Pediatric Airway Management

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Contents

Airway management represents the first priority for the anesthesiologist who is asked to treat a critically ill child.

During pediatric age, the incidence of unpredicted difficult intubation is rare, and most children with difficult airway can be identified during preoperative evaluation.

However, unpredictable difficulties at intubation and/or ventilation may be a cause for high mortality and morbidity [1].

Emergency intubation out of the operating room (i.e., in the emergency room, emergency department, or medical ward) has an increased morbidity and mortality.

While difficult airway management guidelines for the adult were published in the 90s and are commonly applied from anesthesiologists in the pediatric field, they are

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more recent and handled by regional or national societies. Indeed, many anesthesia departments have simply rearranged the adult guidelines without specific pediatric criteria [2–4].

In Italy, pediatric airway management guidelines development was started in 2006 by the SIAARTI/SARNnePI group involving experienced pediatric anesthesiologists and intensivists. Unfortunately, nowadays, there are no randomized clinical trials that can support the development of guidelines with evidence of strong recommendation.

That is the reason why the few documents published until now are mostly based on a panel expert consensus (Delphi method).

At the end of the document, expert opinions are classified as recommendation grades A, B, C, D, or E depending on the consensus percentage obtained from the panel in relation to three recurrent clinical case: (1) difficult mask ventilation, (2) difficult intubation, and (3) difficult ventilation and intubation (Cannot Intubate Cannot Ventilate, CICV). Particularly, Italian guidelines are also extended to newborn, reflecting our specific organizational model in which the anesthesiologist is involved in the management of both the critical newborns in the delivery room and the children in the pediatric intensive care units. Moreover, in the Italian guidelines, a large section is dedicated to the management of the expected difficult intubation, regarding both the planning of anesthesiologic procedures and operative procedures on difficult airways and preparation of instruments needed [5, 6].

The purpose of this chapter is the review of the principal papers published about pediatric airway management with particular attention to our national society guidelines that are so far the landmark for most anesthesiologists and intensivists. Particularly, the peculiar anatomic and physiological characteristics of children, the preoperative evaluation, the use of specific materials, and difficult intubation situations will be discussed.

8.1 Peculiar Anatomic and Physiologic Characteristics in Children

Some peculiar anatomic characteristics of the airway in children are important for the planning of intubation and ventilation procedures.

These characteristics include: (1) prominent occipital bone, (2) macroglossia, (3) large epiglottis, and (4) higher position of the larynx (C3–C4) if compared to the adult population.

Children and infants up to 3 months are considered prevalent nose breathers for the presence of a large, omega-shaped epiglottis in a higher position (C4 vs. C6) that tends to hide the laryngeal aditus in direct laryngoscopy. The narrowest part of the pediatric airway is in the subglottic area at the level of the cricoid ring. The area corresponding to the ventilatory surface is increased during inspiration and decreased during expiration, with consequent interruption of the expiratory flow and the subsistence of a positive end-expiratory pressure that keep the chest wall stable preventing its collapse [7, 8].

Up to 8 years, the pediatric larynx is cone-shaped and its narrowest point is immediately subglottic at the level of the cricoid ring (the only one complete ring of the tracheobronchial tree) [9].

Furthermore, the anterior commissure of the glottis is more caudal than the posterior so that the endotracheal tube may stop at this level and little rotation is needed to assure further advancement [5, 10].

About anatomic characteristics, just few cases of difficult intubation are reported in the literature for healthy children, while different reports describe very difficult situations of the management of airways in children with craniofacial and upper airways malformations (Pierre Robin syndrome, Treacher Collins syndrome, Kabuki syndrome, Noonan syndrome, Franceschetti syndrome, achondroplasia, arthrogryposis, osteomandibular synostosis, mucopolysaccharidosis, and cleft) and/or lower airway malformations (subglottic or supraglottic hemangiomas, subglottic or supraglottic stenosis derived from neonatal intubation, and vascular rings). Particularly, in the craniofacial malformations (Pierre Robin, Treacher Collins, Kabuki, and Franceschetti), the difficulty to intubate is caused by the impossibility to visualize the laryngeal aditus with direct laryngoscopy, preferring elective fiberoptic intubation with sedation and maintenance of spontaneous breathing and the creation of a protection tracheostomy for the postoperative period, in selected cases [11–16].

