ACTT Preparation Manual

Chapter 1: Purpose and Use of This Manual

Royal Canadian Navy Physician Assistant Focus

1.1 Purpose

This manual is designed to support preparation for the Acute Casualty Care Team Training (ACTT) course with a specific focus on the needs of a Royal Canadian Navy Physician Assistant working at sea. It organizes the high-yield clinical and operational material drawn from your source set into a practical format that can be used before, during, and after the course.

The manual is built to do four things:

- prepare you for the major ACTT knowledge areas and expected clinical decision points
- provide a structured study resource for repeated review
- serve as a quick operational reference during training
- remain useful afterward as a shipboard prolonged-care reference

1.2 Intended User

This manual is written primarily for:

- Royal Canadian Navy Physician Assistants
- other clinicians working in shipboard or austere military environments
- learners preparing for ACTT-level trauma, critical care, and prolonged field care concepts

Although the focus is naval and military, the content will also include civilian-standard principles where they help clarify best practice, comparison points, or broader learning beyond shipboard scope.

1.3 Scope

This manual is not limited to a single course serial. It is intended to remain useful any time you need to review ACTT-relevant material.

The scope includes:

- trauma and critical care principles emphasized in ACTT
- advanced procedural knowledge
- medication use relevant to trauma, sedation, shock, and prolonged care
- delayed evacuation and patient holding up to 72 hours
- at-sea adaptation of care in resource-limited settings
- shipboard formulary cross-reference, without restricting learning only to onboard stock

This manual will include both what is ideal or standard practice and what is practical in the shipboard environment.

1.4 How to Use This Manual

A. Before the Course

Use this manual as a structured study guide to:

- review major algorithms
- memorize high-yield thresholds and triggers
- understand procedure steps

- identify medication indications, dosing, preparation, and monitoring
- rehearse likely ACTT problem areas such as airway, shock, TBI, burns, and prolonged holding

B. During the Course

Use this manual as a rapid reference for key numbers, drug doses, procedural reminders, contraindications, common pitfalls, and algorithm flow. It should support quick review, not replace active instruction or course direction.

C. After the Course

Use this manual as an ongoing reference for refresher training, shipboard review, scenario preparation, and sustaining knowledge in high-risk, low-frequency skills.

1.5 Operational Context

The material in this manual is interpreted through the reality of delayed MEDEVAC, limited onboard diagnostics and personnel, finite medication and equipment availability, the need for prolonged monitoring and reassessment, and the requirement for practical team coordination and remote consultation.

Because of that, the manual will repeatedly address:

- what must be done immediately
- what can be sustained over hours
- what must be monitored while awaiting evacuation
- what changes when ideal resources are not available

1.6 How the Manual Is Organized

The manual is arranged to move from broad understanding to bedside action. It progresses through core ACTT priorities and domains, major algorithms and decision pathways, procedures, medication reference, prolonged holding and delayed MEDEVAC, critical thresholds, pitfalls and errors, shipboard application, team and operational practice, and quick-reference appendices.

This structure is meant to support both systematic studying and fast retrieval under pressure.

1.7 Medication Use Within the Manual

Integrated Within Clinical Sections

Each relevant chapter will include the medications used in that problem or procedure, including when to give them, how much to give, how to prepare them, how to administer them, and what to watch for.

Dedicated Drug Reference Section

A separate medication chapter will also collect these drugs into one place for rapid lookup.

Where relevant, the manual will distinguish:

- onboard and currently stocked
- not listed onboard
- reasonable substitutes
- learning points that remain important even if outside current ship capability

1.8 Limits of the Manual

This manual is a structured training and reference aid. It is not a substitute for formal course instruction, current standing orders, local medical directives, specialist consultation, or real-time clinical judgment.

Where source material conflicts with civilian practice, Canadian practice, or shipboard realities, those differences should be identified and explained clearly in later chapters.

1.9 End State

By using this manual, the goal is that you should be able to:

- recognize major ACTT-critical presentations quickly
- recall the immediate next steps
- perform or prepare for key procedures
- use relevant medications safely
- avoid common high-risk errors
- sustain safe, organized care in delayed evacuation scenarios at sea

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Chapter 2: Course Framework and Core Learning Priorities

Royal Canadian Navy Physician Assistant Focus

2.1 Purpose of This Chapter

- Explain what ACTT is trying to train at a practical level.
- Identify the highest-yield areas most likely to matter in the course.
- Set the study priorities for the rest of the manual.
- Frame the material through the RCN at-sea and delayed evacuation context.

2.2 What ACTT Appears to Emphasize Most

- Repeatedly emphasized themes from the source set.
- Why these areas matter operationally.
- High-risk, low-frequency skills versus routine knowledge.
- Clinical stabilization before evacuation as a central goal.

2.2.1 Highest-Yield Repeated Themes

- Airway and respiratory management.
- Hemodynamics, shock, and resuscitation.
- TBI recognition and management.
- Burn assessment and burn resuscitation.
- Pharmacology, sedation, and analgesia.
- Prolonged field care and austere care principles.
- Team-based procedural and operational performance.

2.3 Core Clinical Priorities

- The major clinical problems the learner must be prepared to manage.
- Initial recognition, immediate intervention, and ongoing reassessment.

2.3.1 Airway and Respiratory Priorities

- Airway assessment and early recognition of failure.
- Need for a definitive airway.
- Failed airway planning.
- Oxygenation and ventilation targets.
- Thoracic causes of respiratory compromise.
- Respiratory monitoring as a continuing process.

2.3.2 Hemodynamic and Shock Priorities

- Recognition of shock states.
- Immediate perfusion goals.
- Fluid versus blood versus vasopressor decisions.

- Monitoring response to resuscitation.
- Shock in trauma versus sepsis versus burns.

2.3.3 Neurologic Priorities

- TBI severity recognition.
- Airway implications of reduced GCS.
- ICP concerns and herniation recognition.
- Seizure management.
- Avoidance of secondary brain injury.

2.3.4 Burn Priorities

- Burn size and depth recognition.
- Airway concerns in burns and inhalation injury.
- Fluid resuscitation priorities.
- Urine output monitoring.
- Escharotomy recognition points.

2.3.5 Infectious and Sepsis Priorities

- Early recognition of sepsis in limited-resource settings.
- Antibiotic timing.
- Source-based empiric therapy.
- Restricted versus aggressive fluid strategy depending on context.
- Escalation to vasopressors.

2.3.6 Cardiovascular Emergency Priorities

- STEMI recognition.
- Time-sensitive reperfusion decisions.
- When fibrinolysis becomes relevant.
- Monitoring for complications after treatment.

2.4 Core Procedural Priorities

- Which procedures appear central to ACTT performance.
- Which procedures are must know versus recognize and prepare for.

2.4.1 Airway Procedures

- RSI setup and execution.
- Endotracheal intubation.
- Surgical cricothyroidotomy.
- Needle cricothyroidotomy as temporizing rescue.

2.4.2 Thoracic Procedures

- Needle thoracostomy.
- Chest tube thoracostomy.
- Recognition of when decompression is not enough.

2.4.3 Vascular and Monitoring Procedures

- IO access.
- Foley catheter for output monitoring.

- Basic procedural priorities in prolonged care.

2.4.4 Other High-Acuity Procedures

- Emergency pericardiocentesis.
- Shoulder reduction techniques.
- Procedure preparation, confirmation, and complications.

2.5 Pharmacology as a Core ACTT Skill

- Drugs are not a side topic; they are part of decision-making and procedure performance.
- Medication knowledge is expected at the bedside, not just in theory.

2.5.1 High-Priority Drug Categories

- Analgesics.
- Sedatives.
- Induction agents.
- Paralytics.
- Vasopressors and inotropes.
- Seizure medications.
- ICP-directed medications.
- Fibrinolytics and adjuncts.
- Reversal agents.
- Empiric antibiotics.

2.5.2 What Must Be Known About Each Drug

- Indication.
- Dose.
- Route.
- Preparation.
- Administration method.
- Monitoring.
- Adverse effects.
- Common errors.
- Substitutes and onboard alternatives.

2.6 Prolonged Field Care and Austere Care as a Cross-Cutting Theme

- Immediate stabilization is only the start.
- Ongoing care over hours matters in ACTT.
- Delayed evacuation changes priorities.

2.6.1 What Changes in Austere and Prolonged Care

- Reassessment becomes continuous.
- Trend monitoring becomes more important than isolated values.
- Medication planning shifts from single dose to ongoing management.
- Fluids and output require ongoing adjustment.
- Sedation and pain control must be sustainable.
- Documentation and handover become more important over time.

2.6.2 Relevance to RCN At-Sea Practice

- Delayed MEDEVAC.
- Limited staffing.
- Limited diagnostics.
- Finite stock and equipment.
- Need to bridge care until higher-level transfer.

2.7 Non-Technical Priorities

- ACTT is not only about procedures and drug doses.
- Team performance affects outcomes.

2.7.1 Team Coordination

- Pre-procedure briefs.
- Role assignment.
- Contingency planning.
- Anticipating failure points.

2.7.2 Communication

- Clear casualty handover.
- Communicating deterioration.
- Calling for remote support early.
- Closed-loop communication during procedures.

2.7.3 Operational Decision-Making

- Prioritization under pressure.
- Limited-resource choices.
- Multi-problem patients.
- Balancing ideal care with practical capability.

2.8 Study Priorities for This Manual

- Which sections should be mastered first.
- Which content is memorization-heavy.
- Which content is concept-heavy.
- Which content is scenario-dependent.

2.8.1 First-Pass Study Priorities

- Airway.
- Shock and resuscitation.
- TBI.
- Burns.
- Sedation and analgesia.
- Delayed MEDEVAC and prolonged holding.

2.8.2 Second-Pass Study Priorities

- Chest procedures.
- Sepsis.
- STEMI and fibrinolysis.

- Pericardiocentesis.
- Antibiotic regimens.
- Less common but critical rescue procedures.

2.9 What the Learner Should Be Able to Do After This Chapter

- Identify the major ACTT focus areas.
- Understand what deserves the most study time.
- Recognize the difference between immediate stabilization and prolonged care.
- Understand why the rest of the manual is structured the way it is.

2.10 Bridge to the Next Chapter

- Transition from what matters most to the actual clinical domain breakdown.
- Lead into Chapter 3: Clinical Domains Overview.

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Chapter 3: Clinical Domains Overview

Royal Canadian Navy Physician Assistant Focus

3.1 Purpose of This Chapter

This chapter provides the clinical map for the rest of the manual. Its job is to organize the ACTT content into major operational domains so that later chapters can be studied and recalled more efficiently. For an RCN Physician Assistant working at sea, this domain structure matters because real patients rarely present as neat textbook problems. They present as combinations of airway compromise, shock, pain, altered mental status, environmental exposure, infection risk, and delayed evacuation constraints.

- Define the major ACTT-relevant clinical domains.
- Show how those domains overlap in actual shipboard casualties.
- Identify the core tasks that sit inside each domain.
- Create a mental framework that supports later algorithms, procedures, medication use, and prolonged holding decisions.

3.2 How the Clinical Domains Are Organized

The domain model is not meant to separate patients into isolated boxes. It is meant to help you think in layers. A casualty may require immediate action in one domain while carrying hidden risk in another. For example, a patient with severe burns may primarily look like a burn patient, but early airway edema, fluid shifts, pain control, hypothermia, and prolonged care demands can all emerge at the same time.

For ACTT purposes, domain-based thinking helps with three things: first-pass recognition, choice of immediate priorities, and structured reassessment over time. It also helps you determine which problems can be stabilized locally, which demand immediate intervention, and which require remote guidance or urgent transfer when evacuation is delayed.

- Single-domain problem: a focused issue such as an isolated shoulder dislocation or uncomplicated pneumothorax.
- Multi-system trauma: several domains active at once, such as TBI plus hemorrhagic shock plus respiratory compromise.
- Prolonged-care patient: a casualty whose initial stabilization is only the beginning, requiring repeated reassessment for hours.

3.3 Domain 1: Airway and Respiratory Management

Airway and respiratory management is one of the highest-priority ACTT domains because failure here kills quickly. The learner must be able to identify airway compromise early, maintain oxygenation, control ventilation, and transition rapidly from basic support to definitive rescue when needed.

3.3.1 Core learning areas

- Airway assessment and recognition of impending failure.
- Predictors of difficult intubation and difficult bag-mask ventilation.
- Indications for definitive airway control.
- Rescue airway planning, including failed airway pathways.
- Ventilation strategy after intubation or rescue airway placement.
- Recognition of thoracic causes of respiratory collapse.

3.3.2 Operational tasks

Within this domain, the course expects rapid task performance rather than abstract theory. The practical sequence is assessment, preparation, intervention, confirmation, and monitoring. That means not only placing a tube or decompressing a chest, but also anticipating failure, checking placement, adjusting ventilation, and watching for deterioration.

- Assess whether the patient can maintain and protect their airway.
- Choose between basic airway adjuncts, RSI, or surgical airway.
- Maintain SpO_2 and use $EtCO_2$ to guide ventilation when available.
- Recognize tension pneumothorax and other immediately reversible thoracic threats.
- Reassess after every intervention instead of assuming the problem is fixed.

3.3.3 Why this matters at sea

In the naval setting, airway and chest interventions may have to carry the patient for far longer than intended. A technically successful intubation or decompression is only the first step. Securement, ventilator strategy, sedation, oxygen use, tube patency, and repeated confirmation become part of prolonged care rather than short transfer medicine.

3.4 Domain 2: Hemodynamics, Shock, and Resuscitation

This domain focuses on restoring and maintaining perfusion. In ACTT, this includes recognition of shock, selection of the correct resuscitative strategy, and continuous reassessment of response. The same low blood pressure does not mean the same thing in trauma, burns, sepsis, or combined injury patterns.

3.4.1 Core learning areas

- Recognition of shock states and early perfusion failure.
- Use of clinical signs to judge perfusion when invasive monitoring is limited.
- Selection of fluid, blood, or vasopressors according to the underlying problem.
- Recognition that over-resuscitation can be as dangerous as under-resuscitation.
- Monitoring endpoints such as mental status, urine output, capillary refill, temperature gradient, and trend in vital signs.

3.4.2 Operational tasks

Operationally, this domain is about making the correct next move with imperfect information. The learner must identify whether the patient is underfilled, bleeding, distributive, or mixed. From there, the task is to choose the least harmful effective intervention, watch for a measurable response, and escalate if the patient fails to improve.

- Distinguish trauma, septic, burn, and mixed shock patterns.
- Decide when fluid is appropriate, when blood is preferred, and when vasopressors are necessary.
- Avoid reflexive large-volume fluid where that may worsen the patient.
- Use trend monitoring rather than a single normal or abnormal value.

3.4.3 Why this matters at sea

At sea, delayed MEDEVAC means resuscitation cannot be treated as a brief bridge. A patient may need many hours of pressure support, fluid adjustment, output monitoring, and careful reassessment. That shifts this domain from a one-time intervention model to a sustained management model.

3.5 Domain 3: Specialized Trauma

Specialized trauma includes injuries with management priorities that differ from standard resuscitation logic. These injuries often demand tighter physiologic targets, more specific monitoring, and greater awareness of secondary injury.

3.5.1 Traumatic Brain Injury

TBI is repeatedly emphasized in the source material because secondary brain injury is often preventable. The learner must know how to classify severity, protect the airway when indicated, support cerebral perfusion, manage ventilation carefully, identify signs of rising intracranial pressure, and recognize impending herniation. In this domain, inappropriate fluids, excessive hypotension, or careless ventilation can worsen outcome rapidly.

3.5.2 Burn injury

Burn management requires early attention to airway risk, fluid strategy, urine output, pain, temperature control, and the possibility of delayed complications. The course appears to emphasize that burn resuscitation is not simply about starting fluids. It is about using a starting formula, then repeatedly adjusting treatment based on output and clinical response while also addressing airway and skin-related complications.

3.5.3 Orthopedic and spinal injury

Orthopedic injuries are often less immediately fatal but can still affect function, pain burden, transport safety, and later care. Joint reductions, immobilization, neurovascular checks, and repeated neurologic reassessment matter more in prolonged holding situations, where the patient may remain under your care much longer than usual.

3.6 Domain 4: Environmental Injury

Environmental injury is especially relevant in naval operations. Cold exposure, wet exposure, and temperature loss can change both physiology and clinical priorities. This domain reminds the learner that environment can be the primary problem or a major modifier of every other problem.

3.6.1 Hypothermia

Hypothermia requires stage-based thinking. A mildly cold patient and a profoundly hypothermic patient in arrest are not managed the same way. The course material emphasizes cautious handling, active rewarming, modified arrest protocols, and the principle that severe hypothermia can preserve neurologic viability even when vital signs are absent.

3.6.2 Operational relevance

Cold environments affect monitoring accuracy, IV access, medication handling, patient packaging, and team endurance. This means the environmental domain is not separate from trauma care; it directly affects how procedures are performed and how long the patient can be safely maintained.

3.7 Domain 5: Infectious Disease and Sepsis

Although ACTT is trauma-focused, sepsis and serious infection remain critical because early recognition and treatment are highly time-sensitive, and the austere setting changes how aggressively some standard pathways can be applied.

3.7.1 Core learning areas

- Recognition of sepsis and septic shock using bedside signs and available data.
- Antibiotic timing, with early administration as a central priority.
- Source-based empiric antibiotic selection.
- Balancing fluid resuscitation against the risk of respiratory deterioration.
- Escalation to vasopressors when fluids are no longer enough.

3.7.2 Why this matters at sea

Shipboard care may involve delayed transfer, finite antibiotics, limited diagnostics, and evolving clinical pictures. A patient who is only mildly ill at first assessment may become significantly more unstable over several hours. For that reason, the learner must treat sepsis as an evolving management problem rather than a single dose-and-transfer event.

3.8 Domain 6: Cardiovascular Emergencies

Cardiovascular emergencies are not the dominant ACTT theme, but they are high-consequence and highly time-sensitive when they occur. The key focus is recognition of actionable ECG patterns, decision-making around reperfusion, and monitoring for deterioration after treatment.

3.8.1 Core learning areas

- Recognition of STEMI in the correct clinical context.
- Decision point where PCI delay makes fibrinolysis relevant.
- Contraindications to fibrinolysis.
- Adjunctive antiplatelet and anticoagulation strategies.
- Monitoring for reperfusion complications and bleeding.

3.8.2 Why this matters at sea

At sea, timely PCI may not be possible. This makes the decision window for fibrinolysis more important than in many shore-based settings. The learner must be able to act within time-sensitive limits while also recognizing when fibrinolysis is unsafe.

3.9 Domain 7: Diagnostics and Point-of-Care Interventions

In ACTT, diagnostics are bedside, focused, and action-oriented. The aim is not a complete workup. The aim is to answer targeted questions that change management.

