Original article

Association Between Residency Training Level and Knowledge and Clinical Decision-Making in Perioperative Anaphylaxis Among Anesthesia Residents: A Cross-Sectional Questionnaire-Based Study

Dr. Aman Dhaliwal[1], Dr. Kiran Vinodbhai[2], Dr. Tushar D. Bhavar[3], Dr. Tanvi Joshi[4]

[1] *Junior Resident III, Department of Anaesthesiology and Critical Care, Dr. Balasaheb Vikhe Patil Rural Medical College, Loni, Maharashtra, India;*

[2] *Junior Resident III, Department of Anaesthesiology and Critical Care, Dr. Balasaheb Vikhe Patil Rural Medical College, Loni, Maharashtra, India;*

[3] *Professor & Head, Department of Anaesthesiology and Critical Care, Dr. Balasaheb Vikhe Patil Rural Medical College, Loni, Maharashtra, India;*

[4] *Junior Resident III, Department of Anaesthesiology and Critical Care, Dr. Balasaheb Vikhe Patil Rural Medical College, Loni, Maharashtra, India.*

Corresponding author: Dr. Tanvi Joshi

Abstract

Background: *Perioperative anaphylaxis is an uncommon but potentially life-threatening complication encountered during anaesthesia. Rapid recognition, administration of adrenaline, haemodynamic resuscitation, and appropriate post-event evaluation are essential for reducing morbidity and mortality. Anaesthesia residents are frequently involved in the initial recognition and management of perioperative emergencies; therefore, adequate knowledge and clinical decision-making skills are essential.*

Objectives: *To assess knowledge and clinical decision-making regarding perioperative anaphylaxis among anaesthesia residents and to examine these findings in relation to residency training level, previous clinical exposure, and formal training.*

Materials and Methods: *This observational cross-sectional questionnaire-based study included 25 participants from the Department of Anaesthesiology and Critical Care, Pravara Rural Hospital, Loni. A structured, validated, self-administered questionnaire assessed residency level, previous exposure to perioperative anaphylaxis, formal training, knowledge of triggers and diagnosis, clinical decision-making, and self-reported confidence. Descriptive statistics were used to summarize responses.*

Results: *Of the 25 participants, 68% had previously encountered a suspected or confirmed perioperative anaphylaxis case, whereas 32% had no such exposure. Only 48% reported formal teaching through lectures/seminars and a relatively small proportion reported simulation/workshop exposure. All respondents correctly selected adrenaline as the first-line drug for significant cardiovascular compromise. All recognized hypotension with bronchospasm following drug administration as strongly suggestive of perioperative anaphylaxis. Serum tryptase was correctly identified by 92% as a useful diagnostic investigation. Regarding confidence in recognition, 40% were very or extremely confident, while 48% were moderately confident. For initial management, 36% were very or extremely confident and 44% moderately confident. Lack of hands-on/simulation training and lack of clinical exposure were prominent barriers.*

Conclusion: *Anaesthesia trainees demonstrated high core knowledge and appropriate decision-making in major perioperative anaphylaxis scenarios, but confidence was less uniform. The discrepancy between theoretical knowledge and confidence emphasizes the need for structured simulation-based training, regular emergency drills, and standardized institutional algorithms.*

Keywords: *Perioperative anaphylaxis; anaesthesia residents; residency training; adrenaline; clinical decision-making; simulation training; serum tryptase.*

Introduction

Perioperative anaphylaxis is a rare but potentially catastrophic systemic hypersensitivity reaction occurring during anaesthesia and surgery. Its recognition is particularly challenging because patients are unconscious, several drugs may be administered within a short period, and typical cutaneous manifestations may be concealed by surgical drapes. Cardiovascular collapse, bronchospasm, and cutaneous manifestations are among the major clinical presentations. Antibiotics and neuromuscular blocking agents are important triggers, while chlorhexidine and other perioperative substances are increasingly recognized causes.[1–3] The UK Sixth National Audit Project estimated severe perioperative anaphylaxis at approximately one episode per 10,000 anaesthetics.[4]

Early recognition and immediate adrenaline administration with adequate fluid resuscitation are central to successful management.[5] Serum tryptase measurement and subsequent specialist evaluation are important for confirming mast-cell activation and identifying potential causative agents.[1,5]

Anaesthesia residents are commonly among the first clinicians involved when intraoperative emergencies develop. Their knowledge, decision-making ability, and confidence therefore directly influence patient safety. Although theoretical teaching provides essential knowledge, exposure to actual cases and simulation-based training may determine how effectively this knowledge is translated into clinical practice. The present study assessed knowledge, clinical decision-making and confidence regarding perioperative anaphylaxis among anaesthesia trainees and explored these findings in the context of residency training and previous educational and clinical exposure.

Materials and Methods

Study design and setting

An observational, cross-sectional, analytical questionnaire-based study was conducted in the **Department of Anaesthesiology and Critical Care, Pravara Rural Hospital, Loni**. The attached study protocol specifies assessment of postgraduate anaesthesia residents at different stages of training.

