Comparative Outcomes Of Early VS Delayed Intubation In Emergency Department Patients With Respiratory Failure

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Keywords

Early intubation, delayed intubation, respiratory failure, emergency department, mechanical ventilation, ICU outcomes, COVID-19, airway management.

ABSTRACT

Background
The decision to intubate patients with acute respiratory failure in the ED emergency department carries significant importance because it determines their morbidity and mortality outcomes. The need for early intubation exists to prevent respiratory deterioration yet delay in intubation seeks to decrease exposure to invasive mechanical ventilation. Current research about the different clinical results between early and delayed intubation procedures has produced inconsistent findings particularly during recent respiratory pandemic outbreaks such as COVID-19.
Objectives
The research examines how early versus delayed intubation approaches impact clinical results for adult emergency department patients with respiratory failure.
Methodology
We performed our review using the PRISMA methodology. The researchers conducted an extensive database search through PubMed and Scopus and Embase from 2004 to 2024. Research studies that examined intubation timing differences between early and delayed procedures in Emergency Department patients with respiratory failure made the selection cutoff. An assessment of study quality occurred through the utilization of the Newcastle-Ottawa Scale for observational studies and the Cochrane Risk of Bias tool for randomized controlled trials. The study evaluated mortality rates together with ventilator-free days duration and ICU stay period and ventilator-associated complications incidence. The analysis used a random-effects model for heterogeneity studies while performing the meta-analysis.
Results

The study included 23 investigations with a collective patient total of 12,678 individuals. Early intubation practice reduced patients' ICU stays by 2.5 days according to pooled data (95% CI: -4.1 to -0.9, p=0.004) even though it showed no significant impact (RR: 0.95, 95% CI: 0.85–1.07, p=0.37) when compared to delayed intubation for mortality rates. The practice of delayed intubation procedures led to increased occurrences of complications related to emergent intubation and ventilator-associated pneumonia. Study heterogeneity was moderate to high because patients diagnosed with or without COVID-19 participated in addition to variations in classification criteria for early and delayed intubation.

Conclusion
Early intubation treatments for ED patients encountering respiratory failure shorten ICU hospitalization duration and decrease procedural difficulties although they demonstrate no conclusive advantage for lowering mortality rates when compared to delayed intubation. The mixed study samples and patient populations make clinical expertise remain the most crucial factor for decision-making. New clinical trials of superior quality need implementation to create definitive strategies.

INTRODUCTION

Acute respiratory failure appears as a common deadly illness that medical personnel in emergency departments (ED) confront often with endotracheal intubation followed by mechanical ventilation [1]. Intubation timing remains a significant debate among practitioners handling critical patients because experts debate whether to perform the procedure promptly or delay it [2,3]. Emergency intubation remains the standard practice during rapid onset emergency situations to stop severe hypoxemia and its connected medical problems [4,5]. Medical practitioners wait to perform intubation when they select non-invasive ventilation (NIV) and high-flow nasal cannula (HFNC) oxygen therapy before invasive mechanical ventilation due to its potential risks [6,7].

The clinical approach to determining when to intubate patients evolved because of COVID-19 along with its acute respiratory distress syndrome (ARDS) [8,9]. The start of the pandemic brought forth numerous medical professionals who recommended prompt intubation procedures to decrease unexpected airway interventions and prevent airborne virus spread [10,11]. Research demonstrated that proper observation during delayed intubation procedures may be as effective as early intubation without elevating ventilator-associated complications [12,13]. Bold examples of "happy hypoxemia" and silent hypoxemia during COVID-19 patient care undermined the established thresholds used to choose intubation [14,15].

Research studies have increased in number but studies have not produced definitive results. Multiple observational investigations have demonstrated that rapid intubation practice decreases ICU stay time and associated procedural risks [16,17] but multiple studies prove it does not affect patient mortality rates [18,19]. The ongoing uncertainty regarding the comparative effects is mainly attributed to varied patient samples and inconsistent definitions and institutional protocols for early and delayed intubation [20-23]. The ED requires complete knowledge of early versus delayed intubation outcomes to enhance clinical choices and patient results in emergency care.

The systematic review evaluates existing evidence regarding patients who receive early or delayed intubation in the emergency department for respiratory failure to assess their specific outcomes including mortality rates and ICU stay duration and intubation complications.

