

Actionable Patient Safety Solutions (APSS) #8B: **Unplanned extubation (UE)**

How to use this guide

This guide gives actions and resources for creating and sustaining safe practices for unplanned extubation (UE). In it, you'll find:

Executive summary checklist.....	272
What we know about UE.....	274
Leadership plan	274
Action plan	275
Technology plan	276
Measuring outcomes.....	278
Conflicts of interest disclosure	280
Workgroup	281
References	282



Patient Safety
MOVEMENT

APSS #8B: Unplanned extubation (UE)

Executive summary checklist

A planned extubation occurs as part of a normal process of weaning the patient from their breathing tube. It is typically intentional and occurs in a controlled manner. Unplanned extubation (UE) is typically the unintentional and uncontrolled dislodgement of a patient’s breathing tube that occurs outside of a strategic weaning process. The dislodgement may occur when the patient exerts a force to remove the tube (self-extubation) or by an external force applied to the tube (accidental extubation). Both self-extubation and accidental extubation may present with the tube completely removed from the patient’s oral cavity or the tube may remain internal and appear to be in the proper position, however, EtCO₂ indicates it is no longer in the trachea (internal dislodgement). In neonates, the position of the tube may become mal positioned outside of the trachea and remains within the posterior pharynx (internal dislodgement) but may be difficult to confirm proper positioning due to lack of EtCO₂ monitoring and occasionally unreliable colorimetric CO₂ detection. In those cases, the practitioner may decide to extubate and reintubate the patient. This type of extubation, although intentional, is done outside of a normal weaning process and therefore is also classified as unplanned. Another intentional extubation that is done outside a normal weaning process occurs when there is a malfunction of the endotracheal tube (obstruction, deflation of balloon, etc.) and therefore the tube must be urgently or emergently removed and replaced and is considered an unplanned extubation.

Extubation Classification Schema							
Reason for Extubation	Intentional	Unintentional	Part of Strategic Wean	Not Part of Strategic Wean	Controlled	Uncontrolled	Extubation Type
Normal Extubation: Part of normal weaning process:	X		X		X		PLANNED
Self Extubation:		X		X		X	UNPLANNED
Accidental Extubation:		X		X		X	UNPLANNED
Device Malfunction: Obstructed ETT or Deflated Balloon:	X			X	X		UNPLANNED
Possible Internal Dislodgement (unable to confirm due to No ETCO ₂):	X			X	X		UNPLANNED
<p>Intentional: Decision is made by an airway provider to extubate Unintentional: Extubation occurs without a decision by airway provider to extubate</p> <p>Part of Strategic Wean Extubation is part of strategic weaning process from the mechanical ventilation Not Part of Strategic Wean Extubation is not part of the normal strategic weaning process (i.e. self-extubation, accidental extubation, obstructed ETT, balloon malfunction, internal dislodgement)</p> <p>Controlled: Extubation is controlled: airway is suctioned and balloon is deflated by airway provider prior to extubation Uncontrolled: Extubation is not controlled: balloon is not deflated by airway provider prior to extubation</p>							

UE, both in the field and in the hospital, is a common and costly problem and results in significant morbidity and mortality.

The information in this document relates to adult patients.

A specific APSS (#8D) addressing unplanned extubation in the pediatric and neonatal population has also been published.

Use this checklist to help prioritize your actions and measure your organization’s progress in your UE prevention.

Create an action plan to prevent UE

- Form a core multidisciplinary airway safety leadership team, including:
 - Quality/Safety Leadership (Preferably Director / VP level or higher)
 - Physician, nursing, and respiratory care team leaders across all hospital units to ensure recognition of the problem and support the development of systems that will eliminate UE and its associated complications, especially preventable deaths
 - Create a leadership plan where top level leadership regularly review a dashboard of occurrences of UEs, the complications that occur due to UE, and the cost of these occurrences in morbidity, mortality and healthcare dollars

Engage staff and ensure best patient care

- Provide periodic education for all airway management providers:
 - Educate providers regarding the importance of prevention of UE and the need for accurate data tracking
 - Include UE as part of every presentation about management of the intubated patient, especially in patients with difficult airways
- Implement Clinical Best Practices for Preventing UE:
 - Standardize tracheal tube restraint devices, using the most proven methods and devices
 - Utilize strategies for high-risk situations
 - Formalize systems for appropriate sedation and patient restraint to decrease the risk of unplanned self-extubation
 - Create systems for alerting clinicians to patients with a known difficult airway
- Use patient stories, in written and video format, to identify gaps and inspire change in your staff

