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Outcome of video laryngoscopy versus direct laryngoscopy for emergency tracheal intubation in emergency department: a propensity score matching analysis

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Abstract

Background The high incidence of airway management failure in the emergency department (ED) necessitates a comparative analysis of laryngoscopy methods. This study aims to compare the success and complications associated with video-assisted laryngoscopy (VL) and direct laryngoscopy (DL) in emergency tracheal intubation in ED.

Methods This retrospective cohort study was conducted at the ED of Thammasat University Hospital. It involved adult patients undergoing emergency tracheal intubation using either VL (GlideScope®) or DL (Macintosh®). The outcomes assessed were success rates of intubation and occurrence of peri-intubation adverse events. Propensity score matching and multivariable risk regression analysis were employed for statistical evaluation.

Results The study included 3,424 patients, with 342 in the VL group and 3,082 in the DL group. The initial analysis revealed no significant differences in the intubation success rates between the two methods. However, the VL group experienced fewer peri-intubation adverse events (33% compared to 40%). After propensity score matching, a higher first-attempt success rate was observed in the DL group (88.9% vs. 81.3%, risk difference: 7.6, 95% CI: 1.9 to 13.2, p=0.009), but there was no statistically significant difference in peri-intubation adverse events. VL had a lower first-attempt success rate among low-experience intubators. Subgroup analyses of intubators with moderate and high experience, as well as patients who received both induction agents and neuromuscular blocking agents, show results consistent with the analysis of the entire cohort.

Conclusion Both VL and DL have comparable first-attempt success rates and peri-intubation adverse events. VL is particularly beneficial when used by moderately or highly experienced intubator. The choice of intubation method, combined with clinical experience and technique plays a critical role in the success and safety of emergency intubations.

Keywords Airway management, Emergency Intubation, Video -assisted laryngoscopy, Direct laryngoscopy, First-attempt success, Peri-intubation adverse event

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Background

Laryngoscopy is an essential technique for effective emergency tracheal intubation, particularly in the emergency department (ED). It is critical for managing the airways of patients with severe medical illnesses or injuries. Specifically, laryngoscopy facilitates the establishment

of a definitive airway to prevent aspiration, assists ventilation, and managing patients with anticipated clinical course and a high likelihood of deterioration [1].

In the ED, the requirement for intubation is variable and frequently necessitates immediate action. Comparative analyses suggest that the incidence of airway management failure is greater in the ED setting than in the controlled environment of an operating room [1, 2]. Difficult intubation is a major cause of multiple intubation attempts, with the prevalence of difficult intubation in ED ranging from 5.4% to 27% [2–5]. This rate appears to exceed that observed in the operating room setting, where the incidence ranges from 0.3% to 13.3% [6–8]. Multiple intubation attempts are correlated with an escalating risk of complications, including cardiac arrest, hypoxemia, arrhythmias, regurgitation, and airway trauma [9].Therefore, minimizing the number of intubation attempts is crucial in emergency airway management.

The two predominant methods of laryngoscopy are direct laryngoscopy (DL) and video-assisted laryngoscopy (VL). The rates of successful first-attempt intubation with VL range from 51% to 100% [10–13], compared with 72% to 74% with DL [5, 14, 15]. Previous studies have reported improved laryngeal views, a greater likelihood of success on the first attempt, and fewer intubation maneuvers with VL [16–18]. However, current international guidelines for difficult airway management do not specify which method is superior or should be performed first [13]. The use of VL requires additional equipment, increases costs, and more training compared to the use of DL [19]. Therefore, this study aims to compare the effects of using VL versus DL in terms of the success of endotracheal tracheal intubation in the ED and the associated complications.

Methods

Study design and setting

This is a retrospective cohort study, focusing on patients who underwent emergency intubation using either VL or DL. The study was conducted in the ED of Thammasat University Hospital (TUH), located in Pathum Thani Province, Thailand. TUH is a 600-bed academic tertiary care facility, with its ED handling approximately 60,000 patient visits annually.

The ED at TUH serves as an educational hub for the Emergency Medicine Residency Program, which includes a comprehensive three-year training curriculum. Throughout the year, medical interns and externs (final-year medical students) complete rotations in the ED. During this time, they actively participate in various medical procedures, including intubation, under the supervision of senior emergency medicine residents or attending emergency physicians. All externs or final-year medical students working in the ED have undergone prior training in intubation, which includes practice in the Department of Anesthesiology, emergency intubation training, and Advanced Cardiac Life Support (ACLS). Every intubation procedure is performed under the direct supervision of Emergency physician teaching staff.

Ethical approval

This study and the airway registry were approved by Human Research Ethics Committee of Thammasat University (Faculty of Medicine) MTU-EC-EM-0-190/65. Because this study is observational study from retrospectively collected data, the process of obtaining written informed consent was waived. We followed applicable EQUATOR Network (https://www.equator-network.org/) guidelines during the conduct of this research project. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement recommendations [20].

