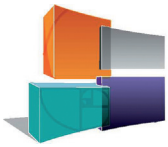
Anaesth Crit Care Pain Med 38 (2019) 637–645



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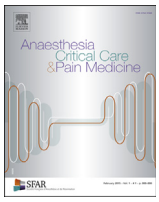

Original article

Description of practices and complications in the French centres that participated to APRICOT: A secondary analysis

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ARTICLE INFO

Article history:
Available online 11 June 2019

Keywords:
Paediatric anaesthesia
Safety
Practice of anaesthesia
Preoperative risks

ABSTRACT

Introduction: Analysing national patients' profile and organisation of human resources are important for improving the perioperative quality of care. The aim of the current study was to achieve these goals using the French data from the APRICOT study.
Material and methods: Data from the French centres that participated to the APRICOT study were extracted and analysed. The primary goal of the study was to describe patients' characteristics, procedures and perioperative anaesthetic management in France, and compare them to the results of the European APRICOT trial. Secondary outcomes were the description of major perioperative complications and the determination of human resources organisation possibly associated with these perioperative complications.
Results: Overall 3535 procedures collected in 20 facilities (17 teaching hospitals, one community hospital and two private institutions) were analysed. Comparison between the French and European APRICOT cohorts found differences related to the more specialised French centres participating to the study. Overall complications (respiratory complications, haemodynamic instability, cardiac arrest, drug errors, and anaphylactic reactions) were observed in 6.4% [95% CI: 5.6; 6.3] of cases. Multivariate analysis identified the anaesthesiologist's experience of < 15 years and the absence of an anaesthetic nurse as human factors independently associated with an increased risk for perioperative complications.
Discussion: The current study identified some important differences between the French and the whole APRICOT cohort in terms of preoperative evaluation, surgical specialties involved, and monitoring of neuromuscular blockade. It confirms that, in France, the presence of an anaesthetic nurse and an experienced anaesthesiologist prevents anaesthetic complications.

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https://doi.org/10.1016/j.accpm.2019.06.001

1. Introduction

Up to now, French data on paediatric anaesthesia were limited and/or monocentric [1,2] or focused on one type of complication [3,4]. The participation of French centres to the APRICOT study allows comparison with other practices in Europe [5]. This study not only gives epidemiologic data on paediatric anaesthesia in Europe, but also explores perioperative management and complications. One of the finding of the APRICOT study was the great heterogeneity between countries regarding both practices and perioperative complications. Some part of this heterogeneity might come from the presence of national recommendations and spread of updated medical information and/or particular organisation of human resources that might influence the overall quality of care and rate of complications. For example, there are in France some specific recommendations (that might not be available in other countries) [6,7] published by some of our scientific societies. Moreover, the level of knowledge of recent developments in paediatric anaesthesia might be different from one country to another, depending upon the availability of continuous medical education, the spread of recent knowledge and the educational methods used for both initial and continuous education [8]. On the other hand, the constant need to limit healthcare expenses while preserving the quality of care, increases the pressure on the operating room teams asking them for more efficiency [9]. Consequently, two practices for the intraoperative management of children are currently identified in France: the first consists in managing two operating rooms with specialised nurses (and/or trainee) in each of them, while the other consists in managing one operatingv room at a time with or without the help of an anaesthetic nurse [3].

We therefore undertook a secondary analysis of the French data in APRICOT. The primary goal was to obtain a description of patients' characteristics, procedures and perioperative anaesthetic management in France. Secondary outcomes were the incidence and timing of major perioperative complications (especially respiratory, the most frequent ones during paediatric anaesthesia) [5] and the determination of human resources organisation (experience of anaesthesiologist and the presence of an anaesthetic nurse) possibly associated with these perioperative complications.

2. Material and Methods

2.1. Study design

The study design has been widely described in the original publication [5]. The study consisted in a prospective collection of perioperative data from children recruited during a consecutive 2-week period freely chosen by each centre, between April 1, 2014, and January 31, 2015 in each participating centre across 33 European countries. The study was nationally approved by an IRB (CPP Sud Méditerranée I n° 2014-A00666-41). Data were collected in an online electronic database (approved by the French regulatory office for the protection of privacy). The current study used all data collected from the French participating centres after approval by the principal investigators of the APRICOT study and the French national coordinators (AL and CD).

The detail of data acquisition is available in the original publication of the APRICOT study but basically, all children up to 15 years old undergoing an inpatient or outpatient diagnostic or surgeries, under regional anaesthesia alone, sedation or general anaesthesia (with or without regional anaesthesia), were eligible for inclusion in the APRICOT study.

