

Intubation bundle: A prospective observational tertiary cancer centre study of clinical practice and adverse events of tracheal intubation out of operation theatre

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ABSTRACT

OBJECTIVE: Tracheal intubation out-of-operation theatre has a higher risk than intubation inside the theatre, and studies on this topic are sparse. Safety interventions during tracheal intubation can reduce adverse events. This study aims to assess current practices, compliance with tracheal intubation bundle guidelines, and the incidence of adverse events during out-of-operating-theatre intubations in our hospital.

METHODS: A prospective observational study was conducted over a 6-month period on all tracheal intubations occurring outside the operating theatre. Data were collected through discussions with the anaesthesia duty team and review of hospital records, using a standardized proforma based on intubation bundle guidelines and adverse events. The variables were summarized using counts and percentages.

RESULTS: Thirty-two patients required out-of-operating-theatre tracheal intubation, with the most common indication being respiratory failure in 13 (40.6%) cases. Airway assessment was performed in 21 (65.6%) cases, and nil per oral status was confirmed in 26 (81.3%) cases. Role planning by the team leader occurred in 27 (84.4%) cases. Fluid loading was administered in 24 (75%) cases, Ryle's tube aspiration in 29 (90.6%) cases, and pre-oxygenation in 30 (93.8%) cases. Rapid sequence induction was used in 26 (81.3%) cases, with first-attempt endotracheal tube placement in 22 (68.8%) cases, aided by a stylet in 21 (65.6%) cases. Capnography was not used in 29 (90.6%) cases to confirm intubation. Alternative airway securing methods (supraglottic airway) were present in 29 (90.6%) cases. Overall, 13 patients (40.6%) experienced adverse events during tracheal intubation.

CONCLUSION: Adverse airway events can be decreased by adhering to the intubation bundle, and staff training should be provided for effective implementation of guidelines. The use of a stylet as an intubation aid helps achieve successful first-attempt intubation and should be incorporated into the bundle. Capnography should be routinely used to confirm endotracheal tube placement.

Keywords: Airway; checklist; intubation bundle; out-of-operation theatre; tracheal intubation.

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Tracheal intubations out-of-operation theatre are commonly performed to secure the airway during emergencies or patient resuscitations. These situations are unpredictable, occur in suboptimal conditions and are often performed without senior supervision, particularly

during odd hours. Such intubations are frequently associated with higher risks compared to those conducted within the operating theatre, due to the lack of immediate access to difficult airway equipment, expert teams, and efficient monitoring post-intubation [1]. Safety in-



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terventions and adherence to tracheal intubation bundle guidelines, can reduce the incidence of adverse events. This study aims to assess the current practice and compliance with these guidelines, and the incidence of adverse events during out-of-operating-theatre intubations at our hospital [2].

MATERIALS AND METHODS

A prospective observational study was conducted on out-of-operating-theatre tracheal intubations at a tertiary care cancer centre from July to December 2021. The study followed the Declaration of Helsinki and received Institutional Review Board approval (IRB No: 07/2021/05) on 2nd July 2021. Patients were selected based on inclusion and exclusion criteria, including all out-of-operating-theatre tracheal intubations, excluding pediatric intubations, cardiac arrest intubations, and intubations without the use of drugs (Fig. 1).

All procedures performed in the study are according to the standard practice methods of the institution and treating team. Data were collected through discussions with the anaesthesia duty team and review of hospital records using a standardized proforma based on intubation bundle guidelines, an intubation checklist, and adverse events. The intubation bundle guidelines include 10 components under pre-intubation, during intubation and post-intubation checklist. They are 1) Presence of two operators 2) fluid loading (isotonic saline 500 ml) in absence of cardiogenic pulmonary oedema, 3) Preparation of sedation, 4) Pre-oxygenation 5) Rapid sequence induction: Etomidate 0.2–0.3 mg/kg or ketamine 1.5–3 mg/kg combined with succinylcholine 1–1.5 mg/kg in absence of allergy, hyperkalaemia, severe acidosis, acute or chronic neuromuscular disease, burn patient for more than 48 h and spinal cord trauma 6) Sellick maneuver. 7) Immediate confirmation of tube placement by capnography 8) Norepinephrine if significant hypotension 9) Initiate sedation 10) protective ventilation.

