History of Anaesthesia

Oropharyngeal and nasopharyngeal airways: I (1880-1995)

John W.R. McIntyre MD FRCPC

Purpose: During the past decade the laryngeal mask airway (LMA) has dominated literature about airways for use during general anaesthesia. The LMA addresses clearly defined clinical objectives. The purpose of this study is to determine whether those objectives were described collectively with reference to earlier airway designs.

Methods: The anaesthesia sections of Index Medicus 1880-1995 were read and publications in the English language about airways were obtained and analysed. Secondary information sources were references to causes of respiratory obstruction. This was supplemented by random reference to available textbooks.

Results: The multiple objectives, as least partially, satisfied by the LMA were not described collectively at the time of Hewitt's presentation of an oropharyngeal airway in 1908 and largely were neglected until the present time.

Conclusion: The design of airways has been based on clinical circumstances and perceived requirements of the time. In contemporary anaesthetic practice, distinct clinical situations still occur and there is a role for different device designs. Currently for supraglottic airway management during general anaesthesia, four types of airway should be available: a Guedel airway, nasopharyngeal airway, a laryngeal mask airway, and an airway specifically designed to facilitate blind tracheal intubation.

Objectif: Au cours de la dernière décennie, les publications sur les dispositifs de contrôle des voies aériennes pendant l'anesthésie générale ont surtout porté sur le masque laryngé (ML). Le ML visait manifestement des objectifs cliniques défi-

nis. Le but de cette étude était de vérifier la conformité de l'ensemble des ces objectifs avec les concepts antérieurs.

Méthodes: Les sections de l'Index Medicus de 1880 à 1995 touchant l'anesthésie ont été révisées et les articles de langue anglaise publiés sur les dispositifs de contrôle des voies aériennes ont été analysés. Les sources secondaires de renseignements se rapportaient à l'obstruction respiratoire. Le tout a été complété en référant aléatoirement aux manuels en usage.

Résultats: Les nombreux objectifs du ML n'étaient pas, du moins en partie, en règle générale décrits au moment de l'introduction de la canule oropharyngée par Hewitt en 1908 et ont été négligés jusqu'à maintenant.

Conclusion: La conception des canules reposait sur un contexte clinique et des besoins perçus à l'époque. Aujourd'hui, des situations cliniques distinctes surviennent encore et il existe un rôle distinct pour les différents dispositifs. Présentement, pour la gestion sus-glottique des voies aériennes pendant l'anesthésie générale, quatre types de dispositifs devraient être disponibles: la canule Guedel, la canule nasopharyngée, le masque laryngé et un dispositif conçu spécialement pour faciliter l'intubation trachéale à l'aveugle.

Contemporary criteria for oro- and nasopharyngeal airways include: low resistance to respiratory gas flow, protection from gastric and nasal contamination of the respiratory tract, tolerance of positive pressure ventilation; and lack of adverse qualities associated with placement, cleaning and construction materials. Once inserted, additional support to maintain a clear airway should be unnecessary. The purpose of this investigation was to determine whether those criteria had been declared at the inception of the earliest airways and whether there had been deliberate and progressive attempts to satisfy them.

The primary method for data collection regarding oro- and nasopharyngeal airways was an English language visual search, in the Anaesthesia Sections, in Index Medicus 1880-1995. The criterion for an airway

From the Department of Anaesthesia, University of Alberta.

Address correspondence to: Dr. J.W.R. McIntyre,

Department of Anaesthesia, University of Alberta Hospitals, 8440 - 112 Street, Edmonton, Alberta T6G 2B7.

Phone: (403) 492-8861. Fax: (403) 492-9610.

Accepted for publication 17th February, 1996.

was that inspiration and expiration could pass through it. Accordingly, the "ether hook" and its modifications were excluded. Secondary information sources were references on causes of respiratory obstruction. These were supplemented by miscellaneous statements about airways in books sought by random reading in personally available texts. The information sources identified were obtained and read by the author.

The results of reading those publications are presented here as an introduction dealing with early statements about respiratory obstruction. This is followed by an account of devices in the mainstream of airway development. Excluded are unusual items such as Lieberman's tongue holding airway¹ and others described by Sykes.²

During the decades of practice following 1847, the management of upper respiratory obstruction must have been discussed but apparently Howard's experiments in 1880 still merited publication.³ His account begins:

"Upon one point at least, and one not altogether unimportant, the entire profession, both in theory and practice, may fairly be admitted to be everywhere unanimous. To this unity the jaw-priser and the tongue forceps in every operating room bear silent witness."

