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ORIGINAL RESEARCH

Airway

Institution of a difficult airway response team for emergency department patients with anticipated or encountered difficult airways: Descriptive analysis of a 5-year experience at an academic teaching hospital

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Abstract

Objectives: This study aimed to describe characteristics and outcomes associated with difficult airway response team (DART) encounters in the emergency department (ED).

Methods: We performed a descriptive analysis of a prospective, single-center database of DART encounters in the ED from April 1, 2016 to March 31, 2021 cross-referenced with retrospective chart review. Adult ED patients ≥18 years old for whom a DART was activated were eligible. We prospectively collected activation characteristics, intubation indications, operator characteristics, and intubation methods used for DART encounters. Retrospective chart review was conducted to obtain patient demographics and outcome variables. Descriptive analyses were computed for all outcomes.

Results: We analyzed 89 DART encounters. No intubation attempts were made prior to DART activation in 52 cases (58.4%). The most common indications for intubation were angioedema ($n = 17$, 19.1%) or other airway obstruction ($n = 15$, 16.9%). A definitive airway was established by anesthesiology ($n = 46$, 51.7%), emergency medicine ($n = 25$, 28.1%), trauma surgery ($n = 9$, 10.1%), and ENT ($n = 5$, 5.6%). The most common method of intubation used to establish a definitive airway was video laryngoscopy with a bougie or D-blade ($n = 29$, 32.6%) followed by flexible fiberoptic intubation ($n = 19$, 21.3%). A surgical airway was required in eight encounters (cricothyrotomy [$n = 4$, 4.5%]; tracheostomy [$n = 4$, 4.5%]). Cases were managed in the ED ($n = 73$, 82%), operating room (OR) ($n = 10$, 11.2%), and intensive care unit (ICU) ($n = 1$, 1.1%). All patients requiring intubation had an endotracheal or surgical airway established.

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Conclusion: Our findings provide important insights regarding ED DART utilization and have implications when considering institution of a DART in the ED.

1 | INTRODUCTION

1.1 | Background

Airway management is a core component of emergency medicine practice. Longitudinal, multi-center registry data suggest that emergency physicians perform the majority of endotracheal intubations in the emergency department (ED), with an increasing proportion managed solely by emergency physician operators—87% (1997–2002) to 95% (2002–2012).[1,2] During an airway management encounter, emergency physicians may be exposed to a difficult airway scenario. The American Society of Anesthesiologists states that, "a difficult airway includes the clinical situation in which anticipated or unanticipated difficulty or failure is experienced by a physician trained in anesthesia care, including but not limited to one or more of the following: face-mask ventilation, laryngoscopy, ventilating using a supraglottic airway, tracheal intubation, extubation, or invasive airway."[3] Thus, in practice, the difficult airway can be anticipated/predicted (ie, by synthesizing demographic, historic, or anatomical characteristics) or encountered during the various stages and techniques used to manage airways. Practice guideline and classically taught emergency airway algorithms recommend to "call for help/assistance" when a difficult airway is predicted or encountered.[3–5] Although emergency physicians report a difficult airway in 11% of airway management encounters,[6] there is institutional variability in the process to call for help when a patient is deemed to have a difficult airway in the ED. Institution of a difficult airway response team (DART) and process designed specifically for ED patients may help to standardize the approach to this critical scenario as well as improve patient outcomes for difficult airways encountered in the ED.

1.2 | Importance

In 2009, Berkow et al. described a comprehensive difficult airway program intervention that included communication, equipment, personnel, and education, and was associated with a reduction in the number of emergency surgical airways performed post-intervention.[7] Since then, similar programs have reported outcomes that include reduction in intubation attempts and no failed airways, deaths due to airway management, sentinel events, or malpractice claims related to airway management.[7–10] However, most of these studies involved patients outside of the ED environment, report a small number of cases in the ED, and/or had activation criteria that incorporated a broad group of patients outside of a specific ED population. Emergency department patients represent a unique population in that they often have undifferentiated presentations, indications for emergent intubation that differ from the operative and inpatient setting, and variable levels of patient stability, and the ED environment has differences in resource availability that require differences in airway management approach. Literature regarding characteristics and outcomes associated with DART encounters in the ED is lacking.

1.3 | Goals of this investigation

We sought to describe patient demographics, activation characteristics, intubation indications, operator characteristics, methods used, and outcomes associated with DART encounters at our institution over a 5-year period following the implementation of a DART in the ED.

2 | METHODS

2.1 | Study design

We performed a descriptive analysis of a prospective, single-center database of ED DART encounters at the University of Florida (UF) Health Shands Hospital in Gainesville, FL ED from April 1, 2016 to March 31, 2021, cross-referenced with retrospective chart review. This study was approved by the University of Florida Institutional Review Board.

2.2 | Setting

This study was performed in the adult ED at UF Health Shands Hospital in Gainesville, FL, an academic teaching hospital and Level I trauma center with an average annual ED census of 60,000 adult patients per year. Resident physicians supervised by attending, board certified, or board eligible emergency medicine physicians serve as the primary airway operator for ED airway management.