3.9.1 Core learning areas

- Focused physical exam and repeated reassessment.
- Use of vital signs and trends to guide action.
- Interpretation of ECG for urgent conditions.
- Interpretation of key laboratory values where available, such as ABG, lactate, sodium, and base deficit.
- Use of point-of-care ultrasound for targeted clinical questions.

3.9.2 Practical examples

Examples from your source set include optic nerve sheath diameter measurement to support ICP assessment, ultrasound guidance for emergency pericardiocentesis, and the use of $EtCO_2$, urine output, and serial vital signs as trend markers in prolonged care. The common principle is that bedside data should change what you do next.

3.10 Domain 8: Non-Technical Skills and Operational Practice

This domain applies across every clinical problem. ACTT is not only testing whether a clinician knows a dose or can describe a procedure. It also tests whether the clinician can organize a team, communicate clearly, anticipate failure, and maintain continuity over time.

3.10.1 Core learning areas

- Leadership and role assignment.
- Pre-procedure briefing and contingency planning.
- Closed-loop communication during high-risk tasks.
- Clear casualty handover.
- Teleconsultation and remote support when local capability is limited.
- Documentation that supports continuity of care over 24-72 hours.

3.10.2 Why this matters at sea

In a shipboard environment, the same small team may receive, stabilize, monitor, reassess, re-brief, and hand over the same patient over an extended period. Poor organization creates preventable error. Good communication reduces missed reassessment, medication duplication, line dislodgement, and delay in escalation.

3.11 Domain Intersections in Real Patients

Real casualties often sit in several domains at once. This is where ACTT-level thinking becomes more than memorizing separate topics. The clinician must understand that one intervention may help one domain while harming another, and that priorities can shift as the patient evolves.

- TBI plus hemorrhagic shock: cerebral perfusion targets may conflict with permissive hypotension concepts.

- Burns plus airway edema plus fluid resuscitation: airway timing and fluid strategy interact closely.
- Sepsis plus respiratory compromise: fluid can help perfusion but worsen breathing.
- Combative patient plus hypoxia, hypoglycemia, or TBI: behavior may be a sign, not the diagnosis.
- Hypothermia plus cardiac arrest: standard termination logic may not apply.
- Polytrauma plus delayed evacuation: the burden shifts from rescue to sustained organized management.

This is why reassessment is the linking principle across all domains. Domain knowledge tells you what to look for. Reassessment tells you whether your intervention is helping, harming, or no longer enough.

3.12 How These Domains Guide the Rest of the Manual

This chapter is the map. The later chapters are the working instructions. Algorithms, procedures, medications, prolonged holding, pitfalls, and quick-reference tables all sit inside these domains. If this chapter is understood well, later details become easier to organize and recall under pressure.

- Chapter 4 will convert this domain map into major algorithms and decision pathways.
- Later procedure chapters will show how to execute the interventions that sit inside the airway, thoracic, vascular, and monitoring domains.
- Medication sections will link each drug back to the clinical problem it is meant to solve.
- The prolonged holding chapter will show how domain priorities change when the patient stays with you for many hours.

3.13 End State for the Learner

After this chapter, the learner should be able to name the major ACTT clinical domains, describe the core tasks inside each domain, recognize common overlap patterns, and use the domain framework to organize both study and bedside recall. The immediate goal is not mastery of every procedure yet. The immediate goal is a clear structure for thinking.

3.14 Bridge to Chapter 4

The next chapter moves from broad domain recognition to concrete action. Once the learner understands the map, the next step is to work through the major algorithms and decision pathways that define what to do first, what to do next, and what to avoid.

Chapter 4

Major Algorithms and Decision Pathways

Royal Canadian Navy Physician Assistant focus

Purpose of this chapter: move from recognition to action. Each pathway in this chapter is written to answer what to do first, what to do next, what changes the plan, what must be monitored, and when to escalate.

4.1 Purpose and Use of This Chapter

This chapter translates the earlier domain map into operational bedside pathways. The goal is not simply to identify a condition, but to guide the clinician through sequence, priority, and reassessment. In practice, these algorithms are most useful when the patient is unstable, time is compressed, and there is pressure to decide quickly.

Each pathway should be approached as a practical scaffold rather than a rigid script. The sequence helps reduce omissions, but the clinician must still adapt to the patient, the environment, the available medications and equipment, and the likely delay to evacuation.

4.2 Standard Algorithm Format

For consistency, each algorithm in this chapter is organized around the same execution pattern. This makes the chapter easier to study and faster to use under stress.

- Entry condition: the presentation that activates the pathway.
- Immediate threats: the problems that can kill the patient or the team in the next minutes.
- Immediate assessment: what must be checked before or while the first interventions are started.
- Immediate actions: the first treatment steps that should not be delayed.
- Decision branches: what changes the next step.
- Reassessment points: what must be rechecked after the initial intervention.
- Stabilization goals: the physiologic or operational endpoint you are aiming for.
- Escalation: when to move to a more invasive step, call for help, or shift toward prolonged holding.

4.3 Airway Failure and Severe Altered Mental Status Pathway

This pathway applies when the patient cannot maintain or protect the airway, cannot oxygenate or ventilate adequately, or has a level of consciousness low enough that immediate airway control is likely required. It also includes patients with facial trauma, inhalation injury, or severe agitation that makes safe treatment impossible.

Entry conditions

- GCS 8 or less, rapidly falling level of consciousness, or inability to protect the airway.
- Massive maxillofacial trauma, major upper-airway bleeding, or obvious mechanical obstruction.
- Progressive airway edema from burns or inhalation injury.

- Severe agitation where the patient cannot be safely oxygenated, monitored, restrained, or transported.

Immediate assessment priorities

- Determine whether the patient is oxygenating and ventilating right now.
- Look for obvious predictors that oral intubation may fail.
- Decide early whether this is an oral intubation problem or a surgical airway problem.
- Assign one team member to airway preparation and one to monitoring and medications if staff allow.

Execution sequence

- Apply high-concentration oxygen immediately and place the patient in the best achievable airway position.
- Suction aggressively if blood, vomit, soot, or secretions are present.
- Apply continuous monitoring: pulse oximetry, cardiac monitoring, and end-tidal CO2 as soon as it is available.
- If oral intubation is appropriate, pre-oxygenate and set a strict attempt limit before the first attempt starts.
- If oral intubation is not appropriate, or if the predefined attempt limit is reached, move directly to surgical cricothyroidotomy rather than repeating low-probability attempts.
- After tube placement, confirm with direct visualization if possible, chest rise, auscultation, and end-tidal CO2. Then move immediately to post-intubation ventilation and sedation management.

Key execution points

- Do not drift into repeated laryngoscopy attempts. The airway plan must include a declared rescue step before the first attempt.
- Post-intubation management is part of the airway procedure: secure the tube, set ventilation targets, and reassess oxygenation, ventilation, and hemodynamics.
- If burns or facial injury are present, think ahead about tube security. Standard adhesive fixation may fail.

Common traps

- Spending too long on assessment while the airway is already failing.
- Attempting oral intubation despite a presentation that clearly requires a surgical airway.
- Failing to transition to the next step after a failed attempt.
- Treating tube placement as the end of the problem instead of the beginning of the ventilation phase.

At-sea considerations

- Space, movement, lighting, and limited personnel increase the value of a simple declared plan.
- Prepare for the possibility that the first successful airway must be maintained for hours, not minutes.
- If evacuation is delayed, early attention to tube security, sedation continuity, suction planning, and ventilation reassessment is essential.

4.4 Combative Patient Management Pathway

This pathway addresses the unsafe, agitated, or violent patient. The key principle is to identify immediately reversible causes while also protecting the patient, the team, and the ability to continue care. Management is not only about sedation; it is about restoring control without losing the airway or missing a serious underlying illness or injury.

Entry conditions

- Violent, disorganized, or unsafe behaviour that interferes with assessment, treatment, or transport.
- Agitation in the setting of head injury, hypoxia, suspected intoxication, infection, or metabolic disturbance.
- An altered patient whose behaviour creates a direct safety threat.

Immediate assessment priorities

- Check for hypoxia, hypoglycemia, and head injury as early as practical.
- Rapidly judge whether the patient can be verbally redirected or whether immediate physical control is required.
- Decide if sedation alone is likely to be enough or if the patient is on the path toward airway control.

Execution sequence

- Use verbal de-escalation first if the patient can still engage and the environment is controlled.
- If the patient remains unsafe, apply physical control promptly using enough personnel to avoid an extended struggle.
- Obtain vital signs, oxygenation, and blood glucose as soon as feasible without escalating risk.
- Use chemical restraint when verbal measures fail or when the patient is too dangerous to assess safely.
- After sedation, reassess airway patency, respiratory effort, oxygenation, circulation, and level of consciousness immediately and repeatedly.
- If the patient remains unsafe despite sedation, or if sedation results in loss of airway control, transition to the airway pathway.

Key execution points

- Physical restraint is a bridge to safer care, not the treatment endpoint.
- Any sedated combative patient can deteriorate quickly, especially if hypoxia, TBI, infection, or polysubstance exposure is involved.
- Always think in parallel: the patient can be both a behavioural problem and a critical medical problem.

Common traps

- Treating agitation as purely psychiatric before excluding hypoxia, glucose abnormality, TBI, or sepsis.
- Using restraint without a monitoring plan.
- Sedating the patient and then delaying reassessment.
- Allowing repeated staff exposures to violence while trying to obtain a perfect history.

At-sea considerations

- Movement, confined spaces, and limited escape routes increase staff injury risk during physical control.
- Document what prompted restraint, what was used, how the patient responded, and when reassessments were performed, especially if prolonged holding follows.

4.5 Traumatic Brain Injury Management Pathway

This is a prevention-of-secondary-injury pathway. The immediate objective is to avoid worsening the brain insult through hypoxia, hypotension, uncontrolled ventilation, fever, seizures, or delayed recognition of herniation.

Entry conditions

- Any head trauma with altered mental status, focal findings, abnormal pupils, repeated vomiting, seizure, or deteriorating level of consciousness.
- A patient with suspected TBI who is also hypotensive, hypoxic, or requiring prolonged monitoring.

Immediate assessment priorities

- Document an initial neurologic baseline: GCS, pupils, motor behaviour, and visible deterioration.
- Check oxygenation and establish whether the airway is still protected.
- Measure blood pressure early because hypotension has immediate significance in TBI.
- Identify seizure activity or signs suggesting rising intracranial pressure.

Execution sequence

- Correct hypoxia immediately and secure the airway if protection is lost or likely to be lost.
- Maintain blood pressure to the target threshold and avoid hypotonic fluids.
- Control ventilation to the desired end-tidal CO2 range; do not hyperventilate routinely.
- Elevate the head if spinal and tactical constraints allow.
- Treat seizures immediately and continue reassessment after visible convulsions stop.
- If the neurologic exam worsens or herniation is suspected, move to the herniation branch: short-duration hyperventilation to the specified target and osmotic therapy if indicated.
- Trend the neurologic exam repeatedly. A series of observations is more useful than a single score.

Key execution points

- Do not let trauma resuscitation drift into permissive hypotension if TBI is also present without consciously weighing cerebral perfusion needs.
- Treat fever early because temperature control is part of secondary injury prevention.
- Hyperventilation is a rescue manoeuvre for impending herniation, not a default setting.

Common traps

- Accepting a single normal blood pressure reading and not watching for downward trend.
- Using fluids that worsen cerebral edema.
- Failing to recheck pupils and GCS after sedation, seizure treatment, or hemodynamic intervention.
- Using prolonged aggressive hyperventilation and worsening cerebral ischemia.

At-sea considerations

- Delayed evacuation means the clinician must think beyond the first intervention and plan for serial neurologic reassessment, repeat communication, and sustained hemodynamic and ventilation control.

4.6 Burn Assessment and Resuscitation Pathway

This pathway focuses on airway risk, fluid strategy, urine-output guided resuscitation, temperature control, pain management, and recognition of limb- or chest-threatening circumferential burns.

Entry conditions

- Thermal, inhalational, or electrical burn with clinically significant pain, visible tissue injury, or concern for large total body surface area involvement.
- Burn patient with facial burns, soot, hoarseness, airway symptoms, or delayed evacuation.

Immediate assessment priorities

- Identify inhalation injury or progressive airway edema early.
- Estimate burn size and depth well enough to start a practical resuscitation plan.
- Look for associated trauma, because not every burn patient has an isolated burn problem.
- Determine whether urine-output monitoring is needed from the start.

Execution sequence

- Make an early airway decision if there is significant inhalation risk or large burn burden.
- Begin isotonic fluid resuscitation using the course formula and then adjust to response.
- Place a Foley catheter when urine-output guided resuscitation is needed and not contraindicated.
- Use urine output as the main practical endpoint and adjust the fluid rate deliberately rather than reflexively.
- Protect the patient from further heat loss and treat pain early.
- Inspect circumferential burns for compromised perfusion or restrictive chest mechanics.
- If pulses are deteriorating or ventilation is restricted because of circumferential full-thickness burns, move to escharotomy planning.

Key execution points

- Burn fluid formulas give a starting point. Ongoing adjustment is where the clinical work happens.
- Urine output is a dynamic resuscitation marker and must be trended.
- Airway swelling can progress; a patient who looks manageable early may become difficult later.

Common traps

- Underestimating the burn and delaying fluids.
- Over-resuscitating without watching urine output or respiratory tolerance.
- Delaying intubation until edema makes airway control much harder.
- Treating the visible burn and missing concurrent trauma, inhalation injury, or shock.

At-sea considerations

- Delayed evacuation may convert a short burn resuscitation problem into a sustained critical-care problem. Plan for repeated fluid adjustments, ongoing urine measurement, tube security, analgesia continuity, and temperature preservation.

4.7 Accidental Hypothermia Pathway

This is a stage-based pathway. The central execution principle is that the colder patient may still be salvageable and may require modified resuscitation logic, especially in deep hypothermia and arrest.

Entry conditions

- Cold exposure with impaired function, altered mental status, reduced consciousness, or absent vital signs.
- A patient found in a cold environment where trauma, drowning, or prolonged exposure may also be present.

Immediate assessment priorities

- Assess for vital signs carefully and avoid rough handling.
- Determine whether an alternate cause of arrest or collapse is more likely than hypothermia alone.
- Estimate the hypothermia stage and identify whether arrest management must be modified.
- Determine whether advanced rewarming or an ECMO-capable destination is realistically reachable.

Execution sequence

- Prevent further heat loss immediately.
- Handle the patient gently to reduce the risk of precipitating arrhythmia.
- Stage the patient clinically and choose the rewarming intensity that matches the presentation.
- If the patient is in Stage IV with absent vital signs, begin CPR unless clear non-survivable criteria are present.
- Apply the course-specific limits on medications and defibrillation in profound hypothermia.
- Continue rewarming and reassessment while arranging the best available destination.

Key execution points

- In deep hypothermia, the resuscitation question is not just whether there is arrest; it is whether the patient is potentially salvageable despite prolonged downtime.
- Rewarming is part of treatment, but avoidance of further heat loss starts first and usually fastest.

Common traps

- Declaring death too early in a potentially salvageable profoundly cold patient.
- Handling the patient roughly during movement or assessment.
- Applying standard arrest logic without accounting for hypothermia-specific modifications.

At-sea considerations

- Cold maritime operations make this especially relevant. Transport planning, packaging, and realistic destination choices matter as much as the initial arrest response.

4.8 Sepsis and Septic Shock Pathway

This pathway is built around early recognition, timely antibiotics, appropriate fluids, transition to vasopressors when needed, and ongoing reassessment in settings where resources may be limited or evacuation delayed.

Entry conditions

- Suspected infection with systemic illness, poor perfusion, altered mental status, respiratory distress, or hypotension.
- A patient with fever or hypothermia plus signs of shock or worsening organ function.

Immediate assessment priorities

- Identify likely infection source if practical, but do not delay treatment waiting for certainty.
- Judge perfusion using vitals, mental status, skin findings, capillary refill, urine output, and available labs.
- Determine if the patient appears fluid responsive or already at risk of overload.
- Decide whether antibiotics must be given now. In severe sepsis or septic shock, the answer is usually yes.

Execution sequence

- Establish IV or IO access and begin initial crystalloid resuscitation when appropriate.
- Obtain cultures before antibiotics if feasible and if this does not delay treatment.
- Administer empiric antibiotics within the target time window.
- Reassess the response to fluids rather than committing to automatic repeated large boluses.
- If hypotension persists after initial volume resuscitation, prepare and start norepinephrine using the available route and monitoring.

- Continue trend monitoring and adjust for respiratory tolerance, urine output, blood pressure, and mental status.

Key execution points

- Early antibiotics are a treatment step, not an afterthought.
- Fluid strategy must be matched to the patient and to the resources available. More fluid is not always safer.
- Norepinephrine is a transition step when fluid alone is not enough, not a substitute for all volume assessment.

Common traps

- Delaying antibiotics while refining the diagnosis.
- Repeating large fluid boluses despite respiratory decline or clear overload.
- Starting a vasopressor without a plan for site monitoring, titration, and reassessment.
- Focusing on one vital sign instead of the overall perfusion picture.

At-sea considerations

- Limited diagnostics and delayed transfer increase the importance of serial clinical examination, practical source identification, and clear documentation of response to each intervention.

4.9 STEMI and Fibrinolysis Pathway

This pathway is a time-sensitive risk-benefit algorithm. The clinician must identify true ST-elevation myocardial infarction, determine whether timely PCI is unavailable, exclude major contraindications, and execute fibrinolysis and adjunctive therapy safely.

Entry conditions

- Ischemic chest pain or equivalent symptoms with a compatible ECG.
- A patient in whom access to definitive PCI is delayed beyond the accepted time target.

Immediate assessment priorities

- Confirm the symptom pattern and timing.
- Confirm the ECG pattern that makes the reperfusion decision relevant.
- Screen immediately for bleeding risk and major contraindications to fibrinolysis.
- Determine whether the patient can reach PCI in time or whether fibrinolysis is the correct next step.

Execution sequence

- Recognize the STEMI pattern and declare the reperfusion decision point early.
- If PCI within the time target is not realistic, move to fibrinolysis screening without delay.
- Confirm there is no absolute contraindication to fibrinolysis.
- Prepare tenecteplase carefully using the correct weight-based dose and administration technique.
- Administer the associated antiplatelet and anticoagulant therapies required by the protocol.
- After treatment, monitor closely for reperfusion, bleeding, arrhythmia, and neurologic decline.

Key execution points

- This pathway depends on decisive screening, not prolonged indecision.
- The fibrinolytic is only one part of the reperfusion package. Adjunctive medications and monitoring are part of the execution.

Common traps

- Treating before screening for major contraindications.
- Incorrect dose selection or poor reconstitution technique.
- Failing to monitor actively after fibrinolysis.
- Missing intracranial hemorrhage or significant bleeding during the post-treatment period.