On the other hand, supraglottic or subglottic stenosis due to previous intubation can make the progression of the endotracheal tube through the laryngeal aditus, cricoid, or trachea very difficult or impossible [17, 18].

Concerning physiological characteristics, newborns, and infants are in a disadvantageous condition compared to adults regarding the onset of hypoxia and hemodynamic complications. In fact, for this population, acute hypoxemia is the principal cause of bradycardia and cardiac arrest.

The term newborn FRC (*Functional Residual Capacity)* is about 30 mL/kg and the compliance of the respiratory system is 5 mL/cmH_2O (1.5 mL/kg). In a 3-kg newborn, minute volume ventilation is 600 mL (with dead space about 50% of tidal volume with a mean alveolar minute ventilation of 300 mL/min) with RR 30–45 breaths/min. The total resistance of the respiratory system is about 70 cmH_2O L/s, principally distributed in distal airways [19]. If compared to the adult population, the newborn has a reduction of compliance by one-twentieth and an increase of total resistance of about 15 times. The majority of the impedance is due to the lung, depending on the presence of surfactants into the alveoli. Instead, the chest wall has a high compliance due to the absence of ossification. During the second year of life, the respiratory system develops and the ratio between lung and chest wall compliance becomes about 50% as in adults [20]. In this situation, the respiratory work in an infant is mostly spent to keep the alveoli open in the absence of the stabilizing role of the chest wall.

In addition, infants have a relative immaturity of the central system of control of breathing and a reduced endurance of respiratory muscles (due to the lack of type 1 muscular fibers). In this condition, the loss of spontaneous breathing caused by pharmacological sedation leads to a rapid alveolar de-recruitment resulting in

hypoxemia, bradycardia, and low cerebral and systemic perfusion. In fact, cardiac output (HR × SV) in infants is strictly related to a high heart rate. The elevated tissue oxygen consumption (5–8 mL/kg/min) keeps the infant more susceptible to hypoxia during bradycardia and desaturation [19].

For all these considerations, children up to 3 years are the pediatric population more at risk of respiratory complications during the management of the airways such as intubation and mechanical ventilation.

8.2 Approach to Intubation in Children

Considering elective intubation in the operating room, several studies describe that it is a safe procedure with a percentage of difficult intubation from 0.25 to 3% in the healthy child [21–25].

In contrast, emergency pediatric intubation (emergency room and ward) is characterized by elevated morbidity and mortality because of the limited possibility to perform adequate ventilation, the limited availability of adequate materials, and the emergency nature of the event. In this situation important desaturation (14–29%), hypotension (3.21%), cardiac arrest (1%), right bronchial intubation (3–6%), esophageal intubation (10%), and airway lesions (2.5%) are described [26–30].

For these considerations, it is clear that one of the priorities for the operator is to identify children with potential difficult airways in order to program, if possible, the procedure with lower risks and the most appropriate pharmacological approach, preparing the most suitable material for the management of the child, and considering the possibility of a secondary transport to a pediatric center for children with known malformative disorders or previous difficulties who need an endoscopic or surgical approach for the management of the airway or a postoperative management in a pediatric intensive care unit.

8.3 Pediatric Airway Evaluation

In the pediatric population, most of the difficult intubations are predictable by anamnestic and clinical criteria considering the particular anatomic and physiological characteristics described above [1].

Particular attention must be paid to the following aspects: (1) presence of apneas, (2) stridor, (3) alterations in the tone of voice, (4) recurrent laryngeal infections, (5) swallow disease or gastro-esophageal reflux disease, and (6) previous difficult intubation.

The Mallampati score cannot be applied to children, so the clinical examination must be focused on potential pathological aspects: reduced mouth opening, macroglossia, and micrognathia [5–8]. Some malformative conditions characterized by micrognathia, retrognathia, mandibular hypoplasia, and glossoptosis are considered the most common conditions associated with difficult intubation. This is caused by an altered insertion of the tongue in hypopharynx (glossoptosis), leading to an

almost impossible epiglottis loading during direct laryngoscopy (Pierre Robin syndrome and Treacher Collins syndrome) [11–16].