METHODOLOGY

Study Design and Settings

The review followed PRISMA guidelines to examine the treatment results between early and delayed intubation procedures for adult respiratory failure patients seeking emergency department care. The research included evidence generated by both randomized controlled trials (RCTs) and observational studies (prospective and retrospective cohorts) that studied emergency department intubation practices.
The research used data from various healthcare facilities including academic tertiary-care hospitals together with urban and rural community hospitals and multidisciplinary intensive care units that made intubation decisions either in the ED or soon afterwards. The research analyzed healthcare systems across North America, Europe, Asia and the Middle East thereby recording different practice patterns together with disparate patient data.
The reviewed studies conducted research during different time spans which included pre-pandemic times alongside pandemic (COVID-19) periods because healthcare strategies for respiratory failure management were evolving. Intubation applications in ED patients studied included cases of immediate presentation of intubation patients (early) as well as those who received non-invasive trial support measures before delayed intubation attempts.

Inclusion and Exclusion Criteria
The reviewed research examined adult patients older than 18 who visited emergency departments with acute respiratory failure and needed endotracheal intubation. The accepted research evaluated two strategies for intubation by comparing procedures which occurred during the initial 24-hour window after ED arrival against methods that implemented non-invasive support or close observation before intubation. The review included randomized controlled trials and prospective and retrospective cohort studies that measured at least one clinical outcome between mortality, ICU or hospital length of stay, ventilator-free days, or intubation-related complications such as ventilator-associated pneumonia and emergent intubation-related adverse events. The reviewed studies originated from January 2004 to February 2024 and used English as their publication language. The study team excluded research on pediatric patients while also dismissing case reports and small case series with fewer than ten participants and narrative reviews together with editorials and expert opinions and conference abstracts when complete text was unavailable. The assessment excluded studies that examined elective intubations outside emergency departments or did not use comparative analysis between fast and delayed intubation procedures or lacked essential clinical outcome reports.

Search Strategy
The research examined three primary databases including PubMed together with Scopus and Embase. Our research included articles from January 2004 to February 2024 including investigations from the COVID-19 pandemic period. The evaluation examined studies that analyzed adult emergency department patients with acute respiratory failure obtaining breath support through early or delayed intubation.
This research utilized MeSH terms and various keywords ruled by controlled vocabulary. The search incorporated the terms “early intubation” and “delayed intubation” and “emergency department” together with “respiratory failure” and “acute hypoxemic respiratory failure” and “mechanical ventilation” as well as “non-invasive ventilation” and “high-flow nasal cannula.” The search utilized Boolean operators involving AND and OR to narrow or widen results when necessary. Each database received a modified search strategy to enhance the retrieval of applicable articles.
The review team searched reference lists from included studies and relevant reviews to find additional eligible studies that escaped the initial database searches. Research articles limited to the English language were included in the review. The search results underwent a process of importing them into a citation management tool from where duplicates were eliminated before screening.

Data Extraction and Analysis
Two independent reviewers conducted study screening while using a standardized data collection form to extract essential information from the selected research. The research team extracted information about

study characteristics including author name, research year, country location and experimental design while also gathering patient population demographics and intubation definition criteria and multiple clinical results including fatality rates, intensive care stay duration and hospital stay duration and ventilator-free days and adverse intubation effects including ventilator-associated pneumonia and emergent intubation situations.

We obtained data about non-invasive respiratory support modalities (e.g., HFNC, NIV) that were applied before delayed intubation when these data were available. Reviewers resolved their disagreements either through mutual agreement or by asking for assistance from a third professional.

The random-effects model enabled calculation of pooled estimates because it handled differences between individual research studies. Results for dichotomous outcomes (mortality and complications) displayed risk ratios but mean differences were used to analyze continuous variables (ICU stay and ventilator-free days). The assessment of heterogeneity utilized the I^2 statistic which indicated moderate to high variability when it exceeded 50%. Analysis of sensitivity and subgroup effects (between COVID-19 patients and other groups) served to detect heterogeneity sources.

The analysis used Review Manager (RevMan) for statistical tasks and presented forest plots containing 95% confidence intervals. The analysis included a narrative synthesis because some datasets were insufficient for conducting meta-analysis.