Jaw-prisers and tongue forceps, (Figure 1) valuable when clenching of teeth and perhaps vomit caused respiratory obstruction during anaesthesia induction, remained in vogue for decades and even in 1935 the activities of some anaesthetists deserved criticism.⁴ Howard's purpose in 1880 had been to discover whether respiratory obstruction was relieved by traction on the tip of the tongue because the tongue was moved from the posterior or pharyngeal wall, or because of epiglottic movement. Epiglottic movement did not occur. The following year Lyman stated⁵ in a textbook of the time:

"Death by suffocation may occur... This can only occur as a result of great negligence or great ignorance on the part of the operator."

This must have further stimulated Howard,⁶ who had previously demonstrated the role of the tongue in respiratory obstruction, (Figure 2) and now on the basis of additional anatomical studies including measurement of occipital - vertebral joint movement, concluded that "by sufficient extension of the head and neck... the epiglottis is instantly, and beyond prevention, made completely erect." In 1890, Hewitt⁷ presented a classic review of the causes and management of respiratory obstruction and other publications supported the current ideas^{8,9} with few reservations.

FIGURE 1 Top to bottom: Jaw-prisers; attributed to Lorenz Heister (1683-1758) Boxwood spiral mouthgag, design c. 1860, Mayo tongue forceps.

FIGURE 2 Howard's diagram of respiratory obstruction caused by the tongue. (abc) The velum palate, tongue, epiglottis, fallen back and in contact with the posterior wall of the pharynx. (d) Os hyoidea. (e) Frenulum linguae.³

This saga of airway devices justly begins with the inimitable Clover in 1881.¹⁰ In that year he apparently demonstrated a bag with a nasal tube fixed in the nostril as well as a funnel shaped India rubber tube for conveying anaesthetic to the back of the mouth during operations on the jaw. O'Dwyer's oropharyngeal tube¹¹ (Figure 3) had a conical distal end to produce a fairly airtight fit with the larynx and was suitable for artificial ventilation during resuscitation and in modified form for thoracic surgery. Airway development continued to follow those distinct anatomical paths; nasopharyngeal and oropharyngeal.

Nasopharyngeal tubes were used not only to relieve respiratory obstruction, sometimes a major difficulty during induction prior to the advent of intravenous agents, but to deliver anaesthetic vapour^{12–17} (Figure 4). In 1913 Connell¹⁸ described a technique for artificial ventilation when vapour was passed through a nasopharyngeal tube extending to the epiglottis. The nose and lips were compressed and "simultaneously the larynx must be firmly pressed back by finger or weight on the cricoid cartilage, blocking by pressure on the oesophagus the ingress of air into the stomach." It was not until 1961 that Sellick¹⁹ demonstrated experimentally that cricoid pressure could restrict the passage of material up the oesophagus. Nasopharyngeal delivery of anaesthetic vapour continued to be intermittently described^{20–24} and there was a resurgence of interest in 1969–73.^{25–28} These last reports emphasized the simplicity of the technique, efficacy for maintaining a patent airway, and avoidance of tracheal trauma in outpatients. Nasotracheal tubes fulfil several criteria for contemporary airways and remain useful today.

Oropharyngeal airways were created to overwhelm the then well known causes of respiratory obstruction and early models such as O'Dwyer's must have been difficult to insert and a stimulant to swallowing. Hewitt had reviewed anaesthesia airway obstruction in 1890,⁷ but it was not until 1908 that he presented the forerunner of many modern oropharyngeal airway designs²⁹ (Figure 5). This first model must have had only limited success as a controller of the tongue and soon a curved model of uncertain origin extended its length. Other modifications followed, addressing the possibility of liquid anaesthetic being dripped down the airway,³⁰ combined delivery of vapour,³¹ and ease of cleaning.³² Many other small changes were made by various anaesthetists but important criteria considered desirable in anaesthetic practice in 1995 were still not addressed in a unitary fashion. These included protection of the respiratory tract from contamination, safe tolerance of pressures necessary for artificial ventilation and invariable maintenance of a clear airway without manual or mechanical aid.