Patient characteristics, location, and indication for intubations were recorded. The checklist covered airway assessment, preoxygenation, Nil Per Oral (NPO) status confirmation, Ryle's tube aspiration, role planning, availability of oxygen source, crash cart, suction apparatus, intravenous access, and fluid preloading. Induction agents, opioids, muscle relaxants, intubation techniques, aids, number of attempts, alternative airways, and tube position confirmation were documented. Adverse events such as death, significant hypotension, significant hypoxemia, dys-

Highlight key points

- Adverse airway events can be decreased by following the intubation bundle guidelines, with training provided to staff members for effective implementation.
- Stylets should be used as intubating aids to increase first-attempt success rates and should be incorporated into the bundle.
- Capnography should be used routinely to confirm endotracheal tube placement.

rhythmia, difficult intubation, dental injury, esophageal intubation, and aspiration of gastric contents were recorded immediately after intubation by the intubating doctor [3].

Significant hypotension was defined as <20% of baseline systolic arterial pressure; a systolic arterial pressure persistently, 90 mm Hg despite fluid challenge; or a requirement for initiation of vasoactive support [2]. Significant hypoxaemia was defined as a decrease in SpO₂ to lower than 80% [3].

Statistical Analysis

Variables were summarized using counts and percentages. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 11.0 (SPSS Ltd, Chicago, IL).

RESULTS

Thirty-two patients required out-of-operating-theatre tracheal intubation during the 6-month study period with comparable demographic data's (Table 1). The most common indication was respiratory failure in 13 (40.6%) cases (Fig. 2). In accordance with compliance with Intubation bundle; in 21 (65.6%) cases airway assessment was done and NPO status confirmed in 26 (81.3%) prior to intubation. Role planning was assigned by team leader in 27 (84.4%) cases. Fluid loading was given in 24 (75%) cases. Ryle's tube aspiration was done in 29 (90.6%) and pre-oxygenation in 30 (93.8%) cases.

Induction agents, opioids, and neuromuscular blocking agents used were shown in Table 2. Airway was secured in all cases by rapid sequence induction in 26 (81.3%) cases; with endotracheal tube in first attempt 22 (68.8%), with stylet as intubation aid in 21 (65.6%). Capnography was not used in 29 (90.6%) to confirm intubation, instead auscultation was used. Alternative airway securing supraglottic airway was present in 29 (90.6%).

TABLE 1. Patient characteristics and location of intubation

Variable	Frequency (n)	Percent (%)
Age (years)		
0–10	0	0
11–20	0	0
21–30	1	3.1
31–40	4	12.5
41–50	9	28.1
51–60	13	40.6
61–70	4	12.5
71–80	1	3.1
Sex		
Male	15	46.9
Female	17	53.1
Location of intubation		
Surgical ICU	11	34.4
Medical ICU	7	21.9
Surgery ward	5	15.6
Medical ward	4	12.5
Chemo ward	1	3.1
Casualty	3	9.4
Others	1	3.1

ICU: Intensive care unit.

Thirteen patients (40.6%) experienced adverse events (Fig. 3) during out of hospital tracheal intubations. Hypotension in 2 (6.3%) cases, aspiration in 2 (6.3%) cases, dysrhythmias in 2 (6.3%) cases, esophageal intubation in 2 (6.3%) cases, hypoxemia in 1 (3.1%) case, difficult intubation in 1 (3.1%) case, dental injury in 1 (3.1%) case, deaths due to hemodynamic instability in 2 (6.3%) cases.