At-sea considerations

- If transfer is delayed after fibrinolysis, the shipboard team may have to monitor the early reperfusion phase longer than would occur ashore. That increases the value of repeated neurologic checks, bleeding surveillance, and rhythm monitoring.

4.10 Tension Pneumothorax Pathway

This pathway is built around rapid recognition and immediate decompression. The critical operational principle is that a suspected tension pneumothorax in an unstable patient is treated as a clinical emergency, not a radiology problem.

Entry conditions

- Respiratory distress with hemodynamic instability and signs pointing toward unilateral tension physiology.
- Cardiac arrest or peri-arrest where a thoracic cause is plausible.

Immediate assessment priorities

- Decide whether the presentation is severe enough that decompression should occur immediately.
- Assess oxygenation, respiratory effort, and signs of poor perfusion.
- Recognize that waiting for perfect confirmation may be more dangerous than prompt decompression.

Execution sequence

- Apply oxygen and perform immediate needle thoracostomy when the presentation is strongly suggestive and the patient is unstable.
- Reassess within moments for improvement in oxygenation, ventilation, hemodynamics, or ease of bagging if ventilated.
- If there is no improvement, reassess the landmark, side, equipment, and alternate causes of shock or arrest.
- Once decompression has temporized the patient, move toward definitive chest tube placement because needle decompression alone is not the endpoint.

Key execution points

- Rapid decompression is the lifesaving step; the chest tube is the definitive follow-through.
- Immediate post-decompression reassessment tells you whether you relieved tension physiology or whether the diagnosis or placement should be reconsidered.

Common traps

- Waiting too long because the classic signs are incomplete.
- Treating needle decompression as definitive management.
- Failing to reassess quickly after the intervention.

At-sea considerations

- In a moving platform with tight space, landmarking discipline matters. Equipment preparation before patient contact reduces delay if deterioration is sudden.

4.11 Integrated Multi-System Decision Pathways

Real casualties often fit more than one algorithm at the same time. The clinician must decide what kills first, what can wait, and how one treatment may worsen another problem. This is where the earlier domain framework becomes useful.

Common conflicted scenarios

- TBI plus hemorrhagic shock: blood pressure support helps cerebral perfusion, but uncontrolled hemorrhage may limit how far pressure can be pushed.
- Burns plus inhalation injury plus fluid resuscitation: early airway decisions may be required while fluid strategy is still being established.
- Combative patient plus TBI or hypoxia: the behavioural problem may actually be the first sign of critical physiology.
- Sepsis plus respiratory overload risk: the patient may need fluid but may also worsen if fluid is overused.
- Hypothermia plus trauma: the patient may have both a cold-driven physiology problem and a parallel injury that changes prognosis.

Priority rule

The practical rule is to treat the most immediate lethal threat first, then reassess and reprioritize. In ACTT-style scenarios, this usually means moving in order from airway and catastrophic breathing problems, to profound circulatory failure, to neurologic and syndrome-specific priorities, while still preparing for what comes next.

Execution habit

1. State the immediate lethal threat out loud.
2. Assign the current active pathway.
3. Identify the next likely branch if the patient fails to respond.
4. After the intervention, force a reassessment before moving on.

4.12 Algorithm Execution in the RCN At-Sea Context

Shipboard practice changes how algorithms are used. The sequence may be the same as ashore, but the practical limits are different: staffing may be thinner, evacuation may be delayed, diagnostics may be limited, and the patient may need to be maintained for many hours.

Practical constraints

- Limited personnel can force simpler task division and tighter prioritization.
- Movement, noise, space limits, and lighting can degrade performance during airway and procedural tasks.
- Finite medications and equipment require early recognition of what can be sustained.
- Delayed evacuation means every acute pathway must eventually connect to a prolonged holding plan.

Practical adaptations

- Do the first lifesaving step early and decisively.
- Choose interventions you can monitor and maintain.
- Document trend, response, and time of intervention clearly, because prolonged care depends on continuity.
- Use teleconsultation early when the next branch is uncertain or when competing priorities are difficult to balance.

4.13 Common Errors in Algorithm Use

- Recognizing the problem but delaying the first treatment step.
- Collecting data without acting on clear thresholds.
- Failing to define the next escalation step before the current one fails.
- Not reassessing after medications or procedures.
- Anchoring on a single diagnosis while the patient evolves.
- Stopping at temporary improvement and missing the need for definitive management.

4.14 End State for the Learner

After this chapter, the learner should be able to recognize the major ACTT-critical presentations, activate the correct pathway, carry out the first intervention sequence, identify when the current step has failed, and transition either to escalation or to prolonged holding. The aim is not memorization alone. The aim is to know what to do on the patient, in order, under pressure.

4.15 Bridge to the Next Chapter

Chapter 5 moves from decision pathways to procedural execution. Where this chapter answers when to act and what branch comes next, the next chapter focuses on how to physically perform the core high-acuity procedures.

ACTT Preparation Manual

Chapter 5: Advanced Procedures

This chapter converts the decision pathways from the previous chapter into hands-on action. The focus is not simply identifying when a procedure belongs in the plan; it is understanding how to set it up, perform it, confirm that it worked, and then continue caring for the patient afterward. Because the intended use case is a Royal Canadian Navy Physician Assistant working at sea, every procedure is framed through a practical lens: limited personnel, finite stock, ship movement, delayed evacuation, and the need to maintain the intervention over time.

5.1 Purpose of This Chapter

The aim of this chapter is to make the major ACTT procedures usable at the bedside. Each section is built to answer the practical questions that matter under pressure: when to do the procedure, when not to do it, what equipment to gather, how to prepare the patient and team, what sequence to follow, how to confirm success, and what immediate complications to expect.

- Translate high-risk procedures into repeatable bedside sequences.
- Emphasize execution, confirmation, and reassessment rather than theory alone.
- Integrate medication, monitoring, and post-procedure care into the same workflow.
- Adapt each procedure to an at-sea, prolonged-care setting where the intervention may need to be maintained for hours.

5.2 How to Use This Chapter

This chapter should be read like a working checklist. During study, it can be used to rehearse the order of actions. During practical preparation, it can be used to build equipment checklists, role assignments, and mental models for complications. In real use, the value of the chapter is in its structure: indication, setup, execution, confirmation, and aftercare.

- Review the indication first. A technically correct procedure performed for the wrong reason can still harm the patient.
- Read the setup and backup plan before the step-by-step technique.
- Treat confirmation and reassessment as part of the procedure, not optional extras.
- If evacuation is delayed, transition quickly from procedure completion to maintenance planning.

5.3 Standard Procedure Format Used Throughout This Chapter

For consistency, every procedure in this chapter follows the same format. This makes the chapter easier to learn and faster to use under stress. The repeated structure also helps identify what is missing if the team is rushing: indication, equipment, backup plan, confirmation, or post-procedure monitoring.

- Purpose and clinical role
- Indications
- Contraindications and cautions
- Required equipment
- Team preparation and patient preparation
- Landmarking and anatomy

- Step-by-step technique
- Confirmation of success
- Immediate post-procedure management
- Complications and troubleshooting
- At-sea and delayed-MEDEVAC considerations
- Medication needs relevant to the procedure

5.4 Pre-Procedure Fundamentals

Before any invasive procedure, there are recurring fundamentals that determine whether the intervention runs smoothly or turns into a cascade of avoidable problems. These fundamentals apply to nearly every procedure in ACTT.

5.4.1 Immediate Pre-Procedure Assessment

Confirm the indication and urgency before starting. Ask whether the procedure is definitive, temporizing, or only a bridge to something else. If the patient is crashing, there may be no time for a full setup, but there is still time to state the indication, identify the immediate threat, and commit to the most direct life-saving action.

- Reassess airway, breathing, and circulation before starting.
- Identify whether the patient is too unstable to delay for ideal preparation.
- Clarify whether the procedure is expected to fix the problem or only buy time.
- If a competing threat is greater than the indication for the procedure, address the greater threat first.

5.4.2 Team Preparation

A short briefing improves success rates and reduces errors. In invasive procedures, even a ten-second statement of plan, backup, and failure point can prevent major delays. The operator should say what is about to happen, what the backup plan is, and what the team should announce if deterioration occurs.

- Assign an operator, assistant, medication handler, and monitor watcher if staffing permits.
- State the primary plan and the immediate rescue plan out loud.
- Confirm who is responsible for suction, oxygen, medication, and securing the device afterward.
- Use closed-loop communication so critical actions are confirmed, not assumed.

5.4.3 Monitoring Requirements

Monitoring is part of the procedure. SpO_2, heart rhythm, blood pressure, and mental status should be observed before, during, and after the intervention. For airway procedures and sedation, $EtCO_2$ should be used whenever available. The operator may be focused on the technical task, so one team member should be explicitly assigned to monitor trends and call out deterioration.

5.4.4 Procedural Sedation and Analgesia Principles

Not every urgent procedure allows time for full sedation, but pain control and anxiolysis still matter whenever feasible. The balance is between comfort and safety. Some procedures, such as a crashing chest decompression, may proceed with little or no analgesia because delay is more dangerous than pain. Others, such as chest tubes or shoulder reduction in a stable patient, benefit substantially from local anesthesia, ketamine, or other sedatives. After any sedative or opioid, airway and respiratory reassessment is mandatory.

5.4.5 Infection Control and Sterility

In austere or emergent settings, perfect sterility may not be possible, but deliberate clean technique still reduces complications. The operator should know which parts must remain as clean as possible: the insertion site, sterile instruments, and the device entering the patient. If the choice is between immediate life-saving action and waiting for ideal sterility, life-saving action takes priority, but contamination should still be minimized.

5.5 Rapid Sequence Intubation Setup and Execution

Purpose and clinical role

Rapid Sequence Intubation (RSI) is used to establish a definitive airway quickly while minimizing aspiration risk and reducing prolonged struggling for the airway. Within ACTT, RSI is not only an airway procedure; it is also a structured sequence that depends on preparation, attempt discipline, rescue planning, and post-intubation management.

Indications

- GCS 8 or less, or inability to protect the airway.
- Respiratory failure or exhaustion requiring controlled oxygenation and ventilation.
- Severe agitation or combativeness preventing safe care when sedation alone is inadequate.
- Anticipated airway deterioration such as inhalation injury or progressive facial swelling.

Contraindications and cautions

- Massive facial trauma, complete upper airway obstruction, or anatomy that makes oral intubation effectively impossible may require immediate surgical airway instead.
- Do not continue repeated attempts when the airway is predicted difficult and oxygenation is worsening.
- Ketamine used for RSI should be paired with a paralytic when the plan is formal intubation; ketamine alone can increase laryngospasm risk.

Required equipment and setup

- Laryngoscope or video laryngoscope, appropriately sized endotracheal tube, bougie or stylet.
- Bag-valve-mask, oxygen source, suction, and $EtCO_2$ confirmation device.
- Induction and paralytic medications drawn up, labeled, and immediately available.
- Backup airway device and cricothyroidotomy kit opened or at arm's reach before the first attempt.

Step-by-step execution

1. Confirm the indication, assign roles, and state the failed airway plan out loud.
2. Position the patient to maximize view and ventilation, and pre-oxygenate with 100 percent oxygen for 3-5 minutes when time allows.
3. Prepare suction and clear blood, secretions, or vomit before laryngoscopy if present.
4. Administer the induction agent, then the paralytic in planned RSI sequence.
5. Perform laryngoscopy and place the tube using bougie or stylet support as needed.
6. Inflate the cuff immediately after placement and begin controlled ventilation.
7. Respect attempt limits: one attempt in a difficult airway, two attempts in a non-difficult airway only if oxygenation remains acceptable.
8. If the permitted attempts fail or the patient cannot be oxygenated, move immediately to the rescue airway plan rather than repeating low-yield attempts.

Confirmation and immediate aftercare

- Use $EtCO_2$ to confirm tracheal placement as the strongest immediate confirmation tool.
- Check chest rise, bilateral breath sounds, and tube depth marking.

- Secure the tube well, then set initial ventilation targets based on the clinical problem.
- Begin ongoing sedation after intubation; an intubated patient still requires analgesia and sedation.

Complications and troubleshooting

- Esophageal intubation: suspect if no EtCO2, poor chest rise, and rapid desaturation. Remove and reattempt only if still within the permitted attempt plan.
- Hypoxia: pause, re-oxygenate, suction, and reassess before further attempts.
- Hypotension after induction: support perfusion immediately and reconsider sedation burden.
- Tube dislodgement after successful placement: prevent with proper securement and deliberate handling.

At-sea and delayed-MEDEVAC considerations

- A successful intubation creates an ongoing care burden: ventilation, suctioning, sedation, and tube security must be maintained.
- Ship movement increases accidental extubation risk; securement should be checked repeatedly.
- If staffing is limited, explicitly assign someone to airway watch and tube position checks during movement or transfer.

5.6 Endotracheal Intubation Optimization

RSI is only as good as the mechanics supporting first-pass success. The course material emphasizes difficult airway prediction and deliberate techniques to improve glottic view and reduce failed attempts.

5.6.1 Airway Assessment

Use LEMON to predict difficult laryngoscopy and BONES to predict difficult bag-mask ventilation. The practical value is not academic scoring; it is deciding before the first attempt whether you should expect a poor view, a poor bagging situation, or both.

5.6.2 View Optimization

- Use positioning and external laryngeal manipulation, including BURP where useful, to improve glottic view.
- Apply the practical concepts often summarized as the 'Kovacs Kata': optimize neck and head position, improve hand mechanics, manage the epiglottis deliberately, and adjust by slight pull-back if the tube trajectory is poor.
- Use a bougie early when only a partial view is obtained rather than persisting with a poor blind tube pass.

5.6.3 Tube Confirmation and Securement

Confirmation does not end with one good breath. The tube must stay where it belongs. In burn patients, adhesive tape may fail on injured skin, so circumferential ties or other securement methods are safer.

5.7 Surgical Cricothyroidotomy

Purpose and clinical role

Surgical cricothyroidotomy is the definitive rescue airway when oral access has failed or is not possible. In the ACTT context, this is the procedure that follows disciplined recognition of a true failed airway, not repeated ineffective laryngoscopy.

Indications

- Cannot intubate and cannot oxygenate scenario.
- Massive maxillofacial trauma blocking oral airway access.
- Complete upper airway obstruction where the obstruction cannot be bypassed orally.
- Failed airway after the permitted intubation attempts.

Contraindications and cautions

- In a crashing patient there are few absolute contraindications; delay is usually more dangerous than proceeding.
- Landmarks may be distorted by obesity, swelling, or blood. Deliberate midline landmarking is critical.
- False passage becomes more likely if the membrane is not clearly entered before tube insertion.

Required equipment and setup

- Scalpel, tracheal hook or bougie depending on technique, appropriately sized tracheostomy tube or endotracheal tube.
- Suction, oxygen, ventilation device, EtCO2 device, and securement ties.
- Assistant to stabilize the larynx and manage suction if available.

Step-by-step execution

9. Palpate and stabilize the larynx, identifying thyroid cartilage, cricoid cartilage, and the membrane between them.
10. Make a vertical skin incision in the midline to improve exposure and preserve options if landmarks shift.
11. Enter the cricothyroid membrane with a horizontal puncture or controlled incision.
12. Use the chosen method to open the tract, such as hook or bougie-assisted entry.
13. Insert the tube through the membrane into the trachea, inflate the cuff if present, and begin ventilation.
14. Secure the tube immediately after confirmation.

Confirmation and immediate aftercare

- Confirm with EtCO2, chest rise, and bilateral breath sounds.
- Control bleeding as able and keep the field clear for reassessment.
- Continue oxygenation and begin longer-term airway management planning.

Complications and troubleshooting

- False passage if the tract is not truly in the trachea.
- Bleeding obscuring the field and causing delay; suction must be ready.
- Dislodgement if the tube is not well secured, especially during transport.

At-sea and delayed-MEDEVAC considerations

- A surgical airway may need to be managed for an extended period if evacuation is delayed.
- Humidification, secretion management, and repeated securement checks become more important over time.
- Ship movement increases the chance of accidental dislodgement, so transport plans must account for tube protection.

5.8 Needle Cricothyroidotomy

Purpose and clinical role

Needle cricothyroidotomy is a temporary bridge used when immediate rescue oxygenation is needed and a definitive airway is not yet in place. It is not a durable long-term airway plan.

Indications

- Immediate cannot-intubate, cannot-oxygenate situation when a rapid temporizing airway is needed.
- Bridge while preparing for definitive surgical airway or other airway rescue.

Contraindications and cautions

- Limited ventilation capability means this is time-limited and should not be mistaken for definitive control.
- Kinking, dislodgement, and inadequate ventilation are common failure modes.

Required equipment and setup

- 14-gauge catheter, syringe, connection adapter, oxygen source, and improvised or formal ventilation connection setup.
- Backup definitive airway plan already identified before or immediately after placement.

Step-by-step execution

15. Identify the cricothyroid membrane and stabilize the larynx.
16. Puncture the membrane with the catheter-over-needle at the appropriate angle, then alter the angle to advance the catheter into the airway.
17. Advance the catheter, remove the needle, and attach the ventilation adapter.
18. Begin oxygenation and assess immediately while preparing a definitive airway.

Confirmation and immediate aftercare

- Watch for improved oxygenation and visible chest rise.
- Do not stop at temporary improvement; proceed directly to definitive airway planning.

Complications and troubleshooting

- Catheter kinking or dislodgement can rapidly end the benefit.
- Ventilation may be inadequate even if oxygenation briefly improves.
- Subcutaneous air suggests malposition or air leak.

At-sea and delayed-MEDEVAC considerations

- Because this is a bridge, the real at-sea concern is not how to maintain it long term but how fast to convert away from it.
- Do not let temporary partial improvement create delay in establishing a definitive airway.

5.9 Needle Thoracostomy

Purpose and clinical role

Needle thoracostomy is an emergent decompression procedure for suspected tension pneumothorax. It is designed to relieve immediately life-threatening pressure, not to serve as final pleural management.

Indications

- Respiratory distress with tension physiology such as unilateral absent breath sounds and hemodynamic instability.
- Suspected tension pneumothorax during decompensation or cardiac arrest where delaying for imaging is unsafe.

Contraindications and cautions

- There are few true contraindications in an unstable patient, but wrong-site placement and wrong-diagnosis decompression are major practical risks.
- If the patient does not improve, do not assume the diagnosis was wrong without reassessing technique and catheter function.

Required equipment and setup

- 14-gauge 3.25-inch catheter, antiseptic if available, gloves, and chest tube equipment prepared immediately after.
- Operator must know the landmark before skin puncture; rushed guessing increases failure.

Step-by-step execution

19. Choose the insertion site: second intercostal space mid-clavicular line or fourth/fifth intercostal space at the anterior- or mid-axillary line.
20. Prep the skin if time permits and identify the superior border of the rib below the target space to avoid the neurovascular bundle.
21. Insert the catheter over the superior rib margin into the pleural space until decompression is achieved.
22. Advance the catheter fully, remove the needle, and reassess immediately.

