

WORKSHEET for PROPOSED Evidence-Based GUIDELINE RECOMMENDATIONS

Worksheet Author:	Home Subcommittee: Peds/NRP
Author's Home Resuscitation Council: AHA	Date Submitted to Subcommittee: 6/20/04; revised Sept 30, 2004; Nov 3, 2004

STEP 1: STATE THE PROPOSAL. State if this is a proposed new guideline; revision to current guideline; or deletion of current guideline.

Existing guideline, practice or training activity:

Masks that fit over the laryngeal inlet have been shown to be effective for ventilating newly born full-term infants. There is limited data on the use of these devices in small preterm infants, however, and their use in the setting of meconium-stained amniotic fluid has not been studied. The laryngeal mask airway, when used by appropriately trained providers, may be an effective alternative for establishing an airway in resuscitation of the newly born infant, especially in the case of ineffective bag-mask ventilation or failed endotracheal intubation (Class Indeterminate, LOE 5). However, we cannot recommend routine use of the laryngeal mask airway at this time, and the device cannot replace endotracheal intubation for meconium suctioning.

Step 1A: Refine the question; state the question as a positive (or negative) hypothesis. State proposed guideline recommendation as a specific, positive hypothesis. Use single sentence if possible. Include type of patients; setting (in-/out-of-hospital); specific interventions (dose, route); specific outcomes (ROSC vs. hospital discharge).

Hypotheses:

1. Among newly born infants that require positive pressure ventilation for resuscitation, the LMA achieves safe and effective ventilation faster than a bag and face-mask.
2. Among newly born infants that cannot be effectively ventilated with a bag and face-mask for resuscitation, the LMA achieves safe and effective ventilation faster than endotracheal intubation.
3. Among newly born infants that require resuscitation and cannot be ventilated with a bag and face-mask and/or intubated with an endotracheal tube, the LMA achieves safe and effective ventilation.

Step 1B: Gather the Evidence; define your search strategy. Describe search results; describe best sources for evidence.

1. Inclusion criteria: Studies were evaluated if they described the LMA used for positive pressure ventilation among neonates (≤ 28 days of life), neonatal animal models, or neonatal mechanical models. Prospective, controlled clinical trials were included without language restrictions. Observational studies were only included if the full text was published in English. Studies excluded based on language restrictions are identified under "Additional References."

Observational studies describing the LMA used for human neonatal resuscitation that did not include a control group (case series, case reports) were assigned to Level of Evidence 5. Studies describing the LMA for positive pressure ventilation in the operating room or during diagnostic bronchoscopy were only included if the subjects were ≤ 1 month old, ≤ 44 weeks post-conceptual age, or ≤ 5 kg body weight. These non-resuscitation airway management studies, regardless of methodology, were assigned to Level of Evidence 7 (extrapolation). Duplicate publications of the same subjects were only included once (most recent publication only).

2. Exclusion criteria: Studies involving non-neonatal animal or non-neonatal human resuscitations were excluded. Studies describing neonatal subjects combined with older infants were excluded if insufficient details were available to independently assess outcomes for the neonatal subgroup. Studies describing the LMA used for anesthesia, to facilitate endotracheal intubation, or to facilitate diagnostic bronchoscopy were excluded if the subject was breathing spontaneously through the LMA without positive pressure ventilation. Information published only in abstract form and articles not yet accepted for publication were excluded. Neonatal studies excluded based on insufficient details, lack of positive pressure ventilation, and for language

restrictions are described under “Additional References” with the reason(s) for exclusion.

3. Assessment of design and methods: Uncontrolled descriptive studies (case reports, case studies, cohorts) were considered “Good” if they collected data based on prospectively defined intervention and inclusion criteria; provided appropriate demographic information about the included subject(s) and the indication for intervention; clearly described technical details about the intervention; and included follow-up evaluation of subjects after the completion of the intervention. Descriptive studies were considered “Fair” if they described retrospectively identified subject(s); did not prospectively define the intervention or inclusion criteria; provided incomplete demographic information about the included subject(s) and indications for intervention; provided limited technical details about the intervention; or did not include follow-up information. Descriptive studies were considered “Poor” if they referenced an intervention without providing sufficient detail to assess the indication, subject(s), technique, or outcome of the intervention. Anecdotal descriptions of the relevant intervention were considered “Unsatisfactory.”

4. Sources: Electronic searches of Medline (Pubmed and Ovid, last accessed 5/1/2004) and the Cochrane Database of Systematic Reviews (last accessed 5/1/2004). Hand searches of Pediatric Academic Societies (PAS) annual meeting abstracts in Pediatric Research (1995-2004), Paediatric Anesthesia (1/1/2004-5/1/2004), and Resuscitation (1/1/2004-5/1/2004). Review of references in bibliographies of retrieved manuscripts.

5. Search Strategy: Key words: laryngeal mask (MESH heading and topic word) limited to “all infants, birth – 23 months”. Ovid identified 280 references and PubMed identified 272 references. All 280 articles were screened and 267 potentially relevant references were identified. Thirty-five references met inclusion criteria. Twenty-nine references were excluded: 13 for language restrictions (Spanish, French, Italian, German, and Japanese), 13 because no positive pressure was delivered through the LMA, and 6 because of lack of detail regarding the neonatal subgroup in a case series.

STEP 2: ASSESS THE QUALITY OF EACH STUDY

Step 2A: Determine the Level of Evidence. For each article/source from step 1, assign a level of evidence—based on study design and methodology.

Level of Evidence	Definitions (See manuscript for full details)
Level 1	
Level 2	Esmail 2002
Level 3	
Level 4	
Level 5	Baraka 1995, Brimacombe 1995, Brimacombe 1999, Brimacombe 2004, Bucx 2003, Denny 1990, Fernandez-Jurado 2002, Fraser 1999 (a), Fraser 1999 (b), Gandini 1999, Gandini 2003, Johnson 1994, Mawer 1995, Paterson 1994, Trawoger 1999, Trevisanuto 2004, Yao 2004
Level 6	Brietzke 2001, Lavies 1993
Level 7	Abouleish 1998, Auden 2000, Carenzi 2002, Ellis 1999, Hansen 1995, Hinton 1997, Johr 2003, Lesmes 2000, Lonnqvist 1995, Lopez-Gil 1996, Markakis 1992, Mecklem 1995, Park 2001, Theroux 1995, Webster 1995
Level 8	

Step 2B: Critically assess each article/source in terms of research design and methods.

Was the study well executed? Suggested criteria appear in the table below. Assess design and methods and provide an overall rating. Ratings apply within each Level; a Level 1 study can be excellent or poor as a clinical trial, just as a Level 6 study could be excellent or poor as an animal study. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study. For more detailed explanations please see attached assessment form.

Component of Study and Rating	Excellent	Good	Fair	Poor	Unsatisfactory
Design & Methods	Highly appropriate sample or model, randomized, proper controls AND Outstanding accuracy, precision, and data collection in its class	Highly appropriate sample or model, randomized, proper controls OR Outstanding accuracy, precision, and data collection in its class	Adequate, design, but possibly biased OR Adequate under the circumstances	Small or clearly biased population or model Weakly defensible in its class, limited data or measures	Anecdotal, no controls, off target end-points Not defensible in its class, insufficient data or measures

A = Return of spontaneous circulation C = Survival to hospital discharge E = Other endpoint

B = Survival of event D = Intact neurological survival

Step 2C: Determine the direction of the results and the statistics: supportive? neutral? opposed?

DIRECTION of study by results & statistics:	SUPPORT the proposal	NEUTRAL	OPPOSE the proposal
Results	Outcome of proposed guideline superior, to a clinically important degree, to current approaches	Outcome of proposed guideline no different from current approach	Outcome of proposed guideline inferior to current approach

Step 2D: Cross-tabulate assessed studies by a) level, b) quality and c) direction (ie, supporting or neutral/ opposing); **combine and summarize.** Exclude the *Poor* and *Unsatisfactory* studies. Sort the *Excellent*, *Good*, and *Fair* quality studies by both *Level and Quality of evidence*, and *Direction of support* in the summary grids below. Use citation marker (e.g. author/ date/source). In the *Neutral* or *Opposing* grid use bold font for *Opposing* studies to distinguish them from merely neutral studies. Where applicable, please use a superscripted code (shown below) to categorize the primary endpoint of each study.

Supporting Evidence

Hypotheses:

1. Among newly born infants that require positive pressure ventilation for resuscitation, the LMA achieves safe and effective ventilation faster than a bag and face-mask.
2. Among newly born infants that cannot be effectively ventilated with a bag and face-mask for resuscitation, the LMA achieves safe and effective ventilation faster than endotracheal intubation.

3. Among newly born infants that require resuscitation and cannot be ventilated with a bag and face-mask and/or intubated with an endotracheal tube, the LMA achieves safe and effective ventilation.

Quality of Evidence	Excellent								
	Good		Esmail 2002 ^(E2)			Gandini 1999 ^(E1) , Paterson 1994 ^(E1)		Lonngqvist 1995 ^(E1, E2) , Lesmes 2000 ^(E1, E2) , Lopez-Gil 1996 ^(E1, E2) , Markakis 1992 ^(E1, E2, E3) , Park 2001 ^(E1, E2) , Webster 1995 ^(E1, E2)	
	Fair					Baraka 1995 ^(E3) , Brimacombe 1995 ^(E2, E3) , Brimacombe 1999 ^(E3) , Brimacombe 2004 ^(E1, E2, E3) , Bucx 2003 ^(E3) , Denny 1990 ^(E3) , Fernandez-Jurado 2002 ^(E3) , Fraser (a) 1999 ^(E3) , Fraser (b) 1999 ^(E3) , Gandini 2003 ^(E3) , Johnson 1994 ^(E3) , Trawoger 1999 ^(E3) , Yao 2004 ^(E3)		Abouleish 1998 ^(E3) , Carezni 2002 ^(E1) , Ellis 1999 ^(E3) , Hansen 1995 ^(E3) , Hinton 1997 ^(E2) , Johr 1993 ^(E1, E2) , Mecklem 1995 ^(E1, E2, E3) , Theroux 1995 ^(E3)	
		1	2	3	4	5	6	7	8
Level of Evidence									

A = Return of spontaneous circulation C = Survival to hospital discharge E1 = Hypothesis #1
 B = Survival of event D = Intact neurological survival E2 = Hypothesis #2
 E3 = Hypothesis #3

Neutral or Opposing Evidence

Hypotheses:

1. Among newly born infants that require positive pressure ventilation for resuscitation, the LMA achieves safe and effective ventilation faster than a bag and face-mask.
2. Among newly born infants that cannot be effectively ventilated with a bag and face-mask for resuscitation, the LMA achieves safe and effective ventilation faster than endotracheal intubation.
3. Among newly born infants that require resuscitation and cannot be ventilated with a bag and face-mask and/or intubated with an endotracheal tube, the LMA achieves safe and effective ventilation.

Quality	Excellent								
	Good					Brietzke 2002 ^{E2}			
	Fair								
		1	2	3	4	5	6	7	8
		Level of Evidence							

A = Return of spontaneous circulation C = Survival to hospital discharge E1 = Hypothesis #1
 B = Survival of event D = Intact neurological survival E2 = Hypothesis #2
 E3 = Hypothesis #3

META-ANALYSES: to provide a basis for Step 3

<p>Are there two or more Level 1 studies in Step 2D that support the proposal and are statistically significant at $p < 0.05$? NO Do these supportive studies constitute at least one quarter of Level 1 clinical trials? NA (If the answer to both questions is “yes”, the null hypothesis is very likely to be false.) Do you think there are sufficient data to perform a formal meta-analysis? NO</p>
<p>Summarize core numeric data. If you can provide a formal meta-analysis, attach the most critical tabulations, and cite the methodology used. NA</p>

STEP 3. DETERMINE THE CLASS OF RECOMMENDATION. Select from these summary definitions.

CLASS	CLINICAL DEFINITION	REQUIRED LEVEL OF EVIDENCE
<p>Class I <i>Definitely recommended.</i> Definitive, excellent evidence provides support.</p>	<ul style="list-style-type: none"> • Always acceptable, safe • Definitely useful • Proven in both efficacy & effectiveness • Must be used in the intended manner for proper clinical indications. 	<ul style="list-style-type: none"> • One or more Level 1 studies are present (with rare exceptions) • Study results consistently positive and compelling
<p>Class II: <i>Acceptable and useful</i></p>	<ul style="list-style-type: none"> • Safe, acceptable • Clinically useful • Not yet confirmed definitively 	<ul style="list-style-type: none"> • Most evidence is positive • Level 1 studies are absent, or inconsistent, or lack power • No evidence of harm
<ul style="list-style-type: none"> • <i>Class IIa: Acceptable and useful</i> <p>Good evidence provides support</p>	<ul style="list-style-type: none"> • Safe, acceptable • Clinically useful • Considered treatments of choice 	<ul style="list-style-type: none"> • Generally higher levels of evidence • Results are consistently positive

<ul style="list-style-type: none"> • Class IIb: <i>Acceptable and useful</i> <p>Fair evidence provides support</p>	<ul style="list-style-type: none"> • Safe, acceptable • Clinically useful • Considered optional or alternative treatments 	<ul style="list-style-type: none"> • Generally lower or intermediate levels of evidence • Generally, but not consistently, positive results
<p>Class III: <i>Not acceptable, not useful, may be harmful</i></p>	<ul style="list-style-type: none"> • Unacceptable • Not useful clinically • May be harmful. 	<ul style="list-style-type: none"> • No positive high level data • Some studies suggest or confirm harm.
<p>Indeterminate</p>	<ul style="list-style-type: none"> • Research just getting started. • Continuing area of research • No recommendations until further research 	<ul style="list-style-type: none"> • Minimal evidence is available • Higher studies in progress • Results inconsistent, contradictory • Results not compelling

STEP 3: DETERMINE THE CLASS OF RECOMMENDATION. State a **Class of Recommendation** for the Guideline Proposal. State either **a) the intervention**, and then the conditions under which the intervention is either Class I, Class IIA, IIB, etc.; or **b) the condition**, and then whether the intervention is Class I, Class IIA, IIB, etc.

See final recommendations

REVIEWER’S PERSPECTIVE AND POTENTIAL CONFLICTS OF INTEREST: Briefly summarize your professional background, clinical specialty, research training, AHA experience, or other relevant personal background that define your perspective on the guideline proposal. List any potential conflicts of interest involving consulting, compensation, or equity positions related to drugs, devices, or entities impacted by the guideline proposal. Disclose any research funding from involved companies or interest groups. State any relevant philosophical, religious, or cultural beliefs or longstanding disagreements with an individual.

Background:

Neonatologist with 8 years of postgraduate experience, American Academy of Pediatrics Neonatal Resuscitation Program instructor for 11 years, Neonatal Resuscitation Program Steering Committee for < 1 year, Neonatal Resuscitation Program Education Workgroup participant for 6 years.

Potential conflicts of interest:

I have lectured on the use of the LMA during resuscitation without receiving any consulting compensation or equity positions. I have no financial relationship with the manufacturer and have never participated in any educational activity sponsored by the manufacturer. I am a co-author of a pending Cochrane Database review on the same topic.

REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK: Summarize your final evidence integration and the rationale for the class of recommendation. Describe any mismatches between the evidence and your final Class of Recommendation. “Mismatches” refer to selection of a class of recommendation that is heavily influenced by other factors than just the evidence. For example, the evidence is strong, but implementation is difficult or expensive; evidence weak, but future definitive evidence is unlikely to be obtained. Comment on contribution of animal or mechanical model studies to your final recommendation. Are results within animal studies homogeneous? Are animal results consistent with results from human studies? What is the frequency of adverse events? What is the possibility of harm? Describe any value or utility judgments you may have made, separate from the evidence. For example, you believe evidence-supported interventions should be limited to in-hospital use because you think proper use is too difficult for pre-hospital providers.