DISCUSSION

In this prospective observational study, 32 tracheal intubations performed outside the operating theatre at a tertiary cancer center were analyzed. The primary indication for intubation was respiratory failure, accounting for 40.6% of cases. The study observed varying levels of compliance with the intubation bundle guidelines, with notable high adherence to pre-oxygenation (93.8%) and role planning (84.4%), but low use of capnography (9.4%) for intubation confirmation. Adverse events were documented in 40.6% of patients, including hypoten-

TABLE 2. Intubation bundle (n=32)

Variable	Frequency (n)	Percent (%)
Pre-intubation		
Consent	30	93.8
Airway assessment	21	65.6
NPO status	26	81.3
Role planning	27	84.4
Oxygen source available	32	100.0
Crash cart available	32	100.0
Preoxygenation performed	30	93.8
Intravenous access	32	100.0
Fluid pre-loading	24	75.0
Vasopressor available	32	100.0
Suction available	32	100.0
Ryles tube aspiration	29	90.6
Per-intubation		
Induction agent		
Propofol	6	18.8
Ketamine	8	25.0
Etomidate	2	6.3
Propofol and Ketamine	7	21.9
Etomidate and Ketamine	9	28.1
Opioid		
Fentanyl	32	100.0
Neuromuscular blocking agent		
Succinylcholine	28	87.5
Rapid sequence induction	26	81.3
Intubation aids		
Bougie	5	15.6
Stylet	21	65.6
Number of attempts		
1 st attempt	22	68.8
2 nd attempt	8	25.0
3 rd attempt	2	6.3
Alternative airway available		
Supraglottic airway	29	90.6
Airway secured by		
Endotracheal intubation	32	100.0
Post-intubation		
Endotracheal tube confirmation		
Auscultation	29	90.6
Capnography	3	9.4
Debriefing	25	78.1

NPO: Nil per oral.