2.3 | DART design

Prior to the study, a multidisciplinary group composed of members from the emergency medicine, anesthesiology, and trauma and acute care surgery departments met to create a process improvement initiative to streamline assistance with airway management during difficult airway encounters in the ED. The process included criteria for activation, multidisciplinary responding personnel, standardized available equipment, a centralized activation paging system for rapid response time, and case review after each encounter for ongoing quality improvement.

In brief, the ED DART included the activating emergency medicine attending, an anesthesiology attending, and trauma and acute care surgery attending, and the senior EM residents currently working in

the ED. These individuals are available 24/7 in-house at our institution. The DART individual members varied based on shift and on-call schedules. To support the DART, we created mobile ED airway carts containing equipment needed for routine and difficult airway scenarios. When an ED patient requiring airway management met predefined difficult airway criteria, a mechanism of activation through a centralized paging system was used to alert members of the DART. After arrival, the team discussed an optimal management strategy for the individual patient. After encounters, the activating emergency physician self-reported process and intubation details on a standardized form. Details regarding its development, process, and activation criteria are outlined in the Supporting Information Appendix.

2.4 | Participants

All adult ED patients ≥18 years old for whom the DART was activated were eligible for inclusion. We excluded pediatric patients (≤17 years old), trauma patients, and those where the DART was activated in the pre-hospital setting or by a non-emergency physician. Encounters were also excluded if miscommunication led to accidental DART activation or if a definitive airway was already established prior to activation.

2.5 | Methods of measurement

Data were collected from April 1, 2016 to March 31, 2021. After a DART activation, the activating emergency physician completed a standardized form that was sent to the director of the DART (NM) within 24 h. This included data such as reason for DART team activation, number of attempts prior to activation, methods of intubation prior to activation, complications prior to activation, DART team member providing definitive airway management, and ultimate method of obtaining a definitive airway among others (see Supporting Information Appendix, File 4). Chart review of each encounter was used to cross-reference self-reports with clinical documentation and any discrepancies were resolved with discussion between the director and emergency physician who completed the form. The data was entered into a prospectively collected database with 100% capture of DART activation encounters.

In addition to emergency physician self-reports, a retrospective chart review of DART activation encounters using the electronic medical record was conducted for patient demographic and outcome variables. This was performed using a single data abstractor (J.L.) who recorded patient demographic and outcome variables. All data were imported into Excel (Microsoft).

2.6 | Outcome measures

We collected patient demographic variables, DART activation variables (i.e., timing of DART activation, reason for activation, number of attempts prior to activation, methods of intubation prior to activation, methods of definitive airway management, and complications), indications for intubation, operator characteristics, and outcome variables—total intubations, patients who did not require intubation, surgical airways performed, in-hospital mortality, and cause of death. A list of definitions for study variables are detailed in the Supporting Information Appendix, File 5.

The Bottom Line

In the emergency department (ED), 87% of patients with a need for endotracheal intubation are managed by emergency physicians. This single center, descriptive study evaluated the implementation of a multidisciplinary Difficult Airway Response Team (DART) utilizing criteria for activation and composition of the responding team. Over 50% of the activations occurred prior to an intubation attempt. Common causes of DART activation included angioedema (19%) and airway obstruction (17%) and were managed in the ED versus the operating room (87% vs 11%) by responding anesthesiologists (52%). All patients had successful airway management highlighting the importance for establishment of protocols for these challenging patients in the ED.

2.7 | Data analysis

Data were summarized using descriptive statistics using Stata (version 17; StataCorp). We calculated mean and standard deviation for normally distributed continuous data. Data with nonnormal distributions are reported as median and interquartile ranges. Categorical variables are reported as frequencies and percentages.

3 | RESULTS

Between April 1, 2016 and March 31, 2021, there were 114 DART activations in the ED. Twenty-five activations were excluded (pediatric patient [$n = 4$], trauma patient [$n = 12$], prehospital activation [$n = 4$], activation by a non-emergency physician [$n = 1$], miscommunication resulting in accidental activation [$n = 3$], and definitive airway already established [$n = 1$]). Thus, a total of 89 encounters were included for analysis. Table 1 depicts DART activation patient demographics and ED characteristics. The median age of patients was 59 years (interquartile range 50–70) and 55 (61.8%) were male. Fifteen were overweight (16.9%) and 47 (52.8%) were obese. The most common comorbidities included chronic obstructive pulmonary disease ($n = 20$, 22.5%), congestive heart failure ($n = 12$, 13.5%), and head and neck malignancies ($n = 12$, 13.5%). A priori determined historical factors that may be associated with difficult intubation were present in patients with prior history of neck surgery ($n = 15$, 16.9%), tracheostomy ($n = 10$, 11.2%), neck radiation ($n = 9$, 10.1%), or difficult intubation ($n = 4$, 4.5%). Eight patients (9%) had a tracheostomy in place at the time of DART

TABLE 1 Difficult airway response team activation patient demographics and emergency department characteristics.