Study population and data collection

Data were extracted from a prospectively collected airway registry, from September 1, 2012, to December 31, 2022. The study encompassed adult patients at least 18 years old who presented to the ED and underwent emergency tracheal intubation. Following each intubation procedure, the intubator filled out a data collection form (supplementary figure S1).

This study collected a detailed recording of patient demographics and clinical parameters. These included gender, age, weight, Glasgow Coma Scale (GCS), physiologic parameters, indications for intubation, the initial intubation method, the experience level of the primary intubator, grade of glottis exposure, types and doses of induction and neuromuscular blocking agents used, indicators of intubation difficulty, outcomes regarding intubation success, total attempts made, and any adverse events occurring peri-intubation. All drug doses used to assist intubation were controlled according to a pre-established medication chart (supplementary figure S2).

For the intubation procedures, both VL and DL were performed using specific devices. For VL, we used Verathon's GlideScope® AVL with single-use blades, while DL was conducted using Riester's laryngoscope with Macintosh® blades. The choice of blade size was determined based on patient anatomy and clinician preference. All laryngoscopes and blades were sterilized and maintained according to standard hospital hygiene protocols. In addition to the laryngoscopes, supplementary tools, such as guide rods, were considered depending on the clinical scenario. Specifically, a rigid stylet was always used for VL, and a bendable stylet was used for DL.

In our study, each intubation encounter was described based on the "method" used and the number of"attempts." A "method" was defined as the specific combination of medications or devices utilized during the procedure, while an"attempt" was characterized as a single effort to establish an airway. We collected detailed data for each attempt, including cases where a more experienced provider replaced the initial intubator. In such instances, the success of the intubation was categorized based on the total number of attempts, regardless of the final intubator's level of experience. This means that, for a single patient, multiple attempts may have been performed by different intubators with varying levels of experience. Despite this, each patient's intubation was reported as a single case.

We categorized the level of operator training into three groups: 1) The low-experience group consisted of individuals in their final year of medical school and first-year internists in general practice; 2) The moderate-experience group included second-year to third-year internists in general practice and first-year residents in emergency medicine; 3) The high-experience group comprised second-year to third-year residents in emergency medicine and emergency attending staff.

Outcomes measurement

Patients were divided into two groups according to the initial method of intubation: VL and DL. The primary outcomes were the success rates of intubation, which included first-attempt success, success within three attempts, and the overall success rate. For the success of the first attempt, we ensured that both the experience level of the initial intubator and the outcome of that attempt were clearly reported. Whether subsequent attempts were performed by the same or a different provider does not impact the primary outcome of the study, which focuses on first-attempt success. The secondary outcomes were the occurrence of peri-intubation adverse events. Peri-intubation adverse events included cardiac arrest (during or immediately after intubation), severe hypoxemia (any event where SaO_2 dropped below 88% during an intubation attempt), failed intubation, postintubation hypotension (systolic blood pressure below 90 mmHg, or mean arterial blood pressure below 65 mmHg), airway injury, and main stem intubation. Outcomes were assessed by trained research coordinators who had received specific training for this study.

Sample size estimation

The sample size was calculated using a two-sample comparison of proportions method, aiming for a statistical power of 90% and a significance level of 5% with a two-sided test. To detect significant differences between the VL and DL groups with a 10% difference in success rates, an estimated sample size of 266 participants per group was determined to be sufficient.

Statistical analysis

Continuous data were presented as means and standard deviations, or as medians and interquartile ranges, as appropriate. The Student's t-test or the Wilcoxon Rank Sum test was applied for analysis of these data. Categorical variables were analyzed using the Chi-square test or the exact probability test, and results were reported as percentages. Univariable analyses were conducted to evaluate the differences between the VL and DL groups. Propensity score matching was utilized to establish comparable groups. Multivariable risk regression analysis was performed to identify independent effects. The magnitude of the differences between two groups were demonstrated by the risk difference with 95% confidence intervals. A *P*-value of less than 0.05 was considered to indicate statistical significance. Data analysis was conducted using the STATA software, version 17 (Stata Corp, College Station, TX, USA).

Results

A total of 3,829 patients underwent emergency intubation in the ED. Of these, 273 patients were excluded due to missing data, and 132 were excluded because they were under 18 years old. The remaining 3,424 patients were included in the analysis. The patients were divided into two groups according to the initial method of intubation (342 patients in the VL group and 3,082 patients in the DL group) (Fig. 1).

Table 1 presents the characteristics of patients and the results from the univariable analysis between the VL and DL groups. There was a statistically significant difference in gender distribution. Although age, weight, and GCS categories showed variations, these differences were not statistically significant. Physiological parameters measured before intubation, such as systolic blood pressure and pulse rate, did not show significant differences between the groups. However, the respiratory rate and oxygen saturation demonstrated significant differences, with higher values in the VL group. Indications for intubation varied notably, particularly for cardiac arrest, and there was a higher utilization of rapid sequence intubation in the VL group ($p<0.001$).