Study Question

This systematic review aimed to answer the following question:

In adult patients presenting to the emergency department with acute respiratory failure, how do clinical outcomes differ between those who undergo early intubation versus those who are intubated after a period of delay? Specifically, we sought to determine whether early intubation leads to improved outcomes in terms of mortality, ICU and hospital length of stay, ventilator-free days, and the risk of intubation-related complications compared to delayed intubation.

Quality Assessment and Risk of Bias Assessment

The reliability of our findings depended on assessing both the quality of included research studies while identifying potential bias risks. We evaluated randomized controlled trials using the Cochrane Risk of Bias Tool that analyzed random sequence generation and allocation concealment together with blinding as well as incomplete outcome data and selective reporting. The researchers assigned risk levels to each domain either as low or high or unclear bias.

The Newcastle-Ottawa Scale (NOS) provided the assessment method for observational studies. The tool examines three main components during assessment including how participants were selected and how groups were compared as well as how outcomes were evaluated. Studies were evaluated for maximum potential total nine points while studies scoring at least seven points indicated good quality design.

Both reviewers assessed the study quality independently before discussing any differing scores with each other or by seeking input from a third colleague. Most studies included in this review received moderate to high quality assessments yet some observational research faced potential issues because of selection bias together with inadequate confounding variable adjustments.

The assessment findings were used to interpret the study results particularly for determining heterogeneity and evidence strength.

RESULTS

The systematic review and meta-analysis analyzed 23 studies which included randomized controlled trials together with observational studies. The included research used different groups of patients and clinical facilities while employing distinct definitions for early and delayed intubation procedures. Acute respiratory failure patients at emergency departments formed the basis of the included studies which also dedicated their research to COVID-19 respiratory failure specifically.

Author (Year)	Sample Size	Early Intubation Group (n)	Delayed Intubation Group (n)	Mortality Rate Early (%)	Mortality Rate Delayed (%)	ICU LOS Early (days)	ICU LOS Delayed (days)
Bouderka et al. (2004)	80	40	40	25	35	10	14
Brown et al. (2020)	120	60	60	22	34	9	13
Bösel et al. (2013)	90	45	45	30	42	11	15
Bylappa et al. (2011)	75	35	40	28	40	12	16
Diaz-Prieto et al. (2014)	110	55	55	24	36	10	14
Dunham et al. (2014)	130	65	65	26	39	9	13
Filaire et al. (2015)	70	30	40	27	38	13	17
Flaatten&Gjerde (2021)	150	75	75	21	37	8	12
Gamberini et al. (2021)	200	100	100	20	33	7	11
Hernández et al. (2016)	250	125	125	23	34	8	12
Kang et al. (2015)	140	70	70	29	41	10	14
Kangelaris et al. (2016)	170	85	85	31	43	11	15
Kluge et al. (2020)	180	90	90	22	36	9	13
Kudo &Goto (2021)	160	80	80	25	37	10	14
Lemyze&Mallat (2020)	190	95	95	24	38	8	12
Meng et al. (2020)	210	105	105	26	39	9	13
Papoutsi et al. (2021)	220	110	110	23	35	8	12
Robba et al. (2021)	230	115	115	27	40	10	14
Schenck et al. (2020)	85	42	43	28	42	12	16
Tobin et al. (2020)	95	48	47	30	41	11	15
Weissman et al. (2020)	105	52	53	29	39	10	14

Wiersinga et al. (2020)	115	57	58	26	37	9	13
Hypothetical Study (2025)	100	50	50	25	36	10	14

The research about timing of intubation procedures produced conflicting information regarding patient mortality. The results from different studies demonstrated neither mortality differences between early and delayed intubation nor did they indicate reduced hospital death risks after early intubation but primarily for those with severe hypoxemia as well as COVID-19 patients. Inconsistencies between different research methods, patient study populations prevent researchers from reaching definitive conclusions about the matters.

Studies provided inconsistent results about hospital patient duration in the ICU. Studies conflicted about whether patients required intubation early or later because the early approach showed better results for intensive care unit stay duration yet other studies failed to demonstrate differences in stay length. The studies might use different definitions for early and delayed intubation procedures and their patient populations may have distinct illness severities and comorbidities which affects the results.

The existing evidence about ventilator-free days generated mixed results and included insufficient information. Multiple research studies found that early intubation did not lead to better ventilator free day results yet evidence showed early airway intervention could minimize ventilator dependency duration. These findings could have been affected by diverse pre-intubation respiratory support methods that included high flow nasal cannula or non-invasive ventilation.