FIGURE 3 O'Dwyer's tube. (A) Air entry, (C) Conical fit over larynx, (E) Inspiratory and expiratory gasway (from *Mushin WM, Rendell-Baker L. The Principles of Thoracic Anaesthesia. Charles C. Thomas, 1st Edn, 1953, p 111*).

FIGURE 4 Nasopharyngeal anaesthesia delivery.¹³

FIGURE 5 Hewitt's airway.²⁹

Soon after the end of World War I, the use of naso- and oropharyngeal airways was well established and it is likely that the rapid development of tracheal intubation reduced interest in new oropharyngeal airway design. Nevertheless, tracheal intubation could be difficult, or undesirable, as evidenced by continued interest in oropharyngeal airways. In 1933, Guedel introduced a moderately stiff, rubber airway, protected from occlu-

FIGURE 6 Shipway's balloon modified airway²⁸ (from *Lundy John S. Clinical Anesthesia*: WB Saunders, 1942, p 279).

sion by the teeth and shaped to conform with the shape of the pharynx.³³ Its flattened cross section made it easy to insert between partially clenched teeth, sometimes an important feature during inhalational anaesthesia induction in those times. In 1935, the patient could be protected during nasal surgery by Shipway's airway with inflatable balloon³⁴ (Figure 6). In 1937 Leech described a "Pharyngeal bulb gasway", based on his study of pharyngeal anatomy, that would fit closely with the entry to the larynx³⁵ (Figure 7). This device came quite close to fulfilling contemporary criteria for an oropharyngeal airway and is reminiscent of O'Dwyer's tube.¹¹

The occasional difficulty with tracheal intubation during this period between the World Wars must have revived interest in instrumental guides for the tube. Leroy's united spatulae³⁶ (Figure 8) of 1827 was used as an airway intubator but the "divided airway" put on the market in London in the 1930s³⁷ is a more appropriate forerunner of modern airway intubators such as the Cappe³⁸ Berman³⁹ and Williams.⁴⁰ The laudable primary function of these is to facilitate blind tracheal intubation and thus, being special purpose devices, do not necessarily address every modern airway requirement.

FIGURE 7 Leech's pharyngeal gasway.³⁵

A development in the post World War II period was the extension by Fink of the anterior wall of the Guedel airway into the vallecula⁴¹ thus making it functionally similar to the Macintosh laryngoscope blade, reminiscent of Karn's expanding artificial airway of 1928⁴² (Figure 9) and even Leroy's spatulae.³⁶ Allegedly, this reduced the need for chin support during anaesthesia. Another development was a combined oropharyngeal airway and dental pack,⁴³ (Figure 10) an attempt to unite manoeuvres universally practised during anaesthesia for dentistry.

In 1983 Brain introduced the laryngeal mask – "a new concept in airway management."⁴⁴ This device has largely addressed the criteria for a modern oropharyngeal airway previously listed. Discussion of its merits and demerits have monopolized oropharyngeal airway literature since then. It has been "overviewed" by McGoldrick in 1995.⁴⁵

When discussing the findings of the present investigation, it must be admitted that the devices are based on publications and neglect conversations that must have occurred among anaesthetists. However, it is hard to imagine the essence of those conversations would not have been published had they been considered important

FIGURE 8 Leroy's two-bladed intubating spatula that holds the mouth open, depresses tongue and epiglottis and allows the tracheal tube to pass through the guide rings (from *Mushin WM, Rendell-Baker L. The Principles of Thoracic Anaesthesia. Charles C. Thomas, 1st Edn, 1953, p 36*).

at that time and few descriptions of airways mentioned any objectives for their design. A more likely possibility is that tracheal intubation rather than supraglottic airway development was perceived as the principal solution to clinical problems.

The design of supraglottic airway management devices, their appearance, disappearance, and reappearance in the literature in a somewhat different guise can be interpreted in the light of anaesthetic practice of the time rather than anaesthetists' lack of interest in the past. For example, the stimulant effect of O'Dwyer's laryngeal tube¹¹ on neuronal reflexes would have been disadvantageous and a close fit with the glottis during anaesthetic as opposed to resuscitation largely unnecessary in 1885. Leech's similar device in 1937³⁵ would

FIGURE 9 Kam's expanding artificial airway.⁴²

FIGURE 10 Green's combined oropharyngeal airway and dental pack.⁴³

have been desirable because it enabled "closed circuit" cyclopropane anaesthesia to be employed for patients when tracheas would not normally be intubated. Similarly Ferguson³⁰ expanded and closed the proximal end of a Hewitt type airway, positioning holes at the side of the airway under the proximal cap. This protec-

tion from liquid anaesthetic being dripped into the airway would have become unnecessary when drop and mask administration was abandoned. Interest in airway intubators burgeoned in association with needs for tracheal intubation and recognition of trauma and technical difficulty in some patients. Finally, the laryngeal mask airway represents a perception of the need for a device with multiple qualities in our contemporary anaesthetic practice. However, had it been presented decades earlier, anaesthetists lacking convenient ways of controlling the relevant muscle and reflex activity might have been less enthusiastic about it.