Study population and sample size

A total of **25 participants** responded to the questionnaire. Participants represented different levels of anaesthesia training. The response distribution recorded in the survey was 28% first-year, 28% second-year, 20% third-year, and 24% senior resident/faculty.

Inclusion criteria

Anaesthesia postgraduate residents/participants belonging to the study department who provided informed consent and completed the study questionnaire were included.

Exclusion criteria

Participants unwilling to provide informed consent and questionnaires with incomplete responses were excluded, consistent with the predefined study methodology.

Study tool

Data were obtained using a **structured, validated, self-administered questionnaire** containing demographic/training information, knowledge-based questions and case-based clinical decision-making questions. The questionnaire evaluated recognition, clinical manifestations, diagnosis, immediate management and pharmacological treatment of perioperative anaphylaxis.

The questionnaire consisted of 15 items. Initial questions assessed residency level, previous exposure to suspected/confirmed perioperative anaphylaxis and formal training. Knowledge questions evaluated first-line pharmacological management, important triggers, characteristic clinical findings and diagnostic investigations. Case scenarios assessed immediate and refractory management, recognition of anaphylaxis following antibiotic administration and appropriate post-event management. The final items assessed confidence in recognition and management and barriers limiting confidence.

Outcome measures

Primary outcomes were the proportion of participants demonstrating appropriate knowledge and clinical decision-making. Secondary outcomes included previous clinical exposure, formal teaching and self-reported confidence.

Statistical analysis

Data were summarized using frequencies and percentages. Because only aggregate response distributions were available from the supplied questionnaire report, inferential comparisons between individual residency levels were not reconstructed from unavailable participant-level data. This avoids generating unsupported P values or associations.

Results

A total of **25 participants** completed the questionnaire.

Table 1. Training profile, previous exposure and formal training (n=25)

Variable	Category	n	%
Training level	First year	7	28
	Second year	7	28
	Third year	5	20
	Senior resident/faculty	6	24
Previous perioperative anaphylaxis exposure	Personally managed	3	12
	Observed/assisted	14	56
	No previous exposure	8	32
Approximate number of cases encountered	None	6	24
	1 case	13	52
	2–3 cases	5	20
	4–5 cases	1	4
Formal teaching/training	Lectures/seminars	10	40
	Simulation/workshop	1	4
	Both	1	4

	No formal training	12	48
	Not sure	1	4

Previous clinical exposure was relatively common: **68%** had either personally managed or observed/assisted with a suspected or confirmed case, while 32% had never encountered one. Nevertheless, actual experience was limited, with more than half reporting only one case. Formal educational exposure was inconsistent, and nearly half reported no formal training.

Table 2. Knowledge and clinical decision-making regarding perioperative anaphylaxis

Questionnaire domain	**Appropriate response**	**n**	**%**
First-line drug in significant cardiovascular compromise	Adrenaline/epinephrine	25	100
Recognition of important perioperative triggers	All listed triggers	19	76
Recognition of hypotension + bronchospasm after drug administration	Appropriate recognition	25	100
Diagnostic investigation after acute episode	Serum tryptase	23	92
Immediate approach to severe hypotension + bronchospasm after induction	Stop/remove suspected trigger, call for help, adrenaline and resuscitation	25	100
Severe hypotension despite initial treatment	Escalate adrenaline-based resuscitation/aggressive cardiovascular support	25	100
Antibiotic followed by bronchospasm, hypotension and erythema	Perioperative anaphylaxis	24	96
Appropriate post-event management	Documentation and allergy investigation/referral	24	96

The knowledge component demonstrated strong performance. All participants selected adrenaline as the first-line pharmacological treatment for significant cardiovascular compromise. This finding is clinically important because current perioperative algorithms emphasize early adrenaline and intravenous fluid resuscitation.[5]

Most respondents (76%) recognized the range of important potential triggers, while 92% identified serum tryptase as an appropriate investigation following the acute event. The survey also demonstrated excellent case-based decision-making, with 100% selecting the appropriate immediate management of sudden hypotension and bronchospasm after induction and 100% selecting escalation of adrenaline-based resuscitation for refractory hypotension.

Table 3. Confidence and perceived barriers to management (n=25)

Domain	Response	n	%
Confidence in recognizing anaphylaxis	Slightly confident	3	12
	Moderately confident	12	48
	Very confident	8	32
	Extremely confident	2	8
Confidence in initiating management	Slightly confident	5	20
	Moderately confident	11	44
	Very confident	8	32
	Extremely confident	1	4
Main factor limiting confidence	Lack of clinical exposure	6	24
	Lack of theoretical knowledge	2	8
	Lack of hands-on/simulation training	6	24
	Uncertainty regarding adrenaline dose/administration	1	4
	Lack of access to emergency kit	1	4
	Feel adequately trained	8	32
	Other	1	4

Although objective questionnaire performance was high, subjective confidence was more variable. Only **40%** described themselves as very or extremely confident in recognizing perioperative anaphylaxis. For initiating management, the corresponding proportion was **36%**. Lack of clinical exposure and inadequate hands-on/simulation training were the most prominent modifiable barriers.

