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Original Research Article

ORIGINAL RESEARCH ARTICLE

Population-based incidence of anxiety-related behaviours during induction of general anaesthesia in children and efficacy of anxiolytic interventions: an international multicentre retrospective observational study

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Abstract

Introduction: Preoperative anxiety in children is a significant challenge for anaesthesiologists. Although various pharmacological and non-pharmacological interventions have been explored to reduce preoperative anxiety, comprehensive data on the incidence of anxiety and the efficacy of these interventions are lacking. This study aimed to determine the incidence of anxiety in children during anaesthesia induction and evaluate the effectiveness of different interventions using real-world data.

Methods: We conducted an international, multicentre, retrospective study, including patients under 18 yr undergoing general anaesthesia. Difficult inductions and anxiety were assessed using the Child Induction Behavioural Assessment tool and the Mask Acceptance Scale.

Results: Among 155 604 patient encounters across six centres, the incidence of difficult induction was 6.2%, the highest rate (11.5%) in children aged 1–3 yr. Significant anxiety behaviours were seen in 22.2% of children, the highest incidence (40.8%) in 1–3-yr-olds. Difficult mask acceptance occurred in 20% of cases, highest in the 1–3-yr age group (34.2%). Premedication was associated with a decreased incidence of difficult induction (adjusted odds ratio=0.78, 95% confidence interval: 0.73–0.84, P<0.001). Conversely, parental presence at induction was associated with a higher incidence of difficult induction (adjusted odds ratio=1.77, 95% confidence interval: 1.55–2.01, P<0.001). 77.8% (121 084) of children did not exhibit anxiety during induction of anaesthesia; half of these required no interventions.

Conclusions: Most children manage without interventions, showing a lower incidence of anxiety behaviours than previously reported. This underscores the need for tailored, evidence-based strategies to address preoperative anxiety, particularly among younger children at greatest risk.

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Keywords: anaesthesia induction techniques; child induction behaviour assessment; modified Yale Preoperative Anxiety Scale; paediatric anaesthesia; parental presence at induction; patient-centred care; preoperative anxiety in children

Introduction

Preoperative anxiety in children continues to be a challenge for anaesthesiologists with reports of 40–60% of children experiencing considerable preoperative anxiety and distress.[1] Distress is highest during the induction of general anaesthesia when stranger, separation, and anticipatory anxiety may be provoked.[2] Children who are highly anxious and distressed during induction of anaesthesia are likely to be distressed on awakening in the PACU and may experience negative post-operative behaviours including crying, defiance towards caregivers, separation anxiety, and temper tantrums, persisting up to 6 months for 20% of children.[3–5]

The prevention and management of preoperative anxiety in children are important to reduce psychological trauma and sequelae related to anxiety. Several pharmacological and non-pharmacological interventions have been evaluated for reducing anxiety during induction of anaesthesia in children.[6–9] Pharmacological agents including midazolam, ketamine, opioids, and dexmedetomidine have all demonstrated efficacy in sedating patients before induction of anaesthesia.[10,11] Parental presence at induction remains controversial, with the most benefit demonstrated in patient–parent dyads where the parent is prepared and calm and the child is anxious, when targeted at a specific age group or where dedicated induction rooms are used.[12–15] Other non-pharmacological interventions such as virtual parental presence and video distraction have shown promise.[9,16,17]

Studies reporting children's anxiety during induction of anaesthesia have been limited to small sample sizes, often as part of interventional study designs. The goal of our study was to provide real-world evidence from an international, multi-centre, population-based perspective on the incidence of difficult inductions and anxiety in children during induction of anaesthesia, and the frequency and efficacy of various pharmacological and non-pharmacological interventions. Real-world evidence is clinical evidence about the use, safety, and effectiveness of an intervention based on data from real-world healthcare settings outside of randomised clinical trials.[18–20]

Our primary aim was to determine the population-based incidence of anxiety-related behavioural responses in children during induction of anaesthesia.

Methods

Study design and population

This retrospective study was approved by the Hospital for Sick Children Research Ethics Board (REB 1000065224). Centres were either tertiary or quaternary paediatric hospitals. Supplementary Table S1 lists all the participating centres. Each individual centre obtained institutional review board approval or waiver as per their local institutional policies. Only data from each hospital's main site were included in the study. The requirement for written informed consent and assent was waived by each centre's institutional ethics review board. Inclusion criteria included all patients <18 yr of age presenting for general anaesthesia at the respective sites from January 2019 to March 2022. Patients who were already intubated were excluded. Each institution had previously implemented and used the Standardised Anesthesia InductioN Tool (SAINT) for documenting anaesthesia inductions in the electronic patient; this formed a standardised dataset collected during routine clinical care.[21]

Data were abstracted from each institution's electronic health record using a common data dictionary. We aimed to minimise differential measurement bias by recording all the data elements that were commonly used during induction of anaesthesia. Data underwent deidentification at each site before being transmitted securely to the study database maintained at the Hospital for Sick Children.