Other particular aspects on the clinical evaluation are about: (1) the temporomandibular joint mobility assessment, whose limitation is extremely uncommon except in lesions, trauma or burns, (2) atlanto-occipital joint limitations (head extension <35°) characteristic of some specific syndromes such as juvenile rheumatoid arthritis, multiple congenital arthrogryposis, Klippel Feil syndrome, or Goldenhar syndrome, and (3) atlanto-occipital joint instability (Down syndrome and Osteogenesis imperfecta).

8.4 Equipment and Materials

According to Italian guidelines, the material for the airway management is divided into two groups: (1) essential equipment for nonspecialized centers: facial masks, Guedel cannulas in different sizes, conventional rigid laryngoscopes with straight and curved blades, endotracheal tubes from 2 mm ID to 6 mm ID, tracheal tube introducers and guides, Magill forceps, soft short stylets, pediatric laryngeal mask airways, and needles for cricothyroid puncture and (2) essential equipment for specialized centers: flexible bronchoscope with light source, masks and facial cannulas for fiberoptic intubation, rigid bronchoscopes, cricothyrotomy set, and retrograde intubation kit [5].

All the equipment for the difficult management of pediatric airways must be checked and kept in a specific tray in the operating room, delivery room, or intensive care unit. Moreover, considering the infrequence of difficult intubation in children, surgical and emergency staff should be trained to use life-saver tools such as neonatal laryngeal masks and to perform elective fiberoptic intubation. Anyhow, spontaneous breathing fiberoptic intubation is still the safest procedure [31–33].

Nowadays, new devices for pediatric intubation are available and are created to improve the endoscopic view on the airway (Storz videolaryngoscope with a straight blade or Miller 1 blade; fiberoptic laryngoscope Airtraq, Glydescope with pediatric blades). Even if clinical trials are still ongoing, there are several evidence showing how these devices improve the endoscopic view and reduce Cormack and Lane score compared to traditional laryngoscopy [34, 35].

Pediatric laryngoscope handles are recommended because they allow contemporary execution of laryngoscopy and cricoid pressure technique.

In general, straight blades can be used in infants to elevate the epiglottis and visualize the glottic opening even if in clinical practice curved blades are often used in newborns.

Pediatric facial masks for assisted ventilation are produced in different sizes and they are transparent, latex free with inflatable cushion. Pediatric Guedel cannulas are disposable for habitual use. The length of the Guedel airway positioned near the children face does not have to exceed the corner of the mouth. A cannula that is too long could push the epiglottis down and close the airway or induce laryngospasm if anesthesia is not deep enough [36]. Generally, in newborns, the use of small

endotracheal tubes causes an increase in airway resistance, so that uncuffed tubes are often used (Newborn 3–3.5 mm; 0–6 months 3.5 mm; 6–12 months 4 mm; 12–18 months 4–4.5 mm; 2–3 years 4.5–5 mm ID). In preterm newborns, the use of cuffed endotracheal tubes for long time is a potential cause of lesions of the tracheal mucosa with possible consequent development of subglottic stenosis and/or granulomas.

A specific problem in newborns is the correct positioning of the endotracheal tube that tends to enter the right or bronchus or is easy to displace for little movements in extension or flexion of the head, being the trachea relatively short.

The use of cuffed tubes for infants and children is largely increased in clinical practice. Even if during the past years, the use of uncuffed tubes was considered the gold standard to avoid lesions due to local compression on subglottic area, nowadays the use of cuffed tubes seems to improve the ventilation in children without causing traumatic lesions (maintaining the cuff pressure under 20 cmH_2O) [37, 38].

To check the correct position of the endotracheal tube, there are different methods: chest X-ray, chest echography, and endoscopy. The use of pediatric stylets and/or guides is not routinely recommended because of the potential traumatic lesions it can produce on the airways.