2.2. Data extraction

Concerning the description of practice of paediatric anaesthesia in France, the analysis of data was focused on the epidemiologic characteristics of the children who underwent anaesthesia, the surgical and non-surgical procedures performed and anaesthesia management during the perioperative management (patients were followed for up to 60 min after anaesthesia or sedation).

Concerning the analysis of perioperative complications and data in relation with organisation and human resources associated with those complications, the following data were extracted: years of experience of the anaesthesiologists and the presence of an anaesthetic nurse with the physician (or a resident). In order to account for confounding factors, all previously identified ones (or presumed to be) associated with respiratory and cardio-vascular complications [1,3–5,10–12] were also included in the analysis, namely: age, prematurity, gender, ASA physical status III to V, actual or previous URTI, fever, wheezing, asthma, parental smoking, allergy, snoring, previous anaesthesia complications, preoperative medication (indicating the presence of a preoperative illness), preoperative handicap or congenital disease, type of surgery or procedure, preoperative premedication and parental presence at induction, inpatient management, emergency anaesthesia, rapid sequence induction, general anaesthesia and use of regional analgesia, intravenous induction, device used for ventilation, method of ventilation used and use of muscle relaxation. Perioperative complications were defined in the APRICOT as following: respiratory complications (laryngospasm, bronchospasm, stridor and aspiration), haemodynamic complications (hypotension, arrhythmia, bleeding, vasodilatation and cardiac arrest), anaphylactic reactions and drug errors, death and neurological complications occurring at 30 days after the anaesthesia.

2.3. Statistical analysis

Descriptive analysis used percentages and mean with their 95% confidence interval. When comparison was performed it used a X^2 test or a Student t test for discrete and continuous variables, respectively.

For determination of human factors associated with perioperative complications, univariate analyses were performed using ANOVA and the X^2, or Fisher's exact test for categorical variables. Where a statistical association was found between a continuous variable and a study outcome, the continuous variable was converted to a discrete variable by categorising it according to its J-point (the maximal value of the Youden index = sensitivity + specificity) following receiving operator characteristics (ROC) analysis. Although multivariate analysis can be performed using continuous variables, transforming continuous variables to discrete values allows the determination of a cut-off value and easier to interpret results [13,14].

All categorical variables exhibiting a level of significance of 0.2 were collapsed as one variable for the following categories: demographic data and preoperative health status (including age, weight, preoperative respiratory risks... etc.), procedure characteristics (type of procedure and surgeries or non-surgical procedures), preoperative preparation (preoperative premedication and parental presence), perioperative anaesthesia management (general anaesthesia, tracheal intubation, postoperative management... etc.) and factors impacting the main studied outcomes (the experience of anaesthesiologists and the presence of an anaesthesiologist nurse).

Odds Ratios were determined for each significant factor (or collapsed category), as were goodness of fit (Hosmer & Lemeshow test with a $P > 0.2$), c-statistics (ROC analysis of the model) [13]. Finally, to avoid collinearity, correlations between predictive factors were analysed and one of the two correlated factors were removed if the correlation was ≥ 0.7. Statistical analysis was performed using SPSS 22.0 software (IBM Company, Chicago, Illinois, USA). The alpha risk for error was set at 5%.

3. Results

Overall 20 centres (17 teaching hospitals, 1 community and 2 private institutions) in France included 3559 procedures, i.e. 11.5% of procedures included in APRICOT, and approximately 4% of all paediatric anaesthetia performed in France during a two-weeks period of time in 2016 (according to the national electronic database on healthcare in France). After cleaning the database for incomplete records, analyses were carried on 3535 procedures.

3.1. Description of patients, procedures and perioperative management in the French APRICOT cohort in comparison to the European APRICOT data

Characteristics of patients are displayed in Table 1. Mean patients' age was 3.3 [95% CI: 2.4; 4.3] years (European cohort: 6.35 ± 4.5). Their ASA status was predominantly I and II (92.2% versus 92% in the European cohort). Among included patients, 7.2% were former premature (7.6% in the European cohort), 14.4% were suffering from a handicap and/or a congenital disease (13% in the European cohort) and 26% were taking medications and among those patients 2.2% specifically cardiovascular and/or anticoagulant treatments. In addition, the preoperative respiratory risk factors found in the French patients were similar to those published in the whole APRICOT cohort apart for snoring (5.5% vs. 14.3% in the European cohort). Finally the incidence of allergies, preoperative medications, a history of previous anaesthetic complications and the presence of a handicap and/or congenital disease were similar between the two cohorts.