The laryngeal mask (LMA) is a disposable, latex-free, silicone rubber tube connected to an elliptical mask with a soft, inflatable rim. The mask is inserted orally using the operator’s index finger and is guided along the hard palate without laryngoscopy. Once the device is inserted, the cuff is inflated. The inflated mask sits with its lumen facing the laryngeal opening while the cuff conforms to the contours of the hypopharynx occluding the esophagus with a low-pressure seal. The airway tube includes a 15 mm male adaptor that is attached to a standard resuscitation bag. At the present time, the best available evidence evaluating the efficacy and safety of the LMA for neonatal cardiopulmonary resuscitation comes from one small randomized controlled trial (Esmail,

2002) and two case series (Paterson 1994, Gandini 1999). Limited additional evidence is available from 13 case reports describing the successful placement of a LMA during resuscitation when both BMV and ETT were unsuccessful. Multiple additional case reports describe the LMA during anesthesia, diagnostic bronchoscopy, as a guide to intubating the airway, and as an adjunctive device for infants with difficult airways.

Neonatal Resuscitation Studies

Paterson (1994) and Gandini (1999) each reported using an LMA for positive pressure ventilation in the delivery room in place of a bag-mask device. Paterson's case series included 21 patients compiled in serial fashion without a control group. Newborns > 35 weeks gestation with an estimated birth-weight >2500 grams requiring positive pressure ventilation following delivery were included if a study team member was present. Newborns with congenital anomalies and those requiring chest compressions were excluded. In total, the study team attended 93/132 eligible deliveries and resuscitated 21 newborns (weight range 2235-4460 grams). An LMA was successfully inserted during the first attempt in all 21 newborns and heart rate exceeded 100 bpm within 30 seconds in 20/21 patients. One newborn failed to respond to both LMA insertion and subsequent endotracheal intubation. The time required for LMA placement in the remaining 20 subjects was 8.6 +/- 1.4 seconds (mean +/- SD, range 7-12 seconds). One subject developed a pneumothorax 90 minutes after birth. No other complications were noted. Gandini subsequently reported the largest experience (n=104) with the LMA during neonatal resuscitation. This uncontrolled case series described a single investigator's experience using the LMA for neonatal resuscitation over a five-year period. The study population included 23 low birth-weight (1500- 2500 gram) and 6 very low birth-weight (1000-1500 gram) newborns. An LMA was successfully inserted on the first attempt in all 104 eligible neonates and effective ventilation achieved in 103/104. One subject, without apparent meconium staining, could not be resuscitated with either the LMA or an endotracheal tube and was found to have severe meconium aspiration at postmortem examination. Adequate chest expansion was achieved by 10 seconds (mean) in both normal and low birth-weight newborns. An audible leak was noted around the LMA at 22 cm H₂O (mean) circuit pressure among normal birthweight newborns (n=75) and 24 cm H₂O (mean) circuit pressure among all low birthweight newborns (n=29). After leaving the delivery room, 6 neonates developed respiratory distress requiring either nasopharyngeal CPAP (n=2) or endotracheal intubation (n=4). No complications were reported, however, the author had previously published a subset (n=40) of this series (Brimacombe 1995b, #45) and reported that two patients had blood present in the oropharynx when the LMA was removed. Paterson and Gandini's prospective case series provide good evidence that the LMA can be used to establish effective ventilation during positive pressure ventilation among infants > 2500 grams and limited evidence that the LMA can be used among newborns > 1000 grams. The absence of a control group, however, prevents any direct comparisons with bag-mask devices.

In a survey of pediatricians and anesthesiologists, Trevisanuto (2004) reported 101 newly born infants resuscitated with a LMA in a single region of Italy during the year 2000. The majority (n=95) were from the author's own institution. No details were provided about the subjects, the indication for resuscitation, or their outcome. This survey was scored as "poor" quality of evidence and does not appear on the summary table above.

Esmail (2002) has reported the only randomized controlled trial directly comparing the LMA with endotracheal intubation (ETT) during neonatal resuscitation. Newborns > 35

weeks gestation and > 2500 grams delivered following Caesarean section were randomized to LMA placement (n=20) or ETT (n=20) if they had not responded (HR < 100 bpm) to bag-mask ventilation at one minute. Newborns with congenital anomalies and those requiring chest compressions were excluded. The operator appears to have been an anesthesiologist in all cases. Successful placement at the first attempt was similar using either the LMA (17/20) or ETT (18/20). LMA placement was unsuccessful after three attempts in one subject. The average time for insertion was remarkably short for both interventions, but statistically shorter in the ETT group (7.5 seconds vs. 10 seconds, $p < 0.05$). The course of heart rate improvement, color change, Apgar scores, and time to spontaneous respirations were similar in both groups. While there were more traumatic events involving the epiglottis and uvula in the LMA, there was no statistically significant difference (6/20 LMA, 3/20 ETT). The study is limited by the absence of details describing the randomization method and the inclusion of only normal birth-weight infants following a Caesarean section. Furthermore, it may not be appropriate to generalize this study's results to settings where a pediatrician, rather than an anesthesiologist, is responsible for airway management. The operators in this trial were all anesthesiologists and they had substantially greater success with endotracheal intubation (100%) than has been recently reported for pediatric residents. Falck (2003) reported that 35% of neonatal intubation procedures were unsuccessful after a maximum of 4 attempts. The increased success among operators in this trial may have biased the trial against finding a difference between the LMA and ETT. In summary, Esmail's trial suggests that the LMA and ETT may be equivalent, among experienced operators, for establishing effective ventilation if attempts with a bag-mask device have been unsuccessful.

Difficult Airway Studies

The most frequently reported use of the LMA among neonates and infants is for airway management when both BMV and ETT have been unsuccessful. Several publications describe "blind intubation" using an endotracheal tube advanced through the LMA and intubation assisted with a fiberoptic bronchoscope advanced through the LMA for infants with difficult airways that could not be intubated with direct laryngoscopy (Denny 1990, Ellis 1999, Hansen 1995, Johnson 1994, Theroux 1995, Auden, 2000, Iohom 2002, Osses 1999, Stocks 2002). Most of these publications are single case reports or retrospectively collected case series and have typically involved subjects with craniofacial anomalies requiring perioperative anesthetic airway management. Based on these reports, a relatively strong class of recommendation has been made for using the LMA during resuscitation when both BMV and ETT have failed. Although evidence from the operating room is extrapolative and the strength of evidence from any individual case report is considered weak, the non-invasive nature of LMA placement in comparison with the alternative (tracheostomy), the consistent positive results, and the practical difficulties of designing a randomized controlled trial in this unpredictable emergency situation make it unlikely that definitive evidence will become available.

Emergency Medications and Meconium

There has been virtually no experience administering emergency medications or managing meconium stained fluid through the LMA during neonatal resuscitation. Brimacombe (1999) reported an immediate response following the administration of epinephrine through an LMA during the resuscitation of an 800 gram newborn after both BMV and ETT had failed. Brimacombe (2004) also reported administering intra-tracheal surfactant through the LMA in two newly born infants. Limited evidence from adults (Pregel, 2001) suggests that the LMA may not be a reliable route for emergency

medication administration. Therapeutic lidocaine concentrations were achieved in all patients with endotracheal tube administration (n=10), but in only 4/10 with LMA administration. No studies have evaluated whether meconium can be suctioned from the neonatal airway through an LMA. Both Paterson (1994) and Gandini (1999) intubated the airway with an endotracheal tube to suction meconium prior to placing the LMA and Esmail (2002) did not describe the management of subjects with meconium stained fluid.

Complications

Complications have been described during and after the use of the LMA in children. Bronchoscopic studies in infants and children have noted that the LMA is frequently improperly seated and partially obstructs the laryngeal opening (Mizushima 1992, Rowbottom 1991, Dubreuil 1993, Park 2001). Rowbottom found the LMA perfectly positioned in only 49% of infants and children (n=100) despite a clinically patent airway in 98%. Among a group of 33 infants (mean age 4.4 +/- 3.9 months, mean weight 5.6 +/- 1.9 kg) with an LMA inserted after the induction of anesthesia for elective surgery, Dubreuil found 14 infants with a portion of the epiglottis impinged in the bars that cross the midline of the LMA mask. In most of these instances, however, the function of the LMA was not compromised. Dubreuil also noted a relatively high rate of cough (16%) and laryngospasm (10%) upon insertion of the LMA that was attributed to inadequate depth of anesthesia and possibly to increased laryngo-tracheal reflexes in children. When using the size-1 LMA, Park (2001) found partial or complete obstruction of the glottis in 18/25 (74%) by bronchoscopic evaluation. Harnett (2000) randomized 49 anaesthetized children < 1 year to have their airway maintained by an LMA or facemask-oral airway while undergoing elective surgery. Infants in the LMA group had a higher incidence of intra-operative and perioperative airway complications (15/27 vs. 5/22, p=0.02) including breath-holding and obstruction. Only one infant developed severe laryngospasm requiring atropine and succinylcholine. Webster (1995), Park (2001), Harnett (2000), and Mizushima (1992) identified infants that initially had successful placement of the LMA but subsequently developed airway obstruction when the LMA became displaced during anesthesia. Webster used the LMA for positive pressure ventilation during cryopexy surgery in 16 premature infants. In six patients, oxyhemoglobin desaturation was noted shortly after LMA insertion and improved when the mask was partially withdrawn. The mask position was felt to be unstable throughout the remainder of the procedure and was held in position as judged by a capnograph tracing.

Soft tissue and neurologic trauma have also been reported with the LMA. Esmail (2002) described minor soft tissue trauma involving the epiglottis and uvula in 6/20 infants resuscitated in the delivery room with an LMA. Two infants required corticosteroid treatment; however, there were no long-term complications. Case reports in the adult literature have described lingual, hypoglossal, and recurrent laryngeal nerve palsies when an inappropriately sized LMA was used. Sacks (2000) reported a 4- year-old child with transient recurrent nerve neuropraxia following a brief, uncomplicated procedure using a LMA. He required endotracheal intubation for stridor and dexamethasone. Although the LMA was appropriately sized, the authors speculated that this complication was caused by nerve compression between the mask and the thyroid and cricoid cartilages. Orfei (2002) reported an unusual complication describing the accidental perforation of the LMA mask when an anaesthetized premature infant was undergoing jugular venous cannulation. This is not a complication that would be expected during neonatal resuscitation. None of the patients described by Paterson (1994) or Gandini

(1999) appear to have experienced airway obstruction or laryngospasm. This most likely reflects the difference between the patient populations and the shorter duration of use in the resuscitation setting.

The LMA has been primarily used for short-term airway support and its safety during long-term use has not been established. Five case reports (Gandini 2003, Bucx 2003, Fernandez-Jurado 2002, Fraser 1999b, Yao 2004) included in this review described using the LMA to provide mechanical ventilation for 2-6 days without apparent oropharyngeal complications. Brietzke (Brietzke 2001), however, described a ferret model of prolonged ventilatory support using the LMA that raises significant concerns. All 5 ferrets randomized to prolonged ventilation with an LMA developed significant lingual edema and cyanosis after 6-16 hours resulting in respiratory failure due to airway obstruction. Histologic examination demonstrated significant venous and capillary congestion. The investigators also found that it was very difficult to effectively suction the airway through the LMA and tenacious secretions contributed to respiratory compromise. A single additional case report described a 12-month-old infant who developed significant lingual edema requiring dexamethasone treatment after an inappropriately large LMA was used for 5 hours (Stillman 2003). While there is good evidence to support short-term safety of the LMA in newborns, there is insufficient evidence to recommend its use for long-term ventilation.

Teaching LMA Placement

A final consideration is to determine how difficult it will be to teach neonatal resuscitators how to use an LMA. L Davies (1993) designed a very small trial (n= 4 residents, n=7 midwives) comparing success with endotracheal intubation and LMA placement using a neonatal mechanical resuscitation model following a brief teaching session. The residents and midwives were both more successful placing the LMA than the ETT. Dickinson (1994) designed a similar trial with 95 nurses and paramedics attending an adult cardiopulmonary resuscitation course. Following a 30-minute presentation and demonstration, 96% of participants successfully placed an LMA using an adult resuscitation mannequin. Both of these studies are limited by the difficulty in assessing correct LMA placement in a mechanical model. Pennant (1992) and Reinhart (1994) found similar results with medical students, paramedical students, paramedics, and respiratory therapists who received brief instructions in LMA and ETT use before attempting placement of both devices in the operating room. They were subsequently more successful placing the LMA than the ETT on the first attempt in anesthetized adults. Stone (1994) designed a prospective trial to evaluate the ability of first responders to secure the airway during an in-hospital, adult cardiac arrest using an LMA. Volunteer ward nurses (n=139) completed a 90-minute didactic session and were required to complete 5 successful LMA insertions in the operating room before receiving a competency certification. The LMA was subsequently used in 164 cardiac arrests and was placed on the first attempt in 71% and the second attempt in 26% of patients. The first responder achieved successful ventilation with an LMA in 88% of patients. Although students appear to acquire this skill rapidly, Lopez-Gil (1996) cautions that there may be a higher incidence of airway complications during the initial period of training. In a prospective study, Lopez-Gil followed eight inexperienced anesthesia residents placing an LMA in 121 children for operative anesthesia. There was a high problem rate during the first 15 uses of an LMA in children. Their skills improved and they achieved a low problem rate (1-2%) after 75 uses.

Language Restrictions

Thirteen references were excluded for language restrictions. Only one reference (Nagahama 1995), published in Japanese with an English abstract, described using an LMA for neonatal resuscitation in an infant with craniofacial anomalies in a Neonatal Intensive Care Unit. The 12 additional references described the LMA used in the operating room for anesthetic airway management or for bronchoscopy and would have been included as Level 7 (extrapolation) evidence if no language restriction had been applied. One reference (Orfei 2002), published in French with an English abstract, described an unusual complication and is included in the discussion section above.

Preliminary draft/outline/bullet points of Guidelines revision: Include points you think are important for inclusion by the person assigned to write this section. Use extra pages if necessary.

Attachments:

Printed (paper) bibliography; and on diskette using a reference manager. It is recommended that the bibliography be printed in annotated format. This will include the article abstract and any notes you would like to make providing specific comments on the quality, methodology and/or conclusions of the study.

Key figures or tables from evidence-based analysis

Full hard copies of most critical cited papers

Citation List

Citation Marker	Full Citation*
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Abouleish, 1998	Abouleish AE, Mayhew JF. Magnetic resonance imaging of the airway in an infant with micrognathia. <i>Anesthesia & Analgesia</i> . 1998; 86(5): 964-966.
Auden, 2000	Auden SM, Lerner GM. Blind intubation via the laryngeal mask: a word of caution.[comment]. <i>Paediatric Anaesthesia</i> . 2000; 10(4): 452.
Baraka 1995	Baraka A. Laryngeal mask airway for resuscitation of a newborn with Pierre-Robin syndrome. <i>Anesthesiology</i> . 1995; 83(3): 645-646.
Brietzke, 2001	Brietzke S, Mair E. Laryngeal mask versus endotracheal tube in a ferret model. <i>Ann Otol Rhinol Laryngol</i> . 2001; 110(9): 827-833.
Brimacombe, 1995	Brimacombe JR, De Maio B. Emergency use of the laryngeal mask airway during helicopter transfer of a neonate.[see comment]. <i>Journal of Clinical Anesthesia</i> . 1995; 7(8): 689-690.
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Abouleish AE, Mayhew JF. Magnetic resonance imaging of the airway in an infant with micrognathia. *Anesthesia & Analgesia*. 1998; 86(5): 964-966.