The experience level of the first intubator varied significantly between the groups, with a greater number of highly experienced intubators in the VL group ($p<0.001$). Regarding success outcomes, there were no significant differences in the success rates of intubation, whether on the first attempt, within three attempts, or in the overall success rate (*p*-values: 0.372, 0.499, and

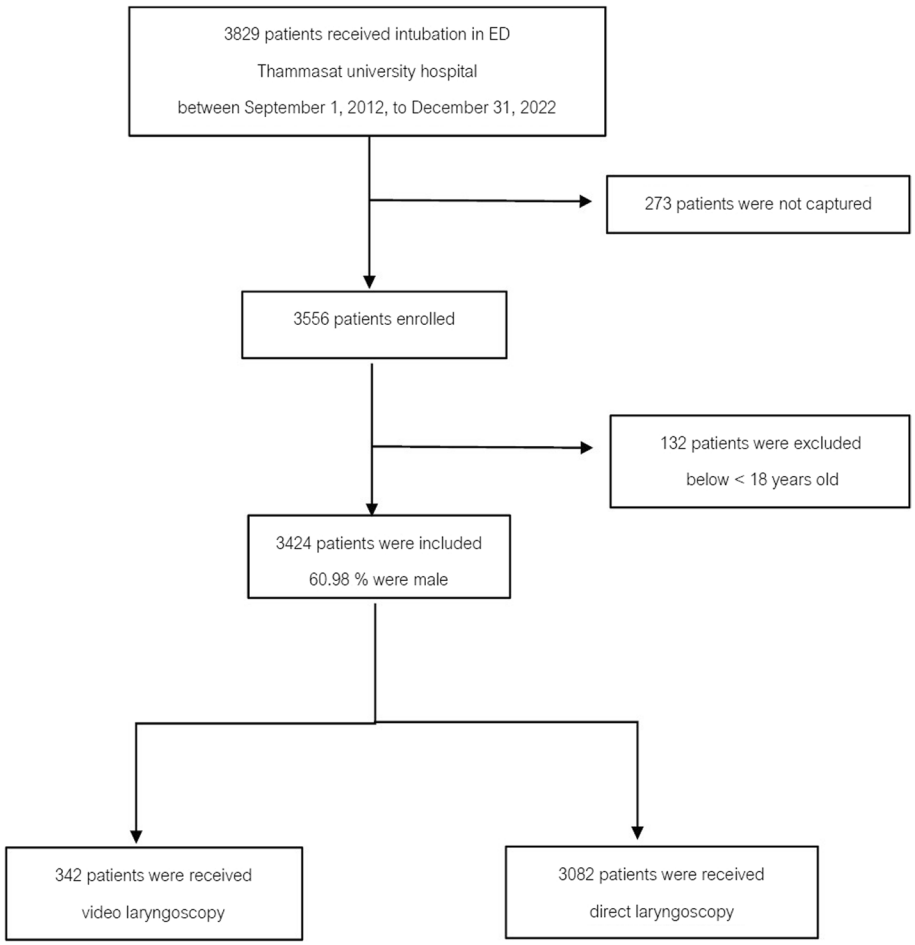

Fig. 1 Flow of the study

0.812, respectively). However, a significant difference was observed in the occurrence of peri-intubation adverse events, with the VL group experiencing fewer events (33% vs. 40%, p=0.012).

Table 1 reports patient characteristics, the intubator's level of experience, and the success rate of intubation, separated by the initial method of intubation (VL or DL) for the first attempt only. In some cases where the first attempt was unsuccessful, the subsequent attempts may have involved a change in the intubation method (crossover) or a different intubator. Details regarding those who failed the first attempt are provided in Table S1, S2, and S3 in the supplementary file.

Table 2, featuring the post-propensity score matching analysis, revealed similar trends, with no significant differences in gender, age, weight, GCS, and physiological parameters before intubation. The success outcomes were also consistent, showing no significant differences in the matched groups. However, the DL group exhibited a significantly higher first-attempt success rate post-matching (p=0.009). The median intubation duration was slightly shorter for VL (3 minutes) compared to DL (5 minutes) (p=0.04).

Table 3 presents the primary and secondary outcomes of the study, both before and after propensity score matching. Regarding success outcomes, no significant differences were observed in the success rates of the first attempt, within three attempts, or overall success before matching. However, after matching, the first-attempt success rate was significantly higher in the DL group (p=0.009). Regarding peri-intubation adverse events, there were notable differences before matching.

Specifically, the rate of peri-intubation severe hypoxemia was significantly higher in the DL group (p=0.033), and post-intubation hypotension was also significantly higher in the DL group (p<0.001). However, after matching, these differences were not statistically significant. The detailed table of adverse events is shown in Table S4 in the supplementary file.