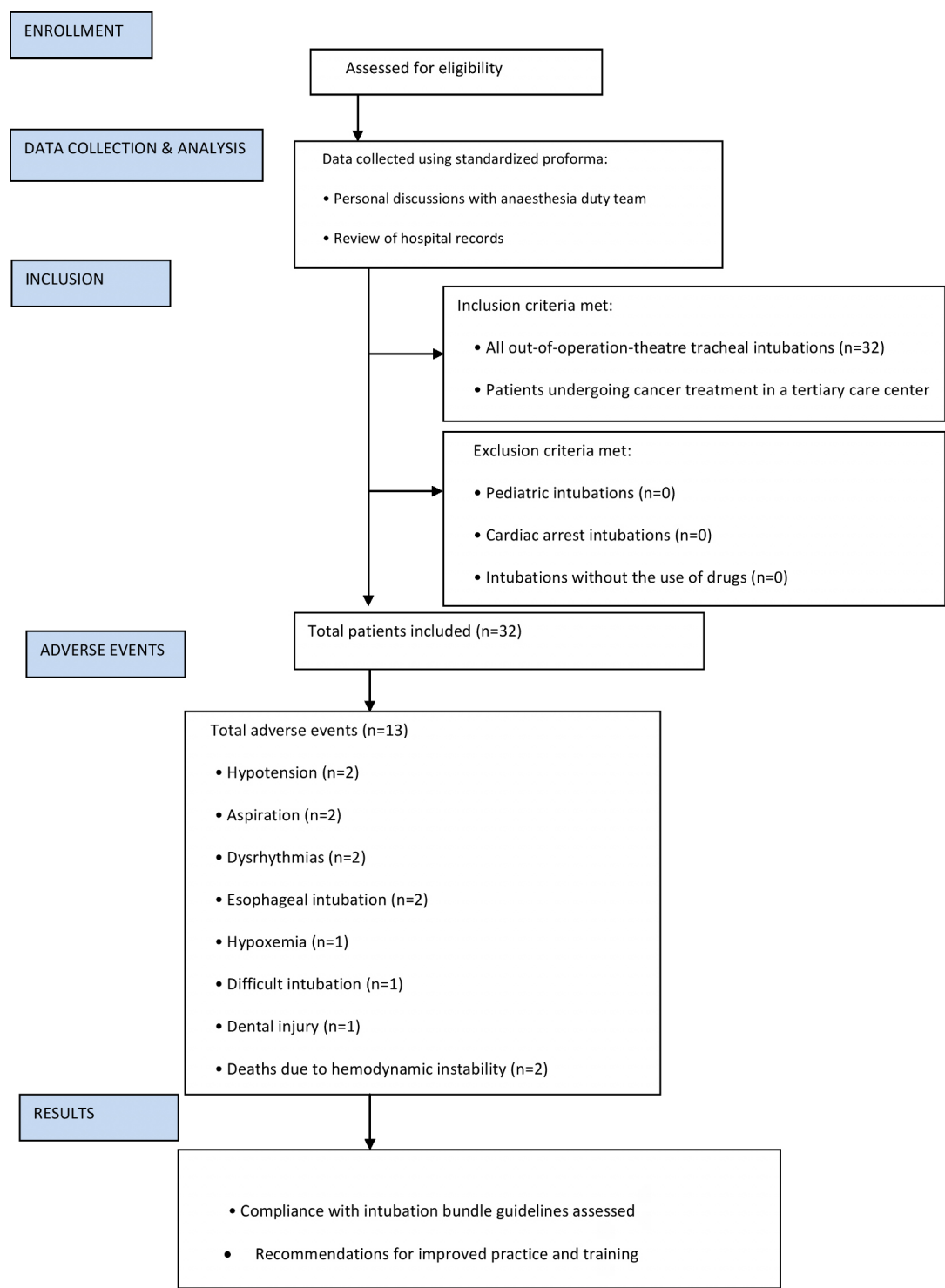


FIGURE 1. STROBE diagram.

sion, aspiration, dysrhythmias, esophageal intubation, hypoxemia, difficult intubation, and dental injury.

This study confirms that tracheal intubations outside the operating theatre are associated with higher risks due to suboptimal conditions and lack of immediate resources

[4]. The high incidence of adverse events (40.6%) underscores the need for strict adherence to intubation bundle guidelines. Most patients in our hospital are undergoing cancer treatment and are immune-compromised. Chemotherapy, radiotherapy, surgery along with other

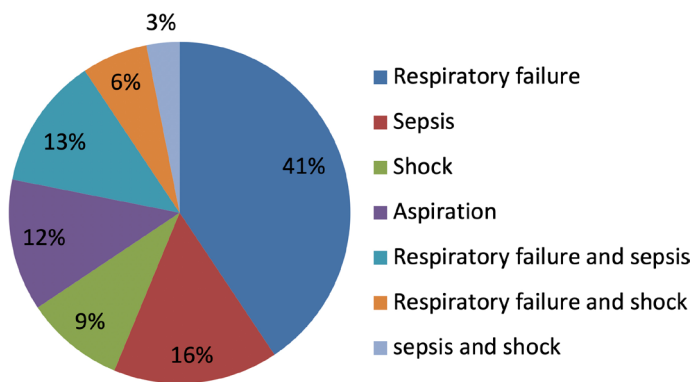


FIGURE 2. Indication for intubation.

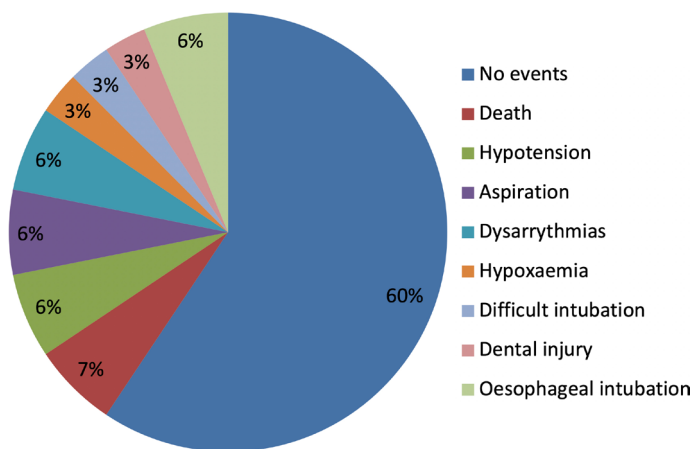


FIGURE 3. Adverse events.