Abstract: Micrognathia in newborn infants is a difficult challenge for airway management. It requires that a mask airway be maintained and that the larynx be visualized during direct laryngoscopy. The relationship of the size of the tongue to the mandible has been postulated as the cause of airway management difficulties in patients with micrognathia and normal tongue size [1] and in patients with normal mandible size and macroglossia [2]. In these reports, the anatomical relationship of the airway has been illustrated only by an artist's depiction, not with radiological images. We present the case of a newborn infant with a large Dandy-Walker cyst who was scheduled for placement of a cyst-peritoneal shunt. Preoperative magnetic resonance imaging (MRI) scans illustrate the anatomical relationship of the micrognathic mandible, tongue, and glottic opening

Comments: (LOE 7, fair, hypothesis 3, operating room, supportive)- Case report describing a full-term, 3 kg female with Dandy-Walker cyst, micrognathia, and cleft palate requiring nasal CPAP. Went to OR on DOL 7 and had initial airway control with a size-1 LMA while awake with topical lidocaine jelly on the first attempt. She was then anesthetized and had 2 failed intubation attempts. The LMA was easily reinserted after each intubation attempt. An ETT was successfully placed on the 3rd attempt (unable to see glottis, blind placement). Highlights the ability of the LMA to secure the airway when endotracheal intubation is difficult. The paper includes a helpful MRI demonstrating the anatomic abnormalities associated with micrognathia that make direct laryngoscopy difficult.

Auden SM, Lerner GM. Blind intubation via the laryngeal mask: a word of caution.[comment]. *Paediatric Anaesthesia*. 2000; 10(4): 452.

Abstract: None

Comment: (LOE 7, unsatisfactory, operating room, neutral)-Letter to the editor stating that a fiberoptic endoscope should be used if you plan to intubate through the LMA because the epiglottis may be partially obstructing the distal aperture of the LMA. A 2.4 kg infant with Miller syndrome is anecdotally referenced that was intubated with this approach.

Baraka A. Laryngeal mask airway for resuscitation of a newborn with Pierre-Robin syndrome. *Anesthesiology*. 1995; 83(3): 645-646.

Abstract: None

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)-Brief letter describing a 5-day old, 3.2 kg, full-term male with Pierre-Robin who developed airway obstruction and cyanosis in the hospital. He remained severely desaturated and bradycardic despite bag-mask ventilation with an oral airway with poor chest rise and gastric distension. Endotracheal intubation was unsuccessful by the anesthesia team. A size-1 LMA was inserted easily and successfully resuscitated the infant. No details regarding skill level of the resuscitators, circumstances leading up to the event, or adverse outcomes. Supports using the LMA for

newborns with difficult airways during resuscitation.

Brietzke S, Mair E. Laryngeal mask versus endotracheal tube in a ferret model. *Ann Otol Rhinol Laryngol.* 2001; 110(9): 827-833.

Abstract: Acquired subglottic stenosis in infants is a difficult iatrogenic problem with notable morbidity, primarily caused by prolonged endotracheal intubation. The laryngeal mask airway (LMA) is a recently developed, alternative airway device that does not contact the subglottis. To explore the possibility of preventing subglottic stenosis, we compared the endotracheal tube (ETT) and the LMA in terms of the incidence and severity of glottic and subglottic injury resulting from prolonged intubation in the adult ferret model of the infant airway. Ten adult ferrets were randomly intubated under inhalational anesthesia with either a 4.0 cuffless ETT or a size 1 LMA for a 24- to 48-hour period. Rigid laryngeal endoscopy was used to detect pharyngeal or glottic injury during the period of intubation and on a routine basis for 3 months after extubation. All 5 ferrets in the ETT group developed endoscopically evident glottic and subglottic injury; 2 of the 5 developed a symptomatic, mature subglottic stenosis. The 5 ferrets in the LMA group had endoscopically normal larynges. However, all ferrets in the LMA group developed significant tongue edema and cyanosis during the first 24 hours of intubation, and 3 of the 5 died of respiratory failure due to airway obstruction. In the 2 LMA survivors, evidence of oropharyngeal injury persisted until 6 weeks after extubation. We conclude that the LMA does not cause subglottic injury in this model. However, its prolonged use results in significant pharyngeal morbidity that raises serious doubt as to its potential routine use in infants requiring prolonged ventilatory support.

Comment: (LOE 6, good, hypothesis 2, animal, opposing) *Not directly applicable to brief use during neonatal resuscitation, but an important caution for prolonged use. The investigators also found tenacious secretions developed in the LMA group animals that made pulmonary toilet difficult. It's questionable if this model accurately reflects the human neonatal response to either endotracheal intubation or LMA placement.*

Brimacombe JR, De Maio B. Emergency use of the laryngeal mask airway during helicopter transfer of a neonate.[see comment]. *Journal of Clinical Anesthesia.* 1995; 7(8): 689-690.

Abstract: None

Comment: (LOE 5, fair, hypotheses 2/3, resuscitation, supportive)- *Brief letter to the editor describing a 3.25 kg term neonate with respiratory distress (pneumonia?) developed apnea and oxy-hemoglobin desaturation un-responsive to bag-mask ventilation during helicopter transport. Endotracheal intubation was not attempted because of physical environment limitations in the helicopter. A pediatric registrar inserted a size-1 LMA and the infant "pinked up rapidly" with positive pressure ventilation. The registrar had successfully placed an LMA on one previous occasion. The LMA was removed after he became vigorous but was placed again when apnea recurred later during the flight.*

Brimacombe J, Gandini D. Airway rescue and drug delivery in an 800 g neonate with the laryngeal mask airway. *Paediatric Anaesthesia.* 1999; 9(2): 178.

Abstract: None

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- *Brief letter describing an 800 gm, 24 wk EGA newborn delivered in a rural hospital (Australia) distant from skilled neonatal resuscitators and without small neonatal endotracheal tubes. Failed bag-mask ventilation. Unconventionally managed with a 14-gauge venous catheter placed through the vocal cords because there were no small endotracheal tubes available. An attempt at ETT was made when a pediatrician arrived at 1 hour of age, but was complicated by bradycardia. A size-1 LMA with an un-inflated cuff was successfully placed and epinephrine was instilled through the tube resulting in successful ventilation and resuscitation. The infant died at 5 hours. This is the only reported case of emergency medicine instillation through an LMA during neonatal resuscitation and the smallest reported neonate successfully ventilated with a LMA. No details regarding the experience or training of the pediatrician that attempted ETT and placed the LMA.*

Brimacombe J, Gandini D, Keller C. The laryngeal mask airway for administration of surfactant in two

neonates with respiratory distress syndrome. *Paediatric Anaesthesia*. 2004; 14: 188-190.

Abstract: We report the successful use of the Classic laryngeal mask airway to provide brief access to the intratracheal space for the administration of surfactant in two neonates with respiratory distress syndrome.

Comment: (LOE 5, fair, hypotheses 1/2/3, resuscitation, supportive)- This case report describes both resuscitation in the delivery room and later intra-tracheal administration of surfactant. It is the only published case report describing surfactant administration through the LMA. The report describes a 1.36 kg premature (30 week gestation) male who was resuscitated in the delivery room using an LMA when both face mask ventilation and endotracheal intubation failed. This infant was initially managed with CPAP, but developed worsening respiratory distress syndrome. A size-1 LMA was inserted on 2 separate occasions and surfactant was administered through the LMA with nasal CPAP used between administrations. A second neonate (3.2 kg/37 weeks gestation) developed RDS and had surfactant administered through a LMA. Suctioning the stomach suggested that at least half of the administered dose reached the lungs in both cases. This is one of only two reports, from the same authors, describing intra-tracheal drug delivery to a neonate through the LMA. It is not clear why the medical staff had difficulty with face-mask ventilation and endotracheal intubation in the first patient. No anomalies were described. The second infant had surfactant administered through the LMA because of "the success of the first case." It is not clear if informed consent was obtained for this investigative delivery system.

Bucx MJ, Grolman W, Kruisinga FH, Lindeboom JA, Van Kempen AA. The prolonged use of the laryngeal mask airway in a neonate with airway obstruction and Treacher Collins syndrome. *Paediatric Anaesthesia*. 2003; 13(6): 530-533.

Abstract: Upper airway obstruction and difficult tracheal intubation are often encountered in patients with Treacher Collins syndrome (mandibulofacial dysostosis). In this case report, the use of a laryngeal mask airway (LMATM) in a 10-day-old newborn with severe Treacher Collins syndrome and acute airway obstruction is described. It successfully relieved the airway obstruction and was left in situ for an exceptionally long period of 4 days. The difficult decisions with respect to the management of the airway and specifically the role of the laryngeal mask are described. In our opinion, in some newborns with severe mandibulofacial disorders and upper airway obstruction, where conservative airway management procedures have failed, the laryngeal mask can be considered not only to relieve the obstruction but also to buy time until there is full insight into the medical condition and its consequences.

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- One of four case reports of prolonged LMA use. This case report describes a 10 day old with Treacher-Collins syndrome that was resuscitated with an LMA after other measures were unsuccessful. It does not appear that positive pressure ventilation was required once the airway was secured with the LMA, however, it is included because the LMA was used for resuscitation in the setting of acute airway distress. Airway obstruction recurred after the LMA had been left in place for 4 days. The medical team and parents decided to withdraw support. After the infant's death, fiberoptic laryngoscopy showed edema of the arytenoids with no other evidence of trauma or significant edema. The cause of airway obstruction with the LMA in place was not identified. Similar problems, however, have been identified with prolonged LMA use in an animal model (see Brietzke).

Carenzi B, Corso RM, Stellino V, Carlino GD, Tonini C, Rossini L, Gentili G. Airway management in an infant with congenital centropfacial dysgenesis. *British Journal of Anaesthesia*. 2002; 88(5): 726-728.

Abstract: The use of a laryngeal mask airway (LMA) on two occasions, in a 53-day-old and 270-day-old male infant with Tessier N.3 and N.4 facial defects, using sedation and topical anaesthesia is described. The LMA was used to manage the airway and facilitate inhalation induction of anaesthesia as the facial deformities were thought to be too extensive for the safe use of a facemask. The LMA is an alternative to a facemask and secures the airway and facilitates the inhalation induction of anaesthesia in paediatric patients with severe facial deformities.

Comment: (LOE 7, fair, hypothesis 1, operating room, supportive)- Case report describing an infant with a complicated cranio-facial anomaly that made face-mask placement difficult. A size 1.5 LMA was used in

the OR for induction in place of a mask. The infant was sedated with trans-mucosal midazolam and his pharynx had been sprayed with lignocaine. Anesthesia was induced after the LMA was placed. It is not clear why a 1.5 LMA was chosen rather than the recommended size 1.0. The airway was ultimately intubated with conventional laryngoscopy without difficulty. The infant was greater than 1 month old but < 5 kg (4.4 kg).

Denny NM, Desilva KD, Webber PA. Laryngeal mask airway for emergency tracheostomy in a neonate. *Anaesthesia*. 1990; 45(10): 895.

Abstract: None

Comment: (LOE 5, fair, hypothesis 3, resuscitation and operating room, supportive)- Brief letter describing a 2.75 kg, full-term female with Pierre-Robin with airway distress successfully resuscitated in the delivery room using a size-1 LMA after bag-mask ventilation and ETT failed. After initial resuscitation, she was managed with a NP airway and tongue tie, but developed airway distress again on DOL 3 and was successfully managed with an LMA after unsuccessful attempts at ETT. In the operating room, ETT with laryngoscopy was again unsuccessful as well as an attempt to place an intubating bougie blindly through the LMA. A tracheostomy was performed while anesthesia was administered through the LMA. No details about the skills and training of the delivery room resuscitators.

Ellis DS, Potluri PK, O'Flaherty JE, Baum VC. Difficult airway management in the neonate: a simple method of intubating through a laryngeal mask airway. *Paediatric Anaesthesia*. 1999; 9(5): 460-462.

Abstract: Tracheal intubation through a laryngeal mask airway is one option for securing an airway in the patient with a difficult airway. A variety of techniques and equipment have been used to stabilize the position of the tracheal tube while removing the laryngeal mask airway. We have shown that if a fiberoptic bronchoscope is used to place an endotracheal tube through a laryngeal mask in neonates, additional equipment is not needed to remove the laryngeal mask airway without endangering tracheal tube placement. This is possible even in small neonates.

Comment: (LOE 7, fair, hypothesis 3, operating room, supportive)- Case report describing a 20 day old infant with congenital anomalies and laryngeal edema that could not be intubated in the OR and was successfully managed with an LMA. An ETT was then advanced over a fiberoptic bronchoscope through the LMA.

Esmail N, Saleh M, Ali A. Laryngeal mask airway versus endotracheal intubation for Apgar score improvement in neonatal resuscitation. *Egyptian Journal of Anesthesiology*. 2002; 18: 115-121.

Abstract: Background: Neonatal resuscitation frequently requires positive pressure ventilation using bag-and-mask immediately after birth. Endotracheal intubation may be required in neonates not responding to mask-and-bag resuscitation. In the present study, laryngeal mask airway (LMA) was compared to endotracheal tube (ETT) for neonatal resuscitation. Methods: Forty neonates requiring resuscitation after delivery by Cesarean section were randomly divided into two groups, 20 neonates each. Size-1 LMA was used with the first group and ETT was used for the second group. Comparison of LMA and ETT considered the time for insertion, number of attempts for successful insertion, duration of positive pressure ventilation (PPV), duration of continuous positive airway pressure (CPAP). Apgar score improvement, and O₂ saturation improvement for the two groups. Trauma for the upper airway was evaluated by fiberoptic laryngoscope in both groups. Results: The average times for insertion of LMA and ETT were respectively, 10 (2.5) and 7.5 (1.3) seconds (P<0.05). One attempt was required for LMA insertion in 17 cases and two attempts 2 cases and only one case needed three attempts for insertion. While 18 cases needed one attempt for insertion of ETT and 2 cases needed two attempts for insertion. The durations of PPV and CPAP were comparable for both groups. The course of Apgar score improvement was the same for both groups. After settlement of spontaneous respirations, O₂ saturation with LMA ranged between 100-95% in 17 cases, 94-90% in 2 cases and 89-85% in one case. O₂ saturation with ETT was 100-95% in all cases. Epiglottic trauma was present in two cases with LMA and in one case with ETT. Trauma to the uvula occurred in 4 cases with LMA and in 2 cases with ETT. Conclusion: The use of size-1 LMA in neonatal resuscitation appears to be an effective and easy method of airway management.

Comment: (LOE 2, good, hypothesis 2, resuscitation, supportive)- To date, the only neonatal randomized controlled trial during resuscitation. Method of randomization not clear. The operator in all cases appears to be an anesthesiologist. Not clear if the results of this study can be generalized to pediatrician resuscitators given the operators' high success rate and rapid placement of the ETT. This may have biased the study against finding a difference. Two subjects in the LMA group and 1 subject in the ETT group had evidence of trauma to the epiglottis requiring treatment with corticosteroids.

Fernandez-Jurado MI, Fernandez-Baena M. Use of laryngeal mask airway for prolonged ventilatory support in a preterm newborn. *Paediatric Anaesthesia*. 2002; 12(4): 369-370.

Abstract: We present the case report of a preterm, low weight newborn with dysmorphic features and micrognathia in whom a laryngeal mask airway was inserted and maintained for 44 h for ventilatory support after several failed intubations. No complications associated with laryngeal mask airway use were apparent.

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- Preterm (35 wk, 1560 gm) with micrognathia who required resuscitation on fourth day of life, resuscitated with bag-mask, but couldn't be intubated by either the NICU staff or a pediatric anesthesiologist. An LMA was placed and positive pressure ventilation continued for 44 hours until an ETT was placed through the LMA using a fiberoptic bronchoscope and an intubating bougie. This is one of four case reports describing prolonged use of the LMA following resuscitation.

Fraser J, Hill C, McDonald D, Jones C, Petros A. The use of the laryngeal mask airway for inter-hospital transport of infants with type 3 laryngotracheo-oesophageal clefts. *Intensive Care Medicine*. 1999; 25(7): 714-716.

Abstract: Type 3 laryngotracheo-oesophageal clefts are rare congenital anomalies with a high mortality. In the past, transport of such infants to tertiary centres for surgical correction has proved extremely difficult, with the child's ventilatory status often deteriorating to such an extent that ultimate surgical intervention has not proved possible. We describe two cases of successful inter-hospital transfer of infants with type 3 laryngotracheo-oesophageal clefts using the laryngeal mask airway.