Patient characteristics	Total[a] (*n* = 89)	Year 1 (*n* = 26)	Year 2 (*n* = 15)	Year 3 (*n* = 19)	Year 4 (*n* = 15)	Year 5 (*n* = 14)
Age, median (interquartile range)	59 (50, 71)	60 (54, 70)	56 (38, 71)	59 (53, 76)	56 (45, 67)	64 (50, 75)
Male, *n* (%)	55 (61.8)	17 (65.4)	8 (53.3)	12 (63.2)	9 (60.0)	9 (64.3)
Race, *n* (%)						
Black or African American	33 (37.1)	14 (53.9)	6 (40.0)	4 (21.1)	5 (33.3)	4 (28.6)
White	50 (56.2)	12 (46.2)	7 (46.7)	13 (68.4)	10 (66.7)	8 (57.2)
Other	5 (5.6)	0 (0)	1 (6.7)	2 (10.5)	0 (0)	2 (14.3)
Unknown	1 (1.1)	0 (0)	1 (6.7)	0 (0)	0 (0)	0 (0)
Body mass index (BMI)[b], *n* (%)						
<18.5 (underweight)	5 (5.6)	2 (7.7)	0 (0)	0 (0)	1 (6.7)	2 (14.3)
18.5–24.9 (normal weight)	19 (21.4)	6 (23.1)	2 (13.3)	5 (26.3)	3 (20.0)	3 (21.4)
25.0–29.9 (overweight)	15 (16.9)	2 (7.7)	6 (40.0)	4 (21.1)	2 (13.3)	1 (7.1)
30.0–34.9 (obesity class I)	18 (20.2)	7 (26.9)	4 (26.7)	3 (15.8)	2 (13.3)	2 (14.3)
35.0–39.9 (obesity class II)	11 (12.4)	2 (7.7)	1 (6.7)	4 (21.1)	3 (20.0)	1 (7.1)
>40 (obesity class III)	18 (20.2)	6 (23.1)	2 (13.3)	3 (15.8)	3 (20.0)	4 (28.6)
Unknown	1 (3.9)	0 (0)	0 (0)	1 (6.7)	1 (7.1)	3 (3.5)
Comorbidities, *n* (%)						
Asthma	8 (9.0)	1 (3.6)	3 (20.0)	1 (5.3)	3 (20.0)	0 (0)
Chronic obstructive pulmonary disease (COPD)	20 (22.5)	6 (23.1)	2 (13.3)	3 (15.8)	5 (33.3)	4 (28.6)
Interstitial lung disease	1 (1.1)	1 (3.9)	0 (0)	0 (0)	0 (0)	0 (0)
Congestive heart failure (CHF)	12 (13.5)	5 (19.2)	0 (0)	1 (5.3)	1 (6.7)	5 (35.7)
Cancer of tongue, tongue base, hypopharynx, larynx, neck	12 (13.5)	5 (19.2)	1 (6.7)	4 (21.1)	2 (13.3)	0 (0)
History of neck radiation	9 (10.1)	3 (11.5)	0 (0)	4 (21.1)	2 (13.3)	0 (0)
History of neck surgery	15 (16.9)	8 (30.8)	1 (6.7)	4 (21.1)	2 (13.3)	0 (0)
History of tracheostomy	10 (11.2)	5 (19.2)	0 (0)	3 (15.8)	2 (13.3)	0 (0)
Current tracheostomy	8 (9.0)	3 (11.5)	1 (6.7)	2 (10.5)	2 (13.3)	0 (0)
History of craniofacial abnormality	1 (1.1)	1 (3.9)	0 (0)	0 (0)	0 (0)	0 (0)
History of difficult intubation	4 (4.5)	0 (0)	1 (6.7)	0 (0)	1 (6.7)	2 (14.3)
Mode of arrival/ED arrival characteristics, *n* (%)						
Walk-in/private vehicle	18 (20.2)	6 (23.1)	2 (13.3)	6 (31.6)	1 (6.7)	3 (21.4)
Ambulance ground	51 (57.3)	15 (57.7)	10 (66.7)	9 (47.4)	7 (46.7)	10 (71.4)
Outside hospital transfer	19 (21.4)	5 (19.2)	3 (20.0)	4 (21.1)	6 (40.0)	1 (7.1)
Within hospital transfer	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (6.7)	0 (0)
Time of arrival, *n* (%)						
7 a.m.–7 p.m.	50 (56.1)	12 (46.2)	9 (60.0)	9 (47.4)	9 (60.0)	11 (78.6)
7 p.m.–7 a.m.	39 (43.8)	14 (53.9)	6 (40.0)	10 (52.6)	6 (40.0)	3 (21.4)
Emergency severity index (ESI)[c]						
ESI 1	36 (40.5)	10 (38.5)	7 (46.7)	4 (21.1)	9 (60.0)	6 (42.9)
ESI 2	46 (51.7)	16 (61.5)	6 (40.0)	13 (68.4)	6 (40.0)	5 (35.7)
ESI 3	7 (7.9)	0 (0)	2 (13.3)	2 (10.5)	0 (0)	3 (21.4)

[a]Total data for Year 1 through Year 5.

[b]It denotes body mass index defined by the Centers for Disease Control and Prevention, source: https://www.cdc.gov/obesity/basics/adult-defining.html.

[c]It denotes emergency severity index defined by the Emergency Nurses Association; *source*: Gilboy N, Tanabe P, Travers DA, et al. *Emergency Severity Index (ESI): A Triage Tool for Emergency Department Care, Version 4. The Implementation Handbook, 2020 Edition*. Emergency Nurses Association (2020).