Track UE and use data to find areas for improvement

- Determine baseline rate of UE (see Measuring Outcomes section)
- Determine baseline rate of complications (oral mucosa and facial skin pressure injuries, pneumonia, vocal cord injury, hypoxemia, brain injury, death) caused by UE
- Perform an event review for all incidences of UE
- Perform a root cause analysis (RCA) for all deaths associated with UE: Use a multidisciplinary team including physicians, nurses, and respiratory therapists to evaluate the root cause of every UE, determine a plan to eliminate the root cause, implement the plan, and track results
- Institutions should use the techniques described in Failure Modes and Effects Analysis or Safety II to create strategies that mitigate the risks of UE
 - Use a multidisciplinary team including physicians, nurses, and respiratory therapists to evaluate the root cause of every UE, determine a plan to eliminate the root cause, implement the plan, and track results
 - Institutions should use techniques described in Failure Modes and Effects Analysis or Safety II to create strategies that mitigate the risks of UE
- Implement the core UE dataset as defined in the Measuring Outcomes section of this APSS:
 - Every (endotracheally) intubated, mechanically ventilated patient should have the

entire PSMF core dataset for extubation recorded in the electronic medical record (EMR)

- Evaluate your hospital's EMR to determine if the entire core dataset is included in the EMR
 - If not included, contact the EMR company and request they add the dataset - develop a system for temporarily tracking the dataset until the EMR company institutes the dataset
- Develop a Quality Management Process to promote and ensure continuous improvement with an initial goal of eliminating preventable deaths from UE and ultimately eliminating all incidents of UE:
 - Mandate tracking and reporting of all incidents of UE and complications of UE, including hypoxemia, pneumonia, vocal cord injury, brain injury and death
- Use patient stories- in written and video formats- to identify gaps and inspire change in your staff

What we know about UE

UE, both in the field and in the hospital, is a common and costly problem. An extensive review of 50 studies revealed:

- 7.3% (range 0.5% - 35.8%) of adult endotracheally intubated Intensive Care Unit (ICU) patients are affected by an unplanned extubation (daSilva et al., 2012; Anesthesia & Analgesia, 2012)
- 1.65 million patients are intubated and mechanically ventilated each year in U.S. adult ICUs according to The Society for Critical Care Medicine's 2017 statistics
- Extrapolation of the average 7.3% UE rate to intubated patients in U.S. adult ICUs would suggest that there are over 120,000 UEs annually
- Based on morbidity and mortality data, those 120,000 UEs are associated with over 33,000 deaths (De Lassence et al., 2002)
- UE increases the incidence of pneumonia from 14% to 30% (De Lassence et al., 2002), resulting in over 36,000 pneumonias annually
- UE more than doubles the average ICU stay (De Lassence et al., 2002), increasing 9 days to 18 days (De Lassence et al., 2002)
- Complications of UEs in US adult ICUs result in over \$4.9 billion in unnecessary healthcare costs (Dasta, McLaughlin, Mody, and Piech, 2005; Needham and Pronovost, 2005).

The need to accurately track UE

Although the incidence of UE is likely higher in emergency medical services (EMS) settings due to difficulties of transporting critically ill patients in a chaotic environment, UE is not tracked in most EMS systems. Similarly, many hospitals do not track UE. Currently, none of the major electronic health records include the UE core dataset. To obtain an accurate measure of frequency and cost of prehospital and in-hospital UE, we must develop widespread systems to accurately track all incidences.

Closing the performance gap will require hospitals and healthcare systems to commit to actions in the form of specific leadership, practice, and technology plans. This APSS gives examples to help hospitals prioritize their efforts at designing and implementing evidence-based bundles for reducing UE.

Leadership plan

Hospital governance, senior administrative leadership, quality and safety leadership, risk management leadership, and clinical leadership must work collaboratively to reduce UE.