Table 1 Characteristics of patients intubated with video laryngoscope (VL) and direct laryngoscope (DL) with result from univariable analysis

Characteristic	VL (*N*=342)		DL (*N*=3,082)		*p*-value
	N	%	N	%	
Gender					0.022
Male	189	55.3	1,899	61.6	
Female	153	44.7	1,183	38.4	
Age, mean (±SD) (year)	64.7 ± 19.7		62.6 ± 19.2		0.052
Weight, mean (±SD) (kilogram)	59.7 ± 11.3		59.4 ± 13.0		0.665
Glasgow Coma Scale					0.061
3-8	156	45.6	1,575	51.1	
9-13	67	19.6	471	15.3	
14-15	119	34.8	1,036	33.6	
Physiologic parameters before intubation					
Systolic blood pressure, mean (±SD) (mmHg)	145.0 ± 41.3		143.9 ± 43.7		0.652
Pulse rate, mean (±SD) (bpm)	110.1 ± 27.8		107.7 ± 27.9		0.131
Respiratory rate, mean (±SD) (per minute)	28.2 ± 10.6		24.6 ± 13.5		<0.001
Oxygen saturation, median (IQR) (%)	95 (85, 99.5)		93 (78, 100)		0.019
Indication for intubation					<0.001
Cardiac arrest	16	4.7	377	12.2	
Traumatic cardiac arrest	0	0	38	1.2	
Other medical encounter	299	87.4	2,387	77.5	
Other traumatic encounter	27	7.9	280	9.1	
Initial method of intubation					<0.001
Rapid sequence intubation	274	80.1	1,288	41.8	
Sedation only without paralysis	53	15.5	979	31.8	
No medication assisted	15	4.4	815	26.4	
Experience of the first intubator					<0.001
Low experience	74	21.7	1,208	39.2	
Moderate experience	88	25.7	726	23.6	
High experience	180	52.6	1,148	37.2	
Glottis exposure grade					0.122
I = Visualized entire vocal cord	209	61.1	1,692	54.9	
II = Visualized part of vocal cord	100	29.2	1,088	35.3	
III = Visualized epiglottis only	26	7.6	251	8.1	
IV = Non-visualized epiglottis	7	2.1	51	1.7	
Induction agent					<0.001
No used	18	5.3	848	27.5	
Diazepam	6	1.7	142	4.6	
Midazolam	40	11.7	286	9.3	
Etomidate	199	58.2	1,103	35.8	
Ketamine	31	9.1	313	10.2	
Propofol	48	14.0	390	12.6	
Neuromuscular blocking agent used	273	79.8	1,209	39.2	<0.001
Difficult intubation indicator					
Facial injury	5	1.5	74	2.4	0.272
Large incisors	1	0.3	59	1.9	0.030
Large tongue	13	3.8	206	6.7	0.039
Limited mouth opening	13	3.8	208	6.8	0.035
Short hypo-mental distance	15	4.4	172	5.6	0.356
Short thyro-hyoid distance	13	3.8	159	5.2	0.275

Table 1 (continued)

Characteristic	VL (*N*=342)		DL (*N*=3,082)		*p*-value
	N	%	N	%	
Presence of obstructed airway	11	3.2	61	1.9	0.130
Poor neck mobility	31	9.1	322	10.5	0.425
Success outcomes					
Successful in the first attempt	281	82.2	2,470	80.1	0.372
Successful within 3 attempts	334	97.7	3,026	98.2	0.499
Overall success	341	99.7	3,075	99.8	0.812
Total number of attempts, median (IQR)	1 (1, 1)		1 (1,1)		0.351
Intubation duration*, median (IQR) (minute)	4 (2, 7)		5 (2, 7)		0.342
Peri-intubation adverse events	113	33.0	1,234	40.0	0.012

* Intubation duration refers to the time from the injection of the induction agent until the placement of the endotracheal tube was confirmed. In crash airway, the time started from declare a crash airway until the confirmed placement

Table 4 compares the success rates of emergency intubation using VL and DL, categorized by the experience level of the first intubator. The success rates on the first attempt were not statistically significant across different experience levels. However, VL demonstrated a lower success rate on the first attempt among intubators with low experience. Focuses on the success rates of the first attempt at emergency intubation using VL, categorized by the experience level of the first intubator. Compared to low-experience intubators, those with moderate and high experience demonstrated significantly higher success rates on the first intubation attempt, with risk differences of 21.7% and 24.8%, respectively.

Table 5 shows the effect of VL and DL on success rates and peri-intubation adverse events before and after propensity score matching in specific subgroup analyses. The results are consistent with the analysis of the entire cohort. For intubators with moderate and high experience, after propensity score matching, the first-attempt success rate was significantly higher in the DL group compared to the VL group (p=0.012), while other peri-intubation adverse events showed no significant differences. For patients who received both induction agents and neuromuscular blocking agent, the DL group had a significantly higher first-attempt success rate after matching (p=0.001). Peri-intubation adverse events did not show statistically significant differences between the groups after matching.

Discussion

The main goal of this study was to compare the success rates and peri-intubation adverse events between the two most commonly used laryngoscopy methods for emergency intubation in EDs. Our findings indicate that after matching for patient characteristics, drug-assisted intubation, and the experience level of intubators, DL may achieve a higher first-attempt success rate. Additionally, there were no significant differences in peri-intubation adverse events between the two methods.