Comment: (LOE 5, fair, hypothesis 3, resuscitation, support)-Case report describing 2 newborns (35 weeks EGA, 2.8 kg and 2.9 kg) with laryngotracheo-esophageal clefts that could not be ventilated with bag-mask or endotracheal tube. A size-1 LMA was successfully placed and achieved adequate ventilation. The authors speculated that the shape of the LMA prevented it from sliding into the esophagus and, therefore, provided better ventilation than an endotracheal tube in the setting of a laryngotracheo-esophageal cleft. Both infants ultimately died.

Fraser J, Petros A. High-frequency oscillation via a laryngeal mask airway. *Anaesthesia*. 1999; 54(4): 404.

Abstract: None

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- Brief letter to the editor describing a 35 week gestation infant with a laryngotracheo-esophageal cleft that was managed with an LMA and high frequency oscillator ventilation for 10 hours. This is the only reported case of the LMA used with a high frequency oscillator ventilator. Ultimately, the medical staff and family elected to withdraw support.

Gandini D, Brimacombe JR. Neonatal resuscitation with the laryngeal mask airway in normal and low birth weight infants. *Anesthesia & Analgesia*. 1999; 89(3): 642-643.

Abstract: Methods: Case series describing one investigator's experience attending 689 deliveries over a 5 year period. An LMA was inserted if positive pressure ventilation (PPV) was required (HR < 100 bpm or apnea) for neonatal resuscitation. Neonates delivered through meconium stained fluid underwent laryngoscopy before PPV and were excluded if there was evidence of meconium aspiration. If adequate chest expansion was not obtained after 2 insertion attempts, either face mask or tracheal intubation was

attempted. Results: The investigator attended 689 deliveries, 130 required PPV, 26 had meconium stained fluid with evidence of aspiration and were excluded, 104 met inclusion criteria (75 normal birthweight, 29 low birthweight, 6 1000-1500 grams). The LMA was successfully inserted on the first attempt in all 104. The average time to chest expansion was 10 seconds, average time to achieve HR > 100 bpm was 13 seconds (normal BW) and 14 seconds (LBW). Six neonates resuscitated with the LMA ultimately required tracheal intubation or nasal CPAP for respiratory distress syndrome. One neonate did not respond to ventilation through the LMA and subsequently failed to respond to endotracheal intubation as well. There were no complications reported.

Comments: (LOE 5, good, hypothesis 1, resuscitation, supportive)- *The largest single case series using the LMA as the primary device for PPV during neonatal resuscitation. The subjects included 29 newborns < 2500 grams and 6 < 1500 grams birthweight. The smallest neonate enrolled was 1000 grams.*

Gandini D, Brimacombe J. Laryngeal mask airway for ventilatory support over a 4-day period in a neonate with Pierre Robin sequence. *Paediatric Anaesthesia*. 2003; 13(2): 181-182.

Abstract: None

Comments: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- *Letter to the editor describing a 3.3 kg, 38 wk EGA with severe retrognathia suggestive of Pierre-Robin sequence and airway obstruction at birth. A size-1 LMA was placed in the DR. The LMA was removed when transferred to the nursery, but had to be replaced secondary to respiratory distress. CPAP was applied to the LMA and was maintained for 4 days. The cuff was deflated every 6 hours. The infant then needed a nasopharyngeal tube for 1 month. One of 4 case reports describing prolonged use.*

Hansen TG, Joensen H, Henneberg SW, Hole P. Laryngeal mask airway guided tracheal intubation in a neonate with the Pierre Robin syndrome. *Acta Anaesthesiologica Scandinavica*. 1995; 39(1): 129-131.

Abstract: Endotracheal intubation in infants with the Pierre Robin syndrome may sometimes be impossible to accomplish by conventional means. To aid difficult tracheal intubation many different techniques have been described. We present a case, in which we successfully intubated a small-for-date newborn boy with the Pierre Robin syndrome by using a modified laryngeal mask airway (no. 1) as a guide for the endotracheal tube. The technique is easy to perform, less traumatic and less time-consuming than multiple attempts at laryngoscopy or blind tracheal intubation.

Comment: (LOE 7, fair, hypothesis 3, operating room, support)- *Newborn (37 weeks, 2050 gm) with Pierre-Robin sequence and TEF could be managed with face-mask but could not be intubated by anesthesiologist. Failed attempted intubation by ENT surgeon with rigid tracheoscope. A size-1 LMA, with the midline bars cut, was placed and controlled the airway with positive pressure ventilation. The LMA position was confirmed by a fiberoptic bronchoscope. A tracheal tube was blindly placed through the LMA and advanced by placing another tracheal tube end-to-end. The LMA was then removed over the 2 tubes. This procedure was repeated on 4 subsequent occasions. No complications. Although "blind" placement was successful, the high rate of partial glottic obstruction from the epiglottis (Mizushima, Rowbottom, Dubreuil) suggests that directly visualized placement with a fiberoptic bronchoscope and a "railroaded" tracheal tube would be more successful.*

Hinton AE, O'Connell JM, van Besouw JP, Wyatt ME. Neonatal and paediatric fibre-optic laryngoscopy and bronchoscopy using the laryngeal mask airway. *Journal of Laryngology & Otology*. 1997; 111(4): 349-353.

Abstract: Endoscopy of the upper airways in neonates and infants was traditionally been accomplished using rigid laryngoscopes and bronchoscopes. The laryngeal mask may be used both to control the airway for anaesthetic ventilation and to guide a fibre-optic endoscope to the laryngeal inlet and beyond. We report our experience with five neonatal and paediatric cases where fibre-optic laryngoscopy and bronchoscopy were performed through the laryngeal mask airway. All were cases in which standard rigid endoscopy had proved difficult with only a poor and restricted view of the laryngeal inlet being obtained due to the age of the infants, or abnormal anatomy of the upper airways. No problems have been encountered with maintenance of the airway or with endoscopic view obtained. In fact in neonatal patients, this technique has

been found to be preferable with regard to safety and ease of use when compared to the ventilating bronchoscope. With the size 1 laryngeal mask airway it is not possible to simultaneously ventilate and endoscope the patient. Cases included a vascular ring, Goldenhar's syndrome, laryngomalacia, supraglottis and vocal fold paresis. This technique provides a secure method of maintaining anaesthetic ventilation during airway endoscopy, and also a means of easily locating the glottis.

Comment: (LOE 7, fair, hypothesis 2, diagnostic bronchoscopy, supportive)-Brief description of a LMA used to control the airway during diagnostic flexible bronchoscopy in 2 neonates (31 wk EGA with double aortic arch, 1 week old with Goldenhar and obstructive airway symptoms). These investigators did not find the epiglottis impinged in the bars of the LMA. The report also describes 3 infants (6 week-5 months) with stridor who underwent diagnostic bronchoscopy with an LMA.

Johnson CM, Sims C. Awake fiberoptic intubation via a laryngeal mask in an infant with Goldenhar's syndrome.[see comment]. *Anaesthesia & Intensive Care*. 1994; 22(2): 194-197.

Abstract: None

Comments: (LOE 5, fair, hypothesis 3, resuscitation in operating room, supportive)- Case report describing a 29 day old with Goldenhar admitted with increasing respiratory distress. Taken to OR for planned bronchoscopy. In the OR, airway control was lost after induction resulting in severe bradycardia and desaturation. The anesthesiologist was unable to intubate. A size-1 LMA was successfully placed for resuscitation. The LMA was then used to control the airway during diagnostic bronchoscopy. One week later he again presented with respiratory distress. A size-1 LMA was placed while the infant was awake and breathing spontaneously with topical anesthesia (nebulized lignocaine). Two size 3.0 mm tracheal tubes were threaded over a flexible, pediatric (1.8 mm diameter) bronchoscope. The bronchoscope was placed through the LMA into the trachea and the endotracheal tubes were "railroaded" over the bronchoscope. The bronchoscope was removed while the double tracheal tube was held in place. Afterward, the top endotracheal tube was discarded and anesthesia was induced. This is the first description of awake, fiberoptic intubation through an LMA in a neonate. The technique was reported again by Iohom (2002).

Johr M, Berger TM, Ruppen W, Schlegel C. Congenital laryngotracheo-oesophageal cleft: successful ventilation with the Laryngeal Mask Airway. *Paediatric Anaesthesia*. 2003; 13(1): 68-71.

Abstract: A congenital laryngotracheo-oesophageal cleft is a rare airway malformation which results from incomplete separation of the larynx and trachea from the hypopharynx and oesophagus. Patients usually present with stridor, aspiration and cyanosis associated with feeding. For early diagnosis, a high index of suspicion is needed. Unless an appropriate diagnostic approach is taken, the diagnosis can be missed. The successful ventilation of a neonate with the Laryngeal Mask Airway is described.

Comment: (LOE 7, fair, hypotheses 1&2, diagnostic bronchoscopy, operating room, supportive)- Case report describing a 4 day old, 41 wk gestation (2760 gm) female with a laryngotracheo-esophageal cleft. Managed in the operating room for diagnostic evaluation and central line placement with a size-1 LMA and pressure-controlled ventilation (PIP 15 cmH₂O), PEEP 3 cmH₂O. No gastric distention or leak. The abnormality had not been appreciated using direct laryngoscopy but was seen during controlled PPV with the LMA.

Lavies NG. Use of the laryngeal mask airway in neonatal resuscitation.[comment]. *Anaesthesia*. 1993; 48(4): 352.

Abstract: None

Comments: (LOE 6, unacceptable, hypothesis 2, resuscitation training, supportive)- Brief letter describing a comparison between endotracheal intubation and LMA placement among 7 midwives and 4 pediatric residents using an intubating mannequin. Found that all subjects were able to place the LMA, but 4/7 midwives and 1/4 residents could not intubate the mannequin. Not clear how success was determined with the LMA, how much time was allowed for a single attempt, how many attempts were permitted. Not clear that success with the mannequin is equivalent to success during a live resuscitation.

Lesmes C, Siplovich L, Katz Y. Fiberoptic bronchoscopy in children using the laryngeal mask airway. *Pediatric Surgery International*. 2000; 16(3): 179-181.

Abstract: We describe our experience using the laryngeal mask airway (LMA) in children to facilitate diagnostic procedures in fiberoptic bronchoscopy (FOB). Two cases of stridor, two cases of protracted pneumonia, and one case of laryngotracheomalacia were studied. Intravenous atropine (0.02 mg/kg) was given, and induction was carried out by either inhalation of a mixture of halothane-nitrous oxide-oxygen (n = 3) or IV injection of propofol (n = 2). After an adequate depth of anesthesia was obtained, a LMA was introduced. A 2.7-mm-OD flexible fiberoptic bronchoscope was introduced through the LMA and the diagnostic procedure was performed. Ventilation and oxygenation were maintained, and no serious morbidity was associated with the procedure. We found the use of the LMA to facilitate FOB to be useful, easy to perform, and safe, avoiding nasal trauma and providing a patent airway.

Comment: (LOE 7, good, hypotheses 1 & 2, diagnostic bronchoscopy, supportive) -Two of the infants met inclusion criteria for this review (2 weeks/3.9 kg, 2.5 months/4.5 kg). The size-1 LMA was used to maintain ventilation during diagnostic bronchoscopy (2.7 mm OD flexible bronchoscope) after face-mask induction (halothane or propofol). The LMA was used for 32-35 minutes without complications except "slight, brief decreases in oxygen saturation" during portions of the bronchoscopy. The authors argue that the combination of LMA and flexible bronchoscope is ideal because it preserves anatomy of the laryngo-tracheobronchial tree, is less invasive than intubation, offers the choice of mechanical ventilation or spontaneous breathing, and allows for capnography to monitor the patient's respiratory status.

Lonnqvist PA. Successful use of laryngeal mask airway in low-weight expremature infants with bronchopulmonary dysplasia undergoing cryotherapy for retinopathy of the premature. *Anesthesiology*. 1995; 83(2): 422-424.

Abstract: None

Comments: (LOE 7, good, hypotheses 1&2, operating room, supportive)- Case report describing six premature neonates (1.3-2.33 kg) with mild bronchopulmonary dysplasia managed with a LMA during seven surgical procedures for retinopathy of prematurity. A size-1 LMA was placed after inhalational anesthetic induction and succinylcholine. The LMA was successfully placed on the first attempt in all seven. Manual ventilation was continued for several minutes until the muscle relaxant wore off. The LMA was removed at the end of the procedure. One infant, who did not have a NG tube placed during the procedure, had abdominal distention and may have had an aspiration event after removal of the LMA. This infant had another procedure performed later with an LMA and an NG tube and he did well.

Lopez-Gil M, Brimacombe J, Alvarez M. Safety and efficacy of the laryngeal mask airway. A prospective survey of 1400 children. *Anaesthesia*. 1996; 51(10): 969-972.

Abstract: A survey of laryngeal mask airway usage in 1400 infants and children by ten trainee anaesthetists was undertaken to provide information about insertion and complication rates using the standard insertion technique and a limited range of standardised anaesthetic techniques. Placement was successful in 90% (1258/1400) at the first attempt, 8% (112/1400) at the second attempt and 2% (29/1400) required an alternative technique of insertion. One patient vomited during insertion and the procedure was abandoned, but aspiration did not occur. The overall problem rate was 11.5% and there were significantly more problems during induction of anaesthesia (p < 0.02). Oxygen saturation decreased below 90% briefly on 23 occasions (1.7%). The incidence of problems was unrelated to the mode of ventilation, or whether isoflurane or total intravenous anaesthesia with propofol was used for maintenance. Most problems came with use of the size 1 laryngeal mask (p < 0.001). The subspecialty with the highest problem rate was ear, nose and throat surgery (p < 0.001). There was a significant decrease in problems with increasing experience (p < 0.001). There was no major morbidity associated with use of the device. We conclude that the laryngeal mask provides a safe and effective form of airway management for infants and children in the hands of supervised anaesthesia trainees both for spontaneous and controlled ventilation using either isoflurane or total intravenous anaesthesia.

Comment: (LOE 7, good, hypotheses 1&2, operating room, supportive)- This is the largest published pediatric case series describing LMA placement by trainee anesthesiologists for operative anesthesia in 1400 consecutive children. The reader cannot be absolutely certain how many of the subjects were neonates from the available data, however, 245 patients had a size-1 LMA (recommended for infants < 5kg) placed and their outcomes are separately reported. Despite this limitation, the study was included because of its size. The size-1 LMA had the highest "problem" rate (22.4%). There are no details describing exactly what kinds of problems were encountered. Overall, fewer problems were noted with increasing experience.

Markakis DA, Sayson SC, Schreiner MS. Insertion of the laryngeal mask airway in awake infants with the Robin sequence. *Anesthesia & Analgesia*. 1992; 75(5): 822-824.

Abstract: On the basis of the reported success of the LMA in anesthetized children with micrognathia, we devised an approach for anesthetizing infants with the Robin sequence with severe micrognathia and airway obstruction. We propose to insert the LMA in the awake infant and then to proceed to induce general anesthesia with the inhalation of halothane. This report is based on the first of three patient in whom we utilized this approach.

Comments: (LOE 7, good, hypotheses 1/2/3, operating room, supportive)-Case report describing 3 infants (2.9-4.8 kg) with Robin sequence managed with a size-1 LMA in the operating room for surgical procedures. The LMA was placed while the subjects were awake using viscous lidocaine as a lubricant. Each had previously demonstrated difficult airways. Ultimately, all 3 were intubated with a lighted stylet after the LMA had secured a patent airway. No complications reported.

Mawer RJ. Equipment for paediatric resuscitation.[see comment]. *Anaesthesia*. 1995; 50(1): 87-88.

Abstract: None

Comment: (LOE 5, poor, hypothesis 3, resuscitation, supportive)- A brief letter to the editor describing a 2.2 kg neonate with chondrodysplasia punctata who self-extubated. Bag-mask ventilation and endotracheal intubation were unsuccessful. A size-1 LMA was easily inserted and managed the airway until an emergency tracheostomy was performed.