Study definitions

Our primary outcome was the incidence of inductions classified as difficult. Our primary outcome measure was the documentation of *difficult induction* on the validated Child Induction Behavioral Assessment (CIBA) tool.[22 23] The CIBA scale is a 3-point Likert scale (1—Smooth: e.g. calm and controlled, cooperative with induction, does not exhibit negative behaviours; 2—Moderate: e.g. cries, pulls away from mask/i.v., verbalises refusal; 3—Difficult: e.g. covers face/limb, pushes away, screams, kicks/flails, appears rigid or limp). The CIBA tool has demonstrated a strong correlation with the Induction Compliance Checklist (ICC) and, unlike the ICC, CIBA is designed and well suited for routine electronic clinical documentation of behaviours during induction of anaesthesia.[23] The CIBA tool is incorporated in the comprehensive SAINT that is used routinely for documenting induction behaviours across several hundred global institutions, including the six study sites.[21,23] The SAINT with CIBA is part of routine clinical documentation and is completed during each anaesthetic along with other standard documentation including ASA physical status (ASA-PS) and procedure notes.

Secondary outcomes were the incidence and prevalence of significant anxiety behaviour during induction and difficult mask acceptance. Significant anxiety behaviour was defined as a CIBA score of 2—Moderate or 3—Difficult. Finally, for the outcome measure of difficult mask acceptance, we used the Mask Acceptance Scale (MAS) to assess anxiety during mask acceptance. The MAS is composed of a 4-point Likert scale: 1=excellent (unafraid, cooperative, accepts mask readily), 2=good (slight fear of mask, easily reassured), 3=fair (moderate fear of mask, not calmed with reassurance), and 4=poor (terrified, crying, combative). Children with MAS scores of 1 or 2 were designated as 'easy mask acceptance=1'; scores of 3 or 4 were considered 'difficult mask acceptance=2'.[21] The SAINT includes other scales for documenting mask acceptance, parental presence, the use of distraction technologies, premedication, and the effectiveness of these interventions using a 3-point Likert scale assessing the efficacy of the interventions, where 1=not effective, 2=somewhat effective, and 3=effective.[21] We also aimed to identify factors that influenced our primary and secondary outcomes.

Statistical analysis

The study design included obtaining a convenience sample; thus, no statistical power calculation was conducted before the study. All data are presented in the overall cohort and stratified by age group (<1, 1–3, 4–12, and 13–18 yr) in keeping with the validation of CIBA in the 1–3 and 4–12 yr age groups.[22,23] These age groups are recognised for developmental milestones relevant to our study. Continuous data are summarised using medians and interquartile ranges (IQRs) and categorical data are presented as frequencies and percentages. Denominators (*n*) are indicated for variables with missing data, or for variables which only pertain to a subset of patients. Multivariable mixed-effects logistic regression analysis was implemented to explore independent associations between clinically meaningful selected variables (age; gender; ASA-PS; anxiolytic techniques; presence of physician trainees, anaesthesia assistants [AAs], or certified registered nurse anaesthetists [CRNAs]; comorbidities including autism, anxiety, learning disabilities; genetic syndromes affecting behaviours; location of induction; and emergency status) and the primary and secondary outcomes. Mixed-effects logistic regression was implemented to account for clustering of multiple anaesthetic encounters within centres, within anaesthesiologists, and within patients and this was determined *a priori*. Variables with substantial collinearity (a situation where two or more predictor variables in a statistical model are so highly correlated that it becomes difficult to distinguish their individual effects on the outcome of interest) as determined by clinical expertise were excluded before modelling. Results from multivariable analyses are reported as adjusted odds ratios (aORs) with 95% confidence intervals (CIs) and *P*-values. All statistical analyses were performed using Stata (version 17.1, StataCorp LLC, College Station, TX, USA). A two-tailed *P*<0.05 was considered statistically significant. The study is reported using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies.[24]

Results

Centres, study population, and patient characteristics

Six centres participated in the study. Supplementary Table S1 provides information on each de-identified centre and their characteristics pertinent to this study. There were 531 unique anaesthesiologists working across the centres during the study period. A total of 155 604 patient encounters met the inclusion criteria, with 101 957 unique patients (Fig 1). Supplementary Table S2 shows the characteristics of the study population. The mean age was 6 (range, 2–11.7) yr. The gender distribution shows a higher percentage of males (57%; 88 759/155 585) in all age groups except for the oldest group. The presence of genetic syndromes or diagnoses was consistent across age groups, ranging from 5.6% to 7.4%. Emergency cases ranged from 4.1% to 8.1%, being highest in the oldest group. The presence of fellows, residents, AAs, and CRNAs varied slightly across ages, with CRNAs involved in 16.1–23.1% of cases. Most procedures occurred in the operating room (70.5–82%), followed by diagnostic imaging. Across the six centres, inhalation (82 130 cases, 60.6%) and intravenous (53 479 cases, 39.4%) techniques dominated, accounting for more than 99% of inductions. Alternative techniques, including inhalation via tracheostomy and intramuscular, are rarely used (<2% total).