The first-attempt success rate in this study was approximately 80% for both the VL and DL groups. However, when patient baseline characteristics were matched between the two groups, DL demonstrated a higher success rate on the first attempt. This finding contradicts previous studies, which include both randomized trials and observational studies, where VL showed a higher success rate on the first attempt [16–18, 21–23]. The higher success rate of DL over VL might be attributed to the fact that medical training and clinical practice primarily utilize DL. Historically, VL has not been emphasized as a fundamental component in the curriculum of medical training. As a result, emergency medicine practitioners tend to exhibit greater proficiency and familiarity with the application of DL as opposed to VL.

The success rates of first intubation attempts correlated with the cumulative years of postgraduate clinical experience, aligning with the expected improvement in skills acquired during residency training. Notably, there was no significant increase in success rates from second-year residents to attending physicians, suggesting that proficiency in airway management among emergency medicine residents tends to plateau by their second year of training. However, it is important to consider that externs and junior physicians are often assigned cases with presumably easier airways, while senior residents and attending staff are more likely to handle complex airway challenges, reflecting a selection bias toward more difficult cases in their patient pool.

Airway management in the ED presents unique challenges, and the experience level of intubators is a critical factor. Differences in experience likely affect the success outcomes and serve as important confounders,

Table 2 Characteristics of patients intubated with video laryngoscope (VL) and direct laryngoscope (DL) after propensity score matching with result from univariable analysis

Characteristic	VL (*N*=305)		DL (*N*=305)		*p*-value
	N	%	N	%	
Gender					0.870
Male	178	58.4	176	57.7	
Female	127	41.6	129	42.3	
Age, mean (±SD) (year)	65.0 ± 19.6		65.2 ± 19.7		0.929
Weight, mean (±SD) (kilogram)	59.4 ± 9.9		58.9 ± 13.7		0.580
Glasgow Coma Scale					0.821
3-8	138	45.3	135	44.3	
9-13	58	19.0	54	17.7	
14-15	109	35.7	116	38.0	
Physiologic parameters before intubation					
Systolic blood pressure, mean (±SD) (mmHg)	144.2 ± 41.2		143.4 ± 42.1		0.850
Pulse rate, mean (±SD) (bpm)	108.7 ± 27.8		109.5 ± 26.3		0.735
Respiratory rate, mean (±SD) (per minute)	28.0 ± 10.6		27.5 ± 11.9		0.527
Oxygen saturation, median (IQR) (%)	95 (88, 100)		95 (84, 99)		0.414
Indication for intubation					0.936
Cardiac arrest	15	4.9	17	5.6	
Traumatic cardiac arrest	0	0	0	0	
Other medical encounter	265	86.9	263	86.2	
Other traumatic encounter	25	8.2	25	8.2	
Initial method of intubation					0.044
Rapid sequence intubation	242	79.3	238	78.0	
Sedation only without paralysis	48	15.8	38	12.5	
No medication assisted	15	4.9	29	9.5	
Experience of the first intubator					0.885
Low experience	70	22.9	65	21.3	
Moderate experience	84	27.6	85	27.9	
High experience	151	49.5	155	50.8	
Glottis exposure grade					0.062
I = Visualized entire vocal cord	186	61.0	165	54.1	
II = Visualized part of vocal cord	89	29.2	115	37.7	
III = Visualized epiglottis only	23	7.5	23	7.5	
IV = Non-visualized epiglottis	7	2.3	2	0.7	
Induction agent					0.002
No used	16	5.3	31	10.2	
Diazepam	5	1.6	5	1.6	
Midazolam	38	12.5	14	4.6	
Etomidate	172	56.4	175	57.4	
Ketamine	30	9.8	43	14.1	
Propofol	44	14.4	37	12.1	
Neuromuscular blocking agent used	241	79.0	235	77.1	0.557
Difficult intubation indicator					
Facial injury	5	1.6	5	1.6	1.000
Large incisors	1	0.3	2	0.6	0.563
Large tongue	12	3.9	14	4.6	0.689
Limited mouth opening	13	4.3	8	2.6	0.267
Short hypo-mental distance	14	4.6	11	3.6	0.540
Short thyro-hyoid distance	10	3.3	12	3.9	0.664

Table 2 (continued)

Characteristic	VL (*N*=305)		DL (*N*=305)		*p*-value
	N	%	N	%	
Presence of obstructed airway	7	2.3	8	2.6	0.794
Poor neck mobility	25	8.2	23	7.5	0.764
Success outcomes					
Successful in the first attempt	248	81.3	271	88.9	0.009
Successful within 3 attempts	299	98.0	302	99.0	0.314
Overall success	304	99.7	305	100	0.317
Total number of attempts, median (IQR)	1 (1, 1)		1 (1, 1)		0.012
Intubation duration*, median (IQR) (minute)	3 (2, 6)		5 (2, 7)		0.040
Peri-intubation adverse events	97	31.8	112	36.7	0.201

* Intubation duration refers to the time from the injection of the induction agent until the placement of the endotracheal tube was confirmed. In crash airway, the time started from declare a crash airway until the confirmed placement