A guide with a working channel can be left on the airway to provide oxygenation or to read capnography. The Magill forceps can help to direct the tube during the progression on the airway.

The use of the laryngeal mask airway should be considered as an urgency device when mask ventilation appears difficult or when local edema or other complications appear. The technique of laryngeal mask placement is the same in children than in adults with the only difference being that in children keeping the cushion partially inflated can help the progression in hypopharynx. It is important to provide adequate sedation in order to avoid complications such as cough laryngospasm, vomiting, or gastric distension.

8.5 Anesthesiologic Procedures

The most important thing in the case of a newborn or infant intubation is to assure adequate ventilation mask before proceeding to deep sedation and intubation. Anyway, upper airway obstruction during mask ventilation is frequent and can be solved with some simple measure as chin lift, jaw thrust, and/or continuous positive pressure. Also, patient lateral positioning (e.g., in the case of tonsillar hypertrophy) can reduce the grade of obstruction [39, 40].

Pediatric difficult mask ventilation is infrequent and can be summarized into the following: (1) nasal obstruction, (2) macroglossia, (3) space-occupying lesions, (4) microretrognathia, (5) supralaryngeal inflammatory disease, and (6) pathological obesity.

When ventilations are impossible, the use of a classic laryngeal mask airway can help to provide adequate oxygenation and ventilation. Different studies report a 95–98% of success in ventilation with a classic laryngeal mask. It is important to

avoid high cuff pressure in order to reduce the risk of mucosal ischemic lesions and postoperative pain [31, 32, 41, 42].

As preanesthetic drugs, it is important to use drugs that do not lead to respiratory depression or protective airway reflex abolition. During the induction of anesthesia with halogenated gases (sevoflurane 2–4%), it is important to maintain spontaneous breathing and verify if mask ventilation is possible. When mask ventilation feasibility is assured, deep anesthesia can be achieved with drugs that can allow intubation in association with local anesthetics and without muscle relaxants, if possible (remifentanil, midazolam, ketamine, and sevoflurane).

In the pediatric population, induction and maintenance of anesthesia are usually performed with an association of halogenated inhaled anesthetics, intravenous anesthetics (hypnotics and/or sedatives), and muscle relaxants when indicated from surgery.

Sevoflurane is the most used inhaled gas to obtain rapid mask induction in children because of its rapid onset/offset time and the absence of irritative effect on airway mucosa. Rapid mask induction is achieved with sevoflurane concentration between 4 and 8%. For its characteristics, sevoflurane is considered safe and easy to use also for the operative procedure on the airway such as flexible or rigid endoscopy. In this setting, the use of sevoflurane was demonstrated more efficient than intravenous anesthetics in maintaining hemodynamic and respiratory stability in children under 2 years undergoing general anesthesia for operative endoscopy [43].

Intravenous anesthetics frequently used are thiopental, propofol, ketamine, midazolam, fentanyl, remifentanil [44–46]. The use of these drugs needs well-defined hospital procedures and regulations. In particular, if these drugs are used in patients in spontaneous breathing, qualified staff and adequate equipment have to be available for immediate respiratory and hemodynamic resuscitation.

Thiopentone. It can be used for preanesthesia to facilitate children separation to parents in the operating room (1–2 mg/kg in infants); for moderate procedural sedation (1–2 mg/kg with additional doses of 1–2 mg/kg titrate at max 6 mg/kg as total dose); for general anesthesia induction 4–6 mg/kg [44].

Propofol. Propofol is approved (FDA) for induction and general anesthesia maintenance for children more than 3 years of age and adult. In children and adults, classified as ASA 1–2, usual dose is 1–2 mg/kg for anesthesia induction (if patient ASA 3–4, consider a reduction of 80% of the dose) and for general anesthesia maintenance is 125–150 μg/kg/min. Propofol is not approved for pediatric sedation in ICU for the risk of myocardial depression, hypotension, bradycardia, and propofol infusion syndrome, especially in hypovolemic or septic patients.