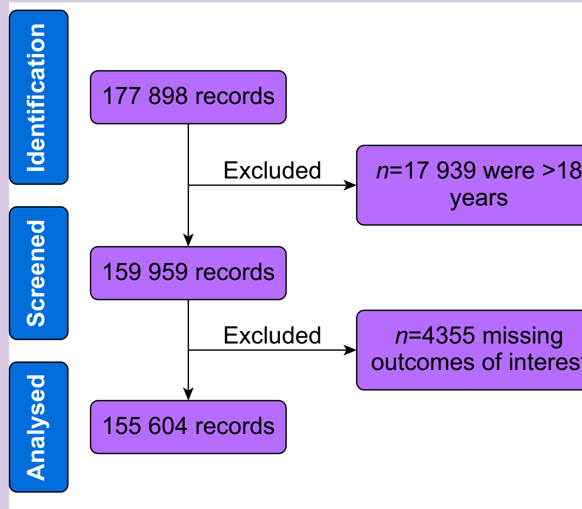

Figure 1. Study flowchart.

Outcomes

The overall incidence of difficult induction was 6.2% (9596/155 604). The highest incidence of 11.5% was observed in the 1–3-yr age group and the lowest incidence of 1.7% among the 13–18-yr age group (Table 1). The lowest incidence of difficult induction occurred in patients who had no anxiolytic intervention (3.5%; 2069/58 848) and those who received premedication alone (2.9%; 1517/51 989) (Table 2).

The overall incidence of significant anxiety behaviour was 22.2% (34 520/155 604). The highest incidence was seen in the 1–3-yr age group (40.8%; 15 876/38 928) (Table 1). The lowest incidence of significant anxiety behaviours occurred in patients who received premedication alone (15.3%; 7965/51 989), those who had a child life specialist (play specialist) present (18.7%; 211/1130), and those who required no anxiolytic intervention (19.6%; 11 555/58 848). Supplementary Figure S1a illustrates the flow of induction and anxiolytic techniques toward the outcomes of difficult induction and significant anxiety behaviours.

The overall incidence for difficult mask acceptance was 20% (15 472/77 298) (Table 1). The highest difficulty mask acceptance rate was found in the 1–3-yr age group (34.2%; 7896/23 073) in contrast with the lowest incidence (5.2%; 404/7821) in the 13–18-yr age group. Similarly, patients who received premedication alone (13%; 3215/24 694) and those who had no anxiolytic intervention (18.9%; 5553/29 379) had the lowest incidence of difficult mask acceptance (Table 2).

Parental presence at induction of anaesthesia was recorded in 31.3% (36 056/115 300) of cases overall. The highest rate of parental presence was in the 1–3-yr age group (38.9%; 11 683/30 057) and lowest in the <1-yr age group (12.1%; 1437/11 894) (Table 2).

Distribution of outcomes and anxiolytic techniques across the six sites

Tables 3 and 4 show the outcomes and anxiolytic techniques at each site, respectively. The prevalence of difficult induction, difficult mask acceptance, significant anxiety, and the use of parental presence at induction of anaesthesia varied significantly across sites (Table 3). Notably, Site 5005, with the lowest

Table 1 Incidence of the outcomes stratified by age group. Data are presented as *n* (%) or *n*/*N* (%).

Outcome	Overall (*n*=155 604)	Age <1 yr (*n*=17 270)	Age 1–3 yr (*n*=38 928)	Age 4–12 yr (*n*=67 033)	Age 13–18 yr (*n*=32 373)
Difficult induction	9596 (6.2)	854 (4.9)	4471 (11.5)	3724 (5.6)	547 (1.7)
Significant anxiety behaviour	34 520 (22.2)	4847 (28.1)	15 876 (40.8)	11 915 (17.8)	1882 (5.8)
Mask acceptance difficult	15 472/77 298 (20)	2198/9472 (23.2)	7896/23 073 (34.2)	4974/36 932 (13.5)	404/7821 (5.2)
Parental presence	36 056/115 300 (31.3)	1437/11 894 (12.1)	11 683/30 057 (38.9)	18 353/50 935 (36)	4583/22 414 (20.5)

Table 2 Incidence of the outcomes by all anxiety techniques. Data are presented as *n* (%) or *n*/*N* (%). *Child life specialist is play specialist in British terminology.