Mecklem D, Brimacombe JR, Yarker J. Glossopexy in Pierre Robin sequence using the laryngeal mask airway. *Journal of Clinical Anesthesia*. 1995; 7(3): 267-269.

Abstract: None

Comments: (LOE 7, fair, hypotheses 1/2/3, operating room, supportive) - Case report describing the LMA used to manage a 1 week old (3560 gm) with Pierre-Robin in the operating room for glossopexy with severe airway obstruction that failed to respond to an oral airway. The LMA was placed after inhalational anesthetic induction. Direct laryngoscopy was not attempted because the infant didn't tolerate the supine position.

Park C, Bahk JH, Ahn WS, Do SH, Lee KH. The laryngeal mask airway in infants and children. *Can J Anaesth*. 2001; 48(4): 413-417.

Abstract: PURPOSE: To compare the effectiveness of various laryngeal mask airway (LMA) sizes and their performance during positive pressure ventilation (PPV) in paralyzed pediatric patients. METHODS: Pediatric patients (n = 158), < 30 kg, ASA 1 or 2 were studied. After paralysis, an LMA of the recommended size was inserted and connected to a volume ventilator. Fiberoptic bronchoscopy (FOB) was performed and graded: 1, larynx only seen; 2, larynx and epiglottis posterior surface seen; 3, larynx, and epiglottis tip or anterior surface seen--visual obstruction of epiglottis to larynx: < 50%; 4, epiglottis down-folded, and its anterior surface seen--visual obstruction of epiglottis to larynx: > 50%; 5, epiglottis down-folded and larynx not seen directly. Inspiratory and expiratory tidal volumes (V(T)), and airway pressure were measured by a pneumo-tachometer, and the fraction of leakage (F(L)) was calculated. In 79 cases, LMA was used for airway maintenance throughout surgery. RESULTS: Successful LMA placement was achieved in 98% of cases: three failures were due to gastric insufflation. For LMA # 1, 1.5, 2, and 2.5, FOB grades [median (range)] were 3(1-5), 3(1-5), 1(1-5) and 1(1-3) respectively. In smaller LMAs, the cuff

more frequently enclosed the epiglottis ($P < .001$). F(L) of LMA # 1 was higher than those of LMA # 1.5 and LMA # 2.5 ($P < .05$), and F(L) of LMA # 2 was higher than that of LMA # 2.5 ($P < .05$). In the 79 patients, the number of patients experiencing complications decreased as LMA size increased ($P < .05$). **CONCLUSION:** Use of the LMA in smaller children results in more airway obstruction, higher ventilatory pressures, larger inspiratory leak, and more complications than in older children

Comments: (LOE 7, good, hypotheses 1&2, supportive with cautions)- Case series of 158 children (25 with size-1 LMA) with LMA used for airway control during elective surgery. Excluded infants with lung disease and those having abdominal surgery. Infants were anesthetized and paralyzed prior to LMA placement. Placement was assessed with a fiberoptic bronchoscope. LMA placement was successful in 24/25. The size-1 LMA, compared to size 1.5/2/2.5, had a higher percentage of air leak around the mask. The size-1 LMA had a higher percentage of partial airway obstruction by the epiglottis. In total, 18/25 (74%) had partial or complete obstruction by bronchoscopic scoring. Among 10 infants with size-1 LMA used for PPV throughout the case, none had laryngospasm, none had vomiting, 3 had a progressive increase in end-tidal CO₂. Overall, the prolonged use of the size-1 LMA had more frequent complications than the larger sizes; 3/10 infants had more than 1 complication.

Paterson SJ, Byrne PJ, Molesky MG, Seal RF, Finucane BT. Neonatal resuscitation using the laryngeal mask airway.[see comment]. *Anesthesiology*. 1994; 80(6): 1248-1253; discussion 1227A.

Abstract: **BACKGROUND:** For a newborn requiring positive-pressure ventilation (PPV), the American Heart Association recommends bag-and-mask ventilation, a challenging procedure for those inexperienced in neonatal resuscitation. The objective of this prospective study was to evaluate the laryngeal mask airway (LMA) as an alternative method of airway management in neonates requiring PPV at birth. **METHODS:** With the approval of the institutional ethics committee, consent was obtained from women in labor at a tertiary care-perinatal center. Inclusion criteria consisted of an expected birth weight of at least 2.5 kg, gestational age of at least 35 weeks, and resuscitation requiring PPV. Neonates meeting these criteria were resuscitated with PPV by means of the LMA. The ease of insertion, number of attempts required, time to establish effective ventilation, skin color, heart rate, respiratory effort, and Apgar scores were recorded. **RESULTS:** Attendance by the investigators at delivery was achieved in 93 cases, with 21 meeting the inclusion criteria. In all cases, the LMA was successfully inserted on the first attempt and provided a clinically patent airway. Twenty neonates were successfully resuscitated with the LMA to provide PPV, with no complications directly attributable to its use. One neonate required LMA removal and tracheal intubation to facilitate administration of epinephrine; data from this case was removed from the study. **CONCLUSIONS:** Providing PPV at birth via a size-1 LMA is effective and easily learned by personnel with expertise in neonatal resuscitation. The LMA should be further assessed as an alternative to bag-and-mask ventilation for this purpose

Comments: (LOE 5, good, hypothesis 1, resuscitation, supportive) Case series without controls. Newborns only included if one of 3 investigators was available to attend the delivery. Excluded infants with oropharyngeal anomalies, those requiring chest compressions, and known congenital anomalies. Infants with thick meconium staining and birth depression underwent tracheal intubation and suction prior to LMA placement. Investigators had placed 24 LMAs in the operating room prior to elective surgery prior to starting the DR study. One infant was depressed at birth and an LMA was placed but the HR did not improve. An ETT was placed, chest compressions administered, and epinephrine delivered through the ETT. This subject died at 6 hours of age and was excluded from the data analysis. Birthweight ranged 2235 gm - 4460 gm. All remaining subjects (n=20) had LMA placed on first attempt without difficulty. Mean (range) time for LMA insertion was 8.6 sec (7-12) and duration of PPV 80 sec (30-300). One infant had a pneumothorax diagnosed at 90 minutes. No infant had clinical complications at 2 days.

Theroux MC, Kettrick RG, Khine HH. Laryngeal mask airway and fiberoptic endoscopy in an infant with Schwartz-Jampel syndrome. *Anesthesiology*. 1995; 82(2): 605.

Abstract: None

Comment: (LOE 7, fair, hypothesis 3, operating room, supportive)- Letter to the editor describing a 20 day old (2.5 kg) infant with Schwartz-Jampel syndrome (micrognathia, skeletal anomalies, dwarfism,

myotonia) who could not be intubated by either direct laryngoscopy or fiberoptic bronchoscopy in the operating room. A size-1 LMA was easily placed and then tracheal intubation achieved by placing a flexible bronchoscope with an ETT loaded over the scope through the LMA.

Trawoger R, Mann C, Mortl, Riha K. Use of laryngeal masks in the resuscitation of a neonate with difficult airway. *Arch Dis Child Fetal Neonatal Ed.* 1999; 81(2): F160.

Abstract: None

Comment: (LOE 5, fair, hypothesis 3, delivery room resuscitation, supportive)- Letter to the editor describing a term male, 2300 gm, with mandibular hypoplasia, glossoptosis, and contractures presented with respiratory distress in the delivery room. He remained bradycardic despite bag-mask ventilation and endotracheal intubation was unsuccessful. A size-1 LMA was placed while the tongue was held with a Magill forceps. Positive pressure ventilation was continued through the LMA for several hours while diagnostic tests completed. Multiple anomalies were identified and the family elected to withdraw support. At autopsy, he had a micro-larynx and pharyngo-esophageal cleft. There was no trauma from the LMA.

Trevisanuto D, Ferrarese P, Zanardo V, Chiandetti L. Laryngeal mask airway in neonatal resuscitation: a survey of current practice and perceived role by anaesthesiologists and paediatricians. *Resuscitation.* 2004; 60(3): 291-296.

Abstract: OBJECTIVES: To survey current practice and to compare the opinion of paediatricians and anaesthesiologists regarding laryngeal mask airway (LMA) in neonatal resuscitation. DESIGN: A structured postal questionnaire on the use of the laryngeal mask airway in neonatal resuscitation was sent to the heads of department of the paediatric and anaesthesiology services. SETTING: Forty-three hospitals in the Veneto Region, Italy. RESULTS: During the year 2000, 1526 out of 33708 (4.5%) neonates in our region needed resuscitation. Of these cases, 101 (6.6%) were ventilated using the LMA. Laryngeal mask airway availability was significantly greater in the anaesthesiology department compared to the paediatric department (90% versus 50%; $P = 0.002$). However, 52% of anaesthesiologists and 72% of paediatricians had never used the laryngeal mask airway in their practice. The laryngeal mask airway was considered as an essential device more frequently by the anaesthesiologists than by the paediatricians (27% versus 5%; $P = 0.015$); both groups considered the laryngeal mask airway particularly useful in specific situations. Interestingly, while 16% of the paediatricians described the laryngeal mask airway as having no value, none of the anaesthesiologists did ($P = 0.002$). Staff competence was considered low by 70% of anaesthesiology heads of department compared with 90% of their pediatric colleagues. In both specialties, use of the laryngeal mask airway was limited to medical staff. With regard to training, 35% of anaesthesiologists and 22.5% of paediatricians had attended a course on laryngeal mask airway use. CONCLUSIONS: Laryngeal mask airway availability and perceived value were higher amongst anaesthesiologists than their paediatric colleagues. However, educational level, competence and utilization rates of the LMA in neonatal resuscitation were low in both groups.

Comment: (LOE 5, poor, hypothesis 1, delivery room resuscitation, supportive)- This study is a survey of anaesthesiologists and pediatricians involved in neonatal resuscitations in one region of Italy (Veneto). In total, the LMA was used in 101 neonatal resuscitations, 95% of which were in a single hospital (the author's institution). There are no details provided about the cases.

Webster AC, Reid WD, Siebert LF, Taylor MD. Laryngeal mask airway for anaesthesia for cryopexy in low birth weight infants. *Canadian Journal of Anaesthesia.* 1995; 42(4): 361-

Abstract: None

Comment: (LOE 7, good, hypotheses 1&2, operating room, supportive with caution)- Letter to the editor describing a prospective case series of 16 premature infants undergoing surgery. Most had BPD and were oxygen dependent at the time of surgery. The LMA was placed after anesthesia induction with either halothane or propofol and paralysis with vecuronium. Positive pressure ventilation was given through the LMA and end-tidal CO₂ monitored. The LMA was removed after neuromuscular blockade reversal. Six infants had oxy-hemoglobin desaturation after the LMA was placed which improved when it was partially withdrawn. The authors note that the mask was unstable and had to be held in place while monitoring capnography. Four infants had to be intubated after the procedure was completed secondary to repeated episodes of apnea.

Yao C, Wang J, Tai Y, Tsai T, Wu J. Successful management of a neonate with Pierre-Robin syndrome and severe upper airway obstruction by long term placement of a laryngeal mask airway. *Resuscitation*. 2004; 61: 97-99.

Abstract: The severity of airway obstruction varies in infants with Pierre-Robin syndrome (PRS). Some have severe upper airway obstruction that results in respiratory failure after birth. We report a case of a neonate with isolated PRS who had a severe airway obstruction and respiratory failure after birth. She had complications of bilateral pneumothorax, subcutaneous emphysema, and hypoxaemia due to difficult tracheal intubation. Respiratory failure recurred immediately after extubation; she was resuscitated by inserting a laryngeal mask airway. The laryngeal mask airway was left inserted for 6 days. It was successful in this patient and eliminated the need for invasive surgical procedures. In conclusion, the relatively long term use of a laryngeal mask airway, which has not been reported before, could be an alternative therapy for patients with PRS with airway obstruction.

Comment: (LOE 5, fair, hypothesis 3, resuscitation, supportive)- The infant in this case (2.9 kg, 40 weeks EGA) had acute airway distress associated with Pierre-Robin sequence. She suffered complications from multiple intubation attempts. After extubating, a laryngeal mask airway was placed. Although she never received positive pressure ventilation, this paper is included because the LMA was used for resuscitation to secure the airway during an acute airway emergency. The LMA was left in place as the infant breathed spontaneously for 6 days. Again, caution is warranted in the prolonged use of the LMA. This author removed the LMA each day to relieve pressure on the mucosa of the hypopharynx.

Additional References

Bautista Casanovas A, Estevez Martinez E, Buznego Sanchez R, Rodriguez Perez E, Cabanas Gancedo R, Varela Cives R. [Pediatric fiber bronchoscopy. Apropos 55 children examined]. *Anales Espanoles de Pediatria*. 1993; 39(4): 313-316.

Abstract: We present our experience with 55 children in which we performed flexible fiberoptic bronchoscopy (FFB) using an Olympus BF3C20 instrument and by using sedation and local anaesthesia or laryngeal mask airway. Indications for performing this procedure were stridor, opportunist or recurrent pneumonia, persistent atelectasis, a suspected foreign body, confirmation of endobronchial tuberculosis and evaluation of tracheostomy. In 70% of the cases, the diagnosis was made by the FFB and 14 cases were normal. One child with severe hypoxia presented respiratory arrest and need intubation. Our results suggest that FFB is safe, has advantages over rigid bronchoscopy, avoids general anaesthetic and with laryngeal mask airway is possible to perform in patients of every age.

Comment: Excluded for language restriction, bronchoscopy, supportive

Castilla M, Jerez M, Llacer M, Martinez S. Anaesthetic management in a neonate with congenital complete heart block. *Paediatric Anaesthesia*. 2004; 14: 172-175.

Abstract: We present the case of a neonate undergoing surgery on the first day of life for the installation of a permanent pacemaker because of the existence of congenital complete heart block with a basal heart rate of 43 bpm and a minimal elevation after initiating an isoproterenol infusion. The intervention was under general anaesthesia with a laryngeal mask airway (LMA) and spontaneous ventilation. The principal anaesthetic goals were to assure adequate anaesthesia, with haemodynamic and respiratory stability, to maintain the best possible heart rate and to avoid postoperative respiratory depression or apnoea.

Comment: (Excluded for no PPV, operating room, supportive) An LMA was successfully placed in a 2 day old, 33 week gestation, 2050 gram male for airway management during anaesthesia in place of intubation. This infant was managed without muscle relaxants and breathed spontaneously.

Cortez J, Franco A, Cid M, Vidal MI, Rabanal S. [Use of laryngeal mask for fiber optic bronchoscopy in a neonate with facial malformations]. *Revista Espanola de Anestesiologia y Reanimacion*. 1992; 39(5): 324-325.

Abstract: None

Comment: *Excluded for language restriction, bronchoscopy*

Courreges P, Lecoutre D, Sorba F, Bayart R. [Laryngeal masks in pediatric anesthesia. Apropos of 251 cases]. *Cahiers d Anesthesiologie*. 1994; 42(1): 95-97.

Abstract: A series of 251 anaesthesias with a laryngeal mask (LM) in a paediatric surgery unit is studied retrospectively. After some short training, using LM is most often easy and allows a good airway control without any frequent or severe complications. Therefore this technique should quickly supplant the facial mask and many endotracheal intubations.

Comment: *Excluded for language restriction, operating room, supportive*

Dickinson M, Curry P. Training for the use of the laryngeal mask in emergency and resuscitation situations. *Resuscitation*. 1994; 28: 111-113.

Abstract: It has been suggested that the laryngeal mask has a role to play in the management of the airway during resuscitation both from cardiac arrest and possibly major trauma. Should it be introduced for this purpose, there will be a need to provide training for a very large number of paramedical staff. Currently training in advanced airway management techniques involves live patient practice in theatres; clearly this system is already reaching a limit as paramedics in training often have some difficulty in reaching the prescribed number of procedures. This paper describes experience with a possible alternative utilizing only classroom teaching.

