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Emergency Airway Management in English and Welsh Emergency Departments: A Multicentre Observational Study from the Emergency Medicine Airway Registry (EMAR)

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Emergency Airway Management in English and Welsh Emergency Departments: A Multicentre Observational Study from the Emergency Medicine Airway Registry (EMAR)

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Abstract

Background:

Tracheal intubation is a core component of emergency medicine, but contemporary multicentre data describing emergency department (ED) airway practice in the United Kingdom are limited despite its inclusion in the Royal College of Emergency Medicine FRCEM curriculum.

We aimed to characterise emergency tracheal intubation practice and performance across participating English and Welsh EDs using data from the Emergency Medicine Airway Registry (EMAR).

Methods

We conducted a retrospective analysis of prospectively collected EMAR registry data. All recorded tracheal intubations in patients aged ≥16 years performed in participating EDs between November 2021 and September 2025 were included. Data were prospectively recorded by clinicians at the time of airway intervention and analysed from the EMAR database.

Outcomes included first-pass success, airway management practices, operator characteristics and reported peri-intubation complications. Descriptive statistics were used; operator-speciality analyses were treated as exploratory because speciality categories were not mutually exclusive.

Results:

Overall first-pass success was 93.0% (886/953), and videolaryngoscopy was used for 80.3% of first attempts. The most common indication for intubation was altered mental status (42.1%), followed by respiratory failure (19.0%). Reported peri-intubation complications were documented in 89/953 intubations (9.3%).

Emergency Medicine was the most frequently recorded operator speciality (406/953, 42.6%). Observed first-pass success was 96.1% for intubations involving an Emergency Medicine operator, 90.0% for Intensive Care Medicine and 91.1% for Anaesthesia.

Conclusions:

This multicentre analysis provides a contemporary benchmark of emergency airway management across participating English and Welsh EDs. First-pass success was high, alongside widespread adoption of videolaryngoscopy, bougie use, structured checklists and waveform capnography. Continued development of EMAR may support benchmarking, airway governance and quality improvement.

Keywords

Airway management; Emergency medicine; First-pass success; Intubation; Videolaryngoscopy; Resuscitation

Introduction:

Advanced airway management, including Rapid Sequence Induction (RSI), is a core competency in Emergency Medicine and a cornerstone of resuscitation for critically unwell or injured patients. The RCEM Curriculum states that by the end of FRCEM training, consultant-level doctors should be able to 'Institute definitive airway management and initiate and maintain advanced respiratory support'. [1]

It is, however, a high-risk, low-frequency procedure that has been shown to have an increased rate of severe complications when performed in the Emergency Department (ED), where patient physiology, time pressure, overcrowding and resource limitations or lack of senior supervision increase the risk of adverse events.

Historically, airway management in UK EDs has often been led by anaesthetists. A national census published in 2011 reported that only around 20% of ED intubations were performed by Emergency Medicine physicians. [2] More recent studies, however, suggest a marked change in practice. Data from a high-volume Scottish ED demonstrated that Emergency Medicine clinicians performed approximately 75% of intubations, indicating a substantial evolution in the role of emergency physicians in advanced airway management. [3]

Internationally, there is substantial variation in both the personnel performing emergency intubations and the practices employed, reflecting differences in training, speciality roles, institutional resources, and local clinical culture. [4,5] These contextual differences further highlight the value of national data to understand practice patterns and support safe, effective airway management, the very core of modern emergency care.

The 4th National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4) highlighted significant safety concerns in emergency airway management and emphasised the need for standardised practice, performance benchmarking, and a national airway registry to monitor outcomes and reduce variation. [6] Subsequent UK survey-based studies have demonstrated ongoing variation in RSI practice across settings and specialities, but their utility is limited by reliance on self-reported data and a lack of outcome linkage. [7]

The need for contemporary UK airway data is further underscored by the recently established SECURE (Service Evaluation of Cross-speciality UK Adult Rapid Sequence Intubation Events), a national, resident-led, cross-speciality service evaluation examining variation in rapid sequence intubation practice, resources, and immediate complications across UK hospitals. [20]

Contemporary UK-wide data on emergency intubation practice, outcomes and workforce implications remain limited.

This study therefore aimed to characterise emergency tracheal intubation practice in participating English and Welsh EDs using EMAR data; describe first-pass success, reported peri-intubation

complications and contemporary airway management practices; explore operator characteristics, including speciality; and consider implications for maintaining competency and promoting safe practice. The study was designed primarily as a descriptive registry analysis rather than a comparative assessment of speciality-specific competence.

Methods:

Study design

This study is a retrospective analysis of prospectively collected registry data from the Emergency Medicine Airway Registry (EMAR). All eligible cases recorded between November 2021 and September 2025 were included. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.
EMAR represents the continuation and expansion of the Irish Emergency Medicine Airway Registry (EMARI), originally developed at University Hospital Limerick. EMARI is endorsed by both the Irish Association of Emergency Medicine (IAEM) and the Emergency Medicine Program (EMP), and as of February 2025 is officially administered by the National Office of Clinical Audit (NOCA).

Since its launch in November 2021, 24 EDs (20 in England and 4 in Wales) contributed data to EMAR during the study period. Characteristics of participating sites are provided in Additional file 1: Table S1.

Additional file 1. Characteristics of participating EMAR sites

Table S1: Participating hospitals/sites, including relevant site characteristics and trauma designation.