The details of procedures performed and their characteristics are displayed in Table 2. Most were surgical procedures (77.3%) with orthopaedics, urological and ear-nose and throat (ENT) surgeries being the most frequent. There were some differences in the proportion of some procedures between the French APRICOT cohort and the European one, especially for most frequent surgeries (more orthopaedics and less ENT surgery). Concerning the non-surgical procedures, gastroenterological endoscopy, magnetic resonance imaging and central venous access were among the most frequent. Outpatient management was performed in 55.1% of cases (versus 37.6% in the European cohort). Timing of anaesthesia was predominantly during the working hours and 77.2% of procedures were elective. Finally, the duration of procedures averaged 45 minutes.

The detail of perioperative management in the French cohort is displayed in Table 3. A preoperative examination prior to anaesthesia was performed in 83.7% of cases: this was higher than observed in the European cohort (59.4%). The mean number of years of experience of the anaesthesiologist caring for the child was 13.5 years, and most physicians performed paediatric anaesthesia during more than 80% of their working time. Standard monitoring consisting in ECG, SpO2, anaesthetic agent monitoring, capnography, non-invasive blood pressure, and temperature was used in 76.3% of cases but one of those elements was missing in 20.5% of cases. General anaesthesia (in comparison to sedation or regional anaesthesia without sedation or anaesthesia) was performed in 97.4% of cases (versus 93.4% in the European cohort). Sedation was mostly performed using ketamine. Induction of anaesthesia was

Table 1
Description of patients' characteristics of the APRICOT French cohort. Data are expressed as percentages or mean with their 95% confidence interval.

Factor	France APRICOT Cohort	Whole APRICOT data
Age (years)	3.3 [2.4; 4.3]	6.35
Weight (Kg)	13.8 [10.9; 16.6]	24.8
Prematurity (%)	7.5 [6.6; 8.4]	7.6
Female patient (%)	39 [37.4; 40.6]	38.8
Ethnical origin		
Caucasian (%)	69.9 [68.4; 71.4]	82.3
Spanish/Hispanic/Latino (%)	2.8 [2.3; 3.4]	4.7
Asian (Indian, Pakistani, Bangladeshi, Chinese, Vietnamese, etc.) (%)	2 [1.5; 2.5]	3.5
Black (Caribbean, African) (%)	8 [7.1; 8.9]	3.0
Arabic (North African, Middle Eastern) (%)	16.5 [15.3; 17.8]	5.8
Mixed (%)	0.6 [0.3; 0.8]	0.6
ASA status		
I (%)	69.9 [68.4; 71.4]	60.7
II (%)	22.3 [21; 23.7]	28.1
III (%)	7.1 [6.3; 8]	9.6
IV (%)	0.6 [0.3; 0.8]	1.6
Actual or previous (2 weeks) signs of URTI (%)	15.5 [14.3; 16.7]	13.5
Fever (>38.5 °Celsius) (%)	3.9 [3.3; 4.5]	2.9
Wheezing (%)	4.9 [4.2; 5.6]	6.3
Asthma (%)	7.6 [6.7; 8.4]	6.1
Atopy (%)	5.6 [4.8; 6.4]	7.5
Parental smoking (%)	7.1 [6.3; 7.9]	14.3
Allergy (%)	10.4 [9.4; 11.4]	12.3
Allergy type		
Food or Nuts or antibiotics or others	9.4 [8.5; 10.4]	8.2
Multiple (%)	0.8 [0.5; 1.2]	NR
Others (pollen, other medications, dress, contrast) (%)	3.8 [3.2; 4.5]	NR
Snoring (%)	5.5 [4.8; 6.3]	14.3
Previous anaesthesia complication (%)	1.6 [1.2; 2]	1.9
Preoperative medication (%)	26 [24.1; 27.4]	23.1
Cardiovascular and/or anticoagulants (%)	2.2 [1.7; 2.7]	NR
Analgesics (non-opioids, opioids, anti-neuropathic) (%)	6.3 [5.5; 7.1]	NR
Preoperative handicap or congenital disease (neurological or metabolic) (%)	14.4 [13.2; 15.5]	13

NR: not reported in the European APRICOT results.

Table 2
Surgery and procedures characteristics in the APRICOT French cohort. Data are expressed as percentages or mean with their 95% confidence interval.

