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Guidelines

Consensus recommendations for paediatric airway topicalisation using lidocaine

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Summary

Introduction Lidocaine is commonly used to provide airway topicalisation in children. However, there is a paucity of evidence and no guidance available on safe dosing practices.

Methods An international expert multidisciplinary, multi-society working group conducted a systematic review of the literature, followed by a three-round Delphi process to produce consensus recommendations. These recommendations aim to improve the safety of children having their airways topicalised with lidocaine.

Results The systematic review identified 26 articles, with 21 recommendations agreed across five domains of practice: dosing; recovery; adverse reactions; institutional responsibilities; and learning from events. Evidence was limited and mainly grades C and D but the strength of the recommendations, based on the expert consensus, was mainly moderate (65–79% consensus) and strong (≥ 80% consensus).

Discussion It is hoped these consensus recommendations will promote safe practice when lidocaine is used for airway topicalisation in children.

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Plain Language Summary may be found on PubMed and in the Supporting Information.

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A consensus statement endorsed by the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI); British Association for Paediatric Otorhinolaryngology (BAPO); British Association of Otorhinolaryngology; Head and Neck Surgery (ENT-UK); Canadian Pediatric Anesthesia Society (CPAS); European Society for Paediatric Anaesthesia (ESPA); Society for Pediatric Anesthesia (SPA); Society for Airway Management (SAM); and Society of Anaesthetists and Intensivists of Papua New Guinea.

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Key recommendations

1. The age and weight of the child, the concentration of solution and the volume required should be taken into account when considering dosing of topical lidocaine for airway procedures (Grade B, strong recommendation).
2. Pre-operative discussion between anaesthetists and surgeons is recommended at the team brief where both parties plan to use lidocaine. The maximum dose should be identified and divided appropriately according to need (Grade D, strong recommendation).
3. A maximum dose of 5 $mg.kg^{-1}$ (ideal body weight) is recommended as a safe dose for procedures up to 2 h; however, lesser doses are often deemed to be clinically effective, and a conservative approach is advised (Grade C, strong recommendation).
4. Ideal body weight should be used for dosing calculations (Grade B, strong recommendation).
5. Lidocaine solutions > 4% should not be used in children (Grade D, strong recommendation).
6. Patients should be routinely fasted for at least 1 h after airway topicalisation with lidocaine. If the child is deemed to be at significant risk of aspiration, this time may need to be extended (Grade C, strong recommendation).
7. Timing of all topicalisation and total dose of lidocaine used should be documented clearly (Grade D, strong recommendation).
8. 20% intravenous lipid emulsion should be immediately available in departments where lidocaine topicalisation takes place (Grade C, strong recommendation).

Why was this consensus statement written?

Topical lidocaine administered as a spray or a gel is used commonly to anaesthetise the airway in children [1–3]. However, there is a paucity of evidence available to guide safe dosing practices during airway topicalisation in paediatric anaesthetic practice [1, 3, 4]. A recent international study showed heterogeneity in practice globally and evidence of patient harm, signalling a need for evidence and consensus [3]. Therefore, an international group was assembled with representation from global stakeholder organisations to produce this consensus statement which aims to provide recommendations that will improve patient safety in key areas of clinical practice. The recommendations made are specific to paediatric anaesthesia.

What guidelines currently exist?

There are some guidelines which describe management of the paediatric airway, with the most recent one specific to neonates and infants [5, 6]. However, guidelines for airway management in adults dominate the literature [4, 7–19]. The Difficult Airway Society Awake Tracheal Intubation guidelines, while containing dosing details on airway topicalisation, are specific to adults [4].

How does this consensus statement differ from existing guidelines?

At the time of writing, to our knowledge, there are no consensus recommendations nor national, international or societal guidelines available on the use of lidocaine for airway topicalisation in children.