Table 3 Effect of video laryngoscope (VL) and direct laryngoscope (DL) on success rate and peri-intubation adverse events before and after being matched with propensity score

Outcome	Before propensity score matching				After propensity score matching			
	VL (*N*=342) n (%)	DL (*N*=3,082) n (%)	Risk difference (95% confidence interval)	*P*	VL (*N*=305) n (%)	DL (*N*=305) n (%)	Risk difference (95% confidence interval)	*P*
Success outcomes								
Successful in the first attempt	281 (82.2)	2,470 (80.1)	2.0 (-2.3, 6.3)	0.356	248 (81.3)	271 (88.9)	7.6 (1.9, 13.2)	0.009
Successful within 3 attempts	334 (97.7)	3,026 (98.2)	0.5 (-1.1, 2.2)	0.540	299 (98.0)	302 (99.0)	1.0 (-0.9, 2.9)	0.313
Overall success	341 (99.7)	3,075 (99.8)	N/A	N/A	304 (99.7)	305 (100)	N/A	N/A
Peri-intubation adverse events	113 (33.0)	1,234 (40.0)	7.0 (1.7, 12.3)	0.009	97 (31.8)	112 (36.7)	4.9 (-2.6, 12.4)	0.200
Cardiac arrest	0	30 (0.9)	N/A	N/A	0	1 (0.3)	N/A	N/A
Severe hypoxemia*	90 (26.3)	977 (31.7)	5.4 (0.4, 10.3)	0.033	76 (24.9)	89 (29.2)	4.3 (-2.8, 11.3)	0.236
Dental trauma	2 (0.6)	31 (1.0)	0.4 (-0.5, 1.3)	0.349	1 (0.3)	2 (0.7)	0.4 (-0.8, 1.4)	0.563
Main stem intubation	1 (0.3)	17 (0.6)	0.3 (-0.4, 0.9)	0.419	1 (0.3)	0	N/A	N/A
Failed intubation	8 (2.3)	56 (1.8)	0.5 (-1.1, 2.2)	0.540	3 (0.9)	6 (1.9)	1.0 (-0.9, 2.9)	0.313
Post-intubation hypotension	17 (4.9)	320 (10.4)	5.5 (2.9, 7.9)	<0.001	16 (5.3)	28 (9.2)	3.9 (-0.2, 8.0)	0.060

* Peri-intubation severe hypoxemia was defined as any event where SaO_2 dropped below 88% during an intubation attempt

both by indication and contraindication. This is evident from the Table 1, where the distribution of experience among intubators shows a significant difference (p<0.001). The varying levels of experience could influence the choice of intubation device (VL or DL), the method of intubation (RSI or non-RSI), and the use of medications (induction agents, neuromuscular blocking agents). Therefore, in this study, we controlled for confounders by indication and contraindication using propensity score matching to balance the distribution of variables between the VL and DL groups. As shown in the Table 2, after propensity score matching, the distribution of experience levels between the two groups became comparable (p=0.885). This allowed for a more reliable analysis of the study outcomes between the VL and DL groups in the post-propensity score matching stage, significantly reducing the level of selection bias.

Table 4 Success rates of video laryngoscopy (VL) compared to direct laryngoscopy (DL) for emergency intubation according to the experience level of the first intubator, as well as the first-attempt success rate of video laryngoscopy for emergency intubation based on the experience of the first intubator

All emergency intubation (*N*=3,424)	**Successful in the first attempt**		
	VL N (%)	**DL N (%)**	***P* value**
Low experience (*N*=1,282)	47 (63.5)	880 (72.9)	0.082
Moderate experience (*N*=814)	75 (85.2)	605 (83.3)	0.651
High experience (*N*=1,328)	159 (88.3)	985 (85.8)	0.361
Intubation with video laryngoscope (*N*=342)	Risk difference of successful in the first attempt	95% confidence interval	*P* value
Low experience (*N*=74)	Ref	Ref	
Moderate experience (*N*=88)	21.7	8.4, 34.9	0.001
High experience (*N*=180)	24.8	12.9, 36.7	<0.001

This study along with previous studies found that the VL group experienced fewer peri-intubation adverse events and post-intubation hypotension compared to the DL group [24–26]. However, this difference disappeared after applying propensity score matching. This outcome may be attributable to the preferential selection of VL by more experienced clinicians, such as senior residents or attending staff, who are more likely to decide to perform endotracheal intubation using the rapid sequence intubation (RSI) method (80% in VL compared to 42% in DL). This can be explained by the fact that the administration of neuromuscular blocking agents must always be supervised by an attending emergency physician. Since this research is designed as an observational study, the decision to use the agent depends on the attending physician, who may choose not to administer it due to contraindications in some patients. As a result, these patients are categorized in the sedation only without paralysis group, which lowers the overall proportion of RSI cases in the registry. However, during the COVID-19 pandemic, the use of VL increased, along with recommendations for more frequent use of neuromuscular blocking agents, leading to a significantly higher proportion of RSI cases in the VL group. We attempted to reduce this difference by matching the method of intubation between patients in the VL and DL groups. As shown in Table 2, the difference was reduced. Used of RSI, along with appropriate medication selection, can reduce the incidence of complications following intubation [27]. Therefore, after performing propensity score matching, which equalized the rate of RSI usage between the two groups, the incidence of peri-intubation complications became similar in both groups.