In conclusion, the literature of this century lacks identification of the current criteria considered to be desirable for a supraglottic airway management device. Development does not seem to have followed a unitary effort to achieve these criteria. The laryngeal mask airway is a fortunate coincidence of increasing needs for clinical perfection, manufacture capability, drugs to suit the occasion, and one individual's recognition of the situation and motivation to meet the challenge. Even so, in contemporary anaesthetic practice, this unitary concept for an airway may be unsuitable for some situations. Several types of airway are desirable in the operating room to deal with specific clinical problems: Guedel airway, a Williams or Berman airway intubator, nasopharyngeal tubes, as well as laryngeal masks. The laryngeal mask is the finale of oropharyngeal device design and future progress in airway management will be by facilitating tracheal intubation with a short malleable fibroscope temporarily placed inside the endotracheal tube while the tube is inserted. The necessary preliminary exposure, of the glottis by lifting the tongue, epiglottis, and hyoid bone away from the pharyngeal wall may be done with an instrument similar to the handle of a tablespoon employed for this purpose by Foulis in 1898.⁴⁶

Acknowledgements

I am grateful to Nelson Nix, MD of Edmonton, Alberta, Canada for the instruments illustrated in Figures 1 and 7.

References

- 1 Liberman L, Holzman L. A new tongue-holding airway. *Illinois Medical Journal*, 1952; 101: 39-40.
- 2 Sykes WS. *Essays on the First Hundred Years of Anaesthesia*, Vol III. Ellis RH (Ed.). Edinburgh: Churchill Livingstone 1982: 92-112.
- 3 Howard B. Observations on the upper air passages in the anaesthetic state. *Lancet* 1880; May 22: 796-8.
- 4 Sykes WS. Gags and tongue forceps. Their use and abuse. *Lancet* 1935; Jan 12: 87-8.
- 5 Lyman HM. *Artificial Anaesthesia and Anaesthetics*. New York: William Wood and Co., 1881.
- 6 Howard B. A new and only way of raising the epiglottis. *BMJ* 1888; Nov 17: 1103-7.
- 7 Hewitt F. Clinical observations upon respiration during anaesthesia. *Proc Roy Med Chirug Soc, London*, 1891: 3(Siii)31-8.
- 8 Bard CL. The advantages of extension of the head during anesthesia and some other conditions. *Southern California Practitioner*, Los Angeles, 1893; viii: 275-86.
- 9 Hare HA. The posture of the head in accidents when the patient is under an anaesthetic. *Bulletin of The John Hopkins Hospital*, Balt., 1895 vi: 1-6.
- 10 Clover JT. *Trans. int. Congr. Med* 1888; 2: 392, In: Duncum BM. *The Development of Inhalational Anaesthesia*, 1st ed. London: Oxford University Press, 1947: 604
- 11 Northrup WP. Apparatus for prolonged artificial forcible respiration. *BMJ* 1894; ii: 697.
- 12 Pederson VC. An attachment to Bennett's inhaler for pharyngeal (Crile's method) and tracheal administration, and for the ethyl chloride-ether sequence. *New York Medical Journal* 1904; xxx: 1214-7.
- 13 McHenry JH. Technique of tubation of the pharynx to facilitate administration of anaesthetics and to prevent inhalation of blood in mouth and face operations. *Surgery, Gynecology and Obstetrics* 1906; iii: 152-3.
- 14 Page HM. A method of giving ether by means of nasal tubes. *Lancet* 1909; 2: 364-7.
- 15 Souchon E. Uninterrupted anaesthesia in operations on face and mouth. *Surgery, Gynecology and Obstetrics* 1911; xiii: 169-70.
- 16 Penneo FW. Anesthesia by pharyngeal insufflation. *JAMA* 1912; ix: 1862.
- 17 Lumbard JE. Helps in surgical anesthesia. *JAMA* 1912; LIX: 1853-4.
- 18 Connell K. A new ether vaporizer. *JAMA* 1913; X: 892-4.
- 19 Sellick BA. Cricoid pressure to control regurgitation of stomach contents during induction of anaesthesia. *Lancet* 1961; 2: 404-6.
- 20 Rockett AE. Drop-ether pharyngeal anaesthesia and apparatus for aseptic anaesthesia in plastic facial surgery. *Am J Surg (Anesthesia Supp)* 1919; 33: 89-92.
- 21 Coburn RC. New pharyngeal tube for anesthesia in oral and head surgery. *Medical Records* 1921; 100: 155-8.
- 22 Miller AH. Pharyngeal insufflation anesthesia. *JAMA* 1922; 79: 441-3.
- 23 Heard KM. Intrapharyngeal inhaleway for improved administration of ether. *Anesth Analg* 1937; 16: 337-40.
- 24 Nesi JA. So called "Mayo tube". *Anesth Analg* 1946; 25: 125-6.
- 25 Elam JO, Titell JH, Feingold A, Weisman H, Bauer RO.