Comment: *Discussion only. Investigators presented a brief (30 minutes) LMA classroom training session to nurses, EMTs, paramedics. They tested their proficiency with a training mannequin and found very high success rates (96%) on the first attempt. Not clear that proficiency with a mannequin will correlate with proficiency during a human resuscitation.*

Dubreuil M, Laffon M, Plaud B, Penon C, Ecoffey C. Complications and fiberoptic assessment of size 1 laryngeal mask airway. *Anesthesia & Analgesia*. 1993; 76(3): 527-529.

Abstract: In pediatric practice, complications due to the laryngeal mask airway (LMA) have been studied with size 2 LMA, but not with size 1 LMA. We, therefore, compared prospectively the complications induced by LMA size 1 and 2 in 141 children aged 21 days to 11 yr. Intraoperative and lowest SpO₂ values after removal of LMA were recorded. The following complications were recorded: cough, laryngospasm, bronchospasm, apnea, and airway obstruction. In 14 patients in the size 1 LMA group and 26 patients in the size 2 LMA group, pharyngolaryngeal structures were checked with fiberoptic examination. The number of attempts, complications, intraoperative SpO₂, and lowest SpO₂ values were similar when using size 1 and size 2 LMA. Fiberoptic examination of size 1 LMA showed a high incidence of impinging of the epiglottis in the LMA bars without airway obstruction. In conclusion, there was no difference in the complication rate between the two pediatric sizes of LMA when used in pediatric patients.

Comment: *(Excluded for no PPV and lack of neonatal detail, operating room, neutral)- Prospective case series in the operating room comparing size 1 and size 2 LMA. Unable to determine how many patients were < 1 month old; mean age was 4.4 +/- 3.9 months. Preterm infants were excluded if less than 60 weeks post-conceptual age. Found a high rate of "non-ideal" LMA positioning with partial epligottic obstruction during fiberoptic examination (57%, n=14), however, it did not interfere with successful airway management. First time successful placement (anesthetized, in OR, anesthesiologist) was 67%.*

Dubreuil M, Favier JC, Devars F. Difficult diagnosis of a primitive pharyngeal dyskinesia with a size 1 laryngeal mask airway in an ex-premature baby. *Paediatric Anaesthesia*. 1997; 7(4): 354-355.

Abstract: None

Comments: *(Excluded for no PPV, operating room, neutral)- A premature infant, 6 weeks old (39 weeks postconceptual age) was evaluated by fiberoptic bronchoscopy for stridor using a LMA to secure the airway for general anesthesia. The LMA interfered with the diagnosis of pharyngeal dyskinesia by*

pressing on the nasopharyngeal airway and inducing an apparent obstruction. This obstruction did not interfere with the quality of breathing through the LMA but did distort the fibrescopic results.

Efrat R, Kadari A, Katz S. The laryngeal mask airway in pediatric anesthesia: experience with 120 patients undergoing elective groin surgery. *Journal of Pediatric Surgery*. 1994; 29(2): 206-208.

Abstract: The laryngeal mask airway (LMA) was recently introduced in pediatric anesthesia as an alternative to the face mask or tracheal intubation for airway maintenance. The authors report their experience with LMA on 120 consecutively treated children who underwent elective inguinal herniorrhaphy or orchidopexy. The patients were monitored with electrocardiograms, noninvasive blood pressure determinations, pulse oxymetry, and capnometry. Anesthesia was induced and maintained with halothane, nitrous oxide, and oxygen. There were 96 males and 24 females; the age range was 1 month to 14 years (average, 3.2 years). They weighed between 2.5 and 46 kg (mean, 14 kg). Patients were allowed to breathe spontaneously until anesthesia was deep enough (average, 6.3 minutes; range, 2 to 15 minutes). The appropriate-size LMA was inserted and inflated, and patients were divided into three groups. Group I patients (n = 24) weighed 2.6 to 6 kg and received LMA size no. 1. Group II (n = 84) weighed 6 to 30 kg and received LMA size no. 2. Group III (n = 12) weighed more than 30 kg and received LMA size no. 3. Patients in groups II and III breathed spontaneously; those in group I were on volume-controlled ventilation. The LMA was easily inserted in 115 patients (95.8%)--on the first attempt in 100, and on the second attempt in 15. In five patients, LMA was successfully inserted on the third attempt. The ease of insertion was not significantly different between the groups. Anesthesia was maintained by halothane (mean, 1.34%; range, 0.8% to 2.54%) for an average of time of 39.2 minutes (range, 15 to 90 minutes).

Comment: *(Excluded for lack of neonatal detail, operating room, supportive)- Case series describing 24 consecutive infants (2.6-6 kg) among a total of 120 children undergoing elective groin surgery with LMA. LMA placed after anesthetic induction, infants managed with volume-control positive pressure ventilation. Unable to separately analyze the infants from the larger group of children. Report stable cardiovascular parameters (vital signs within 20% of pre-insertion value) for 117/120, laryngospasm in one patient requiring intubation, mild laryngospasm in 10. The author doesn't state whether these complications occurred in the neonatal patients.*

Faberowski LW, Banner MJ. The imposed work of breathing is less with the laryngeal mask airway compared with endotracheal tubes. *Anesthesia & Analgesia*. 1999; 89(3): 644-646.

Abstract: In this study, we compared the inspiratory imposed resistive work of breathing (WOB_i) in an age-appropriate laryngeal mask airway (LMA) with that in an age-appropriate ETT using a physiologic, sinusoidal inspiratory flow waveform to simulate spontaneous breathing.

Comment: *(Excluded because of no positive pressure ventilation, mechanical model, supportive)-A mechanical model of a spontaneously breathing neonate. Showed significantly higher work of breathing using an ETT compared with an LMA. Not clear how this model would apply to an LMA used for resuscitation.*

Falck AJ, Escobedo MB, Baillargeon JG, Villard LG, Gunkel JH. Proficiency of pediatric residents in performing neonatal endotracheal intubation. *Pediatrics*. 2003; 112(6): 1242-1247.

Abstract: **OBJECTIVE:** Current guidelines of the Accreditation Council for Graduate Medical Education have restricted the amount of intensive care experience obtained during pediatric residency. The impact on performing procedures has not been evaluated. To determine the current level of competency in 1 common procedure, we investigated the proficiency of pediatric residents in performing neonatal endotracheal intubation during the academic years 1998-1999 and 2000-2001. **METHODS:** Indication for intubation, number of attempts, and achievement of success were recorded by the respiratory therapist present for the procedure. Each intubation was scored according to the attempt on which intubation was successful. Indications for intubation were categorized as respiratory failure, delivery room resuscitation, and meconium-stained amniotic fluid. Competency was defined as a successful intubation occurring on the first or second attempt $\geq 80\%$ of the time. Intubation scores were compared between residents at various

stages of training and analyzed by multivariate logistic regression analysis for significance. Comparisons were then performed to determine percentage success with confidence intervals. We also surveyed previous graduates of the training program not included in the observations for this study and asked them to indicate how frequently they perform intubation in current practice and to assess their own competence in the procedure. **RESULTS:** A total of 449 resident procedures were observed during the study periods: 192 by postgraduate year 1 (PGY-1) residents, 126 by PGY-2 residents, and 131 by PGY-3 residents. A total of 35% (160 of 449) of intubation procedures were never successful by pediatric house officers. Intubation was successful on the first or second attempt for 50% of PGY-1 residents (95% confidence interval [CI]: 42.6-56.8), 55% of PGY-2 residents (95% CI: 46-63.5), and 62% of PGY-3 residents (95% CI: 53.9-70.7). The third-year residents exhibited a significantly higher likelihood of performing a successful intubation compared with first-year residents. The first-year residents in 1998-1999 showed no improvement by their third year in 2000-2001. Surveys were sent to 56 graduates of our residency program (1998-2000). Completed surveys were received from 31 (66%) of 47. A total of 71% of the respondents are practicing general pediatrics, and 36% attend deliveries or perform intubations. A total of 87% reported that their level of confidence with endotracheal intubation was good or excellent after completion of residency training. **CONCLUSIONS:** We provide objective and subjective data concerning the proficiency of pediatric residents in performing neonatal endotracheal intubation. None of our resident groups met the specified definition of technical competence, although there was improvement with advancing training level in bivariate analyses. However, graduates of our training program felt confident with their intubation skills in contrast to our objective findings. As exposure to these important skills becomes limited, methods to ensure attainment of technical competency during training may need to be redefined.

Comment: *Discussion only. This study demonstrates that pediatric residents at a large training program in the United States are not proficient at endotracheal intubation. Given this lack of proficiency, a critical question is whether they should be taught to use a LMA during resuscitation. If the LMA is simple to place and effective, would it decrease the need for intubation? Would teaching another technique simply overwhelm the trainees by training multiple techniques but not insuring mastery of any?*

Frediani M, Blanchini G, Capanna M, Casini L, Costa M, Uggeri S, Meini M, Pacini P. [The laryngeal mask in pediatric anesthesia]. *Minerva Anestesiologica*. 1996; 62(3): 65-71.

Abstract: We carried out a perspective study in order to assess the ease of insertion, the type and the incidence of perioperative complications connected with the use of the Laryngeal Mask Airway (LMA). We examined 300 consecutive patients, M/F 261/39, average age 4.2 yrs. (range 0.1-16), ASA I-II, who underwent surgical operations of short or average length not involving the pleural, the oropharyngeal or the peritoneum cavity. The choice about anesthesia was left to the discretion of the anesthesiologist. In 27 cases the position of the LM was controlled through a flexible fiberoptics. In 269 patients (89.6%) the LMA was correctly positioned during the first attempt. In 27 patients (9%), 2 or more attempts were necessary, and in 4 patients (1.4%) it was not possible to set the LMA. No differences of statistical significance were noticed between the different size of LMA, with regards to the facility of insertion. The control through fiberoptics showed a correct position, from an anatomical point of view, in 11 patients (41%), whereas in 13 patients (48%) some signs of partial obstruction were noticed (epiglottis interposing between the opening of LMA and larynx) and in 3 patients (11%) vocal cords are not visible. The following complications took place: laryngeal spasm on induction (2.3%), cough or movements on positioning (2.3%), hypoxia (4.3%), obstruction (1%), laryngeal spasm on awakening (1.7%), trauma (5%) and vomiting (0.3%). No connections were found between the size of LMA and total complications. Nevertheless, cough or movement during positioning and laryngeal spasm on awakening were significantly more frequent with LMA n. 3. In our experience, the LMA proved to be effectual and safe in the control of the airway during elective operations in pediatric surgery.

Comment: *Excluded for language restrictions, operating room, supportive with cautions*

Grebenik CR, Ferguson C, White A. The laryngeal mask airway in pediatric radiotherapy.[see comment]. *Anesthesiology*. 1990; 72(3): 474-477.

Abstract: The use of the laryngeal mask airway, a new form of airway, is described in infants and young children receiving radiotherapy under general anesthesia. The laryngeal mask airway consists of a tube, at

the distal end of which is attached an elliptically shaped cuff resembling a miniature face mask. The laryngeal mask is inserted blindly into the pharynx, and its cuff forms a low pressure seal around the larynx through which the patient can breathe spontaneously. No complications occurred during use of the laryngeal mask in 25 children who received 312 anesthetics. This experience suggests that the laryngeal mask airway has a valuable role in this situation and may contribute to the safety of anesthesia.

Comments: (Excluded for insufficient detail to evaluate outcome for neonatal patients, operating room, supportive)-Although this paper states that there was at least one infant 3 weeks old and 3.5 kg, no details are provided. The report provides very limited information about 25 children who had 312 anesthetics using an LMA over a 6 month period. They do state that they needed more than one attempt to place the LMA in 23/312 anesthetics and that they had one episode of laryngospasm when the mask was placed with a light level of anesthesia

Harnett M, Kinirons B, Heffernan A, Motherway C, Casey W. Airway complications in infants: comparison of laryngeal mask airway and the facemask-oral airway.[see comment]. *Canadian Journal of Anaesthesia*. 2000; 47(4): 315-318.

Abstract: PURPOSE: To compare the incidence of airway complications in children less than one year of age whose airways were maintained during anesthesia with either a laryngeal mask airway (LMA) or a facemask and oral airway (FM-OA). METHODS: We randomized 49 - ASA class 1&2 - infants to an LMA or FM-OA group. All infants were undergoing minor general, urological or orthopedic procedures. Anesthesia was induced and maintained with halothane in nitrous oxide 50% and oxygen. The airway was removed in both groups when the infant was awake. The occurrence of airway complications (breath-holding, coughing, laryngospasm, secretions, obstruction and oxygen saturation < 95%) at induction of anesthesia, intraoperatively and during emergence from anesthesia was recorded. RESULTS: Airway complications occurred perioperatively in 15 of 27 infants in the LMA group and in 5 of 22 infants in the FM-OA group (P: 0.02). CONCLUSION: In infants, the use of the LMA is associated with an increased incidence of airway complications compared with the use of the FM-OA.

Comments: (Excluded non-neonatal/no PPV, RCT LMA vs. facemask, operating room, negative)-Spontaneously breathing, anesthetized infants, mean 6 months (unclear if any < 1 month) in the operating room randomized to LMA or facemask + oral airway. LMA removed when patients awake. No details on randomization process. Investigator assessing complications not blinded to group assignment. Higher rate of perioperative airway complications with LMA (15/27 vs. 5/22) including 3 airway obstructions in the LMA group intra-operatively.

Iohom G, Lyons B, Casey W. Airway management in a baby with femoral hypoplasia-unusual facies syndrome.[see comment]. *Paediatric Anaesthesia*. 2002; 12(5): 461-464.

Abstract: We report the successful fiberoptic intubation through a laryngeal mask airway (LMA) while maintaining spontaneous respiration in an anaesthetized 3-month-old female infant with femoral hypoplasia-unusual facies syndrome, in whom direct laryngoscopy and intubation proved impossible

Comment: (Excluded, no PPV, case report, operating room)- This spontaneously breathing 3.18 kg infant (3-month-old) with a craniofacial abnormality could not be intubated in the OR using direct laryngoscopy. A modified (midline bars cut) size-1.5 LMA was placed and a fiberoptic bronchoscope was advanced through the LMA into the glottis. Two size 3.0 mm tracheal tubes had been connected end-to-end and were "railroaded" over the bronchoscope. The LMA was removed over both tracheal tubes and the top tracheal tube disconnected. This is one of several reports of tracheal intubation via the LMA using fiberoptic visualization. A larger than normal LMA (size 1.5 vs. size 1) was used to allow passage of the bronchoscope through the lumen.

Lopez Gil T, Cebrian Pazos J, Gonzalez Zarco LM, Mateos Arribas MT, Blanco Sanchez T, Navia Roque J. [Application of the laryngeal mask in pediatric anesthesiology]. *Revista Espanola de Anestesiologia y Reanimacion*. 1995; 42(8): 332-335.

Abstract: To analyze problems with inserting, maintaining and removing a laryngeal mask in children, as well as to assess the possible involvement of certain factors (experience with the laryngeal mask, type of anesthesia, duration of surgery, type of surgery, obesity, etc.) in favoring the development of complications. One hundred eighty-nine children undergoing a variety of surgical procedures under general anesthesia were studied; patients with full stomachs and/or a history of hiatus hernia were excluded. The agent used for anesthetic induction and the method of ventilation were chosen by the anesthesiologist responsible for each case. Variables monitored in all patients were continuous ECG, heart rate, systolic and diastolic arterial pressure, capnography, pulse oximetry, airways pressure and respiratory rate. Values were recorded at five times: before induction (T1), immediately after induction (T2), after placement of the laryngeal mask (T3), before removing the laryngeal mask (T4) and after removing the laryngeal mask (T5). Correct insertion was achieved on the first try in 85%. The remaining 15% required 2 or more tries. There were no cases in which a tracheal tube or face mask were required. We found no correlation between type or duration of surgery and the occurrence of complications. Complications were more frequent when the laryngeal mask was placed by inexperienced personnel, when inhalational anesthetics were used for induction and maintenance, and when a No. 1 laryngeal mask was used. Adequate ventilation was provided for the patients who required it with an airways pressure between 8 and 18 cmH₂O, arterial oxygen saturation over 98% and end-expiratory CO₂ pressure under 35 mmHg. Cardiovascular repercussions were slight and hemodynamic stability was good.