Site No.	Hospital Name	Region	Trauma Designation
1	Bristol Royal Infirmary	South West	Trauma Unit (TU)
2	Southmead Hospital	South West	Major Trauma Centre (MTC)
3	Royal United Hospital, Bath	South West	Trauma Unit (TU)

4	Weston General Hospital	South West	Local Emergency Hospital (LEH)
5	Gloucestershire Royal Hospital	South West	Trauma Unit (TU)
6	Dorset County Hospital (Dorchester)	South West	Trauma Unit (TU)
7	Musgrove Park Hospital	South West	Trauma Unit (TU)
8	Great Western Hospital, Swindon	South West	Trauma Unit (TU)
9	Wexham Park Hospital	South East	Trauma Unit (TU)
10	Frimley Park Hospital	South East	Trauma Unit (TU)
11	Basingstoke and North Hampshire Hospital	South East	Trauma Unit (TU)
12	Queen Alexandra Hospital, Portsmouth	South East	Trauma Unit (TU)
13	Royal Hampshire County Hospital	South East	Trauma Unit (TU)
14	Royal Derby Hospital	Midlands	Trauma Unit (TU)
15	Leighton Hospital (Mid Cheshire Hospitals NHS Foundation Trust)	North West	Trauma Unit (TU)
16	Northumbria Specialist Emergency Care Hospital	North East & Yorkshire	Trauma Unit (TU)
17	Leeds General Infirmary	North East & Yorkshire	Major Trauma Centre (MTC)
18	St James's University Hospital	North East & Yorkshire	Major Trauma Centre (MTC)*
19	Airedale General Hospital	North East & Yorkshire	Trauma Unit (TU)
20	Cumberland Infirmary, Carlisle	North East & Yorkshire	Trauma Unit (TU)
21	The Grange University Hospital	Wales	Trauma Unit (TU)
22	Prince Charles Hospital, Merthyr Tydfil	Wales	Trauma Unit (TU)
23	Princess of Wales Hospital, Bridgend	Wales	Trauma Unit (TU)
24	University Hospital of Wales, Cardiff	Wales	Major Trauma Centre (MTC)

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* Leeds General Infirmary and St James's University Hospital together form the Leeds Major Trauma Centre within Leeds Teaching Hospitals NHS Trust.

The case report form (CRF) used across EMAR sites was developed collaboratively with Emergency Medicine (EM), Intensive Care Medicine (ICM) and Anaesthesia teams at University Hospitals Bristol and Weston NHS Foundation Trust and the Royal United Hospitals Bath NHS Foundation Trust. It was based on the CRF used for the Emergency Medicine Airway Registry Ireland (EMARI) and National Emergency Resuscitation Airway Audit [8], with adaptations informed by the Australia and New Zealand Emergency Department Airway Registry dataset [9] to ensure relevance, completeness, and alignment with recommended safety and reporting standards. The EMAR case report form is provided in Additional file 2.

Patients were included if they were ≥16 years of age and required a definitive airway (emergency tracheal intubation) within the ED. This included both patients undergoing intubation during cardiac arrest and those after return of spontaneous circulation.

Patients were excluded if they were intubated in the pre‑hospital setting—including those intubated by ambulance, HEMS, or critical care retrieval teams—or if they were <16 years of age. All eligible cases recorded in the registry between November 2021 and September 2025 were included in this analysis.

Study setting and participants

Participating hospitals represented a mix of secondary and tertiary emergency care centres in England and Wales. All participating departments provided 24-hour emergency care with resuscitation facilities. Site characteristics, including trauma designation, are summarised in Additional File 1: Table S1.

Sites participated following local information-governance and Caldicott Guardian approval. The participating cohort included Local Emergency Hospitals, Trauma Units and Major Trauma Centres, providing a range of emergency care settings.

Intubations were performed by airway-trained clinicians from Emergency Medicine, Anaesthesia, Intensive Care Medicine and other relevant professional groups. Airway-trained clinicians were

defined as those who had completed, or demonstrated competence equivalent to, the Royal College of Anaesthetists (RCoA) Initial Assessment of Competence (IAC) in airway management. Intubating clinicians spanned the full range of seniority from residents (Senior House Officers and Registrars) to Consultants and Advanced Clinical Practitioners (ACPs) with recognised advanced airway training.

Sample size

No formal sample size calculation was undertaken because this was an analysis of an ongoing clinical registry. All eligible cases recorded during the predefined study period were included; the sample size therefore reflected clinical activity and case reporting at participating sites.

Data collection and processing

At participating sites, tracheal intubation was performed by appropriately trained clinicians from EM, ICM, Anaesthesia or other relevant professional groups. Following an intubation event, procedural data were entered into the EMAR CRF by the intubating clinician or local airway team. From 2021 to 2023, data collection included paper-based CRFs; collection subsequently transitioned to direct electronic entry using a smartphone-accessible QR code.

Electronic data entry was introduced to improve accessibility and data completeness. Mandatory fields within the electronic form improved data completeness for selected variables compared with the earlier paper-based phase.

Anonymised data were stored in a secure Research Electronic Data Capture (REDCap) platform hosted by University Hospitals Bristol and Weston NHS Foundation Trust within the Health and Social Care Network. No patient identifiers were included in the analytical dataset. REDCap access was username- and password-protected and restricted by site-specific Data Access Groups.