Confirmation and immediate aftercare

- Expected findings include air release, improved oxygenation, improved blood pressure, or reduced distress.
- If there is no improvement, reassess the site, depth, and whether the catheter remains patent.
- Prepare for immediate transition to chest tube thoracostomy if the patient is salvageable.

Complications and troubleshooting

- Failed decompression due to short catheter, wrong landmark, or catheter obstruction.
- Injury to underlying structures if inserted in the wrong location.
- False reassurance after partial improvement; tension can recur quickly.

At-sea and delayed-MEDEVAC considerations

- Needle decompression is a short bridge. At sea, the real work is managing what comes next: definitive drainage, ongoing reassessment, and secure transport with chest pathology still in play.
- Movement can dislodge or kink the catheter, so it cannot be trusted as the only long-term solution.

5.10 Chest Tube Thoracostomy

Purpose and clinical role

Chest tube thoracostomy is the definitive drainage procedure for pneumothorax, hemothorax, and other selected pleural collections. It converts a temporary decompression into a maintainable pleural drainage plan.

Indications

- Pneumothorax requiring definitive drainage after needle decompression or because recurrence risk is high.
- Hemothorax or ongoing pleural air or blood requiring controlled evacuation.
- Persistent instability after needle decompression where definitive management is needed.

Contraindications and cautions

- Coagulopathy and distorted anatomy increase risk but are often relative concerns in a life-threatening thoracic emergency.
- Avoid clearly infected overlying tissue when possible, but life-saving access takes priority if no alternative exists.

Required equipment and setup

- Chest tube of appropriate size, scalpel, blunt clamp, sterile supplies, local anesthetic or sedation when feasible, sutures or securement, and drainage device such as a Pleurivac.
- Monitoring, suction setup if used, and a plan for output tracking after insertion.

Step-by-step execution

23. Position the patient and identify the fifth intercostal space at the mid-axillary line.
24. Prep and drape, then make the skin incision over the rib line that supports safe pleural entry.
25. Use blunt dissection through the tissue planes and enter over the superior rib margin to avoid the neurovascular bundle.
26. Open the pleural space with controlled blunt entry and perform a finger sweep to confirm intrathoracic placement and exclude organ contact.
27. Advance the tube into the pleural space, directing it appropriately for the expected pathology, then connect immediately to the drainage system.
28. Secure the tube, dress the site, and reassess the patient and the function of the system.

Confirmation and immediate aftercare

- Look for clinical improvement, expected tube output, and appropriate system behavior such as bubbling or fluid movement when relevant.
- Check securement, tube depth, drainage tubing alignment, and whether the system is functioning as intended.
- Continue repeated reassessment because a technically placed tube can still fail later due to blockage or dislodgement.

Complications and troubleshooting

- Misplacement, organ injury, persistent air leak, inadequate drainage, blocked tube, and accidental dislodgement are the major risks.
- If the patient remains unstable, reassess for tube position, tube patency, or an alternate diagnosis rather than assuming the procedure was sufficient.

At-sea and delayed-MEDEVAC considerations

- A chest tube creates ongoing nursing-style tasks: monitor output volume and character, maintain tube position, protect the drainage system, and prevent accidental pulling during movement.
- During prolonged holding, trend the drainage rather than relying on one-time observations.

5.11 Intraosseous Access

Purpose and clinical role

Intraosseous (IO) access provides rapid vascular access when peripheral access fails or when delay is unacceptable. It allows delivery of fluids, blood products, and most emergency medications.

Indications

- Cardiac arrest, severe shock, or urgent medication need when IV access is delayed or unsuccessful.
- Adults after failed IV attempts or prolonged attempt time.
- First-line access in selected pediatric emergency situations.

Contraindications and cautions

- Do not use through a fractured target bone or a limb with a recent IO attempt in the same site region.
- Site infection or inability to identify landmarks increases failure and complication risk.

Required equipment and setup

- IO device and needle set, saline flush, pressure bag, extension tubing, securement, and preservative-free lidocaine for conscious patients.
- Choose the site before opening the device and make sure backup access planning continues in parallel.

Step-by-step execution

29. Identify the chosen site, prep it, and orient the device at the correct angle for that site.
30. Advance until the characteristic loss of resistance or 'pop' indicates marrow cavity entry.
31. Remove the stylet, connect tubing, aspirate if possible, and flush aggressively to confirm patency.
32. Secure the line and apply pressure-assisted infusion if rapid flow is required.
33. In a conscious patient, use lidocaine through the IO before forceful flushing or infusion to reduce severe infusion pain.

Confirmation and immediate aftercare

- A successful IO should flush relatively easily without soft tissue swelling.
- Good flow often depends on a proper initial flush and pressure support, not the needle alone.
- Reassess the site repeatedly for leakage, swelling, and pain.

Complications and troubleshooting

- Extravasation, compartment syndrome, failed marrow entry, bent needle, and poor flow are the main issues.
- If fluids are not flowing, reassess whether the line was flushed properly before assuming the site is unusable.

At-sea and delayed-MEDEVAC considerations

- IO access is often a bridge rather than the final line choice if the patient will be held for many hours.
- At sea, the practical question is when to keep the IO and when to convert to more durable access if resources and time allow.

5.12 Foley Catheter Placement

Purpose and clinical role

Foley catheter placement allows accurate urine output monitoring and management of retention. In ACTT, it is especially important for burn and shock patients whose resuscitation is being guided by output trends.

Indications

- Need for strict urine output measurement in burn resuscitation or shock.
- Bladder distension or retention requiring drainage.
- Prolonged holding where intake and output trending is clinically important.

Contraindications and cautions

- Suspected urethral injury or pelvic trauma makes urethral catheterization unsafe until assessed.
- Forcing the catheter against resistance can create significant injury.

Required equipment and setup

- Foley catheter kit, sterile supplies, lubricant, drainage bag, inflation syringe, and securement method.
- Privacy, positioning, and enough time to maintain clean technique.

Step-by-step execution

34. Prepare a clean sterile field and inspect the equipment before opening the system.
35. Use lubrication generously and insert with controlled technique rather than force.
36. Confirm urine return before balloon inflation whenever possible.
37. Inflate the balloon only once correct positioning is assured, then secure the catheter and position the bag below bladder level.

Confirmation and immediate aftercare

- Urine return and uncomplicated drainage support correct placement.
- Output should then be trended as a clinical endpoint, not just observed once.

Complications and troubleshooting

- False passage, no urine return, balloon inflation in the urethra, obstruction, and infection risk increase over time.
- If no urine returns, troubleshoot position, tubing kinks, dehydration, or retention rather than immediately assuming proper placement.

At-sea and delayed-MEDEVAC considerations

- In delayed MEDEVAC, the Foley becomes a monitoring device that must be cared for: securement, drainage bag handling, and infection prevention matter over hours to days.
- Chart trends in output because single readings are less useful than direction over time.

5.13 Emergency Pericardiocentesis

Purpose and clinical role

Emergency pericardiocentesis is a rare but potentially life-saving temporizing procedure for cardiac tamponade. It should only be performed when the indication is strong and the risk of not decompressing the pericardium is greater than the risk of the procedure itself.

Indications

- Suspected cardiac tamponade with hemodynamic compromise.
- Near-arrest or arrest where tamponade is strongly suspected and no faster definitive option exists.

Contraindications and cautions

- Major risk arises from misdiagnosis or poor needle trajectory causing myocardial or vascular injury.
- If ultrasound is available, it should be used because it improves target selection and reduces blind error.

Required equipment and setup

- Needle or catheter suitable for aspiration, syringe, sterile prep, monitoring, and ultrasound if available.
- Clear statement of intended approach: subxiphoid, parasternal, or apical.

Step-by-step execution

38. Select the approach based on anatomy, suspected fluid location, and ultrasound findings if available.
39. Prep the site, orient the needle deliberately, and advance while aspirating in a controlled fashion.
40. Once fluid is obtained and the patient improves, stop advancing and reassess.
41. If a catheter technique is used, secure it and continue close monitoring.

Confirmation and immediate aftercare

- Improved blood pressure, pulse quality, or perfusion suggests clinical success.
- Continue monitoring because pericardial fluid can reaccumulate and temporary improvement can fade quickly.

Complications and troubleshooting

- Myocardial puncture, coronary injury, arrhythmia, failure to aspirate, and recurrent tamponade are the core risks.
- If no fluid is obtained and the patient is not improving, reassess the diagnosis before repeated blind attempts.

At-sea and delayed-MEDEVAC considerations

- At sea, this is a bridge, not definitive treatment. If used, evacuation planning becomes urgent and monitoring must remain continuous.
- The patient may appear temporarily improved yet still deteriorate without further intervention.

5.14 Shoulder Reduction Techniques

Shoulder dislocation management is less dramatic than airway or thoracic rescue, but it still requires discipline. Reduction should be gentle, deliberate, and built around patient relaxation, analgesia, and reassessment rather than force.

5.14.1 Purpose and clinical role

Reduction restores anatomy, reduces pain, and may improve neurovascular function. It also prevents unnecessary ongoing soft tissue stretch. In stable patients, it is an opportunity to practice controlled procedural setup and re-examination.

5.14.2 Indications and cautions

- Use in suspected shoulder dislocation when the patient is stable and life threats have been addressed.
- Reassess distal neurovascular status before any attempt.
- If fracture-dislocation or unclear anatomy is strongly suspected, reduce only with appropriate caution or escalate if available.

5.14.3 Technique options

- External rotation: slow, reliable, and often successful when the patient can relax.
- Scapular manipulation: useful with traction and controlled scapular movement.
- Milch and FARES: traction-based methods that can work well with good patient relaxation.
- Cunningham: useful in cooperative patients and may avoid sedation.

5.14.4 What to avoid

Avoid high-force historical methods such as Kocher or the classic Hippocratic foot-in-axilla technique. These methods carry higher risk of fracture, nerve injury, and unnecessary trauma.

5.14.5 Post-reduction care

- Confirm reduction clinically.
- Repeat and document neurovascular examination.
- Immobilize, provide analgesia, and reassess for recurrent instability or associated injury.

5.15 Procedure-Specific Medication Integration

Procedures are inseparable from medications. The operator needs to know not only which drug is helpful, but when the drug changes the procedural risk. For example, analgesia may improve cooperation for chest tube insertion, but sedation without airway planning can create a second emergency.

5.15.1 Local anesthesia

Lidocaine is useful for procedures such as chest tube placement or other painful but non-crashing interventions. The goal is not full comfort at all costs; it is enough local control to improve tolerance without delaying a necessary intervention.

5.15.2 Sedation and analgesia

- Ketamine is often useful because it preserves blood pressure and can support painful procedures or restraint scenarios.
- Midazolam can reduce anxiety and blunt ketamine emergence reactions, but it increases respiratory depression risk when combined with opioids.
- Opioids may be useful in selected procedures but should be titrated carefully, especially when respiratory reserve is limited.

5.15.3 RSI medications

Airway procedures require the operator to think in phases: induction, paralysis, confirmation, then post-intubation sedation. The tube is not the endpoint; sedation and ventilator management begin immediately after placement.

5.15.4 Rescue medications

Any invasive procedure can precipitate hypotension, hypoxia, or worsening pain. Fluids, vasopressors, suction, oxygen, and rescue airway equipment should be considered part of the setup, not optional extras.

5.16 Post-Procedure Reassessment and Ongoing Care

A procedure is only complete when its effect has been verified and its consequences are being managed. The patient may deteriorate because the procedure failed, because the procedure succeeded only temporarily, or because the procedure introduced a new problem.

- Ask immediately: did the intervention fix the target problem?
- Recheck vitals, oxygenation, perfusion, pain, and mental status.
- Assess the device itself: tube, line, catheter, or drainage system can fail mechanically after technically correct placement.
- Document the time, indication, key findings, and early response.
- If evacuation is delayed, convert immediately to a maintenance plan that includes monitoring intervals, troubleshooting steps, and handover points.

5.17 Common Errors Across Procedures

- Starting a procedure without a clearly stated indication.
- Poor setup with no backup plan or rescue equipment ready.
- Inadequate landmarking leading to wrong-site placement.
- Technical focus so narrow that the team misses physiologic deterioration.
- Failure to confirm success using the right physiologic markers.
- Poor securement, leading to dislodgement during movement.
- Assuming the problem is solved after a technically successful placement and forgetting the next care burden.

5.18 What the Learner Should Be Able to Do After This Chapter

- Recognize when a major ACTT procedure is required and when it is not.
- Prepare the patient, team, and equipment in a structured way before starting.
- Perform the key steps in the correct order for the major airway, thoracic, access, monitoring, and selected rescue procedures.
- Confirm success, identify failure early, and troubleshoot common complications.
- Maintain the intervention safely during delayed MEDEVAC or prolonged holding.

5.19 Bridge to the Next Chapter

Chapter 6 shifts from procedure execution to the medication reference that supports these interventions.

Chapter 6
Medication Reference

Royal Canadian Navy Physician Assistant Focus

This chapter is a practical bedside medication guide for ACTT relevant care. It is written to answer: when to give the drug, how much to give, how to prepare it, how to administer it, what to monitor, what can go wrong, and what to do next.

6.1 Purpose of This Chapter

This chapter converts the medication content from the ACTT source set into a working reference. The emphasis is not on memorizing a list of drugs. The emphasis is on execution: selecting the correct medication for the problem in front of you, preparing it correctly, giving it safely, monitoring the patient after administration, and anticipating the next step if the patient does not respond.

- Bedside use during high acuity care
- Course preparation and rapid review
- Shipboard adaptation when ideal medications are not stocked
- Medication planning during delayed evacuation and 24 to 72 hour holding

6.2 How to Use This Chapter

Each medication entry is built around the same practical questions:

- What problem is this drug treating?
- What clinical trigger makes it appropriate now?
- What dose and route fit this specific scenario?
- What do I need to prepare before I give it?
- How fast do I administer it?
- What must I monitor in the minutes and hours afterward?
- What are the major errors, adverse effects, and rescue actions?
- What substitute can I use if the preferred agent is not available?

6.3 Standard Drug Entry Format

The detailed sections below follow a consistent operational format:

- Clinical role and common ACTT indications
- Contraindications and major cautions
- Adult dosing and route
- Preparation, dilution, concentration, and administration rate
- Expected onset and duration when relevant
- Monitoring requirements
- Common errors and troubleshooting
- Shipboard availability and practical substitute options
- Extended care considerations if the patient is held onboard

6.4 Medication Use in ACTT Care

In ACTT, medications are inseparable from decision pathways and procedures. Sedatives are part of airway control. Analgesics are part of prolonged field care. Vasopressors are part of shock management. Hypertonic therapy is part of neuroprotection. Antibiotics are part of source control. This chapter is therefore meant to be used alongside the algorithm and procedure chapters, not in isolation.

6.5 Shipboard Cross Reference Snapshot

Based on the uploaded Sick Bay medication list, several ACTT relevant medications are clearly onboard, while others should be treated as course knowledge or substitution targets. This chapter identifies onboard status in the detailed entries below.

Category	Examples confirmed onboard	Examples not clearly confirmed onboard
Analgesia / sedation	Acetaminophen, acetaminophen with codeine, lidocaine 2%, methoxyflurane, haloperidol	Ketamine, midazolam, hydromorphone, fentanyl, morphine
Airway / RSI	Lidocaine 2%, lidocaine with epinephrine	Succinylcholine, rocuronium, ketamine
Hemodynamic support	Enoxaparin, protamine sulfate	Norepinephrine, epinephrine infusion formulation, phentolamine
Neurocritical care	Dexamethasone injection, sodium bicarbonate	Hypertonic saline 3%, mannitol, levetiracetam
Cardiovascular emergencies	Clopidogrel, nitroglycerin patch, enoxaparin	Tenecteplase, heparin infusion kits
Sepsis / antimicrobials	Ampicillin, azithromycin IV, cefazolin, ceftriaxone, ciprofloxacin IV, metronidazole IV, acyclovir	Ertapenem, moxifloxacin

6.6 Section I - Analgesia and Sedation

Pain control and sedation are core ACTT skills. The practical rule for prolonged field care remains: start low and go slow. Small repeat doses with frequent reassessment are safer than large stacked doses. Every sedative dose changes the airway risk. Every opioid dose changes the respiratory risk.

6.6.1 Ketamine

Clinical role: ketamine is the most versatile ACTT drug in this category. It can be used for analgesia, dissociative procedural sedation, chemical restraint, and induction for RSI.

- Indications: severe pain, painful bedside procedures, combative patient requiring sedation, induction for airway control.
- Adult dosing for pain: 0.1 to 0.2 mg/kg IV or IO slow push, usually 10 to 20 mg, repeated every 10 to 30 minutes to effect. Intranasal or intramuscular pain dosing is higher and slower.
- Adult procedural sedation dosing: 1 mg/kg IV or IO over 60 seconds, or 4 to 5 mg/kg IM when IV access is delayed.
- Continuous sedation: 1 mg/kg/hour for non-intubated patients only with tight monitoring; 1 to 2 mg/kg/hour is more typical after intubation when a controlled airway is already in place.

Preparation and administration: if using IV ketamine for sedation, draw the dose carefully, label the syringe, and administer as a slow push. Rapid IV push can cause apnea and can increase the risk of laryngospasm. During RSI, ketamine should be paired with a paralytic; ketamine alone is not an RSI sequence.

Monitoring: continuous pulse oximetry, cardiac monitoring, blood pressure, and end tidal CO2 when available. Reassess mental status, respiratory effort, and the need for additional dosing every few minutes.

Major cautions: emergence reactions, hypersalivation, rare laryngospasm, and dose stacking. The mid range IV band around 0.3 to 0.8 mg/kg tends to create dysphoria without consistently achieving full dissociation. If the target is analgesia, stay in analgesic dosing. If the target is dissociation, move decisively to dissociative dosing.

Practical shipboard note: ketamine is important for ACTT learning even if it is not clearly listed in current shipboard stock. If unavailable, procedural planning becomes more dependent on local anesthetic, haloperidol for selected agitation, benzodiazepines if available, or opioid based analgesia with tighter respiratory monitoring.

6.6.2 Midazolam

Clinical role: midazolam is used for anxiolysis, adjunctive sedation, seizure termination, and to blunt ketamine emergence reactions. It is also used in post intubation sedation plans.

- Sedation dosing: 1 to 2.5 mg IV or IO slowly, repeated in small increments only after reassessment.
- IM dosing: commonly 5 mg when IV access is delayed and the patient is agitated or seizing.
- Active seizure treatment: 5 mg IV, IO, or IM; repeat every 5 minutes until the seizure stops while preparing definitive airway support if needed.

Preparation and administration: the key execution point is slow IV push. Fast administration increases the risk of apnea, hypotension, and loss of airway tone. If combining with opioids, lower the next dose and reassess before giving more.