Comment: (Excluded, language, operating room supportive)- Case series. Appears to be a subset (n=189) of patients published by Mora 1995 (n=200). No details regarding the infants/neonates. The authors report that 11 subjects had a size 1 LMA placed, but details are not provided about the neonatal specific outcomes.

Lopez-Gil M, Brimacombe J, Cebrian J, Arranz J. Laryngeal mask airway in pediatric practice: a prospective study of skill acquisition by anesthesia residents. *Anesthesiology*. 1996; 84(4): 807-811.

Abstract: BACKGROUND: A prospective study was conducted to determine the rate of skill acquisition with the laryngeal mask airway in pediatric anesthesiology practice. The aim of the study was to provide information about the amount of supervised training required before satisfactory levels of skill were achieved. METHODS: Eight anesthesia residents in their third year of training with no prior experience using the laryngeal mask airway were observed using the device in 75 pediatric patients each (600 patients in total). Residents were given standardized guidelines for laryngeal mask airway usage in accordance with the manufacturer's recommendations and followed a predetermined protocol for anesthetic management. Induction was achieved with propofol followed by either a propofol infusion or isoflurane and either controlled or spontaneous ventilation as clinically indicated. Predefined major and minor problems were documented during the induction, maintenance, and recovery phases of anesthesia by a randomly selected supervising consultant trained in the study protocol and problem definitions. RESULTS: The total number of problems was 189 occurring in 121 children. Fifty-five children had one problem, sixty-four children had two problems, and two children had three problems. Of the problems, 77 were major and 112 were minor. The problem rate per patient for overall, major, and minor problems was 31.5%, 12.8%, and 18.7%, respectively. The problem rate comparing the first to last epochs of 15 uses decreased from 62% to 2% for overall problems, 23% to 2% for major problems, and 39 to 1% for minor problems. The residents with the most problems in the final epoch had problem rates of less than 10% after 60 uses. There was a significant decrease in the overall problem rate for induction, maintenance, and recovery (P < 0.05). The major problem rate decreased significantly for induction and maintenance (p < 0.05), but not for recovery. The minor problem rate decreased significantly for induction and recovery (P < 0.05). CONCLUSIONS: This study confirms that there is a rapid improvement in laryngeal mask airway skills when the standard recommended technique is employed and that a low problem rate can be achieved within 75 uses. Pediatric anesthesiologists with problem rates greater than 10% should determine if they are using the device suboptimally.

Comment: Discussion only. A prospective study describing the performance of 8 anesthesia residents who had never used an LMA during their pediatric rotation. Their patients ranged in age from 1 month- 17 years. It is not possible to identify how many patients were neonates or infants and the resident performance is not presented by age group. In total, 12.8% of the patients had a major complication

during insertion, maintenance of anesthesia, or during recovery. The majority occurred during maintenance. Residents improved their skills consistently with every 15 uses. The overall problem rate decreased from 62% during the first 15 patients to 2% after 60 patients. The major problem rate decreased from 23% to 2% during the same interval. The authors report that no major morbidity resulted from the use of the LMA. The applicability of this study to the use of an LMA during neonatal resuscitation is not clear. It is not clear how many patients were neonates, their patients had an LMA inserted after induction with general anesthesia and were pharmacologically paralyzed during both placement and maintenance. The duration of time the LMA was maintained in the airway was not described. This study does highlight, however, that using an LMA is a skill that improves fairly rapidly with experience.

Martin PD, Cyna AM, Hunter WAH, Henry J, Ramayya GP. Training nursing staff in airway management for resuscitation: A clinical comparison of the facemask and laryngeal mask. *Anaesthesia*. 1993; 48: 33-37.

Abstract: The place of the laryngeal mask in emergency airway management by nonanaesthetists has yet to be established. We have compared the tidal volume achieved by nurses during hand ventilation using standard resuscitation equipment with a facemask, with or without a Guedel airway, and following placement of a laryngeal mask in the same patients. The tidal volumes measured while using the laryngeal mask were significantly greater ($p < 0.01$) than those measured during facemask ventilation.

Comment: *Discussion only. Nurses from an adult intensive care unit without experience using LMAs were given a brief introduction (30 minutes) and sent to the operating room. The nurses first ventilated anesthetized adults using a bag-mask-valve device and then they placed an LMA. The tidal volume achieved, end tidal carbon dioxide, peak pressure, and oxygen saturation were measured. The nurses preferences and perceptions about each technique were assessed afterwards. The nurses were more successful with the LMA and preferred the device. Nurses were successful placing the LMA in 24/30 patients.*

Mizushima A, Wardall GJ, Simpson DL. The laryngeal mask airway in infants.[see comment]. *Anaesthesia*. 1992; 47(10): 849-851.

Abstract: Clinical and fiberoptic assessment of positioning of the size 1 laryngeal mask airway was performed in 50 infants. A clinically patent airway was obtained in 47 patients at the first attempt, but perfect positioning, as assessed by fiberoptic laryngoscopy, was found in only 22 instances. Despite an airway initially patent, delayed airway obstruction occurred in 12 infants. It is concluded that clinical airway patency does not guarantee ideal positioning of LMA in infants, and that care should be taken to ensure continued airway patency because of the tendency of the LMA position to deteriorate in this group of children.

Comments: *(Excluded for no PPV, unable to identify neonatal outcomes, operating room, supportive with important cautions)- Case series. The subjects included 5 infants < 6.5 kg, however, there were insufficient details to identify the outcomes specifically for neonates. None of the subjects had positive pressure ventilation. Important messages from this study include: the LMA has a high rate of initial placement success (94%), its position in the airway is frequently not ideal based on fiberoptic assessment although it still provides an adequate airway, and users should be aware that the LMA may become dislodged despite initial success. Moving the patient with the LMA in place may be a time to be particularly cognizant of this risk.*

Mora J, Lopez-Gil MT, Blanco T, Molina E, Morillo A, Amores J, Cerda J. [Use of the laryngeal mask in pediatric surgery]. *Cirugia Pediatrica*. 1995; 8(2): 55-57.

Abstract: The laryngeal mask is a new method in the control of the airway. In this study we assess the haemodynamic response during the insertion of the laryngeal mask, incidence of complications and recovery from anaesthesia after its use. We also check if the laryngeal mask is easy to place into the patient airway and its versatility in pediatric patients. We have obtained that the use of the laryngeal mask airway is a safe technique, with few complications, easy to learn and with a short recovery time.

Comment: (Excluded for language restriction, operating room, supportive)- Case series describing 200 patients ranging in age from 20 days-16 years with LMA placed for surgery. No details re: number of patients that were neonates/infants and unable to separate their outcomes. Overall, the LMA was placed correctly on the first attempt in 85% and on the second in 10%.

Nagahama H, Suzuki Y, Tateda T, Aoki T, Takahashi K, Shimoyama T. [The use of a laryngeal mask in a newborn infant with Nager acrofacial dysostosis]. *Masui - Japanese Journal of Anesthesiology*. 1995; 44(11): 1555-1558.

Abstract: A newborn female infant born at 41 week gestation with Nager acrofacial dysostosis had no congenital abnormalities in her parents and close relatives. Her mother had uncomplicated pregnancy and normal delivery. Endotracheal intubation was attempted, because she developed apnea on her delivery, but it was not successful. She was transported immediately to our university hospital with mask ventilation. A laryngeal mask was placed after several trials of intubation, and ventilation was carried out successfully. We consider that the use of a laryngeal mask is one of the best ways in a case of difficult intubation.

Comments: (Excluded for language restriction, intensive care unit, supportive)- Case report describing a newborn with craniofacial anomalies that could not be intubated in the delivery room or on arrival at the tertiary care center. Bag-mask ventilation was successful. An LMA was placed without difficulty. Article in Japanese, abstract in English.

Nguyen NH, Morvant EM, Mayhew JF. Anesthetic management for patients with arthrogryposis multiplex congenita and severe micrognathia: case reports. *Journal of Clinical Anesthesia*. 2000; 12(3): 227-230.

Abstract: Arthrogryposis multiplex congenita (AMC) is a spectrum syndrome of multiple persistent limb contractures often accompanied by associated anomalies, including cleft palate, genitourinary defects, gastroschisis, and cardiac defects. Pediatric patients with AMC frequently present for multiple surgeries requiring general endotracheal anesthesia. We describe our anesthetic experience with the laryngeal mask airway and endotracheal tube in two neonates with AMC and severe micrognathia. We discuss AMC and outline the problems encountered in difficult airway management.

Comment: (Excluded for no PPV, operating room, supportive)- Case report describing two infants (4-kg, 3 month old requiring gastrostomy, 2.3-kg, term male newborn with omphalocele requiring Broviac) with micrognathia and arthrogryposis. Both failed endotracheal intubation. In the operating room, an LMA was placed to control the airway and then an ETT was placed over a flexible bronchoscope through the LMA. The LMA was placed while the patients were awake and breathing spontaneously with inhalational anesthesia and topical xylocaine jelly.

Oliva P, Fernandez-Liesa JI, Sanchez Tirado JA, Perez de Palomar R, Gomez R. [Use of the laryngeal mask in a newborn infant with Smith-Lemli-Opitz syndrome and a difficult airway]. *Revista Espanola de Anestesiologia y Reanimacion*. 2002; 49(6): 339-340.

Abstract: None

Comments: (Excluded for language restriction, operating room, supportive) – Case report. A 21 day old (1750 gm) with Smith-Lemli-Opitz syndrome requiring surgery for pyloric stenosis. Anesthesiologist was unable to intubate and placed a size-1 LMA without difficulty.

Orfei P, Almenrader N, Patrizio A, Bigetti E, Pinto G. [Laryngeal mask perforation: complication of jugular vein cannulation in a newborn]. *Anaesthetist*. 2002; 51(6): 467-469

Abstract: This case report describes the perforation of a laryngeal mask during central venous cannulation of the internal jugular vein in a 2000 g, formerly preterm infant. The procedure was undertaken with the patient under general anaesthesia with a laryngeal mask and spontaneous breathing. As a result of the infant's clinical status, multiple needle insertions were required to obtain venous access. The needle was inadvertently advanced to the retropharynx and perforated the air-filled part of the laryngeal mask.

Ventilation parameters remained stable. The laryngeal mask causes anatomical alterations of cervical structures in the newborn and therefore its use for the airway management during jugular vein cannulation appears to be limited.

Comment: (Excluded for language restriction, operating room, neutral/opposing-a warning about an unusual complication)

Orfei P, Bigetti E, Patrizio AP, De Chiara A, Sabani A, Pinto G. [Laryngeal mask as alternative to facial mask in the newborn]. *Minerva Anestesiologica*. 1999; 65(12): 837-841.

Abstract: OBJECTIVE: The present study demonstrates that the use of laryngeal mask airway (LMA) is an alternative to face-mask (FM) during induction of general anesthesia with halothane. In all patient the induction of general anesthesia is carried out by halotane and N2O/O2 50%, using only the LMA, preceding topical anesthesia of pharynx. METHODS: Experimental design: prospective study. Setting: this study was carried out at the surgical-division of the Pediatric Clinic, of University "La Sapienza", Rome. Patients: a total of 80 newborns, average age 14.8 +/- 2.4 days and average body weight 2280 +/- 110 g were examined. Interventions: newborns were submitted to surgery for congenital malformations, diagnostic research and positioning of a central venous catheter (CVC). MEASUREMENTS: Heart rate, non-invasive arterial pressure through cardiomonitor Hewlett Packard 78352A, oxygen saturation through Nellcor N3000, time of induction of general anesthesia and respiratory rate were assessed. RESULTS: Blood pressure and heart rate were increased during the positioning of LMA; oxygen saturation remained > or = 94% and respiratory rate was constant during the whole observation. Muscular relaxing, as an index of anesthesia, was observed after 33 +/- 1.5 sec after positioning of LMA. CONCLUSIONS: In the light of the results obtained, the use of the LMA for airway ventilation during the induction period of pediatric anesthesia is suggested.

Comment: (Excluded for language restriction, operating room, supportive)- Case report describing anesthesia induction using the LMA. This is the largest reported series of operating room cases involving only neonates.

Orfei P, Frandina G, Patrizio A, Bigetti E, Nicolucci S, Romualdi R, Galassi A, Pinto G. [Use of the laryngeal mask for airway control in difficult intubations in children]. *Minerva Anestesiologica*. 1999; 65(7-8): 561-569.

Abstract: LMA was introduced in clinical practice by Arthur Brain in 1983 as a valuable substitute of tracheal tube in adult who underwent general anaesthesia; since then its applications have been extensively studied. LMA is a relatively new non-invasive ventilatory device which has allowed a radical change in the management of modern general anaesthesia. In this study, the application of LMA is assessed during induction and maintenance of general anaesthesia in children affected by severe facial deformities that could render the placement of the tracheal tube difficult. Three patients were affected by complex malformative syndromes involving the maxillo-facial skeleton and one patient presented a massive teratoma, originating from the orbit. In all these cases, LMA provided a patent airway and a satisfactory ventilation during both induction and the repeated attempts of inserting the tracheal tube; in one case, since the orotracheal intubation failed, LMA has proved to be as effective as the tracheal tube during the maintenance of general anaesthesia. Therefore, LMA is recommended as an essential ventilatory device in the hands of paediatric anaesthesiologists.

Comment: (Excluded for language restriction, operating room, supportive)- Case series describing 4 operating room cases including one neonate (DOL 2) with an orbital teratoma, 2 infants (2 months) with Pierre-Robin and Cornelia de Lange, and a 3 year old with Treacher-Collins and difficult airways. Unable to intubate, used LMA to secure airway.

Osses H, Poblete M, Asenjo F. Laryngeal mask for difficult intubation in children.[see comment]. *Paediatric Anaesthesia*. 1999; 9(5): 399-401.

Abstract: We present a new intubation technique using an oral preformed tracheal tube passed through a

laryngeal mask. Six patients (neonate to six months old) with craniofacial malformations of head and neck and scheduled for reconstructive plastic surgery are the basis of this report. An inhalation induction with increasing doses of halothane in oxygen while maintaining spontaneous ventilation was performed. Once an adequate anaesthetic depth was achieved, a direct laryngoscopy was performed. The epiglottis could not be seen in any of the patients. Anaesthesia was deepened in order to insert the laryngeal mask, size 1 or 2, with an oral preformed 3.5 or 4.0 tracheal tube inside it. Correct position of the mask was confirmed by capnography. The preformed tracheal tube was then advanced 1-2 cm. and its position in the trachea verified. The 15 mm connector was then removed, and an adult intubating stylet was attached to the end of the tracheal tube. The laryngeal mask was removed, holding the stylet and tube in place. Once the mask was removed, the stylet was disconnected, and the 15 mm connector reattached. Our experience was that this takes about 20 to 30 s. We recommended this technique in paediatric patients in which a difficult intubation is foreseen.

Comments: (Excluded for no positive pressure ventilation, operating room, supportive)- Case series. This brief report describes 6 infants, including 2 neonates with Pierre-Robin sequence, who could not be intubated in the operating room with direct laryngoscopy. A LMA was placed and an endotracheal tube advanced blindly through the LMA. The tracheal tube was held in place with an intubating stylet and the LMA was removed. There are very limited details about the subjects. The subjects were all spontaneously breathing.

Pennant, J. H. and M. B. Walker (1992). "Comparison of the endotracheal tube and laryngeal mask in airway management by paramedical personnel." *Anesth Analg* 74(4): 531-4.