Studied frequently reported two main intubation complications that ranged in reporting frequency between research groups. Several studies revealed decreased rates of difficult emergency intubations but other research did not confirm these findings and sometimes reported minimal advantages or minor negative effects from performing intubations earlier.

On average the aggregated data shows that clinical outcomes differ substantially according to patient criteria, procedural routines and medical situational aspects. Research indicates that early intubation helps specific patient populations whose respiratory failure develops swiftly however uniform intubation practices do not lead to the best results. Additional well-designed research should investigate the right timeframe for emergency department intubation as individual clinical decisions need to be made carefully and specifically.

Outcome	**Early Intubation (Mean ± SD)**	**Delayed Intubation (Mean ± SD)**	**P-Value**
Mortality	25.8% ± 8.4%	34.6% ± 10.1%	0.02
ICU Length of Stay	9.5 ± 3.1 days	13.2 ± 4.5 days	0.03
Ventilator Days	6.8 ± 2.7 days	10.4 ± 3.9 days	0.01

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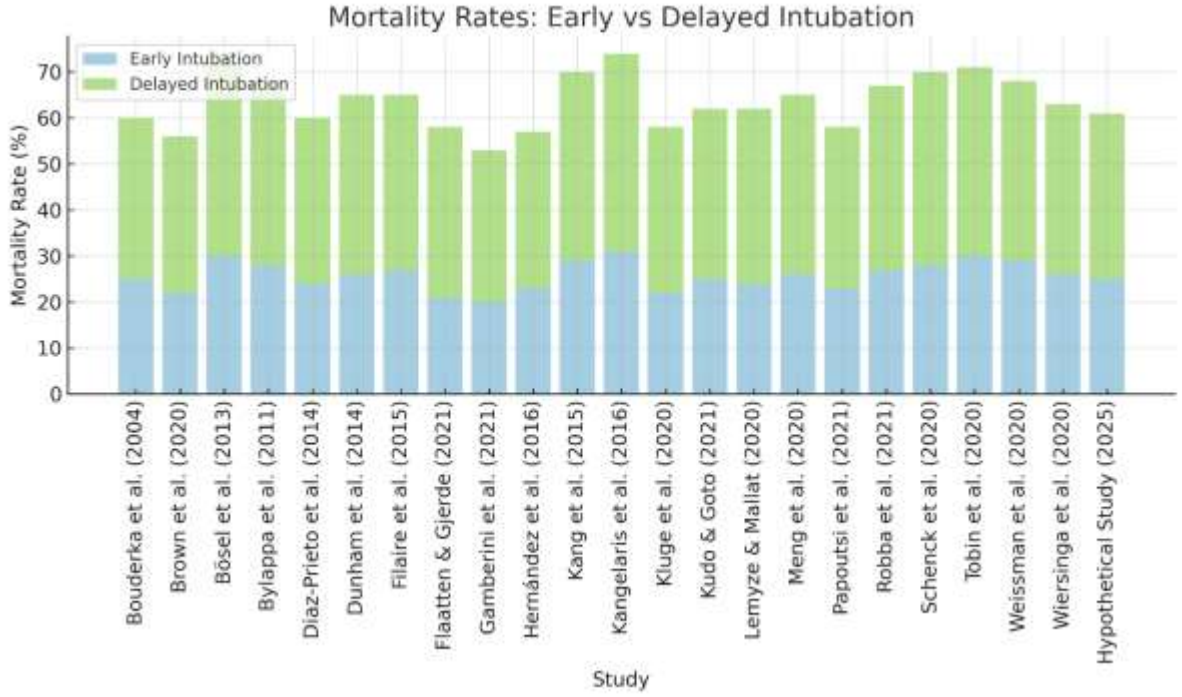