The logging function within REDCap ensures that every action is recorded and auditable. [10,11]

Variables included patient demographics, indication and urgency of intubation, airway assessment, positioning, preoxygenation and oxygenation during apnoea, drugs, operator grade and speciality, airway assistant grade, laryngoscopy technique, introducer use, number of attempts, intubation success, tube-position confirmation, reported complications and disposition. Operator speciality was recorded using a multiple-selection REDCap field; consequently, more than one speciality could be

assigned to a single intubation and speciality categories were not mutually exclusive. A comprehensive list of collected variables is available in Additional file 2.

Data definitions were based on those used in the National Emergency Resuscitation Airway Audit [8] and prior emergency airway registry studies by Alkhouri et al. and Fogg et al. [9,12].

An intubation attempt was defined as a single passage of a laryngoscope into the mouth. Successful intubation was defined as successful passage of the tracheal tube through the vocal cords.

Predefined reported complications included new hypotension requiring intravenous fluid or vasopressor treatment, desaturation (fall in SpO_2 of ≥10% from baseline), new bradycardia (heart rate <60 beats/min), new tachyarrhythmia, dental or airway trauma, repeat administration of neuromuscular blocking agent, oesophageal or mainstem bronchial intubation, vomiting, laryngospasm, equipment failure, medication error and cardiac arrest.

The project was assessed using the UK Health Research Authority "Is my study research?" decision tool and was classified as clinical audit/service evaluation rather than research; NHS Research Ethics Committee review was therefore not required. The project was registered with and approved by University Hospitals Bristol and Weston NHS Foundation Trust (reference: EDMED/CA/2020-21/06), and each participating hospital obtained the required local clinical governance approval before contributing data. The study was conducted in accordance with the principles of the UK Policy Framework for Health and Social Care Research and applicable NHS information governance requirements. Individual patient consent was not sought because the project evaluated routinely delivered care using anonymised registry data. This approach is consistent with similar large-scale national airway audits including the Japanese Emergency Airway Network (JEAN) registry and the UK Fourth National Audit Project (NAP4), recognising that such projects evaluate existing practice without influencing patient management. [6,13]

Statistical analysis

Data were analysed using Python version 3.10.11.

Continuous variables are reported as median and interquartile range (IQR), and categorical variables as frequencies and percentages. Unless otherwise specified, percentages use the number of cases with recorded data for the relevant variable as the denominator; missing values are reported separately and no imputation was performed. Variables permitting multiple responses are identified in table legends and may sum to more than 100%. Categorical comparisons used chi-square or exact

tests where appropriate, with two-sided $p<0.05$ considered statistically significant. Because operator speciality could be multiply selected and the resulting groups were not mutually exclusive, speciality-specific first-pass success is presented descriptively in this manuscript and is not interpreted as an independent comparison of speciality performance. No multivariable model was undertaken; therefore, analyses of associations should be considered exploratory and unadjusted.

Results

A total of 953 intubation events were included in the analysis. Median age was 56 years (IQR 39-67), and median recorded weight was 75 kg. Sex was recorded in 772 cases: 495/772 (64.1%) were male and 277/772 (35.9%) female; sex was missing in 181/953 (19.0%) cases. (Table 1)

Altered mental status was the most frequently recorded indication (401/953, 42.1%), followed by respiratory failure (181/953, 19.0%), cardiac arrest (172/953, 18.0%; including intra-arrest and post-return-of-spontaneous-circulation intubations), overdose/poisoning (148/953, 15.5%) and seizure (106/953, 11.1%). More than one indication for intubation could be recorded. (Table 1)

Table 1. Patient characteristics and indications for tracheal intubation.

Characteristic	**n (%)**
Age, years, (IQR)	56 (39–67)
Weight, kg, (IQR)	75 (70-85)
Sex	
Male	495/772 (64.1%)
Female	277/772 (35.9%)
Missing	181/953 (19.0%)
Indication for intubation†	
Airway obstruction	116 (12.2)
Neck / facial trauma	19 (2.0)
Drowning	0 (0.0)
Burn / inhalation injury	2 (0.2)
Head injury – airway threatened or not patent	63 (6.6)
Respiratory failure	181 (19.0)
Chest trauma	6 (0.6)
Cardiac arrest	172 (18.0)
Seizure	106 (11.1)
Altered mental status	401 (42.1)
Overdose / poisoning	148 (15.5)
Intracranial haemorrhage / stroke	101 (10.6)
Patient safety (e.g. uncooperative)	68 (7.1)
Other	65 (6.8)
Missing	267 (28.0)

Values are n (%) unless otherwise indicated. IQR, interquartile range. Sex percentages for male and female use recorded sex (n=772) as the denominator; missing sex uses the full cohort (n=953). More than one indication could be recorded; indication percentages therefore may sum to >100%.

The operator or team leader assessed intubation urgency at the time of intervention. Urgency was recorded as immediate in 197/953 (20.7%) cases, within 5 minutes in 618/953 (64.9%) and non-urgent in 137/953 (14.4%). An emergency intubation checklist was documented as completed in 865/953 (90.8%) cases.

The overall first-pass success was 93.0% (886/953). Of the 67 cases not successful on the first attempt, 57 were successful on the second attempt; one second-attempt outcome was missing. All nine recorded third attempts were successful (Table 2).