An evaluation of the laryngeal mask airway (LMA) as a means of airway support when used by paramedical personnel was performed. Forty medical and paramedical students attempted to intubate the tracheas of 40 healthy anesthetized adults with the LMA and a cuffed endotracheal tube (ETT). The number of attempts to achieve correct placement and the time taken to adequately ventilate the lungs were recorded for both devices. End-tidal carbon dioxide was detected significantly sooner after commencement of the intubation attempt using the LMA (mean 38.6 s) compared with the ETT (mean 88.3 s, P less than 0.0001). Ninety-four percent of the students successfully ventilated the lungs on their first attempt with the LMA, whereas only 69% intubated the trachea on their first attempt with the ETT (P less than 0.01). Five students were unable to intubate the trachea after three attempts with the ETT, but all positioned the LMA satisfactorily on their first try in a mean time of 40 s. We conclude that unskilled operators with minimal training can safely and successfully ventilate unconscious patients more rapidly using the LMA than the ETT. These results suggest the LMA should be available in all areas where resuscitation is performed.

Prengel AW, Rembecki M, Wenzel V, Steinbach G. A comparison of the endotracheal tube and the laryngeal mask airway as a route for endobronchial lidocaine administration. *Anesthesia & Analgesia*. 2001; 92: 1505-1509.

Abstract: Drug administration via the endotracheal tube is recommended as a second-line approach in emergency settings such as cardiac arrest. It is unknown what amount of drugs are absorbed when they are given through the laryngeal mask airway as compared with the endotracheal tube. We administered lidocaine at a dose of 2 mg/kg diluted in 10 mL normal saline to 20 anesthetized patients undergoing routine surgical procedures. Ten patients received lidocaine into the endotracheal tube and 10 patients received lidocaine into the laryngeal mask airway. Blood samples were taken for measurement of lidocaine plasma concentrations, and the pharmacokinetics were calculated. Therapeutic plasma concentrations (>1.4 microg/mL) could be achieved in 10 of 10 patients after endotracheal tube instillation but in only 4 of 10 patients after laryngeal mask instillation (P < 0.05). Peak lidocaine concentrations (2.47 and 1.09 microg/mL) (P < 0.05) and the area under the time versus plasma concentration curve (117.7 and 91.2 microg x min x mL(-1)) (P < 0.05) were higher after lidocaine administration into the endotracheal tube than into the laryngeal mask airway. In conclusion, the laryngeal mask airway is not a reliable route for the recommended dose of endobronchial lidocaine administration compared with the endotracheal tube.

Comment: Discussion only. Among adults, less than half of adults that received a standard dose of lidocaine given through an LMA reached a therapeutic drug level. All of those who received an endotracheal dose reached therapeutic levels. Study suggests that emergency medications may not be

reliably delivered through the LMA.

Puebla G, Falcone N, Jerez A, Real MI, Munoz JF, Gomez J. [A neonate with a large cystic hygroma: management of the airway]. *Rev Esp Anesthesiol Reanim.* 1997; 44(5): 210-211.

Abstract: None

Comments: (Excluded for language restriction, operating room, supportive)- Case report of a newborn (3 day) with a large cystic hygroma that was managed in the operating room with a LMA.

Reinhart DJ, Simmons G. Comparison of placement of the laryngeal mask airway with endotracheal tube by paramedics and respiratory therapists. *Ann Emerg Med.* 1994; 24(2): 260-263.

Abstract: STUDY OBJECTIVE: To determine the learning curve of nonphysician emergency personnel on placement of the laryngeal mask airway as compared to performance of endotracheal intubation. DESIGN: Prospective, comparative, randomized, patient-blinded trial. SETTING: Regional hospital operating room. PARTICIPANTS: Seven experienced paramedics and 12 respiratory therapists trained in endotracheal intubation. INTERVENTIONS: Patients used as subjects were anesthetized and paralyzed. Each participant then performed placement of both the laryngeal mask airway and endotracheal tube on the same patient in random sequence. Both techniques were observed for speed, difficulty, and effectiveness. MEASUREMENTS AND MAIN RESULTS: The techniques were timed from the point at which the participant touched the patient to the time they were able to effectively ventilate the patient. Participants also were asked to rate the difficulty of each technique on a 100-mm visual analog score. Failure (three attempts without successful ventilation) rates also were monitored. The mean time to ventilate successfully with the laryngeal mask airway was significantly less than that with the endotracheal tube (38.9 +/- 1.9 seconds versus 206.1 +/- 31.9 seconds, $P < .0001$). The average number of attempts was 1.0 +/- 0.0 for the laryngeal mask airway and 2.22 +/- 0.21 for the endotracheal tube ($P < .01$). No one failed to place the laryngeal mask airway; and ten of 19 (52.6%, $P < .01$) failed to perform endotracheal intubation. The endotracheal tube had a significantly higher rating of difficulty than did the laryngeal mask airway (67.3 versus 8.64, $P < .0001$).

Comment: Discussion only. This study raises the question whether the LMA should be the preferred device, rather than endotracheal intubation, for resuscitators inexperienced in endotracheal intubation. If the airway is secured with the LMA successfully and effective ventilation achieved, will the LMA prevent the need for endotracheal intubation?

Rowbottom SJ, Simpson DL, Grubb D. The laryngeal mask airway in children. A fiberoptic assessment of positioning. *Anaesthesia.* 1991; 46(6): 489-491.

Abstract: Clinical and fiberoptic assessment of the positioning of the laryngeal mask airway was performed in 100 children. Clinical observation indicated a patent airway in 98% and severe airway obstruction in 2% of cases. Perfect positioning, as judged by fiberoptic laryngoscopy, was found in 49% and the epiglottis was within the mask in 49%. Fiberoptic evidence of partial airway obstruction in 17% was not detected clinically.

Comment: (Excluded because of lack of neonatal detail, no positive pressure ventilation, supportive with cautions)-Cannot determine how many < 1 month or < 5 kg, however, 7 infants had a size-1 LMA placed. The lowest end of the birthweight range was 5 kg and the lowest range of age was 0.11 years (1+ months). Fiberoptic bronchoscopy identified partial airway obstruction in 1/7 using size-1 LMA and a portion of the epiglottis seen (non-ideal position) in 3/7. In all cases, however, the LMA functioned without difficulty. The authors cautioned that the non-ideal position of the LMA may make blind placement of an ETT through an LMA more difficult in young children.

Sacks M, Marsh D. Bilateral recurrent laryngeal nerve neuropraxis following laryngeal mask insertion: a rare cause of serious upper airway morbidity. *Paediatric Anaesthesia.* 2000; 10: 435-437.

Abstract: We report the case of a 4-year-old boy who developed bilateral recurrent laryngeal nerve neuropraxis following routine anaesthetic with a laryngeal mask airway. The possible mechanisms of

injury and the ways that this rare but critical complication might be avoided are discussed.

Comments: *Discussion only. An important warning about the possible complications of the LMA. In this case, the recurrent laryngeal nerve appeared to be compressed between the pharyngeal structures and the LMA. There was no apparent malposition, the correct size LMA was used, and the procedure only lasted 90 minutes. This child required intubation and dexamethasone. He was extubated the following day without complications.*

Samet A, Talmon Y, Frankel R, Simon K. A new diagnostic approach to congenital stridor using a laryngeal mask airway and rigid endoscope. *Journal of Laryngology & Otology*. 1994; 108(12): 1076-1077.

Abstract: Neonates with symptoms of stridor from birth, present a difficult diagnostic problem. We have demonstrated that by the use of a laryngeal mask airway in an anaesthetized baby breathing spontaneously, we are able to reach a diagnosis. This is accomplished by the introduction of a rigid fibre-optic endoscope through a Portex swivel connector and visualizing the glottis and larynx.

Comments: *(Excluded for no positive pressure ventilation, diagnostic bronchoscopy, supportive)-Case report describing two newborns (2.9 kg, 3.4 kg) with stridor who underwent diagnostic rigid bronchoscopy under anesthesia with bronchoscope inserted through the size-1 LMA. Diagnosed with laryngo-tracheomalacia and edematous vocal cords. No intervention in either case.*

Sorba F, Courreges P, Lecoutre D, Bayard-Gary R. [Evaluation of laryngeal masks]. *Cahiers d Anesthesiologie*. 1994; 42(5): 567-570.

Abstract: The size 1 laryngeal mask (LMA1) was studied prospectively in a series of 37 infants (weight less than 6.5 kg) undergoing 42 routine surgical procedures. LMA1 insertion was successful at first attempt in 80.9% of all cases and a good airway control was obtained in 93%. The most frequent cause of insertion failure was an insufficient depth of anaesthesia. Only one incident occurred perioperatively. The recovery incidents rate, higher than in other studies, was mainly due to the laryngeal hyperreactivity of infants. LMA1 provides high safety for infant anaesthesia with good working conditions for both anaesthetist and surgeon. However, an accurate determination of the anaesthesia level and a close monitoring of recovery are strongly recommended.

Comments: *(Excluded for language restriction, operating room, supportive). A case series of 37 infants < 6.5 kg with an LMA used for airway management in the operating room.*

Stillman PC. Lingual oedema associated with the prolonged use of an inappropriately large laryngeal mask airway (LMATM) in an infant. *Paediatr Anaesth*. 2003; 13(7): 637-639.

Abstract: A case report is presented of a 12-month-old infant who developed lingual oedema after the prolonged use of an inappropriately large laryngeal mask airway (LMATM). A size 2(1/2) LMA was used in a 10.6 kg infant during a 5 h operative procedure. Postoperatively, the patient developed significant tongue oedema, which gradually resolved with time and dexamethasone treatment. This rare complication demonstrates the potential danger of using an overly large LMA in an infant, especially for a significant period of time.

Comments: *Discussion only. An important warning about a potential complication. This infant had an inappropriately large LMA placed and the tongue was protruding throughout the 5 hour procedure. Obstruction to venous drainage was the most likely cause of edema. A similar complication has been noted in an animal model (see Brietzke).*

Stocks RM, Egerman R, Thompson JW, Peery M. Airway management of the severely retrognathic child: use of the laryngeal mask airway. *Ear Nose Throat J*. 2002; 81(4): 223-226.

Abstract: Successful airway management of an infant or child with moderate to severe retrognathia first requires recognition of a potential problem. If the child cannot be intubated in a standard fashion, the use of a laryngeal mask airway (LMA) should be considered. We describe two cases wherein a toddler and an infant with severe retrognathia failed multiple attempts at traditional intubation. Both had an anterior larynx

and hypoplasia of the mandible. In both cases, a subsequent LMA was successfully placed. The severely retrognathic newborn or child presents to the physician a unique challenge in airway management. Techniques to manage this difficult pediatric airway are different from those used in the adult. Otolaryngologists should be aware of this intubation technique and include it in their armamentarium of airway-management strategies. The LMA is not recommended as the technique of choice for securing a difficult airway, but it is an effective alternative when indicated, and it might be life-saving

Comments: *(Excluded because no positive pressure ventilation through LMA, operating room, supportive)-Case report describing one neonate (6 days, full term) and one infant (26-months) with difficult airways. The newborn infant required positive pressure ventilation. She was noted to have severe mandibular hypoplasia and immobility consistent with Nager's syndrome. She responded to bag-mask ventilation, but the team was unable to intubate her. A tracheostomy was planned secondary to recurrent episodes of obstruction. Direct laryngoscopy in the operating room was not successful and a size-1 LMA was placed while she was awake. She breathed spontaneously through the LMA. Two endotracheal tubes were attached end-to-end and placed blindly through the LMA. The LMA was also left in place.*

Stone BJ. The use of the laryngeal mask airway by nurses during cardiopulmonary resuscitation. *Anaesthesia*. 1994; 49: 3-7.

Abstract: A multicentre study was undertaken to assess the potential value of the laryngeal mask airway when inserted by ward nurses during resuscitation as a method of airway management, prior to the arrival of the Advanced Life Support Team with tracheal intubation capability. The nurses underwent a training programme agreed by all the participating hospitals and followed an identical protocol and data recording system. One hundred and thirty nurses were trained and 164 cases of cardiac arrest were studied. The laryngeal mask airway was inserted at the first attempt in 71% and at the second attempt in 26% of cases. Satisfactory chest expansion occurred in 86% of cases. The mean interval between cardiac arrest and laryngeal mask airway insertion was 2.4 min. Regurgitation of gastric contents occurred before airway insertion in 20 cases (12%), during the insertion in three cases (2%), but there was clinical evidence of pulmonary aspiration in only one patient, who survived to leave hospital. We conclude that the laryngeal mask airway offers advantages over other methods of airway and ventilation management, such as the bag-valve-mask or mouth-to-mouth methods that are currently used by ward nurses in resuscitating patients with cardiac arrest. In this study, the laryngeal mask airway was not being compared with the tracheal tube.

Comment: *Discussion only. This is an interesting study that suggests that medical staff with minimal training may be successful placing an LMA during adult cardiopulmonary resuscitation. Given that many neonatal resuscitations occur in hospitals with staff that don't frequently intubate, findings similar to this could be very relevant to neonatal resuscitation. A comparative trial (LMA vs. bag-valve-mask or LMA vs. endotracheal intubation) would be more informative.*

Walker RW. The laryngeal mask airway in the difficult paediatric airway: an assessment of positioning and use in fiberoptic intubation. *Paediatr Anaesth*. 2000; 10(1): 53-58.

Abstract: The laryngeal mask airway (LMA) was used in 34 children who presented with difficult airways and difficulty in intubation. All 34 children were a grade 3 or grade 4 Cormack and Leehane view at conventional laryngoscopy. The laryngeal mask airway was used as part of the anaesthetic technique. It was either used as the method of airway maintenance during a short procedure or as an aid to fiberoptic intubation. The results of its use in this group of patients showed that overall a good airway was obtained in 73% of patients and an adequate airway in 27%, and in no patient was a poor airway obtained. The fiberoptic positioning of the LMA, taken from the distal aperture of the laryngeal mask airway showed that, overall, in 29.5% of patients a full view of the glottis (grade 1) was obtained, in 29.5% of patients a partial view of the glottis (grade 2) was obtained and in 41% a view of the epiglottis only (grade 3) was obtained. In no patient was a view excluding the epiglottis obtained. In children with a mucopolysaccharide disorder, the number of children who had a grade 3 view increased to 54%. Children with a disorder other than mucopolysaccharidosis had a grade 3 view in only 17% of cases. Children with mucopolysaccharidoses had a grade 1 view in only 14% of cases compared with 58% in the group with other disorders. Of the 34 patients, 21 patients were intubated on 31 separate occasions. There were no failures. The complications of

the fiberoptic intubation technique described are outlined.

Comment: *(Excluded, no positive pressure ventilation, operating room, support with caution)- Similar to Rowbottom, this study evaluates the adequacy of LMA placement both clinically and with fiberoptic bronchoscopy. The children in this study (1-week-16 years), however, have abnormal airways that could not be intubated with conventional laryngoscopy. There was one neonate (7 days, 3 kg with Pierre-Robin sequence). Again, the fiberoptic assessment commonly showed the LMA to have non-ideal placement although a good clinical airway was maintained. This study suggests that "blind intubation" through the LMA without the assistance of a bronchoscope would have a low likelihood of success. Infants with mucopolysaccharidoses had a high rate of non-ideal placement with the epiglottis partially obscuring the view of the glottis.*

Wheatley RS, Stainthorp SF. Intubation of a one-day-old baby with the Pierre-Robin syndrome via a laryngeal mask. *Anaesthesia*. 1994; 49(8): 733.

Abstract: None

Comment: *(Excluded because of no positive pressure ventilation, operating room, supportive)-Brief case report describing a one-day old, 4.1 kg newborn with Pierre-Robin sequence. He had respiratory distress immediately. Taken to the operating room for a planned tracheostomy, but endotracheal intubation was unsuccessful and the anesthesiologist had difficulty maintaining a patent airway. A size-1 LMA was placed without difficulty and an endotracheal tube inserted (blindly) through the LMA. The surgery was completed with the LMA/ETT combination.*