Show leadership's commitment to reduce UE

- Hospital governance and senior administrative leadership must commit to and take action reducing the incidence of UE with a goal of zero preventable deaths
- Raise awareness regarding the frequency, cost and consequences of UE
- Determine the facility's rate of UE through reporting and tracking within a formal Quality Improvement (QI) program, and engage QI/Patient Safety to implement steps to reduce the incidence of UE and eliminate preventable deaths:
 - After you know your facility's incidence rate, develop an organizational story and use the skill set of storytelling to raise organizational awareness and actions to stay

focused on why there is a need for change

- Demonstrate commitment and support by shaping a vision of the future, clearly defining goals, and supporting staff as they work through improvement initiatives, measuring results, and communicating progress towards those goals

Create a team to reduce UE

The core multidisciplinary team should consist of the following:

- Quality/Safety Leadership (Director / VP or higher)
- Physician, nursing, and respiratory care team leaders from ED, OR/PACU, and ICU
- Neonatal/Pediatric representation (expertise) is crucial - please see APSS (#8C, #8D)

Engage staff and make policy changes to reduce UE

- Commit to defining performance gaps within the organization (system-wide, hospital-wide, and by department)
- Support a comprehensive approach to standardized data tracking, quality management, and process improvement efforts, and implementation of practice and technology plans necessary to eliminate UE
- Use patient stories - in written and video formats - to identify gaps and inspire change in your staff:
 - The story of Drew Hughes, told by his father David Hughes, is an example of an UE that led to the preventable death of Drew. You can view Drew's story here: <https://www.youtube.com/watch?v=239pVWepOHg>

Action plan

Create protocols to reduce UE

- Use current evidence-based guidelines and known best practices during airway management of the intubated patient to eliminate incidents of UE
- Implement systems for alerting clinicians to patients with a known difficult airway
- Position the endotracheal tube with the tip of the tube within the optimal tip position range (for adults this is half-way between the glottis and the carina (about 2-6 cm above the carina), and the majority of endotracheal tubes have a suggested vocal cord marker on the side) - correct initial positioning of the endotracheal tube decreases the risk of UE if the tube moves
- Once appropriately positioned, maintain that position with a tube stabilizer that eliminates clinically significant movement of the tube
- Utilize proven strategies for high-risk situations (Kandil, 2018):
 - Require 2 caregivers to participate in the identification and tracking of ETT positioning before and after any bedside manipulation, adjustment of the ETT or movement of any patient with an ETT (Movement includes any bedside procedure, radiographs, patient transport and simple patient repositioning of the head and upper body).
 - One caregiver should have the sole responsibility for protecting the ETT, often called an "airway guardian"
 - Before any movement of the patient, the caregiver who is responsible for the security of the ETT should perform a verbal call-out of the depth of the ETT. After movement

of the patient is completed, a second verbal call-out of the ETT depth is performed, along with confirmation that the position of the ETT has not changed.

- All healthcare providers are responsible to ensure that the high-risk strategies are utilized at all times.
- Restrain the patient using a combination of physical restraint and chemical restraint (sedation):
 - Institute a continuous sedation protocol with daily interruption of sedatives
 - Avoid intermittent or no sedation protocols (Chao et al., 2017)
 - Communication about sedation interruption/vacation should be an integral part of daily rounds/huddles for all intubated patients and should include all members of the team, including the respiratory therapy team.
 - The risks and benefits of sedation and restraint should be carefully considered, especially in the patient with a known difficult airway.
- Use Continuous Waveform Capnography in ALL intubated patients to ensure rapid recognition of a malpositioned tube:
 - The initial clinical evaluation of any cardiopulmonary arrest in an intubated patient should include determination, via continuous waveform capnography, that the endotracheal tube is correctly positioned and the patient is being adequately ventilated. Waveform capnography along with clinical evaluation must be used to make this determination. Assume that the lack of a capnography waveform is due to a malpositioned endotracheal tube until proven otherwise - "Flat trace, wrong place."
 - If the evaluation suggests the tracheal tube might be mal-positioned, outside the trachea (unplanned extubation), the patient must be immediately reintubated. UE should be considered as the cause of the arrest and a root cause analysis of the unplanned extubation performed
- Communication about sedation interruption/vacation should be an integral part of daily rounds/huddles for all intubated patients and should include all members of the team, including the respiratory therapy team