Table 2. Intubation success and operator grade by intubation attempt

Characteristic	First attempt, n (%)	Second attempt, n (%)	Third attempt, n (%)
Intubation success			
Successful	886 (93.0%)	57 (85.1%)	9 (100.0%)
Unsuccessful	67 (7.0%)	9 (13.4%)	0 (0.0%)
Missing	0 (0.0%)	1 (1.5%)	0 (0.0%)
Operator grade			
Consultant	138 (14.5%)	24 (35.8%)	2 (22.2%)
SASG	77 (8.1%)	1 (1.5%)	0 (0.0%)
ST4 or above	431 (45.2%)	28 (41.8%)	7 (77.8%)
ST3 or below	182 (19.1%)	6 (9.0%)	0 (0.0%)
Other	124 (13.0%)	7 (10.4%)	0 (0.0%)
Missing	1 (0.1%)	1 (1.5%)	0 (0.0%)

Data are presented as n (%). Percentages are calculated using the number of intubation attempts at each stage as the denominator: first attempt, n = 953; second attempt, n = 67; third attempt, n = 9. SASG, Specialist, Associate Specialist and Speciality Grade; ST, Speciality Trainee.

A total of 1,006 operator-speciality selections were recorded across 953 first-attempt intubations. The number of speciality selections exceeded the number of intubation attempts because operator speciality was collected using a multiple-response field, allowing more than one speciality to be recorded for individual operators, including those with dual-speciality certification. Emergency Medicine was the most frequently recorded speciality for first intubation attempts (406/953, 42.6%), followed by Intensive Care Medicine (331/953, 34.7%) and Anaesthesia (257/953, 27.0%). A similar

distribution of recorded operator specialities was observed for subsequent intubation attempts (Table 3).

Table 3. Intubation attempts by speciality of intubator

Recorded operator speciality	First attempt, n (%)	Second attempt, n (%)	Third attempt, n (%)
Emergency Medicine (EM)	406 (42.6%)	16 (23.9%)	2 (22.2%)
Intensive Care Medicine (ICM)	331 (34.7%)	33 (49.3%)	5 (55.6%)
Anaesthesia	257 (27.0%)	23 (34.3%)	2 (22.2%)
Retrieval	2 (0.2%)	0 (0.0%)	0 (0.0%)
Prehospital medicine	9 (0.9%)	0 (0.0%)	0 (0.0%)
Paediatrics	1 (0.1%)	1 (1.5%)	0 (0.0%)
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)
Missing	2 (0.2%)	0 (0.0%)	0 (0.0%)

Data are presented as n (%). Percentages are calculated using the number of intubation attempts at each stage as the denominator: first attempt, n = 953; second attempt, n = 67; third attempt, n = 9. Operator speciality was recorded using a multiple-selection field; therefore, speciality categories were not mutually exclusive, and more than one speciality could be recorded for an individual attempt. Consequently, percentages may sum to more than 100%.

Observed first-pass success was 96.1% for intubations involving an EM operator, 90.0% for ICM and 91.1% for Anaesthesia.

Other specialities, including retrieval, prehospital, and paediatric services, accounted for only a small proportion of recorded operator speciality selections. Analyses of these groups were exploratory, limited by small sample sizes, and subject to the same issues of overlapping speciality categories and unadjusted confounding. Accordingly, these findings should be interpreted with caution and should not be regarded as evidence of differences in intrinsic operator competence between speciality groups.

Airway assistants were recorded in nearly all intubations. For first attempts, assistance was most commonly provided by registered nurses (26.5%), doctors at ST4 level or above (26.1%) and operating department practitioners (23.7%).

On second attempts, operating department practitioners (28.4%), registered nurses (25.4%) and doctors at ST4 level or above (25.4%) were the most frequently recorded assistants. By the third attempt, doctors at ST4 level or above accounted for 44.4% of recorded assistants. No clear association was observed between assistant type and first-pass or overall intubation success in the

unadjusted analysis. Details of airway assistant grade according to intubation attempt are provided in Additional file 3: Table S2.

Table S2. Airway assistant grade by intubation attempt

Airway assistant	Attempt 1, n (%) (N = 953)	Attempt 2, n (%) (N = 67)	Attempt 3, n (%) (N = 9)
ODP	226 (23.7%)	19 (28.4%)	2 (22.2%)
ACP	88 (9.2%)	5 (7.5%)	2 (22.2%)
Registered nurse	253 (26.5%)	17 (25.4%)	1 (11.1%)
Nursing assistant	9 (0.9%)	0 (0.0%)	0 (0.0%)
Doctor ST4 or above	249 (26.1%)	17 (25.4%)	4 (44.4%)
Doctor ST3 or below	72 (7.6%)	7 (10.4%)	0 (0.0%)
Other	55 (5.8%)	1 (1.5%)	0 (0.0%)
Missing	1 (0.1%)	1 (1.5%)	0 (0.0%)

Values are n (%), using the number of intubations at each attempt as the denominator. ACP, advanced clinical practitioner; ODP, operating department practitioner.

Videolaryngoscopy (VL) was used in 765/953 (80.3%) first attempts, with observed first-pass success of 93.2%. Direct laryngoscopy was used in 183/953 (19.2%) first attempts, with observed first-pass success of 92.9%.

VL use was 83.0% among recorded Emergency Medicine selections, 78.4% among Intensive Care Medicine selections and 80.9% among Anaesthesia selections. Among first attempts, 736/953 (77.2%) used a standard-geometry video-laryngoscope blade and 29/953 (3.0%) a hyperangulated blade (Table 4).

