHEAL INTUBATION

During early decades the emphasis was either on maintaining a plane of general inhalational anaesthesia so light that the protective reflexes were not completely abolished, or by hastening induction so that tracheal intubation could be achieved as rapidly as possible. In order to achieve this the following were advocated:

- i Carbon dioxide to augment respiration
- ii Avoidance of even partial respiratory obstruction, thus reducing the likelihood of regurgitation
- iii A gradual but vigorous increase in concentration of inhaled anaesthesia vapour.

A rapid sequence intravenous induction can be even quicker but a technically difficult tracheal intubation could still take dangerously long and the impor-

TABLE IV Textbook comments regarding oral intake prior to general anaesthesia

		<i>There should be:</i>
Buxton DW ⁶	1900	nothing within a few hours
Gardner HB ⁷	1909	abstinence from food
Hewitt FH ⁸	1922	a regulated diet
Mackenzie JR ⁹	1944	no recent meal
Minnitt RJ, Gillies J ¹⁰	1948	fluids up to three hours preoperatively
Wyle WD, Churchill-Davidson HC ¹¹	1960	starvation for five hours
Evans FT, Gray TC ¹²	1965	nothing within four hours but that delay may be insufficient
Gray TC, Nunn JF ¹³	1971	starvation for six hours
Churchill-Davidson HC ¹⁴	1978	starvation for five hours
Churchill-Davidson HC ¹⁵	1984	starvation for five hours
Nunn JF, Utting JE, Brown BR ¹⁶	1989	light meal up to three-four hours pre-surgery
Healey TEJ, Cohen PJ, Arnold E ¹⁷	1995	free access to fluids up to three hours preoperatively. Access to solids up to five hours preoperatively.
Prys-Roberts C, Brown BR ¹⁸	1996	clear fluids up to two hours preoperatively for children. Some solids up to five-six hours for adults.

tance of awake intubation in the management of patients at risk of aspiration has recently received formal textbook recognition.

Discussion

The increased attention to risk factors during the decade 1940-49 may have been a continuing evolutionary trend, the result of stimulating activities during World War II, or the increase in the number of physicians interested in anaesthesia. However, there are other possibilities to be considered. By this time, the number of patients aspirating had become very considerable. Although aspiration can be associated with any kind of surgery there had been a progressive increase in the amount and complexity of surgery until, by 1925, abdominal surgery was common and markedly increased about 1940.¹⁹ This could result in a more frequent occurrence of aspiration. Unfortunately, this cannot be confirmed by published statistics. The figures for the total deaths per annum under or connected with the administration of anaesthetics reported from the Registrar Generals Statistical Review of England and Wales²⁰ suggest mortality increasing until the mid-thirties but causes are unspecified and criteria for inclusion varied. The fallibility of drawing statistical conclusions from published data is mentioned by several authors in journal articles published between 1927-39.²¹⁻²⁵ There is also evidence that up to the early 1930s pulmonary aspiration was not universally considered a prominent problem in anaesthesia practice. Flemming,²⁶ reporting in 1913 on inquests concerning deaths during anaesthesia, did not mention vomiting, regurgitation, or aspiration though these may have been presented euphemistically

as "embarrassed breathing" or "suffocation". Slot²⁷ discussing, in 1923, deaths under anaesthetics, with special reference to their pathology lacks reference to aspiration, as does a publication dated 1927 titled *Emergencies in Anaesthetics*.²⁸ In 1928, a discussion of anaesthesia and obstetrics at the Royal Society of Medicine²⁹ does not refer to vomiting and aspiration. Furthermore, Featherstone in a 1932 paper titled "Care of the lungs in anaesthesia"³⁰ ignores the possibility of aspiration.

Although definitive evidence that there had been a proportionate increase in deaths due to aspiration during the decade 1940-49 was lacking, there was circumstantial evidence that changes in practice might have increased the likelihood of deaths by aspiration. In obstetrics, the lateral position had become less popular for a simple forceps delivery as had, for more complicated cases, the supine position with the mother's legs hanging down, feet touching the floor. The lithotomy position was substituted. That aggravated the aspiration hazard³¹ and, unless tracheal intubation took place while the patient was supine, was believed to be responsible for deaths.^{32,33} In general surgical practice, though the Wagansteen routine of intestinal decompression reduced the hazard for obstructed patients, nevertheless an induction technique utilizing drugs that suddenly abolished the protection provided by the cricopharyngeus muscle of a patient in the 20° reverse-Trendelenburg, or Trendelenburg tilt increased the likelihood of passive regurgitation.^{31,34-7}

Even if the proportion of patients aspirating had remained constant during the decades before 1940 what might have been acceptable could become intolerable if social and professional attitudes to morbidity

and mortality changed. Whatever the underlying motivation, there is evidence from anaesthesia journals that members of the Association of Anaesthetists of Great Britain and Ireland engaged actively during 1940-49 in reducing the incidence of morbidity and mortality due to pulmonary aspiration.³⁸⁻⁴⁰

During the second half of this century there was an increasing understanding of risk factors, information gradually being adopted from journals into textbooks. Details of pulmonary aspiration prophylaxis in the forms of gastric content control and characteristics of induction of general anaesthesia have been developed, and appeared in textbooks more gradually. The lag time has been for the synthesis of substances for gastric content control and appreciation of the role awake intubation of the trachea plays in the conduct of general anaesthesia.

An incidental finding in this study was the number of comprehensive anaesthesia texts published during each decade. In the first half of the century, individual publications were valuable and a frequent supplement to other forms of continuing education. As has been previously discussed some authors could be forgiven for neglecting a problem that seemed to them infrequent, often avoidable, and less threatening than matters such as cardiac dysfunction. Current series of comprehensive multi-authored anaesthesia texts filter journal publications for the reader but appear much less frequently.

Conclusion

During the decade 1940-49 there was a textbook presentation of risk factors for a complication that previously had been entirely ignored by some authors. Since the 1960s these have been consistently addressed except for a "difficult tracheal intubation" which only in this decade is receiving uniform attention in textbooks. Pulmonary aspiration prophylaxis evolved somewhat more slowly than an appreciation of risk factors. Comprehensive accounts of possibilities were available since the 1980s but the role of awake intubation is apparently not always worthy of mention.

Textbooks have become fewer and much longer during the century and new editions of any one series are published less frequently than established advances are reported in journals. Thus, the role of a single series of major textbooks for anaesthesia education and update merits debate.

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