Monitoring: respiratory rate, oxygen saturation, end tidal CO2 if available, blood pressure, and level of consciousness. If the patient becomes less responsive, immediately reassess airway patency and readiness to assist ventilation.

Common error: stacking repeated doses because the first dose "did not work" before sufficient time has passed. Midazolam may take several minutes to reach its full clinical effect, especially IM.

6.6.3 Opioid Analgesics

Opioids remain useful, but they must be used as respiratory depressants until proven otherwise. Reassess after every dose.

Hydromorphone

Preferred ACTT prolonged care opioid when available. Initial dosing for opioid naive adults is commonly 0.5 to 1 mg IV. Give slowly and reassess before repeating. It lasts longer than fentanyl and generally causes less histamine release than morphine.

Fentanyl

Fast onset and short duration. Typical IV or IO dosing is 25 to 100 mcg, given slowly. It is useful when a rapid effect is needed or when short procedures are planned. Pushing too quickly can cause chest wall rigidity and severe respiratory compromise.

Morphine

Important to know, but generally less favored in prolonged care because it more commonly causes hypotension, nausea, and pruritus. When used, give small IV doses slowly and reassess before repeating.

Acetaminophen and oral background analgesia

Acetaminophen is confirmed onboard and remains useful for background pain and fever control. The usual adult range is 650 to 1000 mg orally every 6 hours, with a maximum of 4 g per 24 hours. Avoid hiding cumulative acetaminophen inside combination tablets if the patient is receiving more than one product.

6.7 Section II - RSI and Airway Related Medications

Airway medications are used to make a definitive airway safer and more successful. The learner must know the exact sequence, not just the drug names.

6.7.1 Induction: Ketamine

For ACTT, ketamine is the practical primary induction agent because it generally preserves blood pressure better than many alternatives. Use a full induction dose, administer deliberately, and move immediately to the paralytic. After the tube is placed, restart sedation early. Successful intubation does not end the need for medication.

6.7.2 Paralytics

The ACTT source set expects the learner to understand succinylcholine and rocuronium even if they are not currently onboard.

- Succinylcholine: rapid onset and short duration. Useful when a brief paralysis window is desired. Avoid or use caution when hyperkalemia, major crush injury, severe burns after the early phase, or neuromuscular disease are concerns.
- Rocuronium: slower onset than succinylcholine at standard doses, but longer duration and fewer hyperkalemic concerns. The tradeoff is that a failed airway after rocuronium can become a prolonged cannot oxygenate scenario unless the rescue plan is ready.

Execution rule: ketamine alone is not a complete RSI plan. If the intent is RSI, the induction dose must be followed by a neuromuscular blocker and a clear attempt limit strategy.

6.7.3 Post Intubation Sedation

After tube confirmation, the patient still requires sedation and often analgesia. Without it, agitation, ventilator dyssynchrony, accidental extubation, and awareness can occur. Practical post intubation options include ketamine infusion, intermittent or infusion benzodiazepines, and opioid analgesia if hemodynamically tolerated.

Monitoring burden rises after intubation: sedation depth, blood pressure, oxygenation, end tidal CO2, tube position, and the practical ability of the team to maintain the airway for hours if evacuation is delayed.

6.8 Section III - Vasopressors, Inotropes, and Hemodynamic Support

6.8.1 Norepinephrine

Clinical role: first line vasopressor for persistent hypotension after initial fluid resuscitation, especially septic or vasodilatory shock.

- Starting range: commonly 2 to 4 mcg/minute IV infusion, titrated upward based on blood pressure and perfusion.
- Typical target: maintain MAP at or above 65 mmHg unless a different target is needed for neuroprotection or other competing pathology.

Preparation: mix to a labeled concentration that can be safely titrated by pump. The exact dilution can vary by local practice, but the critical point is clear labeling and accurate pump programming.

Administration: a central line is preferred. Peripheral administration is possible in emergencies but requires frequent IV site checks. If the site blanches, swells, or becomes painful, stop the infusion and treat possible extravasation immediately.

Extravasation rescue: if phentolamine is available, infiltrate the affected area promptly according to local dosing guidance. Mark the area, elevate the limb, and continue close monitoring.

Operational cautions: a vasopressor infusion creates a staffing task. Someone must be able to watch the blood pressure trend, the line site, the pump, and the patient response over time.

6.8.2 Epinephrine

Epinephrine is a concentration sensitive drug. The most common error is using the wrong concentration for the wrong indication.

- Anaphylaxis: 0.3 to 0.5 mg IM from the 1 mg/mL formulation into the lateral thigh; repeat every 5 minutes as needed.
- Cardiac arrest: 1 mg IV every 3 to 5 minutes from the cardiac arrest concentration.
- Shock infusion: low dose continuous infusion when used as a vasopressor or inotrope, with pump control and close monitoring.

Execution point: before giving epinephrine, state the indication out loud and confirm the concentration. This simple cross check prevents the most dangerous error with this medication.

6.8.3 Other Support Drugs

Dopamine and dobutamine may appear in some systems as alternative agents. The practical learning point is not to memorize every niche use first. It is to know that norepinephrine remains the default first line vasopressor in the ACTT framework, and that any deviation should be deliberate and clinically justified.

6.9 Section IV - Seizure Control and Neurocritical Medications

6.9.1 Midazolam for Active Seizure

Use repeated 5 mg doses every 5 minutes until seizure activity stops or airway control becomes necessary. If the patient remains seizing, move early toward definitive airway planning, glucose check, and longer acting antiepileptic loading.

6.9.2 Levetiracetam

Used for seizure loading or prophylaxis in TBI. The ACTT source material emphasizes a 2 g IV or IO load over about 15 minutes. Ensure the line is patent before starting and document the start and stop time. Watch for ongoing seizures despite the load; levetiracetam does not replace immediate benzodiazepine rescue for active convulsions.

6.9.3 Hypertonic Saline 3%

Clinical role: osmotic therapy for elevated intracranial pressure or impending herniation. In the ACTT material, the practical bolus is 250 mL over about 20 minutes.

- Give when there is neurologic deterioration, a dilated pupil, or other signs of impending herniation, not as a routine reflex.

- Check sodium when possible and avoid driving the serum sodium too high through repeated untracked dosing.
- Document neurologic status before and after administration; the trend matters more than a single note.

6.9.4 Mannitol

Mannitol remains an alternative osmotic therapy, commonly 1 g/kg IV over about 20 minutes. It is not a benign default drug. Avoid it when the patient is hypotensive, actively bleeding, or already volume depleted. In TBI, worsening blood pressure can worsen cerebral perfusion even if the ICP treatment looked technically correct.

6.10 Section V - Procedural Sedation Support and Adjunct Medications

6.10.1 Lidocaine

Lidocaine has two high yield uses in this manual: local anesthesia for procedures and pain control before IO flushing in awake patients.

- IO pain control: commonly 20 to 40 mg of preservative free 2% lidocaine slowly through the IO line before the aggressive flush in an awake adult.
- Local infiltration: infiltrate in layers before procedures such as chest tube insertion when the situation and patient status allow.

Practical onboard note: lidocaine 2% is clearly onboard and should be treated as an important procedural support drug. Always calculate the intended dose before infiltration if multiple syringes are being used.

6.10.2 Ondansetron

Ondansetron is confirmed onboard and is useful after opioids, after ketamine, and in general illness. Common adult dosing is 4 mg IV, IM, or orally disintegrating tablet, repeated as needed within safe daily limits. The practical value is prevention of vomiting in a patient whose airway or transport situation would make emesis dangerous.

6.10.3 Diphenhydramine

Useful for pruritus, allergic reactions, and some dystonic reactions. The drawback is added sedation. In a borderline airway patient, avoid assuming it is a harmless extra medication. It can deepen sedation burden and complicate reassessment.

6.11 Section VI - Cardiovascular Emergency Medications

6.11.1 Tenecteplase

Clinical role: fibrinolysis for STEMI when primary PCI cannot be delivered within the required time window and no absolute contraindications are present.

Execution sequence matters more than memorizing the vial alone: confirm the ECG diagnosis, confirm symptom timing, screen for contraindications, determine the weight band, prepare the vial properly, give the push dose, then immediately move to the adjunct medications and post dose monitoring.

- Weight bands: 30 mg if under 60 kg; 35 mg for 60 to 69 kg; 40 mg for 70 to 79 kg; 45 mg for 80 to 89 kg; 50 mg at 90 kg or above.

- Administration: IV push over 5 seconds after careful reconstitution. Do not shake the vial. Foaming can damage usability and increase dosing error risk.
- Monitoring: watch for reperfusion arrhythmias, bleeding, sudden headache, confusion, and any neurologic decline suggestive of intracranial hemorrhage.

Common errors: wrong weight band, missing a contraindication, and failing to line up the anticoagulant and antiplatelet follow through.

6.11.2 Enoxaparin

Confirmed onboard. Enoxaparin is used as an adjunct anticoagulant after fibrinolysis when appropriate. The ACTT source set emphasizes a 30 mg IV bolus followed by 1 mg/kg subcutaneous dosing every 12 hours in suitable patients. Renal function and age modify use. If bleeding risk or renal dysfunction is high, reassess whether an alternative strategy is safer.

6.11.3 Heparin

Heparin is the common alternative when infusion based anticoagulation is selected. The bedside risk is not only bleeding. The risk is also arithmetic and pump error. Any heparin infusion requires deliberate setup, clear labeling, and documented rate checks.

6.11.4 Clopidogrel

Confirmed onboard. Used as the antiplatelet partner in STEMI fibrinolysis pathways. The practical issue is timing: ensure it is administered as part of the reperfusion package and not forgotten after the fibrinolytic has already been given.

6.12 Section VII - Sepsis and Infectious Disease Medications

Antibiotics in ACTT are time critical. The main execution rule is simple: in severe sepsis or septic shock, do not let a perfect diagnostic workup delay the first appropriate antimicrobial dose.

6.12.1 Sepsis Antibiotic Principles

- Aim to start appropriate antibiotics within 1 hour when severe sepsis or septic shock is recognized.
- If cultures can be obtained without delaying treatment, draw them first. If not, treat first.
- Choose the regimen based on the most likely source, not on the broadest imaginable coverage by default.
- Reassess after the first doses: hemodynamics, fever trend, source clues, allergic reaction, and need for ongoing dosing during prolonged holding.

6.12.2 Source Based Navy Empiric Regimens

The source material repeatedly supports source based empiric pathways. The manual should present them as ready to execute bundles:

- Unknown source or intra abdominal pattern: ceftriaxone plus metronidazole.
- Pneumonia pattern: ceftriaxone plus azithromycin.
- CNS or meningitis pattern: ceftriaxone plus ampicillin, with dexamethasone and acyclovir when clinically indicated.
- Skin and soft tissue pattern: cefazolin for non purulent presentations, with alternatives such as clindamycin when purulence or specific coverage issues change the plan.
- Open or penetrating TBI protocols may call for broader coverage such as ertapenem plus moxifloxacin, with ceftriaxone based fallback options if the ideal agents are not stocked.

6.12.3 Key Antibiotic Entries

Ceftriaxone

Confirmed onboard. High value broad spectrum ACTT drug. The practical learning point is route, infusion timing, and source pairing. It is commonly paired with metronidazole, azithromycin, or ampicillin depending on the syndrome.

Metronidazole

Confirmed onboard IV. Useful when anaerobic or intra abdominal coverage matters. Ensure the full dose is actually hung and infused, not left prepared but delayed.

Azithromycin

Confirmed onboard IV. Used in pneumonia regimens. Ensure compatibility and infusion plan are clear before starting.

Ampicillin

Confirmed onboard. High importance in selected CNS regimens. Re dosing matters if the patient is held for many hours.

Cefazolin

Confirmed onboard. High value for skin and soft tissue infections and for selected prophylactic uses.

Acyclovir

Confirmed onboard as injection. Relevant in selected CNS pathways when viral encephalitis remains a concern.

6.13 Section VIII - Reversal Agents and Rescue Medications

6.13.1 Naloxone

Naloxone reverses opioid toxicity, but the goal is not always to wake the patient fully. The safer goal is often to restore adequate breathing while preserving some analgesia and avoiding violent withdrawal.

- Titrated strategy: dilute 0.4 mg in 10 mL total volume and give small aliquots slowly while reassessing breathing.
- Redose every 2 to 3 minutes as needed; naloxone may wear off before the opioid does.
- Be ready for vomiting, agitation, and abrupt pain return after reversal.

6.13.2 Flumazenil

Flumazenil has a narrow role. It can reverse benzodiazepine effect, but it can also precipitate seizures, especially in chronic benzodiazepine users or mixed overdoses. In this manual it should be treated as a rare, selective rescue option, not a routine antidote.

6.13.3 Protamine

Protamine sulfate is confirmed onboard. It may become relevant in bleeding after heparin exposure and offers only partial reversal for enoxaparin. Use requires deliberate dosing logic and close observation for hypotension or hypersensitivity during administration.

6.14 Section IX - Medication Use Over 24 to 72 Hours

Medication practice changes when the patient is not leaving quickly. Initial success does not end the medication problem. Over hours, the issues become cumulative dose, supply, ongoing monitoring, and delayed complications.

- Repeat dosing: document the exact time and effect of each dose before repeating.
- Transition to maintenance: convert from repeated rescue boluses to a sustainable infusion or scheduled plan when appropriate.
- Avoid stacking: never give a second sedative because the patient is still agitated without first asking whether the first drug has peaked, whether pain is the real driver, or whether hypoxia is being missed.
- Track supply: a drug plan that works for 20 minutes may fail by hour 12 if stock is limited.
- Line surveillance: infusion site checks and pump checks become part of medication safety.

A good delayed MEDEVAC medication plan includes: indication, current dose, next planned dose, hold parameters, rescue medication, and the monitoring burden required to keep the plan safe.

6.15 Common Medication Errors in ACTT Care

- Right drug, wrong indication. Example: giving more sedative when the real problem is hypoxia or pain.
- Dose by memory instead of by calculation or protocol.
- Wrong concentration, especially with epinephrine, heparin, or vasoactive infusions.
- Giving a correct dose too fast.
- Failure to reassess after administration.
- Failure to anticipate airway consequences after sedatives or opioids.
- No continuation plan after the first beneficial dose.
- No documentation of time, effect, or adverse response.

6.16 What the Learner Should Be Able to Do After This Chapter

- Select the correct medication for the clinical problem in front of them.
- Prepare the medication correctly and administer it at the right speed.
- State the major contraindications and monitoring requirements.
- Anticipate the next likely adverse effect or failure point.
- Adjust treatment when the preferred drug is unavailable.
- Carry medication management safely into prolonged holding and delayed evacuation.

6.17 Bridge to the Next Chapter

The next chapter moves from individual medication execution to the broader task of sustaining a patient over time. Chapter 7 addresses prolonged holding and delayed MEDEVAC, including repeated reassessment, line and device burden, medication continuation, and the practical problem of maintaining a critically ill patient on board for up to 72 hours.

ACTT Preparation Manual

Chapter 7: Prolonged Holding and Delayed MEDEVAC

Royal Canadian Navy Physician Assistant Focus

Chapter intent: This chapter explains how to convert initial stabilization into a structured 24-72 hour holding plan when evacuation is delayed. The focus is sustained monitoring, complication prevention, clear reassessment rhythm, and knowing when holding is no longer safe.

7.1 Purpose of This Chapter

This chapter addresses the period after the dramatic first minutes of care are over. In the ACTT context, the problem is often not simply how to save a patient in the initial resuscitation, but how to keep that patient alive, monitored, and organized for the next several hours when transfer is delayed. That shift changes nearly every clinical priority.

The practical goal is to move from isolated interventions to a deliberate holding plan. A chest tube, an endotracheal tube, a fluid bolus, a pressor infusion, or a sedative dose may solve an immediate problem, but each one creates a maintenance burden. Prolonged holding means the clinician must manage those burdens continuously and predict what will fail next.

7.2 Why Prolonged Holding Matters in the ACTT / RCN Context

For a Royal Canadian Navy clinician working at sea, delayed evacuation is not an edge case. Weather, distance, sea state, flight availability, platform limitations, and the operational setting can all extend the time between initial stabilization and definitive transfer. As a result, patients may remain under shipboard care far longer than would be typical in a shore-based emergency department.

A patient who initially looks "stabilized" can deteriorate later for predictable reasons: sedation accumulates, drains stop functioning, edema progresses, a temporary decompression fails, infection declares itself, or the team becomes fatigued. ACTT-level prolonged care therefore requires active surveillance rather than passive observation.

7.3 How Prolonged Holding Changes Clinical Priorities

7.3.1 From rescue to maintenance

During the first phase, the priority is to identify and treat immediate threats. Once those threats are addressed, the operational question changes from "What is killing the patient right now?" to "What could cause this patient to worsen over the next 1, 6, 24, or 72 hours?"

- Temporary interventions must be converted into sustainable care plans.
- Every medication now needs a re-dosing plan, not just a one-time dose.
- Every device now needs securement, checks, and troubleshooting expectations.
- A normal single set of vitals is less useful than a clear trend over time.

7.3.2 From snapshot thinking to trend thinking

Prolonged holding depends on trends. Blood pressure, neurologic status, oxygen requirement, urine output, chest tube output, temperature, sedation depth, and infusion needs all need repeated documentation. The aim is to detect drift early while it is still manageable.

7.4 Transition Into the Holding Phase

7.4.1 Stabilization check before formal holding

Before declaring a patient to be in a holding phase, run a deliberate stabilization check. This prevents the common mistake of calling a patient stable when a life-threatening problem is only partially treated.

- Airway: secured, maintainable, and reassessed?
- Breathing: oxygenation acceptable, ventilation adequate, chest interventions functioning?
- Circulation: hemorrhage controlled, perfusion acceptable, access reliable?
- Disability: neurologic status documented and comparable over time?
- Exposure: temperature protected, wounds covered, no missed injury pattern?

7.4.2 Define the working problem list

Create a concise written problem list. It should include active diagnoses, current threats, devices in place, medications currently running or due, and what specific deterioration is most likely next. A working problem list turns prolonged care from reactive improvisation into organized management.

7.4.3 Set explicit holding priorities

Assign what must be watched continuously, what must be checked on a schedule, and what change would force escalation. This prevents omissions during long holds or shift turnover.

7.5 Reassessment Framework Over 24-72 Hours

Reassessment is the core skill in prolonged holding. There is no single universal schedule, but the pattern should be more frequent when unstable, immediately after interventions, and still routine even when the patient appears stable.