TABLE 2 Principal indication for intubation for difficult airway response team encounters.

	Total[a] (*n* = 89)	Year 1 (*n* = 26)	Year2 (*n* = 15)	Year 3 (*n* = 19)	Year 4 (*n* = 15)	Year 5 (*n* = 14)
Principal indication for intubation, *n* (%)						
Angioedema	17 (19.1)	8 (30.8)	4 (26.7)	4 (21.1)	0 (0)	1 (7.1)
Other airway obstruction[b]	15 (16.9)	3 (11.5)	1 (6.7)	5 (26.3)	3 (20)	3 (21.4)
Cardiac arrest	8 (9.0)	3 (11.5)	1 (6.7)	1 (5.3)	2 (13.3)	1 (7.1)
Hemoptysis/hematemesis	7 (7.9)	3 (11.5)	0 (0)	2 (10.5)	1 (6.7)	1 (7.1)
Pneumonia	5 (5.6)	3 (11.5)	1 (6.7)	0 (0)	0 (0)	1 (7.1)
Oropharyngeal bleeding	6 (6.7)	2 (7.7)	1 (6.7)	2 (10.5)	0 (0)	1 (7.1)
Pulmonary edema	6 (6.7)	0 (0)	1 (6.7)	1 (5.3)	1 (6.7)	3 (21.4)
Tracheostomy issue/exchange	4 (4.5)	2 (7.7)	0 (0)	1 (5.3)	1 (6.7)	0 (0)
Sepsis/septic shock	3 (3.4)	1 (3.9)	1 (6.7)	0 (0)	1 (6.7)	0 (0)
Other[c]	13 (14.6)	1 (3.9)	4 (26.7)	1 (5.3)	5 (33.3)	2 (14.3)
Patient did not require intubation	5 (5.6)	0 (0)	1 (6.7)	2 (10.5)	1 (6.7)	1 (7.1)

[a]Total data for Year 1 through Year 5.

[b]It denotes the following indications for intubation (*n* = total data for years 1 through 5): anaphylaxis (*n* = 4) and *n* = 1 for thyroid mass, obstruction of base of tongue, tonsillar cancer, glottic mass, laryngeal cancer, granulomatous airway mass, Ludwig's angina, tonsillar abscess, peritonsillar abscess, retropharyngeal phlegmon/abscess, oropharyngeal swelling, expanding neck hematoma.

[c]It denotes the following indications for intubation (*n* = total data for years 1 through 5): *n* = 1 for altered mental status, unstable arrhythmia, eclampsia, status epilepticus, stroke, pulmonary embolism, hypoxic respiratory failure, chronic obstructive pulmonary disease, snakebite envenomation; and *n* = 2 for hypercarbic respiratory failure, drug overdose.

activation. Fifty patients (56.2%) arrived between 7 a.m. and 7 p.m. and 39 (43.8%) between 7 p.m. and 7 a.m.

The most common intubation indications for DART encounters included angioedema (*n* = 17, 19.1%), other airway obstruction (*n* = 15, 16.9%), cardiac arrest (*n* = 8, 9%), hemoptysis/hematemesis (*n* = 7, 7.9%), and oropharyngeal bleeding (*n* = 6, 6.7%) (Table 2). Five of the 89 patients (5.6%) had a DART activation but did not ultimately require intubation. Among providers activating the DART, the most common reason included upper airway obstruction (*n* = 45, 50.1%), attending physician discretion (*n* = 37, 41.6%), past medical history suggesting high likelihood of difficult intubation (*n* = 22, 24.7%), three or more difficult airway characteristics (*n* = 22, 24.7%), and anticipated difficult bag-valve-mask ventilation or supraglottic airway placement (*n* = 21, 23.6%) (Table 3). In the majority of encounters, no attempts were made to intubate the patient prior to activation (*n* = 52, 58.4%). When attempts were made, the most common methods of intubation prior to activation were video laryngoscopy with either a bougie or D-blade blade with rigid stylet (*n* = 18, 20.2%), direct laryngoscopy (*n* = 13, 14.6%), or video laryngoscopy (*n* = 11, 12.4%). A flexible fiberoptic scope intubation was used in nine cases (10.1%). When attempts were made, the most common complications prior to activation were hypoxia (*n* = 32, 36%), hypotension (*n* = 6, 6.7%), esophageal intubation (*n* = 5, 5.6%), and cardiac arrest (*n* = 5, 5.6%).

Definitive airway management was most often established by anesthesiology (*n* = 46, 51.7%), followed by emergency medicine (*n* = 25, 28.1%), trauma and acute care surgery (*n* = 9, 10.1%), and ENT (*n* = 5, 5.6%). The most common ultimate method of intubation used to establish a definitive airway was video laryngoscopy with either a bougie or D-blade with rigid stylet (*n* = 29, 32.6%), flexible fiberoptic scope intubation (*n* = 19, 21.3%), or video laryngoscopy (*n* = 12, 13.5%). A surgical airway was required in eight encounters. The majority of cases were managed in the ED (*n* = 73, 82%); however, in some cases, the decision was made to intubate the patient in the OR (*n* = 10, 11.2%) or ICU (*n* = 1, 1.1%).