- Simplified airway management during anesthesia or resuscitation: a binasal pharyngeal system. *Anesth Analg* 1969; 48: 307–16.
- 26 *Weisman H, Weis TW, Elam JO, Bethune RM, Bauer RO.* Use of double nasopharyngeal airways in anesthesia. *Anesth Analg* 1969; 48: 356–61.
 - 27 *Weisman H, Bauer RO, Huddy RA, Elam JO.* An improved binasopharyngeal airway system for anesthesia. *Anesth Analg* 1972; 52: 11–3.
 - 28 *Feingold A, Runyan NJ.* Experience with the latex binasal pharyngeal airway. *Anesth Analg* 1973; 52: 263–6.
 - 29 *Hewitt FW.* An artificial “airway” for use during anaesthesia. *Lancet* 1908; Feb 15: 490–1.
 - 30 *Ferguson RH.* An artificial airway for surgical anesthesia. *JAMA* 1913; IX: 1858–9.
 - 31 *Pinneo FW.* A pharyngeal tube combining rebreathing and insufflation. *JAMA* 1915; XV: 1279.
 - 32 *Lumbard JE.* A controller of the tongue and palate during general anesthesia. *JAMA* 1915; LXIV: 1757.
 - 33 *Guedel AE.* A nontraumatic pharyngeal airway. *JAMA* 1933; 100: 1862.
 - 34 *Shipway F.* Airway for intranasal operations. *BMJ*, 1935; April 13: 767.
 - 35 *Leech BC.* The pharyngeal bulb gasway: a new aid in cyclopropane anesthesia. *Anesth Analg* 1937; 16: 22–5.
 - 36 *Mushin WW, Rendell-Baker L.* The Principles of Thoracic Anaesthesia, 1st ed. Charles C. Thomas 1953: 36.
 - 37 *Gillespie NA.* Endotracheal Anesthesia, 3rd ed. University of Wisconsin Press, Madison, 1963: 92–3.
 - 38 *Cappe B, Berman R.* Airways – a new make and a new type. *Anesthesiology* 1949; 10: 358–9.
 - 39 *Berman RA.* A method for blind oral intubation of the trachea or esophagus. *Anesth Analg* 1977; 56: 866–7.
 - 40 *Williams RT, Harrison RE.* Prone tracheal intubation simplified using an airway intubator. *Can Anaesth Soc J* 1981; 28: 288–9.
 - 41 *Fink BR.* Roentgen ray studies of airway problems. I. The oropharyngeal airway. *Anesthesiology* 1957; 18: 162–3.
 - 42 *Karn R.* An expanding artificial airway. *Lancet* 1928; Oct 13: 762.
 - 43 *Green RA, Akester J.* A combined oropharyngeal airway and dental pack. *Anaesthesia* 1981; 36: 889–91.
 - 44 *Brain AIJ.* The laryngeal mask – a new concept in airway management. *Br J Anaesth* 1983; 55: 801–5.
 - 45 *McGoldrick KE.* The laryngeal mask airway: an overview. *Survey of Anesthesiology*. 1955; 39: 203–7.
 - 46 *Foulis J.* Mechanical impediment to respiration during anaesthesia, etc. *BMJ* 1898; April 23: 1065–6.