All anxiolytic techniques	*n* (%)	Difficult induction	Significant anxiety	Difficult mask acceptance
No intervention	58 848 (37.8)	2069 (3.5)	11 555 (19.6)	5553/29 379 (18.9)
Child life specialist*	1130 (0.7)	47 (4.2)	211 (18.7)	106/533 (19.9)
Parental presence	26 637 (17.1)	3290 (12.4)	8390 (31.5)	3734/13 179 (28.3)
Distraction	3971 (2.6)	369 (9.3)	1294 (32.6)	811/2963 (27.4)
Premedication	51 989 (33.4)	1517 (2.9)	7965 (15.3)	3215/24 694 (13)
Child life specialist + parental presence	746 (0.5)	96 (12.9)	213 (28.6)	105/278 (37.8)
Child life specialist + distraction	347 (0.2)	38 (11)	97 (28)	69/273 (25.3)
Child life specialist + premedication	550 (0.4)	36 (6.6)	139 (25.3)	65/267 (24.3)
Parental presence + distraction	2760 (1.8)	733 (26.6)	1121 (40.6)	452/1538 (29.4)
Parental presence + premedication	4511 (2.9)	695 (15.4)	1792 (39.7)	654/2081 (31.4)
Distraction + premedication	2511 (1.6)	256 (10.2)	929 (37)	447/1425 (31.4)
Child life specialist + parental presence + distraction	310 (0.2)	94 (30.3)	138 (44.5)	54/147 (36.7)
Child life specialist + parental present + premedication	164 (0.1)	42 (25.6)	90 (54.9)	38/81 (46.9)
Child life specialist + distraction + premedication	202 (0.1)	36 (17.8)	90 (44.6)	35/98 (35.7)
Parental presence + distraction + premedication	742 (0.5)	213 (28.7)	397 (53.5)	101/286 (35.3)
Child life specialist + parental presence + distraction + premedication	186 (0.1)	65 (35)	99 (53.2)	33/76 (43.4)

use of premedication and highest use of parental presence, reported the highest percentage of difficult induction cases (29.8%, *n*=2890), whereas Site 1001 had the lowest (4.0%, *n*=1617) (Table 4). Difficult mask acceptance was most prevalent at Site 4004 (29.6%, *n*=1838) and least at Site 1001 (21.1%, *n*=3864). Premedication was the most common anxiolytic technique used across all sites. Parental presence alone was notably common at Site 6006.

Factors associated with difficult induction

Patient factors that were associated with difficult induction included patient age, ASA-PS, and an autism diagnosis. Children aged 1–3 yr (aOR=1.63, 95% CI: 1.31–2.03, *P*<0.001) and 4–12 yr (aOR=1.58, 95% CI: 1.28–1.96, *P*<0.001) were more likely to experience difficult inductions compared with the reference group of 13–18 yr (Fig 2a). Patients who had an autism diagnosis had significantly higher odds of difficult induction (aOR=1.76, 95% CI: 1.31–2.36, *P*<0.001). Other patient factors, such as developmental delay and anxiety, were not statistically significant.

Any interventions involving parental presence significantly increased the odds of difficult induction (aOR=1.77, 95% CI: 1.55–2.01, *P*<0.001). Among distraction techniques, the use of bubbles was associated with lower odds of difficult induction (aOR=0.71, 95% CI: 0.53–0.94, *P*=0.018). Location played a role, with the catheterisation laboratory (aOR=0.7, 95% CI: 0.5–0.95, *P*=0.023) and diagnostic imaging (aOR=0.88, 95% CI: 0.79–0.99, *P*=0.028) having significantly lower odds of difficult induction compared with the operating room.

Factors associated with significant anxiety behaviours

Figure 2b shows multivariate analysis on factors associated with significant anxiety. Examining factors associated with significant anxiety during the induction of anaesthesia, we found that children aged under 1 yr and 1–3 yr exhibited a significantly higher risk of anxiety behaviours, with aORs of 6.33 (95% CI: 5.42–7.39, *P*<0.001) and 6.73 (95% CI: 5.83–7.78, *P*<0.001), respectively. Parental presence at induction of anaesthesia (aOR=1.46, 95% CI: 1.32–1.61, *P*<0.001) was associated with increased anxiety, whereas premedication was associated with lower significant anxiety behaviours (aOR=0.78, 95% CI: 0.73–0.84, *P*<0.001). Autism was significantly associated with higher incidence of significant anxiety behaviours (aOR=2.02, 95% CI: 1.57–2.59, *P*<0.001). Combined techniques were associated with increased incidence of significant anxiety behaviours.

Table 3 Distribution of outcomes by site. Data are presented as *n* (%).