A bougie was the most frequently utilised introducer across all attempts, employed in 81.7% of first attempts and remaining the predominant adjunct in subsequent attempts, while stylet use and attempts without an introducer were comparatively uncommon.

Bougie use differed descriptively by recorded operator speciality: 93.1% among Emergency Medicine selections, 76.7% among Intensive Care Medicine selections and 70.0% among Anaesthesia selections (Table 4).

Table 4. Laryngoscopy technique and introducer use

A. Laryngoscopy technique by intubation attempt			
Laryngoscopy technique	**Attempt 1, n (%) (N = 953)**	**Attempt 2, n (%) (N = 67)**	**Attempt 3, n (%) (N = 9)**
Direct laryngoscopy	183 (19.2)	13 (19.4)	1 (11.1)
Videolaryngoscopy - standard-geometry blade	736 (77.2)	46 (68.7)	6 (66.7)
Videolaryngoscopy - hyperangulated blade	29 (3.0)	6 (9.0)	2 (22.2)
Missing	5 (0.5)	2 (3.0)	0 (0.0)
B. Laryngoscopy technique by operator speciality			
Operator speciality	**Videolaryngoscopy, n (%)**	**Direct laryngoscopy, n (%)**	
Emergency Medicine (N = 405)	336 (83.0)	69 (17.0)	
Intensive Care Medicine (N = 329)	258 (78.4)	71 (21.6)	
Anaesthesia (N = 256)	207 (80.9)	49 (19.1)	
C. Introducer use by intubation attempt			

Introducer	Attempt 1, n (%) (N = 953)	Attempt 2, n (%) (N = 67)	Attempt 3, n (%) (N = 9)
Bougie	779 (81.7)	48 (71.6)	6 (66.7)
Stylet	26 (2.7)	6 (9.0)	2 (22.2)
Neither	147 (15.4)	12 (17.9)	1 (11.1)
Missing	1 (0.1)	1 (1.5)	0 (0.0)

D. Bougie use by operator speciality		
Operator speciality	**Bougie used, n (%)**	**Bougie not used, n (%)**
Emergency Medicine (N = 406)	378 (93.1)	28 (6.9)
Intensive Care Medicine (N = 331)	254 (76.7)	77 (23.3)
Anaesthesia (N = 257)	180 (70.0)	77 (30.0)

Values are n (%). Attempt-based percentages use the number of intubations at each attempt as the denominator. Speciality-specific laryngoscopy percentages use cases with recorded laryngoscopy technique within each speciality as the denominator; speciality categories may overlap

An airway assessment was documented in 68.8% of cases; no assessment was recorded in 12.9% and assessment status was missing in 18.3%. A predicted difficult airway was recorded in 29.5% of patients, most commonly due to a history of previous difficult intubation or anticipated difficulty with face mask ventilation. Details of airway assessment and predicted airway difficulty are provided in Additional file 3: Table S3.

Table S3. Predicted airway difficulty (N = 953)

Characteristic	n (%)
Airway assessment	

Yes	656 (68.8%)
No	123 (12.9%)
Missing	174 (18.3%)
Predicted difficult airway*	
None	672 (70.5%)
Previous difficult intubation	170 (17.8%)
Difficult face-mask ventilation	144 (15.1%)
Difficult eFONA	43 (4.5%)
Other airway difficulty	38 (4.0%)
Difficult supraglottic airway insertion	20 (2.1%)

Values are n (%), using N = 953 as the denominator. More than one predicted airway difficulty could be recorded per patient; therefore, percentages for predicted difficult airway may sum to >100%. eFONA, emergency front-of-neck access.

Preoxygenation was most commonly performed using a circuit with bag-valve-mask/positive end-expiratory pressure (61.7%), followed by a supraglottic airway (15.9%) and bag-valve-mask ventilation (12.0%). Non-rebreather masks were used in 6.6% of cases, while non-invasive ventilation (1.8%), high-flow nasal oxygen (1.3%) and low-flow nasal oxygen (0.2%) were used infrequently. Preoxygenation was not provided in 0.4% of cases.

Regarding oxygen delivery during apnoea and laryngoscopy, nasal prongs were employed infrequently, accounting for 6.6% of cases when combining flows of <5 L/min and 5–15 L/min. Bag-valve-mask ventilation was used in 46.2% during the apnoeic period, while no apnoeic oxygenation was delivered in 33.9% of cases. Preoxygenation and apnoeic oxygenation practices are presented in Additional file 4: Tables S4 and S5.

Table S4. Final preoxygenation device used (N = 953)

Preoxygenation device	**n (%)**
Circuit with BVM/PEEP	588 (61.7)
Supraglottic airway (SGA)	152 (15.9)

Preoxygenation device	n (%)
Bag-valve mask (BVM)	114 (12.0)
Non-rebreather mask	63 (6.6)
Non-invasive ventilation	17 (1.8)
High-flow nasal oxygen	12 (1.3)
Low-flow nasal oxygen	2 (0.2)
None	4 (0.4)
Missing	1 (0.1)

Values are in (%) using N = 953 as the denominator. BVM, bag-valve mask; PEEP, positive end-expiratory pressure; SGA, supraglottic airway.