Introduction

Lidocaine is used commonly to provide airway topicalisation in children [1–3]. While small studies have been carried out looking into the use of lidocaine for airway topicalisation and safe dosing practices in children [1, 2, 20–23], no specific guidelines exist on the use of lidocaine for airway topicalisation in children. The Difficult Airway Society recommends doses up to 9 $mg.kg^{-1}$ (calculated based on lean body weight) in adults [4]. Doses of lidocaine quoted in the paediatric literature vary significantly (0.9–14 $mg.kg^{-1}$) [1–3, 20–22, 24–31]. An international cross-sectional study published in 2023 showed global heterogeneity in practice and evidence of patient harm. It acknowledged the need for research in this area while indicating the power of collaboration and the willingness of international organisations to work together in the best interests of patients [3].

Together, we aimed to produce consensus recommendations to support safe practice where airway topicalisation with lidocaine takes place in children. The recommendations are specific to paediatric practice. The paucity of evidence available means the recommendations are largely based on expert opinion. It is hoped new research in this area can support a more robust evidence-based guideline on this topic in the future.

Methods

These consensus recommendations were developed by a 24-member working group with representation from the: Association of Paediatric Anaesthetists of Great Britain and Ireland; British Association for Paediatric

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Table 1 Grading of recommendations based on the level of evidence available.

Grade	Level of evidence available
A	• Consistent systematic reviews of RCTs, single RCTs or all-or-none studies
B	• Consistent systematic reviews of low-quality RCTs or cohort studies, individual cohort study or epidemiological outcome studies • Consistent systematic reviews of case–control studies, individual case–control studies • Extrapolations from systematic reviews of RCTs, single RCTs or all-or-none studies
C	• Case series, case reports • Extrapolations from systematic reviews of low-quality RCTs, cohort studies or case–control studies, individual cohort study, epidemiological outcome studies or individual case–control studies • Extrapolations from systematic reviews of case–control studies
D	• Expert opinion or ideas based on theory, on bench studies or first principles alone • Troublingly inconsistent or inconclusive studies of any level

RCTs, randomised controlled trials.

Otorhinolaryngology; British Association of Otorhinolaryngology, Head and Neck Surgery; Canadian Paediatric Anaesthesia Society; European Society for Paediatric Anaesthesia; Society for Paediatric Anaesthesia; Society for Airway Management; and Society of Anaesthetists and Intensivists of Papua New Guinea. A patient representative, operating department practitioner, anaesthesia/post-anaesthesia care unit (PACU) nurse, trainee/resident representative and clinical pharmacologist were invited to join the working group alongside consultants in paediatric anaesthesia (including representation from low- and middle-income countries) and consultant ear, nose and throat surgeons. This consensus statement methodology adhered to the AGREE reporting checklist [32].

To inform our recommendations, we performed a systematic review in accordance with the PRISMA reporting checklist and prospectively registered this with PROSPERO [33, 34]. Details of the methodology are reported in online Supporting Information Appendix S1, data extraction in Appendix S2 and risk of bias assessments in Tables S1 and S2. The results of the systematic review were used to inform a three-round Delphi study to formulate recommendations [35, 36]. An initial long list of 28 recommendations was proposed by the working group, with each recommendation reviewed and rated for content and clarity (online Supporting Information Appendix S3). The proposed recommendations were based on a number of factors including: strength of supporting evidence; applicability of evidence to clinical practice; multidisciplinary team involvement; and practical implications of the recommendations. Each recommendation was voted on anonymously using a structured Microsoft Excel sheet (Microsoft, Inc., Redmond, WA, USA) by all members of the working group as either `include´, `exclude´ or `revise´, as well as whether each recommendation should be made a top recommendation. Twenty group members participated in round 1 and 23 in round 2. Recommendations supported by ≥ 75% of those who participated in round 2 ($n \geq 18$) were included. Three recommendations with 50–74% acceptance proceeded to a third and final round of discussions, which took place in the form of a virtual round-table discussion, resulting in a total of 23 recommendations being included.

The strength of evidence was graded using a modified version of the system developed by the Centre for Evidence-based Medicine [37], as used for previous airway guideline recommendations [4, 17, 18]. Recommendations were graded A to D according to the strength of the available evidence (Table 1). The strength of recommendations judgements was made based on analysis of the evidence, consensus voting and discussion through the Delphi process: strong recommendation ≥80% consensus; moderate recommendation 65–79% consensus; and weak recommendation 50–64% consensus. During the development, drafting and finalising of these consensus recommendations, the working group met four times remotely over 10 months. A draft of the document and supporting information was then circulated to all stakeholder organisations for comment. The comments and feedback received were used to further refine and inform the final document.