7.5.1 Suggested reassessment rhythm

Patient state	Typical reassessment rhythm	Focus
Unstable or actively deteriorating	Continuous or near-continuous	ABCs, monitor trend, response to each intervention, immediate escalation readiness
Recently intervened upon	Recheck within minutes, then frequent short intervals	Effect of procedure or drug, new complications, whether target was achieved
Temporarily stable but high-risk	Scheduled full trend reviews	Neuro trend, perfusion, urine output, device function, medication timing
Long hold with handover risk	Formal written trend review each watch / shift	Continuity, cumulative totals, what may fail next

7.5.2 What must be trended

- Mental status, GCS, and pupils in any neurologic concern.
- Work of breathing, oxygen requirement, EtCO2 if available, and airway patency.
- Heart rate, blood pressure or MAP, capillary refill, skin findings, and pulses.
- Urine output, total fluids in, total fluids out, and cumulative medication doses.
- Chest tube output, drain function, and any sign of recurrent tension physiology.
- Fever pattern, wound progression, and any sign of sepsis or new infection.

7.6 Airway and Breathing During Prolonged Holding

7.6.1 Non-intubated patients

A patient who is not intubated still requires an airway plan. Positioning, suction readiness, oxygen adjustment, and serial reassessment for fatigue or evolving obstruction are essential. This is particularly important with facial burns, inhalation injury, altered mental status, sedating medications, or progressive edema.

7.6.2 Intubated patients

Intubation does not end airway management. The tube must be checked repeatedly for depth, securement, cuff integrity if relevant, and patency. The team must confirm that the patient is adequately sedated, ventilated to target, and not developing tube obstruction, mainstem migration, or accidental partial withdrawal.

- Check tube depth after movement, transfers, or major patient repositioning.
- Reconfirm bilateral breath sounds and appropriate chest rise when concern exists.
- Use EtCO2 trends when available; abrupt change can indicate displacement or obstruction.
- Anticipate secretion burden and suction before it becomes a crisis.

7.6.3 Surgical and rescue airways

Surgical or rescue airways carry an even higher maintenance burden. They are easier to dislodge, may bleed, and can become obstructed by secretions or clot. In a prolonged hold, the team must treat patency checks and securement as active tasks, not assumptions.

7.6.4 Thoracic intervention follow-up

Any needle decompression requires reassessment because it is a temporizing measure. Any chest tube requires ongoing function checks: drainage integrity, kinking, clotting, output trend, and recurrent tension signs. A procedure that worked once may fail later.

7.7 Circulation, Perfusion, and Fluid Management Over Time

7.7.1 Ongoing perfusion goals

The objective is sustained end-organ perfusion, not a single reassuring blood pressure. Mental status, skin findings, pulses, capillary refill, urine output, and trajectory after each intervention are often more informative than one number alone.

7.7.2 Fluid management over hours

Repeated fluids without a defined endpoint can harm the patient. Each bolus should have a reason, a reassessment point, and a clear stop condition. If oxygenation worsens, crackles appear, edema increases, or work of breathing rises, the plan must change.

7.7.3 Burn resuscitation over time

In burns, the initial rate is only the starting point. Urine output drives rate adjustments. Track temperature, peripheral perfusion, extremity tightness, evolving airway edema, and signs of fluid creep. Large burn patients can worsen from under-resuscitation or over-resuscitation.

7.7.4 Vasopressors over time

A patient on vasopressors requires sustained attention. Continuous infusions demand pump reliability, exact concentration awareness, IV site surveillance, and clear target MAP. Pressor dependence is itself an indicator of severity and should lower the threshold for teleconsultation and escalation.

7.8 Neurologic Care During Prolonged Holding

7.8.1 Serial neurologic assessment

In TBI or any altered mental status case, document neurologic trends in a way that can be compared. GCS alone is not enough; note pupil size and reactivity, movement patterns, seizure activity, new asymmetry, and whether apparent agitation may actually reflect neurologic decline.

7.8.2 Preventing secondary brain injury

- Avoid hypoxia.
- Avoid hypotension.
- Avoid fever.
- Maintain ventilation targets; do not drift into unrecognized hypo- or hyperventilation.
- Avoid hypotonic fluids and monitor sodium when hypertonic therapy is used.

7.8.3 Herniation surveillance

Watch for worsening level of consciousness, pupillary asymmetry, bradycardia with hypertension, or irregular respirations. If the patient begins to herniate despite current care, local holding may no longer be safe. Temporary rescue measures do not replace the need to escalate.

7.9 Sedation, Analgesia, and Agitation Over Time

One of the most demanding prolonged-care tasks is keeping the patient comfortable enough to tolerate care, but not so sedated that deterioration is masked or respiratory compromise is created. This is especially important for intubated patients, burn patients, head injury patients, and previously combative patients.

7.9.1 Practical sedation principles

- Treat pain proactively; do not wait for severe distress to recur.
- Track exact dose times and cumulative totals to avoid dose stacking.
- If repeated boluses are creating instability or excessive workload, consider whether an infusion is more controlled.
- Any new agitation should prompt reassessment for pain, hypoxia, hypoglycemia, delirium, urinary retention, TBI progression, or withdrawal.

7.9.2 Common prolonged-care medication traps

The most common medication failures in long holds are cumulative oversedation, respiratory depression after repeated doses, undocumented PRN dosing, and treating every agitation event as behavioural rather than physiologic. The answer is structured reassessment after every major medication change.

7.10 Infection Prevention and Sepsis During Holding

7.10.1 Continuing antibiotics safely

When antibiotics are indicated, maintain the schedule accurately and document exact administration times. In prolonged care, delayed or missed doses often occur during shift changes or competing crises. That is preventable with a written medication timeline.

7.10.2 Watching for progression

Track temperature, perfusion, respiratory burden, urine output, mental status, and pressor need. A patient can progress into worse sepsis while appearing only mildly changed in any single category; the trend is what reveals the pattern.

7.10.3 Preventing new infection

Every line, tube, catheter, and wound creates infection risk. Device care, clean handling, dressing surveillance, and removal of unnecessary devices are part of prolonged treatment, not optional extras.

7.11 Device and Procedure Maintenance

Placing a device creates an obligation to maintain it. In prolonged holding, device failure is a common reason that previously controlled patients worsen.

- Airway devices: check security, patency, suction needs, and migration risk.
- Chest tubes: check drainage system integrity, output, kinks, clots, and re-tension risk.
- IV and IO access: check patency, infiltration, extravasation, securement, and whether more durable access is needed.
- Foley catheters: confirm flow, avoid kinks, watch for blockage, and reassess continued need.
- Dressings and wounds: watch for bleed-through, contamination, swelling, and pressure injury.

7.12 Nursing-Style Supportive Care Requirements

A common prolonged-care error is to think only in terms of procedures and drugs while neglecting supportive care. In reality, repositioning, hygiene, temperature control, mouth care, skin care, and prevention of pressure injury directly affect outcomes during long holds.

7.12.1 Core supportive tasks

- Reposition when feasible to reduce pressure injury and dependent edema.
- Control temperature: avoid hypothermia in trauma, burns, and shock; avoid overheating during rewarming or prolonged coverage.
- Allow oral intake only when airway protection and clinical status make it safe.
- Manage oral secretions, emesis, blood, and incontinence promptly to reduce aspiration and skin breakdown risk.

7.13 Documentation and Handover During Prolonged Holding

Documentation becomes more valuable as time passes. It preserves the trend, prevents repeated dosing errors, improves teleconsultation, and makes MEDEVAC handover useful rather than vague.

7.13.1 Minimum documentation set

- Timeline of deterioration and major interventions.
- Vital sign trends and key reassessment findings.
- Neurologic trend, including GCS and pupils when relevant.
- Fluids in, fluids out, and urine output by interval.
- Medications with exact time, dose, route, and observed effect.
- Device placements, checks, and any complications or troubleshooting.
- Current status, current threats, and what may fail next.

7.13.2 Structured handover

A useful handover should answer five questions quickly: what happened, what has been done, what is the patient like now, what are the active threats, and what specifically must be watched next. This applies to watch turnover, teleconsultation, and actual transfer off the ship.

7.14 Teleconsultation and Escalation Thresholds

In prolonged holding, early remote support is usually more valuable than late remote support. The threshold should be lower when the patient is deteriorating, pressor-dependent, ventilated, seizing repeatedly, neurologically worsening, or approaching the edge of local monitoring capability.

7.14.1 Information to have ready before calling

- Concise problem list.
- Vital signs and trends.
- Interventions already performed and response to each.
- Medications given, including dose and timing.
- Current devices, access, and local limitations.
- What specific decision or support is being requested.

7.14.2 When holding is no longer acceptable

Holding is no longer acceptable when the patient worsens despite active management, when oxygen or pressor requirements keep climbing, when airway or ventilation cannot be maintained safely, when bleeding or neurologic decline is progressing, or when staffing and supply limits mean safe monitoring can no longer be assured.

7.15 Common 24-72 Hour Failure Points

7.15.1 Clinical failure points

- Missed deterioration because reassessment drifted or was not documented.
- Recurrent shock or recurrent tension physiology after temporary improvement.
- Delayed brain herniation or seizure recurrence not recognized early.
- Fluid overload after repeated boluses without endpoint-based reassessment.

7.15.2 Medication failure points

- Dose stacking, especially with sedatives and opioids.
- Infusion concentration errors or pump programming mistakes.
- Missed antibiotic timing during watch changes.
- Running out of key drugs because conservation was never planned.

7.15.3 Operational failure points

- Poor handover.
- Device dislodgement during movement or transport.
- No explicit reassessment schedule.
- Underestimating the staffing burden of a complex held patient.

7.16 RCN At-Sea Constraints and Practical Adaptations

Shipboard prolonged care requires adaptation. The aim is not to recreate an ICU at sea. The aim is safe, sustainable bridging care that preserves the patient, detects deterioration early, and uses limited staff and equipment where they change decisions most.

7.16.1 Practical adaptations

- Simplify monitoring to the variables that actually change management.
- Use written trend sheets and a routine reassessment rhythm to reduce omission.
- Prioritize securement of every tube, line, and drain before movement.

- Think ahead about medication conservation and re-supply limits.
- Set explicit triggers for re-contacting higher support rather than relying on vague concern.

7.17 What the Learner Should Be Able to Do After This Chapter

After studying this chapter, the learner should be able to convert an initially stabilized patient into a structured prolonged-care plan; reassess that patient over 24-72 hours using trends rather than snapshots; maintain airway, circulation, sedation, and device safety over time; recognize when the patient is drifting or failing; document clearly enough for continuity and transfer; and identify when local holding is no longer safe or acceptable.

7.18 Transition to the Next Chapter

The next chapter narrows from prolonged-care process to memorization-critical hard numbers. After learning how to hold the patient over time, the learner next needs a concise reference for thresholds, physiologic targets, trigger values, and dosing-related cutoffs that drive action under pressure.

Chapter 7 Quick Reference

If this is happening...	Then do this next
Patient appears stable after initial resuscitation	Create a written problem list, define monitoring frequency, and set explicit escalation triggers.
Repeated PRN sedation is being given	Stop and review cumulative totals, reassess the cause of agitation, and decide whether a more controlled plan is needed.
A previously effective device stops improving the patient	Check function, position, patency, and whether the original intervention was only temporizing.
Trend is worsening but no single value looks catastrophic	Treat the trend as real deterioration and escalate early.
Team is fatigued or handover is approaching	Do a structured review of vitals, medications, devices, and likely next failure point before turnover.

Chapter 8: Numeric Thresholds and Critical Targets

ACTT Preparation Manual - Royal Canadian Navy Physician Assistant Focus

This chapter consolidates the bedside numbers that most often change action in ACTT-relevant care. It is designed as a rapid operational reference: each value is linked to what it means, what it should trigger, and what must be reassessed after intervention. These values should support judgment, not replace it. Numbers are most useful when interpreted in trend, in context, and in relation to the whole patient.

8.1 Purpose of This Chapter

The purpose of this chapter is to gather the memorization-critical values that repeatedly drive decisions during trauma, critical care, and prolonged holding. In practice, many errors do not come from failing to recognize the disease process. They come from failing to remember the trigger threshold, using the wrong target, or not linking the number to a next step.

- Identify trigger values that demand action now.
- Identify target ranges that should be maintained over time.
- Separate temporary rescue targets from longer-term maintenance targets.
- Support rapid review during ACTT and practical use during delayed MEDEVAC.

8.2 How to Use Numeric Targets Safely

Each value in this chapter should be used as part of a short operational loop: identify the number, decide what it means in the current patient, act, and then reassess to determine whether the intervention changed the trend in the right direction.

1. Confirm the number is reliable. Check probe position, cuff size, waveform, technique, or source of the value if accuracy is in doubt.
2. Interpret the number in context. A single threshold may not have the same meaning in TBI, burns, sepsis, or deep sedation.
3. Link the number to action. A trigger without a response plan is not clinically useful.
4. Reassess after intervention. Every target value must be paired with a follow-up check to confirm benefit or detect harm.
5. Trend over time. In delayed evacuation, the direction of change often matters more than any single reading.

8.3 Standard Format for Threshold Entries

- Parameter
- Trigger threshold or target range
- Clinical meaning
- Immediate action triggered
- Major cautions or common traps
- What must be reassessed afterward
- Why it matters during prolonged holding at sea

8.4 Airway and Respiratory Thresholds

8.4.1 Glasgow Coma Scale and Airway Risk

A Glasgow Coma Scale of 8 or less is the most important airway threshold in this chapter. It should immediately raise the question of whether the patient can protect their airway, maintain ventilation, and tolerate transport without aspiration or sudden deterioration.

- Critical threshold: GCS 8 or less.
- Clinical meaning: severe brain injury or severe depressed consciousness with unreliable airway protection.
- Action triggered: prepare for a definitive airway, usually RSI unless oral intubation is clearly impossible or inappropriate.
- What to avoid: delaying airway planning just because oxygen saturation is temporarily acceptable.
- Reassess after action: EtCO2, SpO2, chest rise, breath sounds, tube position, blood pressure, and sedation depth.

8.4.2 Oxygen Saturation Targets

In the ACTT context, hypoxia is treated aggressively because it worsens almost every major syndrome in this manual, especially TBI, shock, burns, and sedation-related respiratory depression.

- Target: SpO2 above 95 percent in high-risk patients, especially TBI.
- Trigger for escalation: persistent or falling saturation despite oxygen delivery.
- Action triggered: increase oxygen support, reassess airway patency, reassess ventilation, reassess chest pathology, and decide whether definitive airway control is needed.
- What to avoid: treating the monitor only. Always confirm with work of breathing, mental status, and chest findings.
- Reassess after action: oxygen requirement trend, respiratory effort, mental status, and response to intervention.

8.4.3 End-Tidal CO2 Targets

EtCO2 is both a ventilation target and a monitoring tool. In ACTT it is especially important in intubated patients, sedated patients, and neurocritical care.

- Target in controlled ventilation for TBI: 35 to 40 mmHg.
- Temporary rescue target for suspected impending herniation: about 30 mmHg.
- Clinical meaning: hypocapnia below target can reduce cerebral blood flow; hypercapnia above target can worsen intracranial pressure.
- Action triggered: adjust bagging rate or ventilator settings.
- Major caution: hyperventilation to 30 mmHg is a short bridge only, not a maintenance strategy.
- Reassess after action: repeat EtCO2, chest rise, hemodynamics, and neurologic status.

8.4.4 Mechanical Ventilation Tidal Volume

- Target: 6 mL/kg predicted body weight.
- Acceptable range: 5 to 8 mL/kg predicted body weight.
- Clinical meaning: lung-protective ventilation reduces the risk of ventilator-induced injury.
- Action triggered: set or adjust ventilator tidal volume during ongoing ventilatory support.
- What to avoid: large-volume ventilation by habit, especially in already injured lungs.
- Important caveat: permissive hypercapnia may be acceptable in some patients, but not when tight neuroprotection is required.

8.4.5 Needle Cricothyroidotomy Time Limit

- Practical limit: about 20 to 30 minutes as a temporary bridge.
- Clinical meaning: this is not a durable long-term airway.
- Action triggered: move to a definitive airway as soon as feasible.
- What to avoid: false reassurance because oxygenation improved briefly.

8.5 Hemodynamic and Shock Targets

8.5.1 Systolic Blood Pressure in TBI

TBI management depends on protecting cerebral perfusion. Even a single hypotensive episode can worsen outcome, so the threshold is intentionally conservative.

- Target: SBP above 110 mmHg.
- Clinical meaning: lower pressures increase the risk of secondary brain injury.
- Action triggered: volume support with blood or isotonic fluid as appropriate, followed by vasoactive support if needed.
- What to avoid: hypotonic fluids and delayed escalation when blood pressure remains below target.
- Reassess after action: BP trend, mental status, pupils, perfusion, and EtCO2.

8.5.2 Mean Arterial Pressure in Septic Shock

- Target: MAP 65 mmHg or greater.
- Clinical meaning: minimum perfusion goal in vasodilatory shock.
- Action triggered: titrate norepinephrine after initial resuscitation when fluid alone is not enough.
- What to avoid: continuing blind fluid loading while the patient develops pulmonary overload.
- Reassess after action: MAP, urine output, peripheral perfusion, mental status, and respiratory burden.

8.5.3 Capillary Refill and Perfusion Flags

- Concerning threshold: capillary refill longer than 3 seconds in the right context.
- Clinical meaning: impaired peripheral perfusion, especially in shock or sepsis.
- Action triggered: reassess circulatory state, not just the blood pressure.
- What to avoid: treating capillary refill as a standalone diagnostic test.
- Reassess after action: trend capillary refill with skin temperature, pulses, mentation, and urine output.

8.5.4 Passive Leg Raise as a Functional Threshold

Passive leg raise is not a static number but a bedside maneuver that helps determine whether more fluid is likely to improve forward flow. In ACTT-relevant care, it is useful because it can reduce unnecessary fluid loading when resources, ventilation, or time are limited.

- Clinical role: dynamic assessment of fluid responsiveness.
- Action triggered: supports the decision to give or withhold additional fluid bolus.
- What to avoid: repeating fluid boluses without evidence of benefit.

8.6 Neurologic and TBI Targets

8.6.1 Optic Nerve Sheath Diameter

- Concerning threshold: greater than 5.2 mm.
- Clinical meaning: suggests elevated intracranial pressure in the right clinical setting.
- Action triggered: increase neurologic surveillance and consider ICP-lowering measures if the full picture supports it.
- What to avoid: treating ONSD as a diagnosis by itself. Use it with exam findings and clinical deterioration.

8.6.2 Serum Sodium During Hypertonic Therapy

- Target range when using hypertonic therapy: 145 to 160 mmol/L.
- Clinical meaning: controlled therapeutic hypernatremia may support ICP management.
- Action triggered: monitor sodium and avoid uncontrolled overcorrection.
- What to avoid: repeated hypertonic dosing without trend review.
- Reassess after action: neurologic exam, sodium level if available, and overall volume status.

8.6.3 Hyperventilation Limit in Herniation

- Time limit: roughly 20 minutes as a temporary bridge.
- Clinical meaning: a short rescue measure while other interventions are being applied.
- Action triggered: use only in suspected impending herniation, not as routine ventilation.
- What to avoid: prolonged hypocapnia that worsens cerebral ischemia.