Outcome	Site 1001	Site 2002	Site 3003	Site 4004	Site 5005	Site 6006
Difficult induction	1617 (4.03)	468 (5.10)	1677 (3.90)	393 (2.82)	2890 (29.82)	2557 (6.45)
Significant anxiety behaviours	7830 (19.52)	1683 (18.33)	6599 (15.33)	2714 (19.45)	3377 (34.84)	12 324 (31.07)
Difficult mask acceptance	3864 (21.05)	972 (16.07)	3315 (12.40)	1838 (29.62)	949 (22.10)	4538 (28.95)
Child Induction Behavioral Assessment						
Difficult	1617 (4.03)	468 (5.10)	1677 (3.90)	393 (2.82)	2890 (29.82)	2557 (6.45)
Moderate	6213 (15.49)	1215 (13.23)	4922 (11.43)	2321 (16.63)	487 (5.02)	9767 (24.62)
Smooth	32 268 (80.47)	7498 (81.67)	36 446 (84.67)	11 239 (80.55)	6315 (65.16)	27 343 (68.93)
Mask Acceptance Scale						
Unafraid	11 011 (59.98)	4540 (75.08)	21 296 (79.67)	3004 (48.41)	2455 (57.17)	7716 (49.22)
Moderate	2417 (13.17)	496 (8.20)	1798 (6.73)	935 (15.07)	586 (13.65)	2619 (16.71)
Slightly	3483 (18.97)	535 (8.85)	2118 (7.92)	1363 (21.97)	890 (20.73)	3422 (21.83)
Terrified	1447 (7.88)	476 (7.87)	1517 (5.68)	903 (14.55)	363 (8.45)	1919 (12.24)
Premedication effectiveness						
Effective	12 588 (86.10)	1786 (85.66)	21 777 (90.10)	5035 (82.77)	853 (62.49)	6509 (75.61)
Not effective	423 (2.89)	47 (2.25)	572 (2.37)	151 (2.48)	87 (6.37)	254 (2.95)
Partial parental presence effectiveness	1610 (11.01)	252 (12.09)	1821 (7.53)	897 (14.75)	425 (31.14)	1846 (21.44)
Effective	2025 (77.47)	332 (59.29)	6389 (82.13)	963 (73.07)	7071 (85.32)	7762 (72.96)
Not effective	182 (6.96)	79 (14.11)	266 (3.42)	61 (4.63)	183 (2.21)	676 (6.35)
Partial	407 (15.57)	149 (26.61)	1124 (14.45)	294 (22.31)	1034 (12.48)	2200 (20.68)

Factors associated with difficult mask acceptance

The multivariable analysis identified several factors significantly associated with difficult mask acceptance in paediatric patients (Fig 2c). Age played a critical role. Children under 1 yr of age had an aOR of 6.13 (95% CI: 5.37–7.00, *P*<0.001), and those aged 1–3 yr had an aOR of 10.8 (95% CI: 9.6–12.3, *P*<0.001). Anxiety management techniques such as parental presence at induction of anaesthesia (aOR=1.63, 95% CI: 1.52–1.76, *P*<0.001) and distraction techniques (aOR=1.52, 95% CI: 1.3–1.78, *P*<0.001) were associated with increased odds of difficult mask acceptance. Similarly, combined techniques were associated with increased incidence of significant anxiety behaviours.

Overall, 77.8% (121 084/155 604) of children did not exhibit anxiety during induction of anaesthesia, and nearly half (48.7%; 58 848/121 084) required no interventions such as premedication or parental presence.

Discussion

Our findings demonstrate difficult inductions were common across six paediatric hospitals, with toddlers in the 1–3-yr age group demonstrating the highest rates of difficult inductions of anaesthesia. The use of premedication was consistently associated with lower incidence of difficult inductions, significant anxiety, and better mask acceptance. In contrast, parental presence was consistently associated with higher incidence of difficult inductions, significant anxiety behaviours and difficulty with mask acceptance.

Our study is unique in that unlike previous studies, it reports a population-based real-world incidence of difficult

Table 4 Distribution of anxiolytic techniques by site. Data are presented as *n* (%). Premed, premedication. *Child life specialist is also play specialist in British terminology.