Results

Dosing

Multiple factors should be considered when selecting an appropriate dose of lidocaine for airway topicalisation. These include child-specific factors such as age, weight and comorbidities, and lidocaine-specific factors such as concentration of solution and volume required.

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When considering the child-specific factors, use of ideal body weight is recommended for lidocaine dose calculations by a number of organisations [38, 39]. Ideal body weight is calculated using the formula age + sex specific BMI at 50th centile (BMI_{50}) × height (m^2) [39]. There is evidence of clinicians using actual body weight primarily for lidocaine calculations and anecdotal evidence from group members suggesting more common use of adjusted body weight in children who are overweight [3]. However, with an increasing prevalence of childhood obesity worldwide, caution is advised as neither of these methods is recommended [39, 40]. Growth charts can help assess whether a child's BMI falls within the national average, guiding ideal body weight calculations [41–43]. Particular caution is advised when calculating the dose in children who are underweight, have comorbidities (e.g. hepatic disease) or are aged < 6 months, with lower doses warranted in these groups [1, 20]. A conservative approach to dosing is preferable, with clinically effective doses often achieved below the maximum recommended.

Factors specific to lidocaine preparation include the concentration of solution and the volume required. It may be necessary to reduce the concentration of solution to achieve the optimal volume, particularly in younger children where the maximum dose calculated may be small. For children weighing < 10 kg, 1% or 2% lidocaine solutions normally provide a suitable volume and efficacy. Additional considerations include: the mode of administration (spray, nebuliser atomiser or gel); the flow rate of driving gas (usually oxygen), which may impact on the spread and distribution of lidocaine; and the presence of secretions/type of tissue surface (raw, vascular, bleeding etc.), which may influence absorption.

Communication between team members is crucial to ensuring safe local anaesthetic administration. A clear pre-operative discussion between anaesthetic and surgical colleagues can help prevent errors of excessive administration where lidocaine use is required by both parties. In prolonged surgery, repeated topicalisation may be required. The maximum recommended dose may be divided into aliquots and applied at intervals to optimise procedural conditions over a longer period of time. Given the elimination half-life of lidocaine is 90–120 min [44–47], it appears appropriate for a single additional (reduced) dose of lidocaine to be given beyond this point, assuming no additional local anaesthetic has been administered by any other routes. This additional dose may also be given in aliquots as required. However, it is important to note the half-life may be prolonged in children aged < 6 months or those with liver impairment, necessitating individual risk–benefit consideration [44].

Hypertensive crises and cardiac arrest have been reported in children where solutions containing vasoconstrictors have been used [48–51]. While these types of solutions may be used more commonly in adult practice for procedures such as awake tracheal intubation, their use in children carries additional risks [4]. It is recognised that these solutions may have a role in certain clinical situations, e.g. to control bleeding, but this consensus statement is specific to airway topicalisation.

- The age and weight of the child, concentration of solution and volume required should all be taken into account when considering dosing of topical lidocaine for airway procedures (Grade B, strong recommendation).
- Ideal body weight should be used for dosing calculations (Grade B, strong recommendation).
- A maximum dose of 5 $mg.kg^{-1}$ (ideal body weight) may be considered a safe dose for procedures up to 2 h; however, lesser doses are often deemed to be clinically effective, and a conservative approach is advised (Grade C, strong recommendation).
- A lower maximum dose of 4 $mg.kg^{-1}$ (ideal body weight) is recommended in children aged < 6 months with immature hepatic enzymes, are underweight or have hepatic disease (Grade C, strong recommendation).
- Where repeated dosing is required, duration of the procedure should be considered and the total dose divided accordingly. Where the procedure duration is over 2 h, up to an additional 2.5 $mg.kg^{-1}$ lidocaine may be utilised after this time (Grade C, strong recommendation).
- Pre-operative discussion between anaesthetists and surgeons is recommended at the team brief, where both parties plan to use lidocaine. The maximum dose should be identified and divided appropriately according to need (Grade D, strong recommendation).
- In children weighing < 10 kg, we recommend the use of 1% or 2% lidocaine solution; this should provide appropriate volume and clinical efficacy (Grade D, moderate recommendation).
- Lidocaine solutions > 4% concentration should not be used in children (Grade D, strong recommendation).
- Total dose of topical lidocaine used should be documented clearly in the patient's record (Grade D, strong recommendation).
- Lidocaine solutions with adrenaline should not be used for topicalisation of the airway. Caution is advised when considering other vasoconstrictors due to the risk of