Ketamine. Ketamine is used in children for induction (2 mg/kg iv), maintenance of general anesthesia, supporting drug in procedural sedation (0.2–1 mg/kg), and for sedation in ICU (5–20 μg/kg/min). It is contraindicated in newborns less than 3 months of age because some studies demonstrate an increase in neuronal apoptosis and delay in cognitive development.

It is relatively contraindicated in the case of airway procedures because of the increases risk of laryngospasm and in the case of intracranial hypertension.

Fentanyl. Fentanyl can be used in children for moderate procedural sedation (1–2 mg/kg dose), as support in general anesthesia induction (2–3 mg/kg dose), and for continuous sedation in ICU (1–3 mg/kg/h).

Remifentanil. Reifentanyl can be used in children for maintenance of general anesthesia with nitrous oxide (0.4–1 μg/kg/min), as analgosedation for intubated children (preterm 0.075 μg/kg/min to titrate at max 0.11 μg/kg/min), and in terms of infants needing mechanical ventilation in ICU (0.15 μg/kg/min to titrate at a reported medium dose of 0.23 μg/kg/min) [47, 48].

Rocuronium. Rocuronium is approved by the FDA for all children and adult patients as a muscle relaxant drug at general anesthesia induction to maintain intraoperative muscle relaxation and in ventilated patients in ICU. The particular interest for this drug derived from its classification as nondepolarizing neuromuscular blocker with rapid onset and for the availability of an antagonist with rapid action (Sugammadex). Pediatric dosage for RSI is 0.9–1.2 mg/kg and for elective intubation is 0.45–0.6 mg/kg. Maintenance dosage is 7–12 μg/kg/min for both intraoperative and ICU patients (to notice that the contemporary use of inhaled anesthetics reduces the needed dose of rocuronium for maintenance of neuromuscular blockade, so it is recommended the titration at the minimum dosage). Rare cases of anaphylaxis, asthma, and arrhythmias are reported.

The use of Sugammadex is nowadays approved by the FDA for children aged higher than 2 years (2 mg/kg). Nondata are available for children less than 2 years and newborns, both for safety and efficacy, so for this age, the use of Sugammadex is not approved yet.

The use of muscular blockers must be avoided in the case of a difficult or impossible ventilation mask. If the use of these drugs is necessary, it is recommended the choice of muscle relaxants with short duration of action for which an antagonist is potentially available (succinylcholine, rocuronium).

It is important to avoid laryngoscopy or airway manipulation if sedation is nonadequate to avoid reactive laryngo or bronchospasm. For this reason, local anesthesia with lidocaine on the vocal cords is recommended (lidocaine 1–2%, 3–5 mg/kg).

In conclusion, according to Italian guidelines, we can summarize that during newborn and infant intubation: (1) preoxygenation with mask is mandatory, (2) before abolition of spontaneous breathing it is mandatory to assure the feasibility of adequate mask ventilation, and (3) the association of sedoanalgesic drugs or inhaled anesthetics with local anesthetics is recommended for intubation.

Finally, for those patients with known malformative diseases, for whom intubation with direct laryngoscopy or videolaryngoscopy is impossible (Pierre Robin, Franceschetti, and Treacher Collins), guidelines recommend elective fiberoptic intubation (see below) with laryngeal mask airway, if indicated.

8.5.1 Planned Difficult Intubation

According to Italian guidelines, in the case of planned difficult intubation, it is mandatory to proceed with the following: (1) clinical investigations to exclude

airway disease or associated malformations in patients with malformative syndromes, (2) in the case of prenatal diagnosis of malformative disease, it is mandatory to prepare preventively in the delivery room of neonatal intensive care unit all the equipment needed to the safest management of the patient, (3) to document in the medical records all the clinical predictors of difficult intubation, (4) to inform the parents or legal guardian about all the possible problems concerning the management of the difficult airway, the planned strategy of risks and possible complications, and (5) to prepare all the equipment needed to carry out the planned strategy.

Finally, it is useful to include in the medical record all the documents about the patient airway as all the equipment utilized to intubate, TC, or endoscopic reports, Cormack score. (For example, after elective fiberoptic-guided intubation, it is possible to perform direct laryngoscopy before the extubation of the patient and to include the Cormack score in the medical record.)