Further details regarding methods used and operator characteristics are provided in Supporting Information Appendix, Tables S1–S3. Anesthesiology performed the majority of fiberoptic scope intubations (*n* = 14/19, 73.7%) when this method was required for definitive airway management, and trauma and acute care surgery performed all surgical airways. Of the eight cases requiring a surgical airway, a tracheostomy was performed in half of the cases. Anesthesiology provided definitive airway management the majority of cases when the DART was activated for angioedema (*n* = 13/17, 76.5%), cardiac arrest (*n* = 5/8, 62.5%), oropharyngeal bleeding (*n* = 5/6, 83.3%), and other airway obstruction (*n* = 8/15, 53.3%).

Patient outcomes are described in Table 4. Among the 89 cases analyzed, five patients (5.6%) did not require intubation and all patients requiring intubation had an endotracheal or surgical airway established. A total of 17 patients (19.1%) died in the hospital during the index visit, the majority from cardiac arrest (*n* = 11, 12.4%).

3.1 | Limitations

There are several important limitations to this study. This was a single-center study performed at an academic teaching hospital and Level I

TABLE 3 Difficult airway response team activation characteristics.

	Total[a] (*n* = 89)	Year 1 (*n* = 26)	Year2 (*n* = 15)	Year 3 (*n* = 19)	Year 4 (*n* = 15)	Year 5 (*n* = 14)
Indication for difficult airway alert activation[b], *n* (%)						
Upper airway obstruction	45 (50.6)	16 (61.5)	6 (40.0)	13 (68.4)	6 (40.0)	4 (28.6)
Hematemesis/hemoptysis/vomiting	16 (18.0)	4 (15.4)	5 (33.3)	4 (21.1)	2 (13.3)	1 (7.1)
PMH suggesting high likelihood of difficult intubation	22 (24.7)	7 (26.9)	4 (26.7)	5 (26.3)	5 (33.3)	1 (7.1)
Anticipated difficult bag-valve-mask/SGA placement	21 (23.6)	10 (38.5)	5 (33.3)	3 (15.8)	2 (13.3)	1 (7.1)
BMI ≥ 50	5 (5.6)	1 (3.9)	0 (0)	0 (0)	1 (6.7)	3 (21.4)
≥3 difficult airway characteristics	22 (24.7)	7 (26.9)	6 (40.0)	4 (21.1)	3 (20.0)	2 (14.3)
≥2 failed attempts by experienced operator	16 (18.0)	2 (7.7)	5 (33.3)	0 (0)	2 (13.3)	7 (50.0)
Attending physician discretion	37 (41.6)	10 (38.5)	5 (33.3)	7 (36.8)	6 (40.0)	9 (64.3)
Number of indications for difficult airway alert activation, *n* (%)						
1	36 (40.4)	10 (38.5)	4 (26.7)	8 (42.1)	8 (53.3)	6 (42.9)
2	29 (32.6)	7 (26.9)	5 (33.3)	8 (42.1)	4 (26.7)	5 (35.7)
3	12 (13.5)	5 (19.2)	3 (20.0)	1 (5.3)	2 (13.3)	1 (7.1)
≥4	12 (13.5)	4 (15.4)	3 (20.0)	2 (10.5)	1 (6.7)	2 (14.3)
Number of attempts prior to activation, *n* (%)						
0	52 (58.4)	15 (57.7)	8 (53.3)	15 (79.0)	8 (53.3)	6 (42.9)
1	12 (13.5)	5 (19.2)	2 (13.3)	1 (5.3)	3 (20.0)	1 (7.1)
2	15 (16.9)	4 (15.4)	3 (20.0)	3 (15.8)	3 (20.0)	2 (14.3)
3	4 (4.5)	1 (3.9)	1 (6.7)	0 (0)	0 (0)	2 (14.3)
≥4	6 (6.7)	1 (3.9)	1 (6.7)	0 (0)	1 (6.7)	3 (21.4)
Methods of intubation prior to activation[c], *n* (%)						
Direct laryngoscopy	13 (14.6)	5 (19.2)	2 (13.3)	1 (5.2)	1 (6.7)	4 (28.6)
Direct laryngoscopy with adjuncts (bougie or D-blade)	5 (5.6)	3 (11.5)	1 (6.7)	0 (0)	0 (0)	1 (7.1)
Video laryngoscopy	11 (12.4)	3 (11.5)	2 (13.3)	0 (0)	3 (20.0)	3 (21.4)
Video laryngoscopy with adjuncts (bougie or D-blade)	18 (20.2)	2 (7.7)	4 (26.7)	1 (5.3)	4 (26.7)	7 (50.0)
Fiberoptic scope	9 (10.1)	1 (3.9)	1 (6.7)	2 (10.5)	3 (20.0)	2 (14.3)
Supraglottic device	5 (5.6)	1 (3.0)	0 (0)	0 (0)	1 (6.7)	3 (21.4)
Tracheostomy tube exchange	4 (4.5)	3 (11.5)	0 (0)	1 (5.3)	0 (0)	0 (0)
Complications during airway management prior to activation, *n* (%)						
Hypoxia	32 (36.0)	9 (34.6)	7 (46.7)	7 (36.8)	4 (26.7)	5 (35.7)
Hypotension	6 (6.7)	3 (11.5)	1 (6.7)	1 (5.2)	0 (0)	1 (7.1)
Esophageal intubation	5 (5.6)	1 (3.9)	2 (13.3)	1 (5.3)	1 (6.7)	0 (0)
Dental trauma	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (6.7)	0 (0)
Airway trauma	4 (4.5)	0 (0)	1 (6.7)	2 (10.5)	0 (0)	1 (7.1)
Arrhythmia	4 (4.5)	0 (0)	1 (6.7)	1 (5.2)	0 (0)	2 (14.3)
Cardiac arrest	5 (5.6)	2 (7.7)	0 (0)	1 (5.2)	0 (0)	2 (14.3)
Not specified	1 (1.1)	0 (0)	0 (0)	0 (0)	1 (6.7)	0 (0)
Response time, *n* (%)						
0–3 min	34 (38.6)	11 (42.3)	7 (46.7)	8 (42.1)	6 (40.0)	2 (15.4)
3–5 min	44 (50.0)	12 (46.1)	7 (46.7)	9 (47.4)	8 (53.3)	8 (61.5)
5–10 min	8 (9.1)	2 (7.7)	1 (6.7)	2 (10.5)	0 (0)	3 (23.1)
≥10 min	1 (1.1)	1 (3.9)	0 (0)	0 (0)	0 (0)	0 (0)