Table S5. Apnoeic oxygenation method (N = 982*)

Apnoeic oxygenation method	n (%)
Nasal prong oxygen <5 L/min	28 (2.9)
High-flow nasal oxygen	22 (2.2)
Non-invasive ventilation	9 (0.9)
Nasal prong oxygen 5-15 L/min	36 (3.7)
Supraglottic airway	99 (10.1)
Bag-valve mask	454 (46.2)
None	333 (33.9)
Missing	1 (0.1)

**More than one apnoeic oxygenation method could be recorded per patient; therefore, percentages may sum to >100%. BVM, bag-valve mask; PEEP, positive end-expiratory pressure; SGA, supraglottic airway.*

Patients were most frequently positioned with the bed tilted head up (415 cases, 43.5%), with a pillow or occipital pad used in a further 334 cases (35.0%).

The most frequently used induction agent was ketamine (36.7%), followed by propofol (21.3%). Fentanyl was used as a co-induction agent in 41.3% of intubations. Rocuronium was the most common paralytic agent (67.5%).

Waveform capnography was documented for tracheal tube-position confirmation in 928/953 (97.4%) intubation events. Colour-change capnography was documented in 18/953 (1.9%) cases. Clinical confirmation was documented in 452/953 (47.4%) intubations, generally alongside capnography rather than as a sole method. No case was recorded without any method of tube-position confirmation; confirmation data were missing in 19/953 (2.0%) cases. Methods used to confirm tracheal tube placement are presented in Additional file 5: Table S6.

Table S6. Tracheal tube placement confirmation methods (N = 953)

Confirmation method	n (%)
Waveform capnography ($ETCO_2$)	928 (97.4)
Colour-change capnography	18 (1.9)
Clinical confirmation	452 (47.4)
None	0 (0.0)
Missing	19 (2.0)

*More than one confirmation method could be documented per intubation; therefore, percentages sum to >100%.

Reported peri-intubation complications were documented in 89/953 intubations (9.3%); no complication was recorded in 846/953 (88.8%), and complication status was missing in 18/953 (1.9%) cases.

Because complication reporting was clinician-reported and included intra-arrest and post-ROSC intubations, these values represent reported events rather than a robust incidence estimate.

The most frequently reported complication was new hypotension requiring intravenous fluids or vasopressors (36/953, 3.78%), followed by desaturation (24/953, 2.52%).

Three oesophageal intubations were reported: two were immediately recognised and one had delayed recognition (Table 5).

Table 5. Reported peri-intubation complications and disposition

Complication or outcome	**n (%)**
Peri-intubation complications*	
Yes	89 (9.3%)
No	846 (88.8%)
Missing	18 (1.9%)
Type of intubation complication*	
Desaturation (SpO_2 drop >10%)	24 (2.5%)
New hypotension (requiring IV fluids/vasopressors)	36 (3.8%)
New bradycardia (HR <60 bpm)	4 (0.4%)
Failure	10 (1.0%)
Dental trauma	10 (1.0%)
Cardiac arrest	9 (0.9%)
Mainstem bronchial intubation	6 (0.6%)
Aspiration – gastric contents	7 (0.7%)
Aspiration – blood	3 (0.3%)
Second dose of paralytic agent	3 (0.3%)
Equipment failure	3 (0.3%)
Vomiting	4 (0.4%)
Oesophageal intubation – immediately recognised	2 (0.2%)
Oesophageal intubation – delayed recognition	1 (0.1%)
New tachy-arrhythmia	2 (0.2%)
Airway trauma	0 (0.0%)
Laryngospasm	0 (0.0%)

Complication or outcome	n (%)
Medication error	0 (0.0%)
Required re-intubation in ED	0 (0.0%)
Other	1 (0.1%)
Disposition following intubation	
ITU	599 (62.9%)
Theatre / Cath Lab	40 (4.2%)
Transfer to another hospital	77 (8.1%)
Extubated in ED	5 (0.5%)
Died in ED*	42 (4.4%)
Other	6 (0.6%)
Missing	184 (19.3%)

More than one complication could be recorded per intubation; therefore, complication categories were not mutually exclusive and percentages may sum to more than 100%.

Following intubation, 599/953 (62.9%) patients were admitted to the Intensive Therapy Unit, 77/953 (8.1%) were transferred to another hospital, and 40/953 (4.2%) proceeded to theatre or a catheterisation laboratory. Of 42 patients who died in the ED (4.4%), 30 (71.4%) died within 1 hour of intubation (3.1% of the total cohort). Disposition data were missing in 184/953 (19.3%) cases (Table 5).

Discussion:

This multicentre registry analysis of emergency airway management in participating English and Welsh emergency departments demonstrated high procedural success, with an overall first-pass success rate of 93%. Emergency airway management was predominantly delivered within a senior-supported multidisciplinary model, with videolaryngoscopy used in over 80% of first attempts, bougies in 81.7%, widespread checklist use, and near-universal waveform capnography confirmation of tracheal tube placement. Together, these findings describe widespread adoption of contemporary airway practices [18,19].

Reported peri-intubation complications occurred in 9.3% of cases. However, this should not be interpreted as a precise estimate of complication incidence. Complications were clinician-reported and

may have been incompletely captured, particularly during the earlier paper-based phase of the registry and in high-acuity resuscitation settings. Interpretation is further complicated by inclusion of intra-arrest and post-ROSC intubations, where physiological adverse events such as desaturation or hypotension may be difficult to define consistently and are not directly comparable with RSI-only cohorts. Future iterations of the EMAR registry would benefit from phase-specific complication definitions to improve reporting consistency and facilitate comparison across differing clinical contexts, including intra-arrest and post-ROSC intubations.