In this study, we observed an imbalance in the usage of VL compared to DL. Although the use of VL has been taught and available for a long time, it has not been widely adopted in developing countries. Historically, almost all emergency intubations were performed using DL [5, 15]. However, since the COVID-19 pandemic, the use of VL for emergency intubations has become more widespread, with its usage increasing significantly from 2020 onward. Therefore, even though this study analyzed a large dataset over an extended period, the proportion of VL usage remains significantly lower than that of DL. Despite this, we calculated the sample size appropriately, and the large patient cohort, combined with the use of propensity score matching, helped balance the characteristics between the VL and DL groups, enhancing the reliability of the study results. Regarding the intubators' experience, our study found that the first-attempt success rate for both VL and DL, before and after propensity score matching, was consistently higher than 80%, which aligns with other studies [10–14]. Thus, we believe that the experience level of intubators in this study is comparable to that of other studies.

This study offers valuable insights into the comparative effectiveness of VL and DL in emergency intubations. The findings indicate that although both methods have similar success rates and rates of peri-intubation adverse events, VL may provide advantages in terms of shorter intubation duration, particularly when used by moderately or highly experienced intubators.

Limitations

The study is subject to limitations, including its retrospective design and the potential for unaccounted confounding factors in the analysis. This study attempts to address significant confounders, including confounder by indication and confounder by contraindication, through the use of propensity score matching. This study lacks information on how intubators decided between VL and DL, as it is a retrospective study. This could introduce selection bias, particularly if intubators tended to choose VL for more difficult intubations. To reduce this

Table 5 Effect of video laryngoscopy (VL) and direct laryngoscopy (DL) on success rates and peri-intubation adverse events before and after propensity score matching in specific subgroup analyses. NMB; neuromuscular blocking agent

Only moderate and high experience intubator (*N*=2,142)	Before propensity score matching				After propensity score matching			
	VL (*N*=268) n (%)	DL (*N*=1,874) n (%)	Risk difference (95% confidence interval)	*P*	VL (*N*=226) n (%)	DL (*N*=226) n (%)	Risk difference (95% confidence interval)	*P*
Success outcomes								
Successful in the first attempt	234 (87.3)	1,590 (84.8)	2.5 (-1.8, 6.8)	0.261	195 (86.3)	211 (93.4)	7.1 (1.5, 12.6)	0.012
Successful within 3 attempts	263 (98.1)	1,841 (98.2)	0.10 (-1.6, 1.8)	0.905	223 (98.7)	226 (100)	N/A	N/A
Overall success	268 (100)	1,867 (99.6)	N/A	N/A	226 (100)	226 (100)	N/A	N/A
Peri-intubation adverse events	97 (36.2)	835 (44.6)	8.4 (2.2, 14.5)	0.008	78 (34.4)	70 (30.9)	3.5 (-5.1, 12.2)	0.422
Cardiac arrest	0	25 (1.3)	N/A	N/A	0	0	N/A	N/A
Severe hypoxemia	77 (28.7)	683 (36.5)	7.8 (1.9, 13.6)	0.010	62 (27.4)	60 (26.6)	0.8 (-7.3, 9.1)	0.832
Dental trauma	2 (0.8)	18 (1.0)	0.2 (-0.9, 1.4)	0.641	1 (0.4)	2 (0.9)	0.5 (-1.1, 1.9)	0.562
Main stem intubation	1 (0.4)	11 (0.6)	0.2 (-0.6, 1.0)	0.604	0	2 (0.9)	N/A	N/A
Failed intubation	5 (1.9)	33 (1.8)	0.1 (-1.6, 1.8)	0.905	3 (1.3)	0	N/A	N/A
Post-intubation hypotension	16 (5.9)	212 (11.3)	5.4 (2.2, 8.5)	0.001	15 (6.6)	13 (5.8)	0.8 (-3.6, 5.3)	0.696
Patients who received both an induction agent and NMB (cardiac arrest not excluded) (*N*=1,908)	Before propensity score matching				After propensity score matching			
	VL (*N*=286) n (%)	DL (*N*=1,622) n (%)	Risk difference (95% confidence interval)	*P*	VL (*N*=246) n (%)	DL (*N*=246) n (%)	Risk difference (95% confidence interval)	*P*
Success outcomes								
Successful in the first attempt	235 (82.2)	1,375 (84.8)	2.6 (-2.2, 7.4)	0.284	198 (80.5)	224 (91.1)	10.6 (4.5, 16.7)	0.001
Successful within 3 attempts	280 (97.9)	1,604 (98.9)	1.0 (-0.7, 2.7)	0.265	241 (97.9)	245 (99.6)	1.7 (-0.3, 3.5)	0.099
Overall success	285 (99.7)	1,619 (99.8)	0.1 (-0.6, 0.9)	0.652	245 (99.6)	246 (100)	N/A	N/A
Peri-intubation adverse events	94 (32.9)	649 (40.0)	7.1 (1.2, 13.1)	0.018	74 (30.1)	81 (32.9)	2.8 (-5.3, 11.1)	0.497
Cardiac arrest	0	8 (0.5)	N/A	N/A	0	0	N/A	N/A
Severe hypoxemia	75 (26.2)	554 (34.2)	8.0 (2.3, 13.5)	0.005	58 (23.6)	61 (24.8)	1.2 (-6.3, 8.8)	0.752
Dental trauma	1 (0.4)	9 (0.6)	0.2 (-0.6, 0.9)	0.603	1 (0.4)	2 (0.8)	0.4 (-0.9, 1.7)	0.562
Main stem intubation	1 (0.4)	13 (0.8)	0.4 (-0.4, 1.2)	0.274	1 (0.4)	3 (1.2)	0.8 (-0.8, 2.4)	0.315
Failed intubation	6 (2.1)	18 (1.1)	1.0 (-0.7, 2.7)	0.265	5 (2.0)	1 (0.4)	1.6 (-0.3, 3.5)	0.099
Post-intubation hypotension	14 (4.9)	156 (9.6)	4.7 (1.8, 7.6)	0.001	12 (4.9)	21 (8.5)	3.6 (-0.8, 8.1)	0.104