Factor	France APRICOT Cohort	Whole APRICOT dataset
Procedures		
Surgery (%)	77.3 [75.9; 78.7]	71.4
Non-Surgical (%)	22.7 [21.3; 24.1]	28.6
Surgical procedures (alone or associated with another)		
Orthopaedics (%)	28.7 [27.3; 30.3]	15.3
Abdominal (%)	20.4 [19.1; 21.7]	17.5
Urological (%)	15.8 [14.6; 17.1]	16
Ear-Nose-Throat (%)	15.7 [14.6; 17]	25.3
Skin surgery (%)	5.8 [5.1; 6.7]	5.1
Ophthalmological (%)	3.2 [2.7; 3.8]	4.3
Plastic and palate surgery (%)	3.1 [2.5; 3.5]	4.8
Head and Neck (%)	2.8 [2.3; 3.4]	3.0
Neurosurgery (%)	2.5 [2; 3.1]	2.3
Traumatic (multiple) (%)	1.4 [1; 1.8]	3.7
Thoracic (%)	0.6 [0.4; 1]	0.7
Cardiac (%)	0.4 [0.2; 0.7]	1.1
Other (%)	0.6 [0.4; 0.9]	0.6
Hepatic-Biliary (%)	0.4 [0.2; 0.6]	0.3
Non-Surgical procedures (alone or associated with another)*		
Magnetic resonance imaging (%)	20.5 [19.2; 21.9]	22.4
Gastroenterology endoscopy (%)	18.2 (16.9; 19.5]	16.1
Venous access (%)	14.5 [13.4; 15.7]	7.2
Burns care (%)	13.9 [9.6; 15.1]	2.2
Dental surgery (%)	10.6 [1.9; 11.6]	18.0
Bronchial endoscopy (%)	5.7 [5; 6.5]	3.9
Biopsy (%)	3 [2.4; 3.6]	1.9
Ophthalmological examination (%)	3.1 [2.5; 3.7]	2.2
Bone marrow aspiration and/or lumbar puncture (%)	2.2 [1.8; 2.7]	10.0
Scannographic imaging (%)	1 [0.7; 1.3]	14.6
Others (%)	7.3 [6.4; 8.2]	3.7
Outpatient management (%)	43.9 [42.3; 45.5]	37.6
Emergency status		
Elective (%)	77.2 [75.8; 78.6]	81.2
Emergency (%)	21.6 [20.3; 23]	16.1
Vital emergency (%)	1.1 [0.8; 1.5]	2.7
Timing of anaesthesia between 7 am and 6 pm (%)	92.7 [91.9; 93.6]	92.1
Mean duration of the procedure (minutes)	44.7 [34.3; 55.21]	NR

NR: not reported in the European APRICOT results.

predominantly performed using a volatile agent (sevoflurane in 70.4% of cases of general anaesthesia) and sufentanil was the most frequently used opioid during the intraoperative period (69.3% of cases of general anaesthesia). Airway was secured in more than 50% with endotracheal intubation, and controlled ventilation was the most frequent ventilation mode used. In case of rapid sequence induction, suxamethonium was used in 63.3% of cases and a non-depolarising muscle relaxant in 23.7% of cases (Table 3).

Overall, tracheal intubation was performed in 23.9% of cases after the administration of a muscle relaxant. Monitoring and reversal of neuromuscular blockade were used in 59.9%, and 19.6% of the cases when a NDMR was used, respectively. This was much more frequent than in the European cohort (16%) for the monitoring but less than in the European cohort (33%) for reversing NDMR. Finally, after anaesthesia, most patients were managed in the postoperative acute care unit.

3.2. Description of perioperative complications and their timing in the French APRICOT cohort

Perioperative complications as defined in the method section occurred in 223 patients (6.4% [95% CI: 5.6; 6.3] versus 5.2% [95% CI 5.0; 5.5] in the European cohort). The incidence of respiratory complications was: 3.7% [95% CI: 3.1; 4.3] (versus 3.1% [95% CI 2.9; 3.3] in the European cohort) and incidence of cardio-vascular complications was 2.9% [95% CI: 2.3; 3.4] (versus 1.9% [95% CI: 1.7; 2.1] in the European cohort). Incidence and timing of the different types of complications are displayed in the supplemental table 1. Haemodynamic instability consisted in bleeding (25%), arrhythmia (9%), hypotension (90%) or other type (7%) of the complications (with some patients experiencing more than one complication). Other complications reported in the French cohort of the APRICOT study were drug errors in five patients ([95% CI: 0.1; 0.3]: no details were available about those drug errors). No patient experienced neurological complications or anaphylactic reactions in the French cohort.