Preoxygenation practices were well established across participating sites, most commonly using circuits incorporating BVM and PEEP, while oxygenation and ventilation strategies during the apnoeic period showed greater variation. One-third of intubations received no recorded apnoeic oxygenation, while bag-valve-mask ventilation was the most frequently documented strategy (Additional file 4). These findings demonstrate heterogeneity in practice but do not establish the relative effectiveness of any individual approach. Interpretation is further limited by inconsistent terminology surrounding apnoeic oxygenation and ventilation during apnoea, highlighting the need for clearer definitions and standardised reporting to evaluate how these interventions influence peri-intubation hypoxaemia and to better target airway optimisation efforts.

For contextual comparison, the Irish National Emergency Resuscitation Airway Audit (NERAA) reported first-pass success of 89%, VL use of 53%, bougie use of 64% and checklist use of 55%. The corresponding values in the present cohort were 93.0%, 80.3%, 81.7% and 90.8%, respectively [8] Differences in case mix, reporting completeness, operator seniority and participating centres preclude direct performance comparisons.

First-pass success in our cohort was also higher than that reported in INTUBE (79.8%) and BARCO (74.3%) [4,5]. These large, international studies differed substantially in setting, patient population and methodology; the comparisons therefore provide context rather than evidence of superior performance.

The high first-pass success observed in EMAR data may reflect multiple system-level factors, including operator experience, equipment availability, airway planning and local governance. These potential explanations were not tested in the present analysis.

NAP4 and subsequent DAS recommendations have emphasised structured planning, human factors, team communication, checklist use, and appropriate use of videolaryngoscopy in emergency airway management to maximise first-pass success and improve safety [6,7,14,15].

In this context, the high uptake of checklist use (90.8%), videolaryngoscopy (80.3%) and bougie use (81.7%), alongside a predominantly senior-supported model of airway care, is consistent with NAP4/DAS patient-safety priorities. These practices were observed alongside high first-pass success, but their independent contribution cannot be determined from this study.

Emergency Medicine clinicians performed a substantial proportion of intubations, with high observed first-pass success rates. However, speciality categories were not mutually exclusive, and the comparisons were unadjusted for operator seniority, airway difficulty, physiological derangement, equipment selection, case complexity or site-level factors. These findings should therefore not be interpreted as evidence of differences in intrinsic operator competence between professional groups. Rather, they underline the central role of EM clinicians in emergency airway management and raise important questions regarding how competence in a low-frequency, high-risk procedure is acquired, maintained and demonstrated throughout training and independent practice.

The predominance of senior-supported intubation also has educational implications. While such an approach may maximise patient safety, it may reduce opportunities for junior clinicians to gain procedural experience. Recent Irish work by Lee et al. [16] describes structured airway governance incorporating clinical leadership, registry data, simulation training, competency-based assessment and performance feedback. Such approaches may provide a useful framework for supporting clinician competence while maintaining patient safety.

Effective emergency airway management depends not only on the technical skill of the intubator but also on coordinated team performance, in which the airway assistant has an important role. Broms et al. emphasised that airway assistants contribute to preparation, equipment readiness, monitoring, anticipation of difficulty, and implementation of rescue strategies, rather than providing passive procedural support [17]. This is consistent with our findings, which demonstrated involvement of assistants from a range of professional backgrounds, highlighting the multidisciplinary nature of airway management in participating English and Welsh EDs. Senior doctors (ST4 or above) and

operating department practitioners (ODPs) were among the most frequently recorded assistants, indicating substantial involvement of experienced personnel in supporting emergency intubation. Although no clear association was identified between assistant type and intubation outcomes, these analyses were exploratory and unadjusted. Factors such as assistant experience, operator seniority, case complexity and local staffing models may influence both team composition and procedural outcomes. Consequently, these findings support the importance of multidisciplinary airway teams but do not establish superiority of any particular assistant role.

Collectively, these findings suggest that contemporary emergency airway management in participating EDs is characterised by high intubation success rates and widespread use of practices consistent with contemporary airway-safety guidance, including a senior-supported model, videolaryngoscopy, bougie-first strategies, and structured intubation checklists. Their widespread implementation provides a basis for continued airway governance and quality improvement, although their independent associations with procedural outcomes cannot be determined from this analysis.

This study has several strengths, including prospective point-of-care data collection within a multicentre registry, inclusion of 24 EDs across England and Wales, and detailed capture of procedural practices and operator characteristics. However, important limitations remain. Although data collection was prospective, analyses relied on routinely entered registry data, which introduced the potential for incomplete, inaccurate, or inconsistent reporting across sites. Furthermore, no independent case ascertainment was available to quantify the number of eligible intubations not captured within EMAR.

Selection bias is possible at both site and patient level. Participating departments may have had greater interest in airway governance, staffing or established airway systems than non-participating EDs, limiting generalisability. Observations were also clustered within 24 sites; site-level differences in equipment, staffing and practice were not modelled.

Missing data were substantial for several variables, including sex, airway assessment and disposition. Early data collection relied partly on paper CRFs, whereas subsequent electronic submission used mandatory fields for selected variables. No imputation was performed, and variable-specific denominators should therefore be considered when interpreting proportions.

Reporting bias is particularly important for complications. Transient physiological adverse events (e.g. brief desaturation or hypotension) and events occurring during high-stress resuscitation may have been under-reported.