Anxiolytic technique	Site 1001	Site 2002	Site 3003	Site 4004	Site 5005	Site 6006
Child life specialist*	637 (3.01)	210 (5.86)	58 (0.18)	150 (1.77)	0 (0.00)	75 (0.34)
Child life specialist + distraction	204 (0.96)	70 (1.95)	19 (0.06)	42 (0.50)	3 (0.03)	9 (0.04)
Child life specialist + parental presence	365 (1.72)	37 (1.03)	187 (0.58)	63 (0.74)	37 (0.39)	57 (0.26)
Child life specialist + parental presence + distraction	56 (0.26)	5 (0.14)	54 (0.17)	19 (0.22)	144 (1.53)	32 (0.15)
Distraction alone	2034 (9.60)	464 (12.94)	113 (0.35)	679 (8.03)	45 (0.48)	636 (2.91)
Parental presence alone	2816 (13.29)	583 (16.26)	7004 (21.73)	858 (10.14)	5940 (63.02)	9456 (43.21)
Parental presence + distraction	155 (0.73)	38 (1.06)	194 (0.60)	122 (1.44)	1713 (18.18)	544 (2.49)
Premed alone	13 717 (64.72)	1889 (52.68)	22 568 (70.01)	5104 (60.34)	36 (0.38)	8676 (39.64)
Premed + distraction	818 (3.86)	123 (3.43)	443 (1.37)	736 (8.70)	14 (0.15)	377 (1.72)
Premed + parental presence	261 (1.23)	49 (1.37)	1356 (4.21)	295 (3.49)	1007 (10.68)	1545 (7.06)
Premed + parental presence + distraction	22 (0.10)	4 (0.11)	52 (0.16)	50 (0.59)	349 (3.70)	265 (1.21)
Premed + child life specialist	51 (0.24)	72 (2.01)	110 (0.34)	216 (2.55)	1 (0.01)	100 (0.46)
Premed + child life specialist + distraction	42 (0.20)	36 (1.00)	21 (0.07)	80 (0.95)	6 (0.06)	17 (0.08)
Premed + child life specialist + parental presence	11 (0.05)	5 (0.14)	37 (0.11)	30 (0.35)	22 (0.23)	59 (0.27)
Premed + child life specialist + parental presence + distraction	6 (0.03)	1 (0.03)	18 (0.06)	15 (0.18)	108 (1.15)	38 (0.17)