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precipitating hypertensive crisis (Grade C, strong recommendation).

Recovery

The duration of action of lidocaine for topical anaesthesia is thought to be approximately 30–60 min, but this may vary between individuals. There is evidence to suggest that when applied to the oral mucosa, the duration of action may be much shorter, with some studies suggesting the hypoalgesic effect lasts < 15 min [1, 4, 52–55]. Clear communication and documentation are required to ensure effective handover between operating theatre teams and PACU staff [56–58].

- Postoperatively, patients should be nursed in PACU by an appropriate practitioner (Grade D, strong recommendation).
- Patients should be routinely fasted for at least 1 h after airway topicalisation with lidocaine. If the child is deemed to be at significant risk of aspiration, then this time may need to be extended (Grade C, strong recommendation).
- Timing(s) of all topicalisation and total dose of lidocaine used should be documented clearly (Grade D, strong recommendation).
- The specific time from which the child can recommence oral intake should be documented clearly and handed over to PACU, ward staff and parents (Grade D, moderate recommendation).
- A period of observation should take place following airway topicalisation. Nursing staff should be aware of signs or symptoms of aspiration and local anaesthetic systemic toxicity (Grade D, strong recommendation).

Adverse reactions

Whilst rare, adverse reactions such as anaphylaxis and local anaesthetic systemic toxicity secondary to lidocaine use in children have been reported [3, 59, 60]. WebAIRS (the anaesthetic incident reporting system from the Australian and New Zealand Tripartite Anaesthetic Data Committee) captured nine cases of local anaesthetic systemic toxicity during regional anaesthesia in Australia and New Zealand; however, none of those reported were secondary to the use of lidocaine [61]. The United States National Poison Data System captured 37 paediatric cases with adverse outcomes following topical lidocaine exposure over 20 years, yet none of these cases were secondary to airway topicalisation [60]. Self-reporting of cases in the airway topicalisation in paediatrics survey identified eight cases of local anaesthetic systemic toxicity following airway topicalisation seen globally among 1638 participants [3]. Cases presented with a variety of signs/symptoms, including seizures; somnolence; twitches; tachyarrhythmia; and peri-oral tingling.

Medical professionals have a responsibility to be open and transparent with patients and/or their families following adverse events [62]. Sharing information with patients and detailed medical records can help prevent repeat circumstances by informing future care providers. Local and national procedures for incident reporting may vary, but engagement with such processes plays an important part in keeping patients safe [63].

- Adverse reactions believed to be secondary to lidocaine topicalisation, e.g. local anaesthetic systemic toxicity, should be reported according to local and national procedures (Grade D, strong recommendation).
- Where adverse reactions believed to be secondary to lidocaine topicalisation have occurred, parents or guardians should be informed (Grade D, strong recommendation).

Institutional responsibilities

The recommendations set out in this document aim to improve patient safety. They serve to support clinicians and organisations. Multidisciplinary team involvement, supported by a systematic review, has been key to their production. Institutions may adopt a number of strategies to mitigate against risk; these may include individual risk leads; local polices; and training programmes. Local anaesthetic systemic toxicity is a recognised anaesthetic emergency, and we expect most departments will already have strategies in place to support delivery of specific guidelines related to its management [64, 65].