3.3. Organisationof Human Resources associated with perioperative complications

Univariate analysis identified the following factors as associated with the occurrence of respiratory or cardiovascular complications in the French cohort (Table 4): preoperative health condition (age < 3 years, prematurity, ASA III to V status, actual or previous signs of URTI, wheezing and asthma, preoperative medication, previous anaesthetic complications and preoperative handicap or genetic disorder), procedure characteristics in hospital management (emergency surgery, procedure duration > 65 minu-minutes, abdominal surgery, neurosurgery, cardiac surgery, traumatic (multiple), dental surgery, biopsy, tomodensitometric imaging), preoperative preparation (absence of premedication or parental presence), intraoperative management (general anaesthesia, muscle relaxation and intubation) and human resources organisation (the experience of anaesthesiologist < 15 years and the absence of an anaesthetic nurse). Collapsing those factors within each category (defining as the presence of one of the factors in relation with the corresponding category) also found the derived categories, except for preoperative preparation, to be significantly

Table 3
Anaesthesia and perioperative management in the APRICOT French cohort. Data are expressed as percentages or mean with their 95% confidence interval.

Factor	France APRICOT Cohort	Whole APRICOT dataset
Preoperative consultation (%)	83.7 [82.5; 84.9]	59.4
Experience of the anaesthesiologist (mean in years)	13.5 [11; 16]	NR
Mean duration of anaesthesia (minutes)	73.7 [60; 87.5]	NR
Anaesthesiologist experience		
80% activity in paediatrics (%)	85.3 [84.1; 86.5]	59.2
50% to 80% activity in paediatrics (%)	2.9 [2.4; 3.5]	14.0
< 50% activity in paediatrics (%)	10.8 [9.8; 11.8]	19.2
Resident (with a senior) (%)	27.2 [25.7; 28.5]	NR
Nurse (with a senior) (%)	78.5 [77.1; 79.9]	NR
Resident alone (%)	0.3 [0.1; 0.5]	7.8
Anaesthetic nurse alone (%)	0.3 [0.1; 0.5]	NR
Premedication (%)	60.5 [58.8; 62.1]	49.2
Parental presence (%)	5.7 [4.9; 6.5]	50.7
Type of anaesthesia		
Regional anaesthesia alone (%)	0.8 [0.5; 1.1]	0.2
Sedation (%)	1.7 [1.3; 2.2]	6.3
Anaesthesia (%)	97.4 [96.9; 97.9]	93.4
Hypnotic drugs for sedation		
Propofol alone (%)	0.1 [0; 0.3]	NR
Ketamine alone (%)	1.2 [0.8; 1.5]	NR
Rapid sequence induction: RSI (%)	8.2 [7.3; 9.1]	4.4
Modified with mask ventilation during RSI (%)	23 [18; 27]	48
Cricoid pressure during RSI (%)	39.5 [30.1; 45.2]	46.7
Non-depolarising muscle relaxant	63.3 [61.6; 64.8]	41.7
Suxamethonium	23.7 [22.3; 25.1]	39.3
Regional anaesthesia (%)	32.5 [30.9; 34]	24.4
Type of induction		
Volatile agent (%)	69.8 [68.3; 71.4]	50%
Intravenous (%)	27.4 [25.9; 28.8]	36.2%
Airway device		
No device (%)	1.8 [1.4; 2.2]	4.3
Face mask (%)	13.7 [12.6; 14.8]	16
Supraglottic airway device (%)	30.3 [28.8; 31.8]	35
Endotracheal intubation (ETT) (%)	52.7 [51; 54.3]	44
Cuffed ETT (%)	50.5 [48.8; 52.1]	31
Pressure monitoring (ETT) (%)	46.5 [44.9; 48.2]	48
Intraoperative Monitoring		
Standard: ECG, SpO2 anaesthetic agent, capnography, NIBP, temp (%)	76.3 [74.9; 77.7]	61.5
Standard+: Standard AND Arterial, central line (%)	1.4 [1; 1.7]	2.1
Standard ++: Standard+ AND NIRS, EEG derivate data (%)	1.8 [1.3; 2.2]	1.1
Standard minus one standard monitoring lacking (%)	20.5 [19.1; 21.8]	35.2
Use of muscle relaxation during tracheal intubation	23.9 [22; 25.9]	61.3
Monitoring of muscle relaxation in case of NDMR use (%)	59.9 [59; 60]	16
Muscle relaxant reversalin case of NDMR use (%)	19.6 [19.2; 30]	33
Postoperative location		
Ward (%)	0.5 [0.3; 0.7]	13.1
PACU (%)	95.5 [94.8; 96.2]	80.3
Intermediate care (%)	0.1 [0; 0.3]	1.9
Intensive care (%)	3.9 [3.2; 4.5]	4.7
Caregivers		
Qualified nurse (%)	88.3 [87.2; 89.3]	NR
Nurse in training (%)	1 [0.7; 1.4]	NR
Other (%)	10.6 [9.5; 11.6]	NR
Postoperative O2 administration		
Systematic (%)	42.7 [41.1; 44.4]	NR
If Necessary (%)	13.6 [12.5; 14.7]	NR
No administration (%)	43.1 [41.5; 44.8]	NR