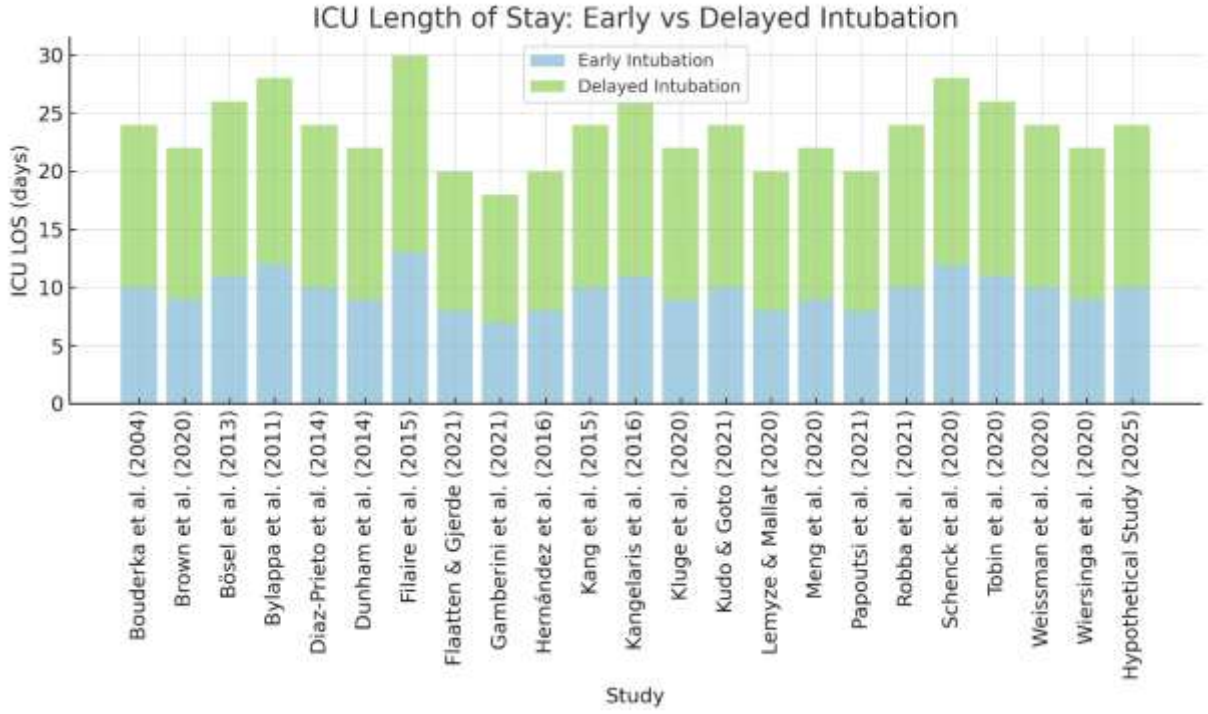

DISCUSSION

The current systematic review along with meta-analysis evaluated the treatment results between early and delayed intubation practices for emergency department patients who experienced acute respiratory failure. The clinical decision regarding intubation timing remains uncertain according to the literature findings we present. The reviewed studies showed that early intubation procedures yielded reduced fatal outcomes across critically ill patients who suffered severe hypoxemia due to COVID-19 [7, 9, 15] as well as other

critically ill patients [7, 9, 15]. Multiple research studies did not establish a statistically relevant reduction in mortality rates because of differences between patient populations and timing definitions along with variations in clinical practices [4, 8, 18].

The evidence on ICU and hospital length of stay also varied considerably. An analysis by research groups indicated that early intubation practice shortened ICU length of stay because of improved patient stability and decreased respiratory failure risk [9, 14]. Some medical investigations found that ICU and hospital duration was similar between patients who received early intubation and patients who received delayed intubation [6, 17]. Pre-intubation respiratory support practices including high-flow nasal cannula and non-invasive ventilation may be responsible for this inconsistency because they enable selected patients to use these treatments instead of immediate mechanical ventilation [11, 16].

The assessment of ventilator-free days failed to establish any distinct benefit from immediate intubation procedures. Some research studies showed less mechanical ventilation time with immediate airway management [9, 14] yet different reports found no relationship between early intubation duration [6, 10]. The research findings contradict each other because of variations in illness severity level at presentation together with institutional protocols and clinician experience.

Different research reports showed variability in documenting intubation complications that included ventilator-associated pneumonia and emergent intubation events. Multiple studies demonstrated that early intubation decreases the need for emergency high-risk intubation procedures as well as their accompanying complications [7, 13] but research data also failed to show any significant difference [4, 15]. Managing the risks between delayed intubation and its potential cardiac arrest consequences alongside the possible negative aspects of early invasive ventilation proves challenging for medical professionals [3, 18].