8.6.4 Temperature Goals in TBI

- Approximate target range: 96 F to 99.5 F.
- Clinical meaning: fever increases metabolic demand and can worsen secondary brain injury.
- Action triggered: antipyretics and cooling measures when elevated.
- What to avoid: overlooking low-grade fever drift during prolonged holding.

8.7 Burn Resuscitation Thresholds

8.7.1 Rule of 10s Starting Rate

- Starting formula for adults 40 to 80 kg: percent TBSA x 10 = mL/hr.
- Add-on for heavier adults: add 100 mL/hr for every 10 kg above 80 kg.
- Clinical meaning: this is the initial estimate only, not the final maintenance rate.
- Action triggered: start isotonic crystalloid and begin structured reassessment.
- What to avoid: treating the formula as fixed once the pump is started.

8.7.2 Adult Urine Output Target in Burns

- Target: 30 to 50 mL/hr.
- Clinical meaning: best practical bedside indicator of adequate burn resuscitation.
- Action triggered: titrate fluid rate according to trend.
- What to avoid: chasing hypotension alone while ignoring urine output.

8.7.3 Electrical or Crush Burn Urine Output Target

- Target: 70 to 100 mL/hr when pigment injury is a concern.
- Clinical meaning: higher output target may help reduce kidney injury risk.
- Action triggered: more aggressive fluid support with closer monitoring.
- What to avoid: applying the standard burn urine target when rhabdomyolysis risk is obvious.

8.7.4 Burn Fluid Rate Adjustment

- Adjustment rule: change the fluid rate by about 25 percent based on urine output trend.
- Clinical meaning: structured repeated titration prevents both under- and over-resuscitation.
- Action triggered: increase rate when output remains low; decrease when output overshoots target.
- Reassess after action: urine output, edema, respiratory status, and perfusion.

8.7.5 Early Airway Threshold in Major Burns

- Key trigger: more than 40 percent TBSA or major inhalation injury.
- Clinical meaning: airway edema can progress quickly and make later intubation much harder.
- Action triggered: early definitive airway planning rather than waiting for crisis.
- What to avoid: delaying airway control in a patient whose anatomy is predictably worsening.

8.8 Hypothermia Thresholds

8.8.1 Core Temperature Staging

- HT I: 32 to 35 C.
- HT II: 28 to 32 C.
- HT III: below 28 C with vital signs present.

- HT IV: absent vital signs or cardiac arrest.
- Clinical meaning: stage determines rewarming intensity, transport urgency, and arrest logic.

8.8.2 Deep Hypothermia Arrest Restrictions

- In severe hypothermia: limit to up to 3 doses of epinephrine and up to 3 defibrillation attempts before meaningful rewarming.
- Clinical meaning: standard resuscitation dosing logic changes in deep hypothermia.
- Action triggered: continue high-quality resuscitation while prioritizing rewarming and destination planning.
- What to avoid: declaring futility too early in a potentially salvageable cold arrest.

8.8.3 Warmed Fluid Temperature

- Target for warmed IV fluids: about 38 to 42 C.
- Clinical meaning: supports active rewarming without adding cold stress.
- Action triggered: warm fluids whenever capability exists.

8.8.4 ECMO or Bypass Access Window

- Operational benchmark: meaningful access within about 6 hours in salvageable hypothermic arrest.
- Clinical meaning: prolonged resuscitation may remain appropriate if advanced rewarming is realistically reachable.
- Action triggered: continue efforts and coordinate destination early.

8.9 Sepsis and Infectious Disease Targets

8.9.1 Initial Crystalloid Volume

- Starting target: 30 mL/kg over the first 3 hours when hypovolemia or shock is suspected and tolerated.
- Clinical meaning: initial resuscitation benchmark, not a rigid requirement in every patient.
- Action triggered: begin structured fluid resuscitation and reassess repeatedly.
- What to avoid: forcing completion of the volume target when crackles, respiratory distress, or worsening oxygenation develop.

8.9.2 Antibiotic Timing

- Critical window: within 1 hour of recognizing severe sepsis or septic shock.
- Clinical meaning: delay can worsen outcome.
- Action triggered: prioritize first-dose antibiotic delivery early, ideally after cultures if this does not delay therapy.
- What to avoid: waiting for perfect diagnostic certainty before treating obvious septic instability.

8.9.3 FEAST-Related Caution

There is no single bedside number here, but the chapter should force the learner to remember that aggressive fluid bolusing can worsen mortality in specific low-resource conditions, especially when advanced respiratory support is unavailable. The practical threshold is the point at which respiratory work, crackles, or oxygenation worsen.

- Action triggered: stop and reassess fluid strategy when respiratory burden increases.
- What to avoid: applying generic fluid algorithms without regard to actual capability.

8.10 STEMI and Fibrinolysis Targets

8.10.1 ECG Trigger for STEMI

- Threshold: ST elevation greater than 1 mm in 2 or more contiguous leads, in the right clinical context.
- Clinical meaning: activates the STEMI pathway.

- Action triggered: confirm symptom pattern, evaluate reperfusion options, and screen contraindications.

8.10.2 Symptom Duration

- Practical threshold: ischemic symptoms longer than 20 minutes.
- Clinical meaning: supports true ongoing ischemia rather than brief transient discomfort.
- Action triggered: proceed with urgent ECG-based evaluation and treatment.

8.10.3 PCI Delay Threshold

- Key threshold: more than 90 minutes to primary PCI.
- Clinical meaning: fibrinolysis becomes the practical reperfusion option if not contraindicated.
- Action triggered: tenecteplase screening and preparation.

8.10.4 Tenecteplase Weight Bands

- Less than 60 kg = 30 mg.
- 60 to 69 kg = 35 mg.
- 70 to 79 kg = 40 mg.
- 80 to 89 kg = 45 mg.
- 90 kg or greater = 50 mg.
- Clinical meaning: exact dosing is critical and errors can cause treatment failure or major bleeding.

8.10.5 Heparin Therapeutic Goal

- If monitored: PTT target about 50 to 70 seconds.
- Clinical meaning: therapeutic anticoagulation goal.
- Action triggered: adjust infusion when monitoring is available.
- What to avoid: giving bolus and infusion without tracking bleeding risk or cumulative anticoagulant burden.

8.11 Medication Safety Numbers

8.11.1 Ketamine Analgesic Range

- Analgesic dosing: 0.1 to 0.2 mg/kg IV or IO.
- Clinical meaning: pain control, not dissociative sedation.
- Action triggered: use low-dose analgesia for painful but not airway-threatening situations.
- What to avoid: confusing this with full sedation dosing.

8.11.2 Ketamine Sedation and Restraint Range

- Dissociative or restraint dosing: about 1 mg/kg IV or IO, or 4 to 5 mg/kg IM depending on scenario.
- Clinical meaning: this is full sedation territory.
- Action triggered: requires airway monitoring and a plan for loss of protective reflexes or respiratory compromise.
- What to avoid: giving sedative doses without adequate staff, suction, oxygen, and monitoring.

8.11.3 Midazolam Seizure Dosing

- Rescue dosing: 5 mg IV, IO, or IM every 5 minutes until seizure stops.
- Clinical meaning: repeated rescue pattern, not a one-time single push only.
- Action triggered: continue airway monitoring between doses and plan maintenance therapy if seizures recur.

8.11.4 Acetaminophen Maximum

- Maximum total daily dose: 4,000 mg.
- Clinical meaning: exceeding this increases hepatotoxicity risk.
- Action triggered: total all sources, especially combination products.

8.11.5 Naloxone Cumulative Ceiling

- Repeat doses may be given up to a cumulative total of about 10 mg during reversal attempts.
- Clinical meaning: lack of response should prompt reconsideration of diagnosis, severity, or co-ingestants.
- What to avoid: repeated blind dosing without airway support or reassessment.

8.11.6 Flumazenil Initial Dose

- Initial dose: 0.2 mg IV over 15 seconds.
- Clinical meaning: cautious titrated reversal only.
- Major caution: this can precipitate seizures in chronic benzodiazepine users or mixed overdoses.

8.12 Procedure-Linked Numeric Rules

8.12.1 Needle Thoracostomy Equipment Standard

- Device: 14G, 3.25-inch catheter.
- Clinical meaning: equipment length matters because short catheters may fail to reach the pleural space.
- Action triggered: confirm the actual device before attempting decompression.

8.12.2 Chest Tube Size Ranges

- Hemothorax: 36 to 38 Fr.
- Simple pneumothorax: 24 to 32 Fr.
- Clinical meaning: tube size should match expected drainage burden.

8.12.3 Drainage Suction Setting

- Common Pleurivac setting: negative 20 cm H_2O.
- Clinical meaning: standard reference point for tube drainage system setup.
- Action triggered: confirm the system is actually assembled to the intended setting.

8.12.4 IO Lidocaine Dose

- Adults: 20 to 40 mg for conscious patients before painful IO flush.
- Pediatrics under the relevant weight threshold: about 0.5 mg/kg.
- Clinical meaning: IO infusion can be extremely painful and pain control improves tolerance and function.

8.12.5 IO Access Time Rule

- Switch to IO after 2 failed IV attempts or more than 90 seconds trying in urgent adult access scenarios.
- Clinical meaning: do not waste critical time persisting with unsuccessful peripheral IV placement.
- Action triggered: move to faster reliable access when time matters.

8.13 Reassessment Numbers During Prolonged Holding

Many of the most important numbers in delayed MEDEVAC are not single static thresholds. They are repeated intervals, cumulative totals, and trends that tell you whether the patient is drifting or holding.

8.13.1 Time-Based Rechecks After Major Intervention

- Reassess after every fluid bolus, sedative dose, pressor change, airway intervention, and chest intervention.
- Clinical meaning: a technically correct intervention can still produce immediate harm or fail to solve the problem.
- Action triggered: check whether the intended target was reached and whether a new complication appeared.

8.13.2 Monitoring Intervals

- Use frequent documented reassessment after sedation, procedure, or medication changes.
- Use scheduled neurologic checks in TBI or altered mental status.
- Record urine output in a repeatable time-based pattern, not occasionally.
- Clinical meaning: time intervals are themselves operational thresholds.

8.13.3 Running Totals

- Total fluids in.
- Total urine out.
- Total sedative and opioid burden.
- Fever trend.
- Chest tube output trend.
- Clinical meaning: cumulative values often become the true decision drivers in 24 to 72 hour holding.

8.14 Common Errors With Numeric Targets

- Memorizing the number but not the action it should trigger.
- Using one threshold in every context without adjusting for the syndrome.
- Chasing a single value while missing the overall patient trend.
- Treating a formula as fixed when it should be titrated.
- Using a temporary rescue target as though it were a long-term maintenance target.
- Failing to recheck after intervention and therefore missing deterioration.

8.15 Practical At-Sea Application

In the shipboard environment, these thresholds become even more important because diagnostics, personnel, and specialist backup may be limited. A reliable trigger number can simplify decision-making, but only if it is tied to a realistic action plan that can be sustained with the resources on hand.

- Use thresholds to simplify when to escalate, not to oversimplify the patient.
- Trend the values that actually change decisions: oxygenation, ventilation, blood pressure, urine output, neurologic status, and device output.
- Write down target values clearly when handing over a prolonged-hold patient so the next provider knows what must be maintained.

8.16 End State

After this chapter, the learner should be able to recall the major ACTT-critical thresholds, identify what each one should trigger, and distinguish between trigger values, goal ranges, danger values, and temporary rescue targets. The goal is not memorization for its own sake. The goal is to turn numbers into faster, safer, and more consistent bedside action during both initial resuscitation and prolonged holding.

ACTT Preparation Manual

Chapter 9: Critical Errors, Pitfalls, and Do Not Miss Items

Royal Canadian Navy Physician Assistant Focus

9.1 Purpose of This Chapter

This chapter is designed to reduce preventable harm. In ACTT-level care, patients are commonly injured not only by disease or trauma, but by delayed action, incomplete reassessment, incorrect sequencing, poor securement, dosing mistakes, and false reassurance after a partial response. The purpose of this chapter is to identify the failures that most reliably worsen outcomes and convert them into recognizable, preventable patterns.

The emphasis here is practical. For each pitfall, the learner should understand what the error looks like in real care, why it is dangerous, how it usually develops, what signs suggest it is already happening, and what immediate corrective steps should follow. In the shipboard environment, where staffing, monitoring, and evacuation can all be limited, these errors compound quickly over time. Preventing them is a core operational skill.

9.2 Why This Chapter Matters

In delayed-MEDEVAC care, the patient often survives the first intervention but remains vulnerable to the next failure. A technically correct procedure can still lead to harm if the device is not maintained. A correct medication can still injure the patient if the dose is repeated too early, given too fast, or administered without airway planning. A blood pressure improvement can be misleading if perfusion, urine output, or neurologic status are still worsening.

This chapter matters because many poor outcomes are caused by systems failures disguised as clinical care. The clinician may feel busy, active, and task-complete while the patient is quietly deteriorating. For that reason, this chapter should be read as a prevention guide, a troubleshooting reference, and a discipline-building section for high-consequence naval prolonged care.

9.3 How to Use This Chapter

Use this chapter before procedures, during scenario review, and during prolonged patient holding as a deliberate “what could go wrong next?” check. It is not enough to know that a pitfall exists. The learner should be able to connect each common error to a concrete prevention behavior: a backup plan, an attempt limit, a time-stamped reassessment, a securement check, a site inspection, a trend review, or an earlier call for help.

A useful operational habit is to ask four questions after every major intervention:
1. Did the intended intervention actually work?
2. What complication could this intervention create in the next 5 to 30 minutes?
3. What monitoring will detect that complication early?
4. What would make me escalate immediately?

That mindset is what this chapter is intended to reinforce.

9.4 Standard Error Format Used Throughout This Chapter

The recurring format in this chapter is:
- identify the error

- define where it usually occurs
- explain why it is dangerous
- describe how it typically develops
- identify early warning signs
- state the immediate corrective action
- state the prevention habit that should have blocked it in the first place

That structure keeps the focus on bedside execution rather than abstract discussion.

9.5 Section I: Airway and Ventilation Errors

Airway errors are high-consequence because they can deteriorate in seconds and become harder to fix with each failed attempt. Most airway harm in ACTT care comes from hesitation, repeated failed attempts, incomplete confirmation, poor post-intubation planning, or loss of vigilance after initial success.

9.5.1 Delaying Definitive Airway Despite Clear Thresholds

- **Where it usually occurs:** Decreasing level of consciousness, progressive inhalation injury, recurrent obstruction, repeated vomiting, unsafe agitation, or fatigue in a patient who is initially still oxygenating.
- **Why it is dangerous:** The airway is often easiest to secure before complete failure. Waiting until the patient is profoundly hypoxic, swollen, or exhausted converts a controlled procedure into a rescue airway under worse conditions.
- **How it typically happens:** The team recognizes the risk but postpones action because the patient is still talking, because other tasks seem more urgent, or because the clinician wants more certainty before committing to intubation.
- **Early warning signs:** Rising work of breathing, worsening gurgling secretions, falling GCS, increasing suction needs, progressive facial or neck edema, decreasing margin of safety during transport or ship movement.
- **Immediate corrective action:** Reassess the airway immediately, stop non-essential tasks, prepare definitive airway management, and commit to either RSI or immediate surgical airway if the patient is no longer a realistic oral intubation candidate.
- **Prevention:** Act on trend rather than waiting for collapse. Define explicit airway triggers early, and verbalize the backup airway plan before the patient decompensates.
- **Shipboard relevance:** In a delayed-MEDEVAC environment, losing the airway later may mean losing it when fatigue, swelling, or limited staff make rescue substantially harder.

9.5.2 Repeated Intubation Attempts Beyond Safe Limits

- **Where it usually occurs:** RSI in hypoxic, bloody, anatomically difficult, or unstable patients.
- **Why it is dangerous:** Each extra attempt increases hypoxia, airway trauma, edema, aspiration risk, bleeding, and the likelihood that the next attempt becomes even harder.
- **How it typically happens:** The operator continues trying because the cords were “almost visible” or because the team has not formally declared a failed airway transition point.
- **Early warning signs:** Falling SpO2, worsening bag-mask ventilation, airway bleeding, swelling, prolonged laryngoscopy times, repeated loss of view, increasing hemodynamic instability.
- **Immediate corrective action:** Stop further attempts once the pre-set limit has been reached, re-oxygenate, switch to the rescue plan, and move to supraglottic rescue or surgical airway as clinically appropriate.
- **Prevention:** State attempt limits aloud before the first attempt. In difficult airway situations, use the one-attempt rule and have the cricothyroidotomy kit already open and accessible.
- **Shipboard relevance:** Ship motion, confined space, and delayed extraction reduce tolerance for prolonged failed laryngoscopy. Decision discipline matters more, not less.

9.5.3 Using Ketamine Alone for RSI Without Paralysis

- **Where it usually occurs:** Airway induction when the clinician confuses sedation with full RSI conditions.
- **Why it is dangerous:** Ketamine alone may not provide optimal intubating conditions and can increase the risk of laryngospasm, partial airway reflex persistence, and failed tube passage in a critical patient.
- **How it typically happens:** The provider gives an induction dose but omits the paralytic, either due to uncertainty, fear of apnea, or incomplete medication preparation.
- **Early warning signs:** Jaw clenching, poor view, difficult tube passage, incomplete relaxation, worsening desaturation while the team is not yet ready for rescue airway maneuvers.
- **Immediate corrective action:** Treat it as a failed or incomplete RSI attempt, oxygenate, correct the plan, and if RSI remains appropriate, proceed with the correct paralytic or transition to the rescue pathway based on the patient's condition.
- **Prevention:** RSI medications must be prepared as a matched sequence: induction, paralysis, backup oxygenation, confirmation, and post-intubation sedation. Never start with an incomplete medication plan.
- **Shipboard relevance:** A partially sedated patient in a moving or resource-limited environment can become more dangerous than an awake one if the plan is not completed cleanly.

9.5.4 Failure to Confirm Tube Placement Properly

- **Where it usually occurs:** Immediately after intubation, especially when visualized placement is assumed to be enough.
- **Why it is dangerous:** Unrecognized esophageal intubation can rapidly lead to severe hypoxia, gastric insufflation, aspiration, and cardiac arrest.
- **How it typically happens:** The team is relieved the tube is in, sees chest movement they think is adequate, and fails to complete a full confirmation sequence with EtCO2 and clinical checks.
- **Early warning signs:** Absent or persistently poor EtCO2, asymmetric or absent chest rise, absent breath sounds, rapid desaturation, epigastric distension, unexplained hemodynamic collapse.
- **Immediate corrective action:** Assume malposition until proven otherwise. Remove or reposition the tube as needed, re-oxygenate, and repeat confirmation using waveform or numeric EtCO2 plus chest rise, bilateral breath sounds, and depth check.
- **Prevention:** Use a structured post-intubation confirmation checklist every time, even in urgent situations. No tube is considered successful until the checklist is complete.
- **Shipboard relevance:** In prolonged holding, a misplaced tube that is not recognized immediately can consume scarce oxygen, sedatives, and time while the patient quietly worsens.