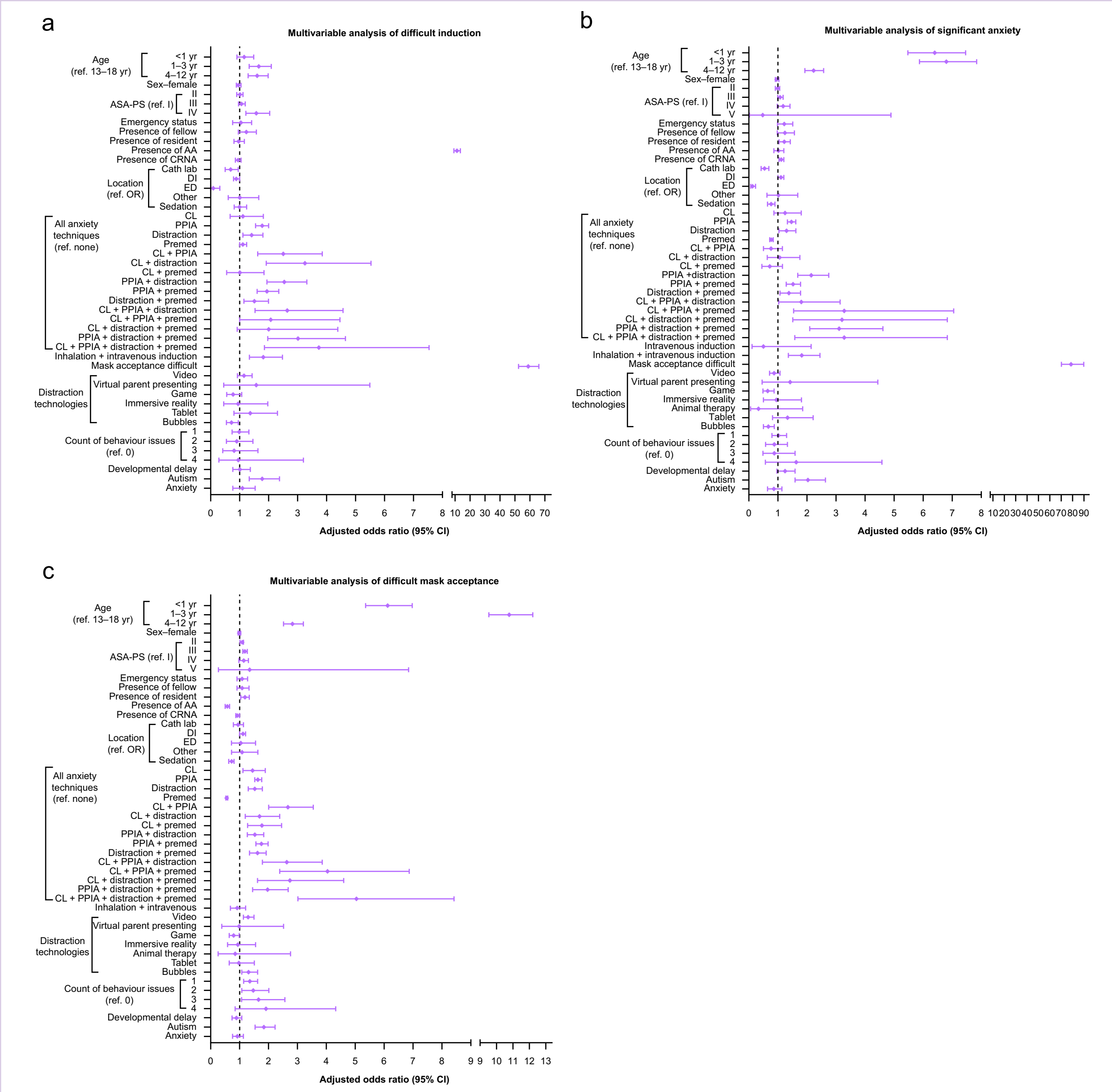

Figure 2. Factors associated with difficult induction, significant anxiety, and mask acceptance. (a) Multivariable analysis of factors associated with difficult induction. (b) Multivariable analysis of factors associated with significant anxiety behaviours. (c) Multivariable analysis of factors associated with difficult mask acceptance. Child life specialist is also play specialist in British terminology. 95% CI, 95% confidence interval; AA, anaesthesia assistant; ASA-PS, ASA physical status; Cath Lab, catheterisation laboratory; CL, child life specialist (play specialist); CRNA, certified registered nurse anaesthetist; DI, diagnostic imaging; ED, emergency department; OR, operating room; PPIA, parental presence at induction of anaesthesia; Premed, premedication.

induction, significant anxiety behaviours, and difficult mask acceptance among the paediatric population presenting for general anaesthesia. Our reported incidence of difficult inductions at 6.2% is lower than what has been previously reported. This may be explained in part by that researchers inadvertently grade anxiety higher than clinicians.[11] Further, our results confirm a high incidence of difficult induction behaviours during anaesthesia induction in the 1–3-yr-old group, which is consistent with previous literature. However, it should be noted that the incidence of the difficult induction is lower in our real-world population-based study, as compared with previous literature. These findings emphasise anxiety as a significant issue in this young age group and highlight the need to use targeted interventions in this cohort. Indeed, younger children are more challenging to manage during induction, likely because of their developmental stage and limited ability to cooperate. Factors significantly associated with difficult induction included younger age, higher ASA-PS, and the presence of an AA.

In our study, premedication was the most effective intervention, leading to the lowest incidence of difficult inductions, anxiety-related behaviours, and highest mask acceptance. In contrast, parental presence during anaesthesia induction was linked to higher odds of difficult induction behaviours. Routine parental presence with or without appropriate preparation of parents may need reconsideration in favour of patient-tailored approaches, including premedication, child life specialists, and other non-pharmacological interventions.

The broader evidence on parental presence during induction of anaesthesia remains inconclusive. Our data and practical experience show that although some parents provide significant comfort, many children remain anxious. Potential solutions could involve clinicians selectively determining which parents are best suited to reassure specific children—something paediatric anaesthetists, skilled at identifying supportive figures, already do well. Further allowing children to choose whether they actually require accompaniment to the operating room, and if so, which parent or caregiver, may help reduce anxiety levels during anaesthesia induction for both the child and the parent.[8,12,25,26]

Our study demonstrated that mask acceptance was difficult in 20% of cases, with the highest incidence in the 1–3-yr age group (34.2%). Factors influencing mask acceptance difficulty included younger age, presence of residents, and certain anxiety management techniques such as parental presence and distraction. Interestingly, the presence of AAs and CRNAs was associated with reduced mask acceptance difficulty. Our study did not assess distress during venous access before intravenous inductions compared with mask inductions. Nevertheless, our findings underscore that not all patients will tolerate or welcome mask inductions and the use of premedication among the anxious patients improves mask acceptance.

Of interest was the use of combined anxiolytic approaches. Our study shows that these combined approaches were associated with higher incidence of difficult inductions and were less effective than the use of premedication alone. There are several reasons for using combined techniques, but one common issue is failure of premedication. For instance, a patient may spit out some of the administered oral premedication or the team may decide to move to the operating room before adequate time has passed and request parental presence as backup, or local policies may mandate the use of parental presence or distraction techniques.[8,26–28] In highly anxious patients or with violent behaviour, all techniques may be used and in some instances with good effect and in some, still with poor effect. These combined approaches require further investigation to improve outcomes for patients. Further, institutions may need to review their local policies to allow for patient-tailored and evidence-based approaches to reduce preoperative anxiety rather than standard policies.[8,9,12,17,26,28] In our study, institutions had strong practice patterns based on policies and local practice. Despite these institutions being well versed in their processes, some processes were associated with significantly lower difficult inductions, significant anxiety behaviours, and mask inductions more than others.

Our study shows that 77.8% (121 084) of children did not exhibit anxiety during induction of anaesthesia, with a significant proportion of these, almost 50%, not requiring any intervention at all; premedication, parental presence at induction of anaesthesia, and presence of child life specialists were unnecessary, with smooth inductions. This observation not only underscores the notable resilience and developmental maturity of these children but may also be attributable to the fact that a substantial proportion do not experience preoperative anxiety to begin with. Among those who do, effective preparatory strategies implemented by parents, caregivers, and healthcare professionals likely play a critical role in fostering adaptive coping mechanisms to manage the stress associated with anaesthesia induction. Additionally, the expertise of paediatric anaesthetists and care team members in building rapport with patients and caregivers, along with their ability to identify and manage preoperative anxiety—especially in highly anxious children—may support the provision of care to these patients at these experienced tertiary paediatric centres.