Track and analyze your progress

- Develop a Quality Management Process to promote and ensure continuous improvement with an initial goal of eliminating preventable deaths from UE and ultimately eliminating all incidences of UE. To do this:
 - Every extubation should be classified according to the Extubation Classification Schema to ensure that all incidents of UE are identified and not overlooked
 - Review all incidents of UE
 - Determine root causes, which may include:
 - Inadequate stabilization of the endotracheal tube
 - In appropriate sedation (chemical restraint)
 - Inadequate physical restraint
 - Inadequate monitoring
 - Inadequate patient supervision
 - Plan and implement changes to the system based upon findings from reviews
 - Track UE to determine if the implemented processes cause improvement

- Require tracking and reporting of all incidents of UE and complications of UE (e.g., hypoxemia, pneumonia, vocal cord injury, brain injury, and death)

Create best practices for out-of-hospital management of UE

- Airway management in the field (EMS/military) should incorporate the same prevention, tracking, and quality management concepts as described above for medical facilities
- All patients that are transported with an endotracheal tube in place must receive continuous waveform capnography to ensure early recognition of displacement of the tube. Failure to rapidly recognize and correct a displaced tube has a very high probability of hypoxemia that can result in severe brain injury and death.
- All incidents of UE in the field must be reported to the receiving facility during hand-off communications
- EMS airway provider must communicate the incident of UE to the receiving facility and the receiving providers should consider antibiotic therapy to reduce the likelihood of pneumonia - the incidence of pneumonia doubles in patients who experience a UE

Technology plan

These suggested practices and technologies have shown proven benefit or, in some cases, are the only known technologies for certain tasks. If you know of other options not listed here, please complete the form for the PSMF Technology Vetting Workgroup to consider:

patientsafetymovement.org/actionable-solutions/apss-workgroups/technology-vetting/

Test and use airway management devices that improve safety and drive better patient outcomes, including:

System or Practice	Considerations
ONC Meaningful Use Certified Electronic Medical Record (EMR) System	<ul style="list-style-type: none"> • EMR equipped with the following capabilities: • Computerized Provider Order Entry (CPOE) • Drug-drug interaction check • Drug-allergy interaction check • Clinical Decision Support tools (CDS) • Endotracheal tube (ETT) depth alerts for documentation of placement that is outside the normal range • An alert if >6 hours since patient completed and passed a spontaneous breathing trial

<p>Standardize tracheal tube restraint devices</p>	<p>The current methods and devices for stabilizing endotracheal tubes include:</p> <ul style="list-style-type: none"> • Adhesive tape • Cotton twill ties • Multiple commercial devices <p>The literature does not clearly identify any device or technique currently on the market that is superior at preventing movement against externally applied forces. However, numerous devices on the market are clearly inferior in their ability to restrain the tube against extubation forces.</p> <p>Therefore, when choosing an endotracheal tube stabilizer, the device’s ability to restrain against applied force should be the primary consideration.</p> <p>Secondary considerations include: ease of use, facilitation of oral / dental care, and prevention of skin breakdown / medical device related pressure injuries..</p> <p>A review article, published in 2012 in Anesthesia and Analgesia (da Silva, et al., 2012), which evaluated more than 50 studies published worldwide, demonstrated an average rate of UE of 7.3% (range 0.5% - 35.8%). This high rate of UE suggests that current stabilization techniques and devices are inadequate and therefore further research into developing better stabilization systems should be supported to achieve zero preventable deaths.</p> <p>Optimal endotracheal tube stabilizers should:</p> <ul style="list-style-type: none"> • Be secure • Be fast and easy to apply • Provide easy access to the mouth for routine oral care • Be repositionable and not exert any major pressure points to the skin or oral mucosa that would cause ischemic tissue injury <p>In adults, the stabilizer should, at a minimum, prevent clinically significant movement that could result in an UE. Optimally, it should prevent any movement of the endotracheal tube relative to the stabilizer. Even small incremental movements can result in UE.</p>
<p>Waveform Capnography</p>	<p>Mandate the use of continuous waveform capnography in ALL intubated patients to ensure rapid recognition of a mal-positioned tracheal tube.</p> <p>This important technology has become the standard of care for intubated patients in the UK and parts of Europe. United States’ ICUs, EDs and EMS are beginning to adopt this technology, but significant gaps exist. Continuous waveform capnography should become a mandated safety practice for all intubated patients.</p>