(Continues)

TABLE 3 (Continued)

	Total[a] (*n* = 89)	Year 1 (*n* = 26)	Year2 (*n* = 15)	Year 3 (*n* = 19)	Year 4 (*n* = 15)	Year 5 (*n* = 14)
Service providing definitive airway management[d], *n* (%)						
Emergency medicine	25 (28.1)	7 (26.9)	5 (33.3)	5 (26.3)	6 (40.0)	2 (14.3)
Anesthesiology	46 (51.7)	13 (50.0)	8 (53.3)	10 (52.6)	5 (33.3)	10 (71.4)
Trauma surgery	9 (10.1)	5 (19.2)	1 (6.7)	1 (5.2)	2 (13.3)	0 (0)
ENT (otolaryngology)	5 (5.6)	2 (7.7)	0 (0)	2 (10.5)	1 (6.7)	0 (0)
Methods of intubation after activation[c], *n* (%)						
Direct laryngoscopy	14 (15.7)	6 (23.1)	1 (6.7)	2 (10.5)	3 (20.0)	2 (14.3)
Direct laryngoscopy with adjuncts (bougie or D-blade)	7 (7.9)	3 (11.5)	3 (20.0)	1 (5.2)	0 (0)	0 (0)
Video laryngoscopy	19 (21.4)	8 (30.8)	2 (13.3)	3 (15.8)	4 (26.7)	2 (14.3)
Video laryngoscopy with adjuncts (bougie or D-blade)	33 (37.1)	7 (26.9)	10 (66.7)	4 (21.1)	7 (46.7)	5 (35.7)
Fiberoptic scope	31 (34.8)	12 (46.2)	2 (13.3)	9 (47.4)	5 (33.3)	3 (21.4)
Supraglottic device	6 (6.7)	2 (7.7)	1 (6.7)	1 (5.3)	2 (13.3)	0 (0)
Supraglottic device with adjunct (bougie or fiberoptic exchange)	5 (5.6)	2 (7.7)	0 (0)	0 (0)	0 (0)	3 (21.4)
Surgical cricothyrotomy	5 (5.6)	1 (3.9)	1 (6.7)	1 (5.3)	2 (13.3)	0 (0)
Surgical tracheostomy	4 (4.5)	3 (11.5)	0 (0)	0 (0)	1 (6.7)	0 (0)
Tracheostomy tube exchange	6 (6.7)	3 (11.5)	0 (0)	2 (10.5)	1 (6.7)	0 (0)
Ultimate method of definitive airway management[e], *n* (%)						
Direct laryngoscopy	6 (6.7)	2 (7.7)	0 (0)	2 (10.5)	1 (6.7)	1 (7.1)
Direct laryngoscopy with adjuncts (bougie or D-blade)	4 (4.5)	2 (7.7)	2 (13.3)	0 (0)	0 (0)	0 (0)
Video laryngoscopy	12 (13.5)	4 (15.4)	1 (6.7)	3 (15.8)	3 (20.0)	1 (7.1)
Video laryngoscopy with adjuncts (bougie or D-blade)	29 (32.6)	5 (19.2)	10 (66.7)	3 (15.8)	5 (33.3)	6 (42.9)
Fiberoptic scope	19 (21.4)	5 (19.2)	0 (0)	9 (47.4)	2 (13.3)	3 (21.4)
Supraglottic device	1 (1.1)	1 (3.9)	0 (0)	0 (0)	0 (0)	0 (0)
Supraglottic device with adjunct (bougie or fiberoptic exchange)	4 (4.5)	1 (3.9)	0 (0)	0 (0)	0 (0)	3 (21.4)
Surgical cricothyrotomy	4 (4.5)	1 (3.9)	1 (6.7)	1 (5.3)	1 (6.7)	0 (0)
Surgical tracheostomy	4 (4.5)	3 (11.5)	0 (0)	0 (0)	1 (6.7)	0 (0)
Trach exchange	6 (6.7)	3 (11.5)	0 (0)	2 (10.5)	1 (6.7)	0 (0)
Location of definitive airway management[c], *n* (%)						
Emergency department	73 (82.0)	22 (84.6)	13 (86.7)	13 (68.4)	12 (80.0)	13 (92.9)
Operating room (OR)	10 (11.2)	4 (15.3)	1 (6.7)	3 (15.8)	2 (13.3)	0 (0)
Intensive care unit (ICU)	1 (1.1)	0 (0)	0 (0)	1 (5.3)	0 (0)	0 (0)

[a]Total data for Year 1 through Year 5.