NR: not reported in the European APRICOT results. Percentages of surgical and non-surgical procedures are expressed as a proportion of overall included patients.

associated with perioperative complications (Table 5). Although some factors such as mask ventilation, use of supraglottic devices and ventilation strategies were identified in the univariate analyses as predictive of perioperative complications, they were not entered in the collapsed variables in order to avoid collinearity. Including those categories with the experience of the anaesthesiologist and presence of an anaesthetic nurse in a multivariate analysis served to find the following categories or factors independently associated with the occurrence of respiratory or cardiovascular complications: preoperative health condition, procedure characteristics, intraoperative management, experience of the anaesthesiologist < 15 years and absence of an anaesthetic nurse (Table 5). The Hosmer & Lemeshow test exhibited a *P* value of 0.98, and the area under the curve of the ROC analysis of the model was 0.7 (95% CI 0.67; 0.74). No collinearity was identified in the model.

4. Discussion

The current study summarises the data from the French centres that participated to the APRICOT study and allows comparing them to the European data. In addition, it served to identify two human resources factors associated with perioperative complications, namely: the experience of the anaesthesiologist and presence of an anaesthetic nurse.

Table 4
Univariate analysis of factors associated with perioperative complications. Data are expressed as N (%).

Factor	No Complication ($N = 3312$)	Complication ($N = 223$)
Age < 3 years	1046 (31.6%)	127 (57%)***
Prematurity	231 (7%)	34 (15.2%)***
ASA physical status III to V	227 (6.9%)	48 (21.5%)***
Actual or previous (2 weeks) signs of URTI	490 (14.8%)	57 (25.6%)***
Fever (> 38.5 °Celsius)	127 (3.8%)	11 (4.9%)
Wheezing	152 (4.6%)	21 (9.4%)**
Asthma	247 (7.4%)	22 (9.9%)
Atopy	185 (5.6%)	13 (5.8%)
Parental smoking	240 (7.2%)	11 (4.9%)
Allergy	350 (10.6%)	18 (8.1%)
Snoring	183 (5.5%)	12 (5.4%)
Previous anaesthesia complications	48 (1.4%)	9 (4%)**
Preoperative medication	835 (25.2%)	83 (37.2%)***
Preoperative handicap or congenital disease (neurological or metabolic)	465 (14%)	43 (19.3%)*
Surgical procedures		
Orthopaedics	728 (22%)	36 (16.1%)*
Abdominal	495 (14.9%)	49 (22%)**
Hepatic-Biliary	11 (0.3%)	1 (0.4%)
Urological	406 (12.3%)	21 (9.4%)
Ear-Nose-Throat	410 (12.4%)	22 (9.9%)
Ophthalmological	82 (2.5%)	4 (1.8%)
Skin surgery	155 (4.7%)	7 (3.1%)
Plastic and palate surgery	78 (2.4%)	6 (2.7%)
Neurosurgery	56 (1.7%)	15 (6.7%)***
Cardiac	5 (0.2%)	7 (3.1%)***
Thoracic	18 (0.5%)	2 (0.9%)
Traumatic (multiple)	36 (1.1%)	0 (0%)
Head and Neck	76 (2.3%)	4 (1.8%)
Other	17 (0.5%)	0 (0%)
Non-surgical procedures		
Gastroenterology endoscopy	129 (3.9%)	9 (4%)
Bronchial endoscopy	37 (1.1%)	4 (1.8%)
Dental surgery	76 (2.3%)	9 (4%)
Biopsy	20 (0.6%)	4 (1.8%)
Medullar aspiration and/or lumbar puncture	18 (0.5%)	0 (0%)
Ophthalmological examination	24 (0.7%)	0 (0%)
Scannorgraphic imaging	5 (0.2%)	3 (1.3%)
Magnetic resonance imaging	158 (4.8%)	7 (3.1%)
Venous access	111 (3.4%)	6 (2.7%)
Burns care	103 (3.1%)	9 (4.0%)
Others	84 (2.5%)	7 (3.1%)
Inpatient management	1813 (54.7%)	169 (75.8%)***
Emergency	736 (22.2%)	70 (31.4%)**
Timing of anaesthesia: Out of working hours and during week-end	342 (10.3%)	20 (9%)
Duration of the procedure (minutes)	48 ± 49	93 ± 97***
Duration of the procedure > 65 minutes	676 (20.5%)	99 (45%)***
Experience of the anaesthesiologist (years)	15 ± 10	12 ± 9***
Experience of the anaesthesiologist < 15 years	1705 (51.5%)	141 (63.2%)***
Absence of anaesthetic nurse	674 (20.4%)	75 (33.6%)***
Absence of premedication	1269 (39.1%)	101 (45.5%)
Absence of parental presence during anaesthesia induction	3117 (94.1%)	215 (96.8%)
General anaesthesia	3223 (97.3%)	221 (99.1%)
Rapid sequence induction	268 (8.1%)	23 (10.3%)
Regional anaesthesia	1078 (32.5%)	71 (31.4%)
Type of induction		
Volatile agent	2313 (69.8%)	158 (70%)
		65 (29.1%)
Intravenous	902 (27.2%)	
Muscle relaxation during induction	394 (11.9%)	53 (23.8%)***
Airway device		
Face mask	475 (14.3%)	9 (4%)***
Supraglottic airway device	1038 (31.3%)	33 (14.8%)***
Endotracheal intubation (ETT)	1687 (50.9%)	175 (78.5%)***
Intraoperative ventilation		
Spontaneous	525 (15.9%)	11 (4.9%)***
Pressure support	349 (10.5%)	7 (3.1%)***
Controlled ventilation	2435 (73.5%)	203 (91%)***