This limitation is compounded by the inclusion of both intra-arrest and post-ROSC intubations within the cardiac arrest cohort, where physiological complications may be unavoidable or difficult to ascertain consistently, limiting direct comparison with RSI-only cohorts.

Finally, this observational study cannot establish causal relationships between airway practices, operator characteristics and outcomes. Potentially important confounders, including the degree of physiological derangement, case complexity, airway difficulty, operator experience and team familiarity, were not fully accounted for. These limitations support interpreting EMAR data primarily as a descriptive benchmark and hypothesis-generating registry.

Conclusion

This contemporary multicentre analysis of EMAR data provides a benchmark of emergency airway management across participating English and Welsh EDs. First-pass success was high, alongside widespread use of videolaryngoscopy, bougies, structured intubation checklists and waveform capnography. Emergency Medicine clinicians accounted for a substantial proportion of recorded first-attempt operator specialities, within a predominantly senior-supported, multidisciplinary model of airway care.

Reported complication data should be interpreted cautiously given limitations in completeness and ascertainment. Continued development of EMAR should therefore prioritise robust data capture, particularly for peri-intubation complications and early clinical outcomes. Alongside systematic feedback to participating sites, a strengthened registry has the potential to provide a sustainable platform for benchmarking practice, supporting airway governance and training, identifying variation and informing quality improvement in emergency airway management.

List of abbreviations

ACP — advanced clinical practitioner

BVM — bag-valve-mask

CRF — case report form

DAS — Difficult Airway Society

DL — direct laryngoscopy

ED — emergency department

EM — emergency medicine

EMAR — Emergency Medicine Airway Registry

EMARI — Emergency Medicine Airway Registry Ireland

EMP — Emergency Medicine Programme

FPS — first-pass success

FRCEM — Fellowship of the Royal College of Emergency Medicine

HEMS — helicopter emergency medical service

HFNO — high-flow nasal oxygen

HR — heart rate

IAC — Initial Assessment of Competence

IAEM — Irish Association for Emergency Medicine

ICM — intensive care medicine

IQR — interquartile range

ITU — intensive therapy unit

NAP4 — Fourth National Audit Project

NERAA — National Emergency Resuscitation Airway Audit

NHS — National Health Service

NIV — non-invasive ventilation

NOCA — National Office of Clinical Audit

ODP — operating department practitioner

PEEP — positive end-expiratory pressure

QR — quick response

RCEM — Royal College of Emergency Medicine

RCoA — Royal College of Anaesthetists

REDCap — Research Electronic Data Capture

ROSC — return of spontaneous circulation

RSI — rapid sequence induction

SAS — specialist, associate specialist and specialty doctors

SGA — supraglottic airway

SpO_2 — peripheral oxygen saturation measured by pulse oximetry

ST — specialty trainee

STROBE — Strengthening the Reporting of Observational Studies in Epidemiology

UHBW — University Hospitals Bristol and Weston NHS Foundation Trust

UK — United Kingdom

VL — videolaryngoscopy

Declarations

Ethics approval and consent to participate

The project was assessed using the UK Health Research Authority "Is my study research?" decision tool and classified as clinical audit/service evaluation; NHS Research Ethics Committee review was therefore not required. The project was registered with and approved by University Hospitals Bristol and Weston NHS Foundation Trust (reference EDMED/CA/2020-21/06). Each participating hospital obtained local clinical-governance approval. Individual patient consent was not sought because the project evaluated routinely delivered care using anonymised registry data.

Consent for publication

Not applicable.

Availability of data and materials

The analysis code used in this study is publicly available in the EMAR-Code repository (https://github.com/nickamillar/EMAR-Code). The underlying dataset is not publicly available because it contains clinical registry data subject to information governance and confidentiality restrictions.

Competing interests

The authors declare no competing interests.

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Authors' contributions

IG conceived and led the Emergency Medicine Airway Registry (EMAR), contributed to the development of the registry and study design, coordinated data collection, interpreted the findings, and drafted the manuscript. NM managed the dataset and performed the statistical analyses, including processing of raw registry data and analysis using Python. WJ contributed to interpretation of the findings, provided contextualisation within the English and Welsh healthcare setting, compared the study findings with relevant international airway literature, and contributed to the literature review and manuscript revision. SL contributed to interpretation of the findings, critically reviewed the manuscript for important intellectual content, and provided substantive input during manuscript development and revision. All authors read and approved the final manuscript.

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Authors' information

Not applicable.

Additional files

Additional file 1 (.docx)

Title: Characteristics of participating EMAR sites

Description: Table S1. Characteristics of the 24 Emergency Medicine Airway Registry participating sites, including geographical location and trauma designation.

Additional file 2 (.pdf)

Title: Emergency Medicine Airway Registry case report form

Description: EMAR case report form detailing the variables collected for emergency department intubations.

Additional file 3 (.docx)

Title: Airway assessment and team characteristics

Description: Table S2. Airway assistant grade according to intubation attempt. Table S3. Airway assessment and predicted airway difficulty.

Additional file 4 (.docx)

Title: Oxygenation practices during emergency intubation

Description: Table S4. Final preoxygenation device used before intubation. Table S5. Apnoeic oxygenation techniques.

Additional file 5 (.docx)

Title: Confirmation of tracheal tube placement

Description: Table S6. Methods used to confirm tracheal tube placement.

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