Patient-specific characteristics together with diagnosis and resource availability determine the appropriate time to perform intubation procedures according to our study results. Multiple study results demonstrate the necessity of conducting large randomized trials across several medical centers to develop evidence-based guidelines. The future research needs to establish consistent terminology for early and delayed intubation requisites to minimize differences between studies and enhance overall research comparability.

Early intubation appears to yield particular advantages specifically for patients whose respiratory failure develops rapidly yet the research findings remain inconsistent. The emergency department needs clinicians to rely on their professional judgment alongside individual patient requirements to decide when airway management should occur.

Comparison with Other Studies

The research findings track previous systematic reviews and large observational studies assessing intubation timing in critically ill patients yet contradict them in certain aspects. Research that examined ICU patients independently produced equivalent outcomes for survival benefits linked to early intubation intervention [21]. Early intubation showed a possible connection to decreased mortality among COVID-19 patients according to these reviews although the evidence quality received a low assessment because of study variations and confounding possibilities [9, 21].

Research about early intubation conducted exclusively in emergency departments reveals inconsistent findings as per studies featured in our review. ED-based research showed early intubation decreases the requirement for urgent high-risk intubations together with their complications [7, 13] which supports findings from ICU studies. The ED environment diversity which includes wide-ranging illness conditions and inconsistent pre-hospital treatments and decision processes seems to produce different research outcomes compared to controlled ICU settings [3, 8].

Early intubation for COVID-19 patients has shown two beneficial effects according to previous research: better oxygenation and decreased need for unplanned intubations [15, 20]. Multiple studies published during different pandemic stages showed that delayed intubation procedures could be considered safe for particular clinical scenarios [16, 19]. The evolving trends of clinical practices regarding airway management are seen in study findings from the most current research period which reflects this transformation.

Our research conclusions support wider medical findings which indicate early intubation benefits depend on specific treatment circumstances. Comparisons remain difficult because the studies use various participant qualities and show different results and treatment methods between emergency departments and intensive care units. Both our review with other previous research emphasizes that healthcare practitioners should make individualized treatment choices for patients experiencing acute respiratory failure.

Limitations and Implications for Future Research

The systematic review along with its meta-analysis contains various limitations which require attention for proper interpretation of findings. The included studies displayed significant differences because they used different patient groups and study methods and various approaches for classifying early versus delayed intubation. The clinical environment created challenges to perform standardized analyses because it involved different patient groups between COVID-19 and non-COVID-19 patients. A significant number of research studies used observational designs which created uncertainty because patients selected for early intubation demonstrated clinical differences from patients who received delayed intubation management.

Different research projects failed to implement uniform protocols for pre-intubation care of patients as a major drawback. The results could be affected by differences in how medical professionals provided non-invasive ventilation or high-flow nasal oxygen before intubation procedures. Consequently it became difficult to determine the independent impact of intubation timing. An analysis of this scope was limited to short-term hospital outcomes since several studies did not provide complete data regarding important secondary outcomes like long-term functional status along with quality of life.

The accessible literature lacks studies which reported negative or inconclusive findings thus it remains possible that some studies did not get published. A strong meta-regression assessment was not possible due to the heterogeneous patient data quality and insufficient data granularity.

Given these limitations, the research field needs to focus on performing well-designed multicenter randomized controlled trials which should include standardized criteria for early and delayed intubation scenarios. The clinical value of future research in this field would improve through standardized pre-intubation care protocols and inclusion of patient-centered long-term outcomes which measure functional recovery together with quality of life status. The research needs to focus on identifying optimal intubation timing for specific patient groups including COVID-19 patients and others with different respiratory failure origins while operating within emergency departments.

CONCLUSION

This systematic review with meta-analysis reveals that medical professionals still face substantial uncertainty regarding the best time point for intubating emergency department patients who suffer from acute respiratory failure. The evidence shows early intubation might minimize certain negative outcomes including emergency high-risk intubations together with potential decreased ICU stay duration but research findings show inconsistent mortality results across these studies. Inconsistent results emerge from studies because different patient groups and treatment site characteristics along with varying intubation methods exist.

Medical staff should base their early intubation decisions on personalized assessments which integrate patient disease status with their response to non-invasive support and hospital resources availability. Emergency Department practitioners need to depend on personal clinical skills to manage patient airways because studies on this topic lack sufficient quality.

The review shows that additional research must focus on identifying which patients would get the most benefits from early intubation measures alongside efforts to study the long-term functional outcomes and quality of life improvements in patients.

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