* $P < 0.05$
** $P < 0.01$
*** $P < 0.001$.

Table 5
Univariate analysis after collapsing data to different categories and multivariate logistic regression analysis.

Categories & Factors	OR	95% Confidence Interval of the OR	*P*
Preoperative Health condition	3.5	[2.4; 5.2]	< 0.001
Age < 3 years			
Prematurity			
ASA status III to V			
Actual or previous (2 weeks) signs of URTI			
Wheezing			
Asthma			
Previous anaesthesia complication			
Preoperative medication			
Preoperative handicap or congenital disease (neurological or metabolic)			
Procedure characteristics			
Inhospital	2	[1.4; 2.9]	< 0.001
Emergency			
Procedure duration > 65 mn			
Abdominal surgery			
Neurological			
Neurosurgery			
Cardiac			
Traumatic (multiple)			
Dental surgery			
Biopsy			
Scannogaphic immaging			
Experience of the anaesthesiologist < 15 years	1.5	[1.02; 2.5]	0.001
Absence of anaesthetic nurse	1.8	[1.3; 2.4]	< 0.001
Preoperative preparation			0.26
Absence of premedication	Excluded by the analysis	Excluded by the analysis	
Absence of parental presence during anaesthesia induction	Excluded by the analysis	Excluded by the analysis	
Intraoperative management	4.2	[1.02; 17]	0.12
General anaesthesia			
Muscle relaxation during induction			
Endotracheal intubation (ETT)			
Controlled ventilation			

Data are expressed as N (%); OR: odd Ratio. Hosmer & Lemeshow test = 0.97.

4.1. Comparison between the French APRICOT and European APRICOT cohorts [5]

The proportion of patients undergoing a preoperative evaluation was greater in the French cohort. This is expected, as a pre-anaesthetic evaluation is mandatory by Law in France. However, it did not reach 100% despite this legal obligation of the preoperative consultation and the immediate preoperative assessment (an additional ultimate check few hours before anaesthesia): this should be interpreted cautiously, bearing in mind the fact that 22.7% were either emergency or urgent cases, and that a pre-anaesthetic evaluation more than 24 h before the procedure was by definition not possible. In addition, given the French legal obligation of using ECG, SpO2, anaesthetic agent monitoring, capnography, and non-invasive blood pressure monitoring, the lacking element was probably temperature. However, knowing the importance of monitoring in patients' security, more efforts have to be undertaken to improve the situation, even if considering that the lacking basic monitor was probably temperature.

Interestingly, the proportion of parental presence during induction of anaesthesia was less frequent in France in comparison to the European cohort, despite the fact that most participating centres were specialised ones. One might hypothesise that this practice is far from French cultural management, given concerns regarding its effect on perioperative quality of care [15].

The use of muscle relaxation for intubation was less frequent in the French cohort in comparison to the European one. However, this proportion will probably increase in regards to recent French recommendations for airway management in children [7] and studies indicating a potential benefice of using muscle relaxant during intubation in children [16,17]. The rates of monitoring and reversal of muscle relaxation were different between cohorts: specifically, the rate of reversal of NDMR blockade was lower in the French cohort. This data cannot be interpreted because we do not know in how many cases reversal was systematic or adapted to the result of neuromuscular monitoring in both cohorts. Although no controlled trial has investigated the usefulness of reversing muscle relaxation in children, a strong relation between residual neuromuscular block and postoperative respiratory complications has been described in adult patients [18]. Further studies evaluating the effects of residual relaxation on postoperative respiratory outcomes are specifically needed in the paediatric population. Finally, rapid sequence induction (RSI) was performed more frequently in the French cohort. This is probably in relation with the higher proportion of emergency surgery. Interestingly, in 25% of cases, mask ventilation was performed, and in nearly 39% of cases no cricoid pressure was performed. Although in accordance with major evolution in practice of RSI and recent French recommendations, it was not yet recommended in France at the time of the APRICOT study [7,19]. In addition, muscle relaxation for RSI was achieved with a NMDR in 25% of cases, while recommendations still indicated the use of suxamethonium at that time [7].