[b]It denotes predefined criteria met for difficult airway alert activation. Totals exceed 100% as multiple criteria were able to be selected.

[c]Totals do not add to 100% given no attempts were made in 58.4% of cases, five patients did not require intubation, and during some cases, multiple methods of intubation prior to and after activation were performed.

[d]Total cases adds up more than 84 cases where definitive airway management was performed, as one case involved airway co-management by ENT and anesthesiology.

[e]Although five patients did not require intubation, total exceeds 84 cases where definitive airway management was performed, as two cases involved use of fiberoptic scope to facilitate tracheostomy exchange, two cases involved use of video laryngoscopy to facilitate trach exchange, and one case involved use of video laryngoscopy with D-blade to facilitate fiberoptic scope intubation.

TABLE 4 Difficult airway response team encounters outcome measures.

	Total[a] (*n* = 89)	Year 1 (*n* = 26)	Year2 (*n* = 15)	Year 3 (*n* = 19)	Year 4 (*n* = 15)	Year 5 (*n* = 14)
Intubated, *n* (%)	84 (94.4)	26 (100)	14 (93.3)	17 (89.5)	14 (93.3)	13 (92.9)
Patient did not require intubation, *n* (%)	5 (5.6)	0 (0)	1 (6.7)	2 (10.5)	1 (6.7)	1 (7.1)
Surgical airway, *n* (%)	8 (9.0)	2 (7.7)	2 (13.3)	2 (10.5)	2 (13.3)	0 (0)
Cricothyrotomy	4 (4.5)	1 (3.9)	1 (6.7)	1 (5.3)	1 (6.7)	0 (0)
Tracheostomy	4 (4.5)	1 (3.9)	1 (6.7)	1 (5.3)	1 (6.7)	0 (0)
In-hospital mortality, *n* (%)	17 (19.1)	4 (15.4)	1 (6.7)	4 (21.1)	3 (20.0)	5 (35.7)
Cause of death, *n* (%)						
Cardiac arrest	11 (12.4)	4 (15.4)	0 (0)	1 (5.3)	2 (13.3)	4 (28.6)
Septic shock	2 (2.3)	0 (0)	2 (10.5)	0 (0)	0 (0)	0 (0)
Stroke	2 (2.3)	0 (0)	0 (0)	0 (0)	1 (6.7)	1 (7.1)
Hemorrhagic Shock	1 (1.1)	0 (0)	0 (0)	1 (5.3)	0 (0)	0 (0)
Subarachnoid Hemorrhage	1 (1.1)	0 (0)	1 (6.7)	0 (0)	0 (0)	0 (0)

[a]Total data for Year 1 through Year 5.

trauma center with 24/7 in-house availability of anesthesiology and trauma and acute care surgery attending physicians. This may limit process feasibility and generalizability for smaller hospitals with single emergency physician coverage and lack of availability to 24/7 access to anesthesiologists and surgical specialists to assist with difficult airway management. In addition, our difficult airway equipment included flexible fiberoptic scopes, which was used by emergency physicians prior to DART activation in 10% of encounters. A 2005 survey by Reeder et al. reported that 76% of emergency medicine residency programs had flexible fiberoptic scopes available in the ED.[10] Although their results may differ from a more contemporary sample, our study findings may be limited to academic teaching hospitals with training programs that have flexible fiberoptic scopes available in the ED. Our sample is limited to difficult airway encounters where a DART was activated, rather than *all* difficult airway encounters. Our study excluded pediatric patients, trauma patients, and cases where the DART was activated by a non-emergency physician. Thus, our results can only be generalized to adult ED patients where our DART was activated by an emergency physician for a primary medical indication for intubation. Lastly, variables obtained through self-reporting are subject to bias, including recall and social desirability biases that could lead to over or underestimation of the data collected. We attempted to mitigate this by contacting the providers who submitted self-reports and by performing chart review for cross-referencing.

4 | DISCUSSION

This study outlines a DART specifically designed for ED patients with anticipated or encountered difficult airways, providing important insights regarding DART activations and utilization in the ED. Our findings have implications when considering institution of a DART in the ED and providing opportunities for future research.

Our study provides insight into *when* during a difficult airway encounter emergency physicians made the decision to call for assistance. We found that in over half of DART activations, no attempts were made to intubate the patient, and in a minority of cases, three or more attempts were made prior to activation. This suggests that our DART was utilized mainly in anticipation of a difficult airway or as a rescue during an encountered difficult airway early in the airway management process. To our knowledge, we are the first to report when during an airway management encounter an emergency physician may call for assistance utilizing a DART. We also found that a high number of cases (43.8%) arrived between 7 p.m. and 7 a.m., consistent with findings in the non-ED setting and pediatric population.[9,11] This should be considered when planning DART pathways in the ED and a consistent response would need to support 24/7 availability.