We also recommend to draw up a difficult airway report and to give it to the children's parents in the event that the child will necessitate urgent intubation among other centers.

8.6 Elective Fiberoptic-Guided Intubation and the Use of Supraglottic Airway Devices (SGA)

Fiberoptic-guided intubation in spontaneous breathing is nowadays the safest technique in the case of planned difficult intubation with or without the aid of SGA (specific laryngeal mask). It is important to plan the fiberoptic elective intubation as the first choice to avoid potential local lesions on the mucosa caused by other procedure that could make difficult the progression of the fibroscope (oedema, bleeding). Flexible fibroscopes with operative channels and cameras are available for the pediatric population in different sizes (1.8 mm in an ETT 3, 2.2 mm in an ETT 3.5, 2.8 in an ETT 4).

The intubation technique is the same as in the adult population. Considering the poor co-operativeness of the children and the elevated reactivity of the airways the fiberoptic intubation must be performed with adequate sedation maintaining spontaneous breathing. A possible technique consists of local anesthesia with lidocaine 3–5 mg/kg in association with inhaled or intravenous anesthesia. The fibroscope is advanced until the glottic plane and the vocal cords are visualized. Local anesthetic is then applied and the fibroscope is advanced into the trachea with the endotracheal tube sliding on the fibroscope that is in the end retired. At the end of the procedure, the correct positioning of the endotracheal tube is checked.

Patient oxygenation can be assured with nasofaringeal oxygen probes, manual ventilation, or noninvasive ventilation with mask (usually in patients with respiratory failure in ICU) with specific junctions used to pass the fibroscope through the endotracheal tube connected to the ventilatory circuit.

Fiberoptic-guided intubation can be facilitated with the use of specific supraglottic airway devices, such as specific laryngeal masks created to allow the transition

through the ventilatory way of a flexible fibroscope with an endotracheal tube or a tube exchanger.

Supraglottic airway devices (SGA) can be defined as devices that allow both ventilation and oxygenation and that are placed immediately out of the larynx to which they are secured by an inflated cuff. These devices are nowadays an integral part of the basic requirements used for the management of the pediatric airway in emergency situations including pediatric emergencies and neonatal resuscitation. SGA can be divided into two groups of first- and second-generation based on the presence or absence of a drainage gastric channel. First-generation devices consist of a simple ventilation tube connected to the ventilation mask (LMA Classic, LMA Unique); secondary generation devices used in the pediatric population (LMA Proseal, Air-Q, I-gel, Ambu Aura I) have an inbuilt drainage channel which allows the insertion of a gastric tube to deflate the stomach. If the laryngeal mask is correctly positioned the inflated cuff creates an adequate adhesion to the hypopharynx and allows positive pressure ventilation. Second-generation devices have the best adherence to hypopharynx, leading to a more efficient positive pressure ventilation and allowing a better drainage of the stomach and a reduction of the risk of inhalation [49, 50].

The Classic laryngeal mask (LMA Classic) is a first-generation device frequently used in pediatric anesthesia for minor procedures.

Hemodynamic response is reduced in LMA positioning if compared to endotracheal intubation and it is similar to the insertion of an oral cannula. Its positioning by inexperienced staff is easier and quicker than endotracheal intubation. Anyway, LMA positioning in children is characterized by the onset of mire complication if compared to adults (malposition, gastric reflux, laryngeal, and bronchospasm). Laryngeal mask Proseal is a second-generation device with a gastric drainage channel introduced in 2004 in clinical practice and available in neonatal and pediatric sizes.

It allows a better adherence to hypopharynx and it is made of an armored ventilation tube that reduces the risk of occlusion of the airway. It can be used for fiberoptic-guided intubation. Anyway, the small diameter of the airway of the device makes impossible the direct insertion of an endotracheal tube, so that a tube exchanger should be used as a guide for the positioning of the endotracheal tube.

LMA Classic and Proseal are the most used devices for pediatric anesthesia to which all new devices are compared in terms of safety and efficacy [51, 52].