bias, we used propensity score matching to adjust for variables indicating a higher likelihood of difficult intubation, ensuring an equal distribution between the VL and DL groups. This is evident in the changes in the *p*-value for difficult intubation indicators, where the differences decreased in Table 2 compared to Table 1.

This study has limitations regarding intravenous fluid and vasopressor administration. We did not collect data on the volume of IV fluid given before intubation, making it difficult to evaluate its impact on outcomes. Additionally, the absence of a standardized protocol for vasopressor administration during emergency intubation in the ED, and the lack of specific data on vasopressor use, limits our ability to accurately differentiate between patients with hypotension who did not receive vasopressors and those who did, potentially affecting the analysis of adverse events.

In our study, we exclusively used hyperangulated blades with a rigid stylet for all video laryngoscopy (VL), which may differ from practices in other institutions where VL is performed using CMAC or MAC-like blades. This choice could impact comparability, as intubation

techniques vary with blade type. By standardizing with hyperangulated blades and providing pre-training for all intubators on both the hyperangulated blade and rigid stylet, we aimed for consistency across experience levels. Hyperangulated blades differ significantly from MAC-like blades in terms of insertion and visualization angles, as well as the necessity of a rigid stylet to guide the endotracheal tube. These differences may impact the learning curve and overall success rates for intubators of various skill levels. Therefore, our findings should be interpreted as outcomes specific to this blade type. Future studies comparing the effectiveness of MAC-like and hyperangulated blades could offer a more comprehensive understanding of VL performance and success rates across diverse clinical settings.

All data were retrospectively extracted from a data registry, which limits confidence in the accuracy of the collected data. Additionally, this study relies on self-reported data, as the intubator completes the study form without external validation. This could lead to reporting bias or inaccuracies. Future studies should consider incorporating external validation methods, such as supervision or video review, to enhance data reliability.

Conclusion

In conclusion, this study presents a comprehensive analysis of the effectiveness and safety of VL and DL in emergency intubations in ED. Both VL and DL have comparable first-attempt success rates and peri-intubation adverse events. VL is particularly beneficial when used by moderately or highly experienced intubator. DL shows a higher success rate on the first attempt, especially for less experienced intubators, likely due to its prevalent use in medical training and practice. The choice of intubation method, combined with clinical experience and technique (such as the use of RSI), plays a critical role in the success and safety of emergency intubations.

Abbreviations

ED	Emergency department
VL	Video-assisted laryngoscopy
DL	Direct laryngoscopy
GCS	Glasgow Coma Scale
RSI	Rapid sequence intubation

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions

Conceptualization: TK, KK, WS. Protocol development: TK, KK, WS. Data collection: TK, WS. Data analysis: TK, WS. Writing and editing manuscript: TK, KK, WS. All authors read and approved the final manuscript.

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Data availability

Zenodo: Dataset of Outcome of video laryngoscopy versus direct laryngoscopy in ED.https://zenodo.org/doi/10.5281/zenodo.10967455. Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

Declarations

Ethics approval and consent to participate

This study and the airway registry were approved by the Human Research Ethics Committee of Thammasat University (Faculty of Medicine) (approval number: MTU-EC-EM-0-190/65) on December 13, 2022. This study was conducted in accordance with the principles of the Declaration of Helsinki. As this study is an observational study using retrospectively collected data, the patients' identification data were hidden and cannot be accessed. Consequently, the process of obtaining written informed consent was waived with approval from the Human Research Ethics Committee of Thammasat University.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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