co-morbidities places them at high risk of complications [5]. Head and neck cancers are associated with anticipated difficult airway. Several guidelines were put forward by 4th National Audit Project of the Royal College of Anaesthesiologists [6], Montpellier- ICU intubation algorithm [7, 8], and Difficult Airway Society intubation checklist [9] and it highlight the importance of pre-intubation preparations and role planning [10]. Our findings align with these studies, demonstrating that compliance with bundle guidelines can reduce complications. In this study we assessed the compliance of intubation bundle proposed by Divatia et al. [2, 11].

Pre-intubation variables like airway assessment, NPO status confirmation, role planning by team leader, Ryle's tube aspiration, preloading with fluids, pre-oxygenation and availability of oxygen source, crash cart, suction, and vasopressors can improve the intubation success rate and minimize the adverse effects. Out of 32 cases, 18 intubations were performed in surgical and medical ICUs (34.4% and 21.9%) respectively and during all the in-

tubations there was presence of two operators who are anaesthesiologists and intubation was performed by one of the operators. Respiratory failure, sepsis, shock, aspiration or a combination of these factors were indications for intubation [3].

Preoxygenation aims to increase the duration of the apnea without desaturation, by an increase of the functional residual capacity and the oxygen reserves, thereby reducing the occurrence of hypoxemia [12]. Pre-oxygenation was performed in 30 (93.8%) which has prevented hypoxemia [13]. Role planning was done in 27 cases (84.4%) and rapid sequence induction and sellick maneuver was performed in 26 (81.3%) since most of the patients are not in NPO status, have abdominal distensions or obstructions, gastroparesis etc. and are at high risk of aspiration. Ryle's tube aspiration was done in 29 cases (90.6%) and rapid sequence induction in 26 (81.3%) which has resulted in no aspiration in 30 cases.

Hemodynamic failure is one of the most severe complications associated with endotracheal intubation in the critically ill patients [14, 15]. The PrePARE study [16] concludes that administration of an intravenous fluid bolus did not decrease the overall incidence of cardiovascular collapse during tracheal intubation of critically ill adults compared with no fluid bolus [16, 17]. Fluid loading with 500 ml crystalloids such as ringer lactate or normal saline was done in 24 cases (75%) in patients without cardiogenic pulmonary oedema. Etomidate and Ketamine are recommended for intubating critically ill patients [10]. In this study; Propofol, Ketamine, Etomidate or a combination of these drugs were used for intubation depending on haemodynamic parameters. But in our study only 2 cases had hypotension, the remaining cases were haemodynamically stable may be due to fluid pre-loading 24 (75%) and the use of ketamine as induction agent in 24 cases. No cases required vasopressors like norepinephrine post-intubation may be due to adequate fluid loading and use of ketamine, etomidate as induction agents. Fentanyl was administered for all cases and neuromuscular blockade with succinylcholine was given for 28 (87.5%) cases [18]. Long term sedation was started in all cases as per guidelines.

The presence of consistent capnography waveforms reinforces tracheal placement of the endotracheal tube [19]. The 2009 Intensive care society recommends [1] the use of capnography for tracheal intubation; however in this audit capnography was used only for 3 (9.4%) cases and is concerning due to immediate non availability outside operation theatre. Auscultation was

done in rest of the cases to confirm endotracheal tube position. For instance, studies conducted in developed countries often report higher compliance with capnography use due to better access to advanced monitoring equipment [2, 20]. In contrast, the low utilization of capnography in this study can be attributed to resource constraints and limited availability of equipment, common challenges in resource-limited settings.