4.2. Perioperative complications and human resources associated with perioperative complications

The rate of overall and respiratory complications was similar between the overall and French cohorts. However, perioperative cardio-vascular complications appeared more frequent in the French cohort. One can hypothesise that the heterogeneity in patients' management, the lower age of patients included in the French cohort and distinct procedures performed in comparison to the European cohort (Table 5) might contribute to these apparent

differences between French and European cohorts. They might be explained by the quasi-exclusive participation of specialised centres in France with specific high-risk patients.

The current study identified two major human and organisational factors associated with the occurrence of perioperative complications. In agreement with the literature [3,5,20,21], the present study showed evidence of the role of the anaesthesiologist's experience in the occurrence of severe critical events. Our results are consistent with the RHUBARBE study on perioperative respiratory complications in patients with preoperative respiratory tract infection, which identified an experience of the anaesthesiologist < 15 years as a risk factor of perioperative desaturation [3]. However, due to the limited number of patients and procedures included in the APRICOT French cohort, we could not evaluate the possible influence of the number of cases performed in each centre or by each anaesthesiologist during the study period. The second independent factor of interest consisted on the presence of an anaesthetic nurse. This is also consistent with a recent study in adults that found that the presence of a team consisting of a physician and anaesthetic nurse, in comparison with a solo anaesthesiologist, was associated with a 30-day decrease in mortality [22]. The reasons advocated for explaining the results obtained in the latter were the optimisation of intraoperative care with a resulting long-lasting improvement in the overall outcomes; the same explanation can also apply to our finding. Alternatively, the presence of an anaesthetic nurse could indicate that a difficult case was anticipated. The current result seems to indicate that the presence of an anaesthetic nurse together with a physician, a resident or their combination would be part of the preventive strategies that should be considered in order to avoid complications, especially in patients with perioperative risk factors of complications.

The current study suffers from limitations, some of which have already been developed in the original APRICOT publication [5]. This includes a selection of patients from structures who agreed to participate to the study, the limited time of inclusion within each centre (2 weeks) and the freedom to choose the inclusion period, although the latter probably mitigated some seasonal variations in complication rate. The major and specific limitation of the current study is its limited representativityof the overall paediatric anaesthesia activity in France, given that the current French dataset represents only 4% of the overall yearly paediatric anaesthesia activity. In addition, one might question the fact that 17 of the 20 facilities that participated to the study were specialised ones. This is reflected by the difference in the rate of ambulatory surgery in France [23], which seems to be higher than that reported in Europe by APRICOT, independently of the ENT surgery that has been reported to be performed in private institutions in France [23,24]. In addition, the practice of paediatric anaesthesia was different from the whole APRICOT cohort (59% versus 85.3% of participants with more than 80% paediatric anaesthesia practice in the European and French cohorts, respectively) [10]. We could thus analyse only the tip of the iceberg that is the whole paediatric anaesthesia practice in France. Second, the French cohort was compared to the overall European one. This means that French data were included in this comparison. However, this is unlikely to have compromised the comparison, given that French data were representing only 11% of the included patients.

In conclusion, despite its limitations, the French APRICOT cohort gives important insights concerning paediatric anaesthesia practice in France. This study allows determining key factors for improving security and quality of healthcare during the perioperative period of paediatric anaesthesia. It might be considered as a starting point for further studies aiming to evaluate and improve the quality of paediatric anaesthesia practice in France.

Funding

Support was provided by a Grant from the European Society of Anaesthesiology.

The current study was registered in ClinicalTrial.gov, number NCT01878760.

Authors' contribution

Dahmani S: study conception, data collection, data analysis, interpretation of results, drafting and correcting the manuscript and approved the final version of the manuscript.

Laffargue Anne: study conception, data collection, interpretation of results, drafting and correcting the manuscript and approved the final version of the manuscript.

Dadure C: study conception, data collection, interpretation of results, drafting and correcting the manuscript and approved the final version of the manuscript.

Veyckemans F: study conception, data collection, data analysis, interpretation of results, drafting and correcting the manuscript and approved the final version of the manuscript.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.accpm.2019.06.001.

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