Our data help identify *which* patients prompted DART activation. Our results reveal that DART activations in the ED occur for airway emergencies less commonly encountered in the ED and differ from those in the non-ED setting. Over one-third of our patients required intubation for some form of upper airway obstruction followed by bleeding into the airway. Angioedema and other upper airway obstructions represent <1% of all ED intubations in large database samples.[1,12] Several studies involving DARTs in non-ED settings do not clearly define the indication for intubation when a DART was activated.[7,13,14] A study involving an airway rapid response system in the ICU and wards reported nearly one-third of activations were for complications related to an in situ airway (tracheostomy, laryngectomy, or endotracheal tube).[14] In a study that compared activation of a hospital-wide DART in the wards versus the ED, Yu et al. found that airway obstruction was more common in the ED group (22.8% vs. 10.4% in the ward group).[15] Our study supports the findings by Gonzalez et al., where the predominant indication for intubation for DART activations in their ED subset were for angioedema (41%) and other airway obstruction (33%).[8] Our study adds bleeding into the

airway—hemoptysis, hematemesis, and oropharyngeal bleeding—as a major contributor to DART activations in the ED. This has implications for equipment needs and team training (i.e., in situ simulation) to effectively manage these conditions in the ED for institutions with hospital-wide DARTs who respond to the ED and those considering adopting a DART process.

Our study also provides insight into *what* occurs during a DART encounter in the ED. We found that for DART encounters, definitive airway management was most often established by anesthesiology (51.7%), followed by emergency medicine (28.1%), trauma and acute care surgery (10.1%). This again mirrored findings by Gonzalez et al.[8] Although not part of our DART, we found that ENT performed definitive airway management in 5.6% of encounters, similar to findings in the non-ED setting where additional involvement of ENT external to the DART was required to secure the airway.[17] This may have future implications for their role in an ED DART. We explored the method of intubation used to establish a definitive airway and found that a variety of methods were used. Video laryngoscopy with either a bougie or D-blade with rigid stylet (32.6%), flexible fiberoptic intubation (21.3%), and video laryngoscopy (13.5%) were the most common, demonstrating that even in these high-risk airway encounters, common methods were used to establish a definitive airway. We found that for DART encounters, each specialty performed airway management techniques less commonly utilized by emergency physicians, with anesthesiology performing the majority of flexible fiberoptic intubations, surgery performing tracheostomies, and ENT performing difficult tracheostomy tube exchanges, supporting the utility of having interdisciplinary team members for an ED DART. Emergency tracheostomy is not currently incorporated in emergency medicine practice and flexible fiberoptic intubation, while becoming more common, is still only performed in 1.1% of ED intubations with a success rate of 74.3%.[18,19] This may explain why emergency physicians in our study called for assistance when these methods of intubation were anticipated and supports the utility of a multidisciplinary team facile in airway management methods less commonly utilized by emergency physicians. Implementation of a multidisciplinary difficult airway course as part of an ED DART process may supplement difficult airway management knowledge and skill acquisition, reinforce protocols, and enhance teamwork and collaboration among team members.[20]

With respect to patient outcomes, we found that all patients where the ED DART was activated who required intubation had an endotracheal or surgical airway established. We found that 5.6% of activations did not require intubation, which is comparable to previous findings (8%), suggesting an anticipated over triage rate for DART activations in the ED.[8] We also found that after multidisciplinary discussion, a decision was made to intubate the patient in the OR in 11.2% of cases. These findings support the notion that the ED may not be the best environment for airway management in rare, select cases and a DART could streamline decision-making and expedite the process in these cases. Lastly, we found a 19.1% in-hospital mortality rate among ED patients whose airways were managed by the DART. These rates are lower than previous studies that included all ED intubations.[21–23] Future research can explore whether airway management by a DART in the ED is independently associated with a reduction in in-hospital mortality for difficult airway encounters.

In summary, we developed a DART specifically for ED patients by adapting key components of DART design that are effective in the non-ED setting. In sharing our process and characteristics of DART encounters in the ED, institutions adopting a DART approach to difficult airway emergencies requiring additional assistance in the ED can be more informed.

AUTHOR CONTRIBUTIONS

Nicholas G. Maldonado and Liam Holtzman conceived the study, designed the data collection approach, and obtained institutional review board approval. Nicholas G. Maldonado supervised the implementation of the intervention and data collection, including quality control. Nicholas G. Maldonado, Rolando Otero, and Jonathan Liu performed data collection. Muhammad Abdul Baker Chowdhury analyzed the data. Nicholas G. Maldonado, Caroline Srihari, Meredith Thompson, and Rosemarie Fernandez interpreted data. Nicholas G. Maldonado drafted the manuscript, and all authors contributed substantially to its revision. Nicholas G. Maldonado takes responsibility for the paper as a whole.

CONFLICT OF INTEREST STATEMENT

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DATA AVAILABILITY STATEMENT

The entire deidentified dataset, data dictionary, and analytic code for this investigation are available upon request from the date of article publication by contacting the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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