Discussion

The present study evaluated knowledge, clinical decision-making, experience and confidence regarding perioperative anaphylaxis among 25 anaesthesia trainees/participants. The principal observation was a relatively high level of theoretical and case-based knowledge despite considerably more variable self-reported confidence.

Perioperative anaphylaxis is uncommon, which inherently limits clinical exposure during residency. NAP6 reported an incidence of approximately **1:10,000 anaesthetics**, illustrating why even residents working in busy centres may encounter relatively few cases.[4] In our study, 32% had never encountered a suspected or confirmed case, while only 12% had personally managed one. This limited exposure provides an important explanation for the observed confidence gap.

Knowledge regarding first-line treatment was excellent. All 25 participants correctly identified adrenaline as the most appropriate first-line vasopressor/inotropic agent for significant cardiovascular compromise. Current perioperative-specific guidance emphasizes **intravenous adrenaline administered by experienced anaesthetists**, together with rapid fluid resuscitation, in significant perioperative anaphylaxis.[5] This differs somewhat from generic community anaphylaxis algorithms, where intramuscular adrenaline is usually emphasized.

Recognition of clinical presentation was similarly strong. All participants recognized hypotension with bronchospasm occurring after administration of a drug as strongly suggestive of perioperative anaphylaxis. Dewachter and Savic emphasized cardiovascular collapse, tachycardia and cutaneous manifestations as characteristic severe presentations, while bronchospasm may also be prominent.[1] Importantly, cutaneous signs can be absent or concealed during surgery, making unexplained cardiovascular or respiratory deterioration particularly significant.[6]

Knowledge of potential triggers was somewhat less complete. Seventy-six percent selected the comprehensive response incorporating multiple recognized triggers. This is important because perioperative anaphylaxis can result from numerous exposures, including antibiotics, neuromuscular blocking agents, chlorhexidine and latex.[1–4,7] NAP6 identified antibiotics as the leading culprit group, followed by neuromuscular blocking agents and chlorhexidine.[4] Consequently, residents should avoid assuming that neuromuscular blockers are the only major cause.

Serum tryptase was correctly selected by 92% of participants. Tryptase measurement is valuable in supporting a diagnosis of mast-cell activation, but interpretation depends substantially on timing. Current guidance recommends appropriately timed acute samples followed by a baseline sample after recovery.[5] Residents should therefore understand not merely which investigation to request but also when samples should be obtained.

Case-based clinical decision-making was particularly encouraging. All participants selected immediate discontinuation/removal of the suspected trigger, calling for assistance, adrenaline administration and resuscitative measures when presented with sudden severe hypotension and bronchospasm following induction. Similarly, all selected escalation of adrenaline-based resuscitation and aggressive cardiovascular support when severe hypotension persisted. These findings indicate that participants possessed a strong conceptual understanding of the priorities of emergency management.

However, the discrepancy between knowledge scores and self-confidence is educationally important. While questionnaire performance approached ceiling levels on several critical questions, only 40% were very/extremely confident in recognizing anaphylaxis, and only 36% were very/extremely confident in initiating treatment. Knowledge obtained from lectures does not necessarily equate to readiness to perform during a rapidly evolving intraoperative crisis.

Nearly half of participants reported no formal training in perioperative anaphylaxis. Moreover, only a small proportion specifically reported simulation/workshop exposure. This finding is particularly relevant because 24% identified lack of hands-on or simulation training as their principal limitation, while another 24% identified inadequate clinical exposure. Since the event itself is rare, waiting for residents to acquire competence through real cases is neither reliable nor educationally optimal.

Simulation provides an appropriate solution. High-fidelity scenarios can reproduce sudden hypotension, bronchospasm, difficulty identifying the causative agent, adrenaline dosing decisions, fluid resuscitation and team communication without exposing patients to risk. Repeated simulation may also improve non-technical skills such as leadership, task allocation and crisis-resource management.[8-12]

Conclusion

The study demonstrates strong core knowledge and clinical decision-making regarding perioperative anaphylaxis among anaesthesia trainees, particularly for adrenaline use, recognition of hypotension with bronchospasm, emergency resuscitation and post-event management. Nevertheless, confidence in independently recognizing and managing anaphylaxis was substantially lower than objective knowledge performance.

Limited clinical exposure and inadequate hands-on/simulation training emerged as important barriers. Residency programs should therefore supplement theoretical teaching with regular simulation-based anaphylaxis drills, standardized perioperative emergency algorithms, training in adrenaline preparation and administration, and structured post-event investigation protocols. Larger studies with individual-level data are required to determine whether progression through residency independently improves knowledge and clinical decision-making.

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