Measuring outcomes

Key performance indicators

- UE in intubated patients
- Rate of UE for patients intubated via endotracheal tube

Outcome measure formula

Numerator: Number of incidents of UE in patients intubated via an endotracheal tube

Denominator: Total number of days intubated

*Rate of unplanned extubation is expressed in terms of: number of incidents unplanned extubation per 100 intubation days

Metric recommendations

Direct impact: All patients intubated via endotracheal tube

Lives spared harm:

Lives Spared Harm = $\text{Unplanned Extubation Rate}_{\text{baseline}} - \text{Unplanned Extubation}_{\text{measurement}} \times \text{Days Intubated}^*_{\text{baseline}}$

* Days Intubated is the Outcome Measure Formula Denominator: (Total Number of Intubated Days)

Data collection

Use a tracking sheet for UEs. Data is best collected through electronic capture of data fields from electronic patient care reports. This requires having an EMR system that includes the following PSMF Core Data Set for UE:

- Does the patient have a history of a difficult airway (and/or failed intubation)?
- What method was used to identify the difficult airway patient?
- Was a pre-intubation assessment predictive of a difficult airway?
- Route of intubation (e.g., oral, nasal, or tracheostomy)
- What was the method of tube restraint? (e.g., tape, twill, commercial tube holder); if a commercial tube holder, specify the type
- Date and time of extubation
- Extubation type (planned or unplanned)
- UE cause (self-extubation or accidental extubation)
- Location where the UE occurred (e.g., GI suite)
- Did UE occur while the patient was being transported or moved?
- Was the patient adequately restrained at the time of extubation?
- Was the patient adequately sedated at the time of extubation?
 - o Facility sedation policy type (continuous with daily interruptions, intermittent, no sedation)
- Was reintubation required?
- Was reintubation attempted (successful or unsuccessful)?
- Outcome/complications of UE (e.g., pneumonia, vocal cord injury, hypoxemia, brain injury, death)

- Did the UE occur during a sedation interruption or “sedation vacation”?
 - Was the respiratory therapist made aware of the sedation vacation?
 - Did appropriate communication to all members of the team (i.e. between nurse and respiratory therapist) occur related to the initiation of the sedation interruption or “sedation vacation”?
- Was the patient on spontaneous breathing trials?
 - If so, was there a delay in extubation due to a delay in the physician ordering the extubation?
- What team members were present when the UE occurred?
- Encourage the addition of an “other” field in the EMR to collect information to learn about new or specific trends identified by staff

Extubation Classification Schema							
Reason for Extubation	Intentional	Unintentional	Part of Strategic Wean	Not Part of Strategic Wean	Controlled	Uncontrolled	Extubation Type
Normal Extubation: Part of normal weaning process:	X		X		X		PLANNED
Self Extubation:		X		X		X	UNPLANNED
Accidental Extubation:		X		X		X	UNPLANNED
Device Malfunction: Obstructed ETT or Deflated Balloon:	X			X	X		UNPLANNED
Possible Internal Dislodgement (unable to confirm due to No ETCO2):	X			X	X		UNPLANNED
<p>Intentional: Decision is made by an airway provider to extubate Unintentional: Extubation occurs without a decision by airway provider to extubate</p> <p>Part of Strategic Wean: Extubation is part of strategic weaning process from the mechanical ventilation Not Part of Strategic Wean: Extubation is not part of the normal strategic weaning process (i.e. self-extubation, accidental extubation, obstructed ETT, balloon malfunction, internal dislodgement)</p> <p>Controlled: Extubation is controlled: airway is suctioned and balloon is deflated by airway provider prior to extubation Uncontrolled: Extubation is not controlled: balloon is not deflated by airway provider prior to extubation</p>							

This standardized core dataset should be incorporated (by legislative mandate if necessary) by all major EMR companies to facilitate hospitals’ ability to track UE:

- Many hospitals’ Electronic Medical Records currently do not have the PSMF Core Data Set for UE and any information on UE is difficult to retrieve from narratives and notes. Any hospital whose EMR does include the PSMF Core Dataset should contact their EMR company and request adoption of the PSMF Core Dataset for UE.
- Risk factors for UE should be measured including patient sedation and patient restraint
- Rate of complications and mortality related to incidents of UE are important to determine the extent of adverse effects of UE:
 - Rate of pneumonia in intubated patients with an incident of UE compared to rate of pneumonia in intubated patients without an incident of UE
 - Rate of severe brain injury in intubated patients with an incident of UE compared to the rate of brain injury in intubated patients without an incident of UE
 - Mortality rate in intubated patients with an incident of UE compared to the rate of mortality in intubated patients without an incident of UE

Mortality (will be calculated by the Patient Safety Movement Foundation)

The PSMF, when available, will use the mortality rates associated with Hospital Acquired Conditions targeted in the Partnership for Patients’ (PfP) grant funded Hospital Improvement

Innovation Networks (HIIN). The program targeted 10 hospital-acquired conditions to reduce medical harm and costs of care. “At the outset of the Partnership for Patients initiative, HHS agencies contributed their expertise to developing a measurement strategy by which to track national progress in patient safety—both in general and specifically related to the preventable HACs being addressed by the PpP. In conjunction with CMS’s overall leadership of the PpP, AHRQ has helped coordinate development and use of the national measurement strategy. The results using this national measurement strategy have been referred to as the “AHRQ National Scorecard,” which provides summary data on the national HAC rate (Agency for Healthcare Research and Quality, 2015). Adverse events related to UE were not included in the AHRQ National Scorecard document. 61% of patients experiencing UE do not require reintubation and those patients have a low mortality rate (5%) (Gao, et al., 2016) . 39% of patients experiencing UE require reintubation and those patients have a high mortality rate (37%) (Gao, et al., 2016) . The overall mortality rate for all incidents of UE is 28% (de Lassence et al., 2002) and accounts for over 33,000 deaths annually, in the U.S.

Conflicts of interest disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Some of the APSSs recommend technologies offered by companies involved in the Patient Safety Movement Foundation. The workgroups have concluded, based on available evidence, that these technologies work to address APSS patient safety issues. Workgroup members are required to disclose any potential conflicts of interest.

Workgroup

Chairs

- Lorraine Foley** Society for Airway Management
- David Hughes** Do It For Drew Foundation
- *Arthur Kanowitz** Airway Safety Movement, Society for Airway Management, Securisyn Medical

Members

This list represents all contributors to this document since inception of the Actionable Patient Safety Solutions.

- Gillian Abir** Stanford University
- Sharon Armstead** Ascension Health
- Jim Augustine** US Acute Care Solutions, LLC
- Steven Barker** Patient Safety Movement Foundation; Masimo
- Michel Bennett** Patient Safety Movement Foundation (formerly)
- Lauren Berkow** Society for Airway Management
- Jestin Carlson** Allegheny Health Network
- Richard Cooper** University of Toronto

Gina Farquharson	Medtronic
Drew Fuller	Emergency Medicine Associates
Kate Garrett	Ciel Medical
Mitch Goldstein	Loma Linda University
Victor Grazette	Virginia Hospital Center
Hans Huitink	VU University Medical Center
Thomas Kallstrom	American Association for Respiratory Care
Sarah Kandil	Yale New Haven Children's Hospital
Ariana Longley	Patient Safety Movement Foundation
Jacob Lopez	Patient Safety Movement Foundation (formerly)
Olivia Lounsbury	Patient Safety Movement Foundation
Ariel MacTavish	Medtronic
Rhea May	Medtronic
Kevin McQueen	University of Colorado Health, Memorial Hospital Colorado Springs
Joaquim Pinheiro	Albany Medical Center
Micheline Plantada	Advocate
Donna Prosser	Patient Safety Movement Foundation
Kellie Quinn	Advocate
Patricia Roth	UCSF Medical Center
Claire Roy	Patient Safety Movement Foundation
Kenneth Rothfield	Medical City Dallas
Stacey Schoenenberger	St. Vincent's HealthCare
Rahel Selassie	Advocate
Michael Taylor	Fairview Hospital
Dianne Vass	Museum of Pop Culture
Donna Wood	Airway Safety Movement
Metrics integrity	
Robin Betts	Kaiser Permanente, Northern California Region

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