- 20% intravenous lipid emulsion should be immediately available in departments where lidocaine topicalisation takes place (Grade C, strong recommendation).
- Departments should conduct multidisciplinary simulation training regularly covering the management of local anaesthetic systemic toxicity (Grade D, strong recommendation).
- Departments carrying out topicalisation should have a standard operating procedure or local guideline which is reviewed regularly and updated in line with emerging evidence (Grade D, strong recommendation).

Learning from events

There is a paucity of evidence on the use of lidocaine for airway topicalisation in children. While some small studies

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have been conducted, there is a need for larger studies to inform clinical practice. Publication of case reports in areas such as this is a way to enable global education and learning from challenging cases. National database reporting and discussions at mortality and morbidity meetings allow opportunities for shared learning. Discussions around adverse events create an environment of reflection, analysis and continuous learning, fostering a proactive culture of education in the interests of patient safety and ultimately will improve clinical care.

- Shared learning from adverse events is encouraged, e.g. in mortality and morbidity meetings/national database reporting. We encourage publication of case reports since the literature on the use of lidocaine for airway topicalisation in children is limited (Grade D, strong recommendation).

Discussion

In the absence of evidence, our aim was to establish a safe and pragmatic framework to support clinical practice. Combining the currently limited evidence base with the expertise and insights of the working group, we developed recommendations which we consider to be applicable to clinical practice and useful to clinicians.

The dosing recommendations made were informed by pharmacokinetic studies including information from intravenous administration of lidocaine [20, 22, 27, 44, 47]. There was only one recent pharmacokinetic study available and specific to airway topicalisation with lidocaine [20]. This used a dose of 5 $mg.kg^{-1}$ as standard, with no cases of toxicity seen clinically despite plasma levels in excess of 5000 $ng.ml^{-1}$ in 4/50 patients [20]. It also showed the rapid redistribution (α) phase of lidocaine in children of approximately 10–15 min [22]. This α distribution is also shown in a study from the 1980s which used a dose of 4 $mg.kg^{-1}$ [66]. Given the small numbers of participants in both of these studies and specific patient groups known to be at higher risk of local anaesthetic systemic toxicity, an additional safety/uncertainty factor of 20 has been applied for these patients in the recommendations.

When considering repeat dosing, pharmacokinetic principles have been applied based on the elimination half-life of the drug. While complete elimination would require 4–5 half-lives to take place, it was considered safe to allow one additional reduced dose after a single elimination half-life, where clinical need necessitates, assuming no other local anaesthetic has been administered. We have taken a precautionary approach to this by basing the recommendation on the longer elimination half-lives reported and consider the rapid redistribution phase to be protective. The initial and additional dose may be divided and used in aliquots to optimise procedural conditions given the comparatively short duration of action.

It is accepted that significant gaps in the current literature limit the strength of evidence supporting the recommendations, highlighting the need for further research in this area. Data were synthesised qualitatively and there was no statistical analysis. Additional limitations include our decision not to consider use of adjuncts (such as glycopyrronium) and not differentiating between awake, sedated and anaesthetised patients, accepting that sedative and anaesthetic drugs such as propofol have the potential to mask some of the early signs and symptoms of local anaesthetic systemic toxicity. Other factors which may be of relevance and not discussed include mode of delivery; type of ventilation; and the surgical procedure itself. While solutions containing vasoconstrictors have been commented upon briefly, their use for airway topicalisation is less common in children than adults, and so their use was considered to fall outside the scope of this work.

This global collaboration has sought to promote safe practice when lidocaine is used for airway topicalisation in children. The lack of evidence highlights this area as a future research priority. We recognise the potential challenges of implementing all of the recommendations in low-resource settings where access to, for example, 20% lipid emulsion or simulation training, may be limited. However, it is hoped that these consensus recommendations will support the provision of appropriate equipment and training, therefore improving patient safety and outcomes. We believe these consensus recommendations are applicable across a diverse range of healthcare settings and hope they will be welcomed by the paediatric anaesthetic community.

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Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1. Systematic review methodology.
Appendix S2. Data extraction spreadsheet.
Appendix S3. Delphi study results (three rounds).
Table S1. Risk of bias assessment for included observational clinical studies.
Table S2. Risk of bias assessment for included randomised controlled trials clinical studies.
Plain Language Summary

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