The Air Q system is an oval-shaped supraglottic device with a curved and angulated airway that permits to avoid the down fold of the epiglottis. AirQ is available as a first-generation device with standard cuff and as a second-generation device with gastric access, but at the moment, this new version is not available in pediatric sizes. Different studies have tested AirQ in children with a body weight of less than 15 kg. They reported good efficacy, better adherence, less leaks, and better endoscopic view of laryngeal opening with this device when it is used for endoscopic intubation compared to other supraglottic devices (Ambu Aura). Retrospective studies on the pediatric population with craniofacial malformations reported the good efficacy of this device when it is used for fiberoptic-guided intubation.

Second-generation devices available for the pediatric population reported in the literature include the Laryngeal mask Supreme, Ambu Aura, and I-gel. The use of the LMA Supreme airway is associated with less gastric regurgitation, less air leaks, and easier positioning, also in neonatal resuscitation.

The I-gel laryngeal mask is a second-generation device made from a medical-grade thermoplastic elastomer, uncuffed, that creates a seal on the airway by anatomical adaptation. Compared to other SGA, I-gel has a better view during endoscopy, while no differences are reported concerning the onset of complications, easiness in placement or displacement [55].

Ambu Aura is a second-generation SGA specifically created for pediatric fiberoptic-guided intubation. It offers a similar endoscopic view if compared to AirQ and i-gel, but 1 and 1.5 sizes do not allow the passage of cuffed tubes [53, 54].

In conclusion, during the last years, different SGA were introduced for pediatric use. In the healthy child in general anesthesia, classical devices as LMA Classic and Unique are largely used except for children with low weight (less than 10 kg, for whom second-generation devices are indicated) for their simple position procedure and the better stability.

AirQ and Ambu Aura have the best endoscopic view and the easiest removal maneuver after fiberoptic-guided intubation. No specific guidelines are available in the case of cardiac arrest or in the out of hospital setting.

In the pediatric literature, the role of new devices such as videolaryngoscopes, fiberoptic videolaryngoscopes, or lighted stylet is unclear and it has not been sufficiently studied to include them into the Australian guidelines, even if they should be available in each center.

In conclusion, according to Italian guidelines, we can say that: (1) it is useful to have expertise in fiberoptic-guided pediatric intubation, (2) it is recommended for each hospital to create a procedure for the management of pediatric difficult airway, (3) it is opportune to keep all the equipment in a dedicated tray situated in the surgical unit, (4) it is mandatory to assure the feasibility of mask ventilation before proceeding to deep sedation, (5) it is recommended to reassure adequate oxygenation of the child between different intubation attempts, (6) it is mandatory to avoid more than three attempts of intubation to avoid the onset of impossible mask ventilation situation, (7) if intubation becomes impossible, it is recommended to awake the child and postpone the procedure, (8) in pediatric patients fiberoptic intubation should be performed with pharmacological analgesia and sedation with local anesthesia and 100% oxygen supply devices, and (9) children with predicted difficult airway should be transported to a pediatric reference center.

8.7 Unpredicted Difficult Intubation

Unpredicted difficult intubation in children is infrequent if compared to the adult population and when it occurs, everything should be performed to avoid the onset of cannot intubate/cannot ventilate situation. LMA can be used as an urgency device in a child who cannot be intubated and ventilated to assure temporary adequate

oxygenation and ventilation. In extreme cases, cricothyroid puncture to preform jet ventilation is indicated, even if in newborns and infants this procedure is very risky and often unsuccessful, because of the elevated difficulty to find the cricothyroid membrane, the elevated tissue flexibility, and small anatomic spaces. Indeed, this procedure is complicated with high mortality and morbidity. When jet ventilation is successfully performed, a surgical tracheostomy should be considered [55, 56].

8.8 Conclusions

Pediatric airway management is a particular skill for anesthesiologists. Pediatric airway has many anatomic and physiological differences from adults as well as different pathologic conditions (craniofacial malformative syndromes).

An adequate knowledge of these conditions, the available equipment, and the national guidelines allow the intensivist to perform the best management of the child airway both in elective and in urgency situations with collaboration between pediatric and nonpediatric centers.

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