This study has several limitations that must be considered when interpreting the results. Firstly, as a retrospective study, it relies on the accuracy and completeness of electronic health records, which may be subject to documentation biases and inconsistencies across different institutions. In our study, only 2.7% of records lacked the outcomes of interest (Fig 1), underscoring a robust dataset. By contrast, randomised clinical trials report a median of 9% (range, 0–79%) missing outcomes.[29] In addition, structured and standardised anaesthesia electronic health records—used in our study and shown to be more accurate and complete than paper records—likely minimised documentation bias in our cohort.[30–34] Secondly, the study's observational nature precludes any causal inferences between identified factors and outcomes. The generalisability of the findings may also be limited, as the data were collected from six specific centres, which might not represent broader practice variations. Furthermore, three centres from different regions contributed almost 80% of the cases, which could be considered a potential source of bias. Practices vary widely across healthcare systems and even within the same hospital. For example, some institutions routinely use induction rooms, whereas others do not, and within a single hospital, some operating rooms may include induction rooms while others do not. These varied practices may impact our analysis. However, Supplementary Table S1 allows the reader to compare practice patterns at each study site to determine if the most heavily weighted sites have practice patterns that resemble their own. Although the study utilised standardised tools such as the validated CIBA and the MAS, the subjective nature of these assessments could introduce variability in how anxiety and induction difficulties are recorded. The CIBA tool was designed and validated for assessing anxiety-related behaviours during routine clinical care and documentation using the electronic patient care record with no additional training.[21–23] Further, the strength of the study is its use of validated clinical documentation while reflecting the experience of a very large sample of children across several institutions and countries. In contrast, the commonly used modified Yale Preoperative Anxiety Scale (mYPAS) in randomised clinical trials is designed to assess anxiety; however, as an observational tool, it remains subjective, is also cumbersome to administer, requires specialised training, and necessitates user calibration.[35,36] Additionally, mYPAS often necessitates multiple observers during induction, making it impractical for routine clinical care.[35,36] Future prospective studies with standardised protocols and broader populations are needed to confirm these findings and address these limitations and explore the long-term sequalae of difficult inductions and significant anxiety behaviours, and adverse effects from interventions such as premedication or even post-traumatic stress among some parents present at induction.[26] The use of standardised routine clinical documentation like the SAINT may assist with benchmarking outcomes and comparing practice patterns across several institutions using predefined metrics as included in this current study.[21,29]

Implications for clinical practice

Our study is the first large-scale, real-world analysis of 150 000 paediatric patients across multiple countries and institutions, providing a more comprehensive view of difficult induction and mask acceptance than previously reported. These findings emphasise the importance of age-appropriate strategies for managing paediatric anaesthesia. Younger children, particularly those aged 1–3 yr, are at higher risk for difficult induction, significant anxiety behaviour, and mask acceptance difficulties. Across all age groups, the use of premedication was associated with the lowest incidence of difficult inductions and significant anxiety behaviours. A good proportion of children did not require any intervention. Parental presence was associated with difficult inductions. Tailored interventions that consider the most effective techniques and the presence of experienced anaesthesia personnel could mitigate these challenges. Anaesthesiologists and supporting staff should continually review their practice to incorporate the best evidence-based techniques in a safe manner. Further, children in the 1–3-yr-old group are often excluded from intervention studies and more research and data are needed in this group.[37] Finally, our study highlights the importance of continued research, education, and training for paediatric anaesthesia providers and stakeholders. The goal is to enhance outcomes in paediatric patients by utilising patient-specific and evidence-based approaches, which may include no intervention or premedication as needed.

Conclusions

Our study offers valuable real-world insights into the incidence of anxiety and negative behaviours during paediatric anaesthesia induction. Although many children underwent smooth inductions—often without the need for intervention—it remains essential to recognise and address the subset who experience significant distress. These findings highlight the need to optimise existing strategies through patient-tailored approaches, re-evaluate one-size-fits-all institutional policies, and advance innovative solutions to more effectively support children undergoing anaesthesia.

Authors' contributions

Conception and design of the study: CTM
Acquisition of data: CTM, GLD, TL, JJT, AVW, AFS, AYW
Analysis and interpretation of data: CTM, JY, CL, YW
Drafting and revising the article: CTM, GLD, TL, JJT, AVW, AFS, AYW
Revising the article: JY, CL, YW
Interpretation of data: GLD, TL, JJT, AVW, AFS, AYW

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Declaration of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bjao.2025.100411.

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