First- intubation attempt success is associated with fewer complications related to intubation [20]. As the number of intubation attempts increases, there is high chance of mucosal injury, bleeding, airway oedema, poor visibility of vocal cords and hence results in difficulty in securing airway leading to catastrophes like hypoxia, hypoxic brain injury or even cardiac arrest [2]. The study done by Rusotto et al. [21] found that the incidence of major adverse intubation events was significantly lower with first-pass intubation success. In this study the availability of intubation aids improved successful intubation in first attempt in difficult situations. Intubation with stylet was performed in 21 (65.6%) and bougie in 5 (15.6%) cases respectively. Out of 22 (68.8%) cases which were intubated in first attempt stylet was used in 21 (65.6%) cases which resulted in safe secure of airway. In STYLETO study, a multicentre randomised controlled trial, conducted in 32 intensive care units, among 999 critically ill adults undergoing tracheal intubation, using a stylet improves first-attempt intubation success (78.2%) [22]. The use of stylet as intubating aid during first attempt of intubation can be recommended as it increases the chance of successful intubation. The availability of alternative airway such as supraglottic airway is life saving in difficulty intubation scenarios and unfamiliar locations. This can avoid unnecessary surgical airway manipulations like tracheostomies.

The International Observational Study to Understand the Impact and Best Practices of Airway Management in Critically Ill Patients (INTUBE) study which was an international, multicenter, prospective cohort study involving consecutive critically ill patients from a convenience sample of 197 sites across 29 countries, concluded that cardiovascular instability-were observed frequently peri-intubation, which has lead to mortality and morbidity [21]. In the study conducted by Natesh et al. [23] states that a high incidence of complications (50%), with severe cardiovascular collapse being the commonest during intubation and the importance of vasopressors during intubation. In this audit, 19 (59.4%) patients had no adverse events and were successfully in-

tubated. Hypotension, aspiration, dysarrhythmias and oesophageal intubations were present in 2 patients each (6.3%) respectively and hypoxaemia, difficult intubation and dental injury in rest of patients (3.1%) respectively. Hypotension was managed with fluid boluses and vasopressors; patients who had aspirations were taken care with lung protection ventilator strategies. Dysarrhythmias, especially tachycardia subsided immediately and was managed with sedatives. Oesophageal intubations were reintubated on second attempt with the aid of stylet and airway secured. Hypoxemic episode was transient are saturation was normal immediately after intubation. Patients who had difficult intubation was intubated by the second operator with stylet and airway was secured. Dental injuries were minor and occurred mainly due to loose teeth and misalignment of dentition. All adverse events were adequately managed due to effective team work and role planning. Two death cases were reported as adverse event due to haemodynamic instability, terminally ill and poor general condition of patient. Debriefing was carried out in 25 out of operation theatre scenarios to assess and improve intubation technique and prevent further complications. The incidence of adverse events in this study (40.6%) is higher than the rates reported in some international studies, which typically range from 20–30% [24]. This discrepancy could be due to differences in patient populations, with cancer patients possibly having more complex health issues and higher baseline risks. Additionally, the lack of senior supervision and suboptimal conditions during off-peak hours in this study might contribute to the higher adverse event rate.

The combination of a limited physiologic reserve in the critically ill patients and the potential for difficult mask ventilation and intubation mandates careful planning and justifies the use of an guideline based approach to tracheal intubation [12, 25]. Intubation bundle guidelines when followed in reliable manner, improves patient outcome in difficult scenarios [26, 27].

Conclusion

The study on tracheal intubations conducted outside the operating theatre at a tertiary cancer center highlights several critical insights into clinical practices and the occurrence of adverse events. The findings underscore the significant role of adherence to intubation bundle guidelines in minimizing complications during these high-risk procedures. Adherence to intubation bundle guidelines can significantly reduce adverse airway events.

Recommendations for further improvement are regular training for staff on intubation bundle guidelines; incorporation of stylet on first attempt of intubation; routine use of capnography for verifying tube placement. Policies for the resuscitation of terminally ill patients should be reviewed to avoid unnecessary intubations. This study provides a foundation for future improvements in clinical practice and emphasizes the ongoing need for vigilance and adherence to safety protocols in airway management.

Ethics Committee Approval: The Regional Cancer Centre granted approval for this study (date: 02.07.2021, number: 07/2021/05).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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