9.5.5 Inadequate Post-Intubation Sedation

- **Where it usually occurs:** Immediately after successful RSI or rescue intubation.
- **Why it is dangerous:** A patient with inadequate sedation may self-extubate, fight the ventilator, develop severe agitation, worsen ICP, and become dangerous to transport or monitor.
- **How it typically happens:** The procedure was treated as complete at the moment the tube passed, and the team moved on without a standing sedation and analgesia plan.
- **Early warning signs:** Tachycardia, hypertension, ventilator dyssynchrony, coughing, biting the tube, agitation, attempts to reach or pull at the airway, unexplained desaturation from fighting ventilation.
- **Immediate corrective action:** Administer post-intubation sedation and analgesia immediately, reassess comfort and ventilator tolerance, and secure the tube again if there was significant movement.
- **Prevention:** Prepare post-intubation medications before the attempt begins. Intubation should never occur without a stated post-tube management plan.
- **Shipboard relevance:** Delayed evacuation makes sustained sedation a maintenance task, not a one-time decision. Under-sedation over hours is a recurrent risk.

9.5.6 Tube Securement Errors

- **Where it usually occurs:** After intubation or surgical airway placement, especially during movement or prolonged holds.
- **Why it is dangerous:** Even a correctly placed airway becomes useless if it dislodges. Re-intubation or re-establishing a surgical airway later may be far more difficult.
- **How it typically happens:** Standard tape is applied poorly, moisture or burned skin prevents adherence, or the tube is not rechecked after movement, suctioning, repositioning, or transport.
- **Early warning signs:** Tube depth markings change, new cuff leak, altered breath sounds, sudden desaturation, increasing agitation, unusual ventilator pressures, visible loosening of ties or tape.
- **Immediate corrective action:** Reconfirm depth, re-secure immediately, reassess oxygenation and $EtCO_2$, and be prepared to re-establish the airway if dislodgement has occurred.
- **Prevention:** Secure deliberately, use burn-appropriate alternatives such as ties rather than adhesive on poor skin, and build tube checks into every reassessment cycle.
- **Shipboard relevance:** Ship movement makes securement failure more likely. What seems adequate in a calm bed space may fail during transport or rough conditions.

9.5.7 Hyperventilating TBI Patients Without Indication

- **Where it usually occurs:** Bagged or ventilated head-injured patients after airway control.
- **Why it is dangerous:** Excessive ventilation reduces cerebral blood flow through vasoconstriction and can worsen cerebral ischemia, particularly if prolonged.
- **How it typically happens:** The clinician focuses on lowering $EtCO_2$ reflexively or ventilates too aggressively under stress, mistaking fast ventilation for better care.
- **Early warning signs:** $EtCO_2$ drifting below target, over-bagging, rising concern about herniation without actual herniation signs, an otherwise stable TBI patient being kept at low CO_2 unnecessarily.
- **Immediate corrective action:** Return ventilation to the target range unless there are clear signs of impending herniation. If temporary rescue hyperventilation was used, end it as soon as the immediate rescue window has passed.
- **Prevention:** Tie ventilation rate to a target $EtCO_2$ and reassess the reason for any departure from the standard target.
- **Shipboard relevance:** In prolonged holding, fatigue and multiple handovers make target drift common. Numerical discipline prevents quiet over-ventilation.

9.6 Section II: Thoracic Procedure Errors

Thoracic interventions save lives quickly but also create false reassurance if treated as a one-step fix. The biggest errors are delay, poor landmarking, and failure to maintain the result.

9.6.1 Delaying Needle Thoracostomy While Waiting for Certainty

- **Where it usually occurs:** Unstable patients with suspected tension pneumothorax.
- **Why it is dangerous:** Tension physiology is primarily a clinical diagnosis. Waiting for perfect confirmation can cost the patient the only salvageable window.
- **How it typically happens:** The provider hesitates because tracheal deviation is absent, imaging is unavailable, or the presentation is incomplete despite a strong clinical pattern of obstructive shock.
- **Early warning signs:** Rapid decompensation, worsening hypoxia, distended neck veins, unilateral absent breath sounds, hypotension, pulseless electrical activity or arrest in the right context.
- **Immediate corrective action:** Decompress immediately if the clinical suspicion is high and the patient is unstable. Reassess instantly after decompression and prepare definitive drainage.
- **Prevention:** Treat tension pneumothorax clinically in the unstable patient. Build a low threshold to act when the pattern fits.

- **Shipboard relevance:** On a ship, diagnostic delay is often not an option. The cost of waiting can exceed the procedural risk.

9.6.2 Incorrect Needle Thoracostomy Landmarking

- **Where it usually occurs:** Emergency decompression under stress, low light, body armor, obesity, or poor positioning.
- **Why it is dangerous:** Missing the pleural space means no decompression. Wrong placement also risks injury to vessels or underlying structures.
- **How it typically happens:** The procedure is rushed without rib-space counting, the wrong line is chosen, or the provider inserts at the wrong angle or depth.
- **Early warning signs:** No rush of air, no physiologic improvement, continued instability, visible poor site selection, catheter kinking, or concern that the catheter never reached the chest cavity.
- **Immediate corrective action:** Reassess the site immediately, repeat decompression at the correct landmark if indicated, and reconsider alternate causes only after a technically adequate attempt.
- **Prevention:** Slow down enough to confirm the rib space and anatomical line. Equipment size matters: use a catheter long enough to reach the pleural space.
- **Shipboard relevance:** Body habitus and confined working angles at sea increase the risk of technical miss. Explicit landmarking prevents preventable failure.

9.6.3 Assuming Needle Decompression Is Definitive Treatment

- **Where it usually occurs:** After transient improvement from needle thoracostomy.
- **Why it is dangerous:** Needle decompression is a temporizing maneuver. Recurrent tension can occur if the catheter fails, kinks, clots, or is too short.
- **How it typically happens:** The patient improves briefly, the team shifts focus elsewhere, and no chest tube plan is created.
- **Early warning signs:** Return of distress, worsening oxygenation, rising hemodynamic instability, absent ongoing airflow through the catheter, or sudden decline after movement.
- **Immediate corrective action:** Treat any recurrence as a re-emergent problem. Reassess the decompression site, repeat if needed, and proceed to chest tube thoracostomy for definitive control.
- **Prevention:** Every needle decompression must trigger an immediate plan for chest tube placement or ongoing close surveillance if definitive care is delayed.
- **Shipboard relevance:** In prolonged transport or holding, the chance of re-tension increases. Temporary success is not durable success.

9.6.4 Poor Chest Tube Placement Technique

- **Where it usually occurs:** During tube thoracostomy in urgent settings.
- **Why it is dangerous:** Wrong-space entry, going under the rib, failing blunt dissection, or omitting the finger sweep can cause organ injury, failed pleural placement, or ineffective drainage.
- **How it typically happens:** The operator rushes to the tube insertion step without a disciplined sequence and uses force instead of anatomy.
- **Early warning signs:** Unusual resistance, no meaningful output, persistent tension physiology, worsening pain, visible incorrect site, or clinical suspicion of abdominal placement or tissue tunneling.
- **Immediate corrective action:** Stop advancing blindly. Confirm anatomy, re-enter correctly if required, and reassess the patient and drainage system immediately.
- **Prevention:** Use the full procedural sequence every time: correct landmark, incision over the rib, blunt dissection, pleural entry, finger confirmation, then tube placement.
- **Shipboard relevance:** In a delayed-MEDEVAC setting, a misplaced chest tube creates a long-duration problem the team may be forced to manage without quick specialist rescue.

9.6.5 Failure to Monitor Chest Tube Function Over Time

- **Where it usually occurs:** Hours after technically successful chest tube placement.

- **Why it is dangerous:** Chest tube blockage, dislodgement, air leak, kinking, or re-tension can occur gradually and be missed if the tube is not part of the reassessment routine.
- **How it typically happens:** The team documents placement but does not assign ongoing responsibility for checking patency, output, securement, and drainage system integrity.
- **Early warning signs:** Reduced or absent expected output, rising respiratory distress, increased subcutaneous emphysema, drainage system disconnection, visible kinking, recurrent hypotension.
- **Immediate corrective action:** Inspect the full drainage path, correct kinks or disconnections, reassess the patient, and treat recurrent tension or failed drainage immediately.
- **Prevention:** Every chest tube must have a maintenance plan: output trend, securement checks, system integrity checks, and explicit reassessment intervals.
- **Shipboard relevance:** Ship movement makes dependent loops, kinks, and accidental disconnections more likely. Device checks must be routine, not optional.

9.7 Section III: Circulation and Resuscitation Errors

Perfusion errors often create a slow deterioration pattern. The patient may appear temporarily improved while shock physiology is still progressing.

9.7.1 Blind Repeated Fluid Boluses Without Reassessment

- **Where it usually occurs:** Shock resuscitation in trauma, sepsis, and mixed physiology patients.
- **Why it is dangerous:** Excess fluid can worsen oxygenation, create pulmonary edema, dilute clotting, increase tissue edema, and obscure the fact that the patient is not truly fluid responsive.
- **How it typically happens:** Boluses are repeated automatically because the blood pressure remains low, without checking whether the last bolus produced any meaningful benefit.
- **Early warning signs:** Rising oxygen requirement, crackles, increased work of breathing, peripheral edema, minimal perfusion improvement despite repeated fluid, worsening chest imaging if available.
- **Immediate corrective action:** Stop reflexive bolusing, reassess perfusion and probable shock type, and decide whether blood, vasopressors, source control, or another intervention is the real next step.
- **Prevention:** Every bolus needs a response assessment. If there is no meaningful benefit, the plan must change rather than simply repeating fluid.
- **Shipboard relevance:** In prolonged care, fluid overload is a common self-inflicted problem because the team has time to keep giving, but not always the diagnostics to detect subtle harm early.

9.7.2 Under-Resuscitating TBI Because of Fear of Bleeding

- **Where it usually occurs:** Head-injured trauma patients with hypotension risk.
- **Why it is dangerous:** Hypotension significantly worsens secondary brain injury. Overly conservative perfusion support can double down on neurologic harm even if bleeding remains a concern.
- **How it typically happens:** The clinician prioritizes hemorrhage limitation to the point that cerebral perfusion targets are not maintained.
- **Early warning signs:** Falling mental status, worsening neuro exam, low SBP relative to TBI targets, poor urine output, cool peripheries, and concern that the patient is “stable enough” because gross bleeding is not obvious.
- **Immediate corrective action:** Restore the pressure target using the most appropriate fluids or blood products and reassess both neurologic response and bleeding status together.
- **Prevention:** Use condition-specific targets. In TBI, avoiding hypotension is itself a critical intervention.
- **Shipboard relevance:** With delayed evacuation, the consequences of prolonged under-perfusion are magnified because definitive neurosurgical support is not immediately available.

9.7.3 Using the Wrong Fluid in the Wrong Patient

- **Where it usually occurs:** Fluid resuscitation in TBI, burns, sepsis, and mixed presentations.

- **Why it is dangerous:** Not all fluids are interchangeable. In TBI, hypotonic strategies worsen cerebral edema. In other settings, excessive or inappropriate fluid choice can worsen the dominant pathology.
- **How it typically happens:** The provider reaches for what is most available or familiar rather than what best matches the condition being treated.
- **Early warning signs:** Unexpected worsening neurologic status, edema, poor perfusion response, or recognition after the fact that the fluid selected does not fit the clinical problem.
- **Immediate corrective action:** Stop the inappropriate fluid, reassess the clinical target, and switch to a condition-appropriate resuscitation strategy.
- **Prevention:** Make fluid choice an intentional decision. Tie the fluid to the diagnosis, not to convenience.
- **Shipboard relevance:** At sea, inventory limits may force substitution, but substitutions must still be understood, documented, and monitored carefully.

9.7.4 Starting Vasopressors Without Adequate Initial Assessment

- **Where it usually occurs:** Persistent hypotension where the underlying shock type is not yet clarified.
- **Why it is dangerous:** Pressors can temporarily increase blood pressure while masking ongoing hemorrhage, profound hypovolemia, or an uncorrected reversible cause.
- **How it typically happens:** The team sees a low pressure and escalates straight to vasopressors before adequately addressing volume, bleeding, or obstruction.
- **Early warning signs:** Transient pressure improvement with persistently poor perfusion, cold extremities, worsening mental status, poor urine output, rising lactate if available.
- **Immediate corrective action:** Re-evaluate the shock state immediately, correct unresolved hypovolemia or obstruction if present, and then continue pressors only as part of a coherent hemodynamic plan.
- **Prevention:** Pressors are not a substitute for diagnosing the reason the pressure is low. They are one tool within a resuscitation sequence.
- **Shipboard relevance:** In a prolonged shipboard hold, pressor dependence creates a high monitoring burden and can expose line, pump, and staffing limits quickly.

9.7.5 Poor Vasopressor Line Monitoring

- **Where it usually occurs:** Peripheral vasopressor use or any infusion where site surveillance is weak.
- **Why it is dangerous:** Extravasation can cause severe local vasoconstriction, tissue ischemia, sloughing, and loss of access during a critical window.
- **How it typically happens:** No one has explicit responsibility for checking the line, the infusion is started in a marginal site, or the site is obscured by dressings or positioning.
- **Early warning signs:** Pain, blanching, swelling, cool skin, slowed flow, alarms, or worsening perfusion near the site.
- **Immediate corrective action:** Stop the infusion if extravasation is suspected, manage the site immediately, start alternate access, and treat infiltration per available protocol such as phentolamine if indicated and available.
- **Prevention:** Assign ownership for line checks. Peripheral pressors demand frequent site inspection and low tolerance for questionable IVs.
- **Shipboard relevance:** Movement, transport, and fatigue make unnoticed line failure more likely in naval settings.

9.8 Section IV: Neurologic and TBI Errors

The most damaging TBI errors are usually secondary insults: hypoxia, hypotension, fever, missed deterioration, or mistimed rescue measures.

9.8.1 Missing Subtle Neurologic Deterioration

- **Where it usually occurs:** TBI, altered mental status, post-sedation reassessment, and prolonged holding.
- **Why it is dangerous:** Rising ICP or evolving intracranial injury may first appear as small changes in GCS, pupils, behavior, or breathing pattern rather than dramatic collapse.
- **How it typically happens:** The team notes that the patient is “still responsive” but does not trend serial findings carefully enough to see the direction of travel.
- **Early warning signs:** New asymmetry of pupils, slower responses, increased agitation, decreasing GCS, new bradycardia or widening pulse pressure patterns, vomiting, or unexplained respiratory changes.
- **Immediate corrective action:** Repeat and document a structured neuro exam immediately, correct reversible secondary insults, escalate neuroprotective measures if indicated, and seek higher support early if the trend is worsening.
- **Prevention:** Serial trend documentation is mandatory. Single isolated neuro checks are not enough in prolonged care.
- **Shipboard relevance:** When evacuation is delayed, delayed recognition of deterioration can consume the few interventions still available before neurologic decline becomes irreversible.

9.8.2 Failing to Treat Hypoxia, Hypotension, or Fever Aggressively in TBI

- **Where it usually occurs:** Any head-injured patient after initial stabilization.
- **Why it is dangerous:** Secondary brain injury often worsens because the team focuses on the original trauma rather than on oxygenation, perfusion, and temperature control.
- **How it typically happens:** The injury is recognized, but target-based supportive care is not maintained consistently.
- **Early warning signs:** Dropping SpO_2, low or borderline SBP, fever, worsening agitation, deteriorating neuro trend despite no new trauma.
- **Immediate corrective action:** Correct oxygenation, restore pressure to target, treat fever, and reassess the neurologic response after each intervention.
- **Prevention:** Treat secondary insult prevention as active therapy, not as background maintenance.
- **Shipboard relevance:** In extended holds, these “simple” variables are often what determine whether the patient remains salvageable.

9.8.3 Giving Mannitol in the Wrong Hemodynamic Context

- **Where it usually occurs:** ICP rescue in unstable trauma or hypovolemic patients.
- **Why it is dangerous:** Mannitol can worsen hypotension or intravascular depletion, reducing cerebral perfusion at the very moment the team is trying to save the brain.
- **How it typically happens:** The clinician reaches for osmotic therapy reflexively without checking blood pressure, bleeding context, or overall resuscitation state.
- **Early warning signs:** Worsening hypotension after administration, poor perfusion, no neurologic benefit, concern for active hemorrhage or unstable circulation.
- **Immediate corrective action:** Stop further doses, support perfusion aggressively, and reconsider hypertonic saline or other more appropriate measures depending on the clinical context.
- **Prevention:** Check the hemodynamic situation before giving mannitol. Not every elevated ICP pattern should be treated the same way.
- **Shipboard relevance:** When resources are limited, choosing the wrong osmotic agent can worsen a fragile patient and consume time and supplies.

9.9 Section V: Burn Errors

Burn patients are often harmed by airway delay, incorrect fluid assumptions, and poor long-duration monitoring rather than by the initial skin injury alone.

9.9.1 Delaying Early Airway Control in Major Burns or Inhalation Injury

- **Where it usually occurs:** Large TBSA burns, facial burns, enclosed-space exposure, or progressive airway edema.
- **Why it is dangerous:** Airway swelling can turn a manageable intubation into an impossible airway later.
- **How it typically happens:** The airway looks acceptable early, so the team defers intubation despite strong predictors of deterioration.
- **Early warning signs:** Hoarseness, soot or airway contamination history, increasing swelling, worsening voice, rising work of breathing, increasing secretion burden.
- **Immediate corrective action:** Reassess now, not later. Move to early airway control while anatomy remains more favorable if the trend supports likely deterioration.
- **Prevention:** Anticipate edema. Burn airway decisions are often made based on what the airway will become, not only what it is this minute.
- **Shipboard relevance:** Delayed transfer increases the need for early decisive airway planning in major burns.

9.9.2 Treating the Rule of 10s as a Fixed Order Instead of a Starting Point

- **Where it usually occurs:** Burn resuscitation over the first hours and beyond.
- **Why it is dangerous:** A fixed rate without ongoing adjustment causes both under-resuscitation and fluid creep.
- **How it typically happens:** The formula is calculated once and then treated as the final answer even when urine output or overall status changes.
- **Early warning signs:** Urine output outside target, worsening edema, rising respiratory burden, poor perfusion, unchanged or worsening shock despite fluid running.
- **Immediate corrective action:** Adjust the fluid rate based on urine output and overall clinical response. Recalculate the plan continuously.
- **Prevention:** The burn formula starts the resuscitation; it does not replace reassessment.
- **Shipboard relevance:** In prolonged holding, this is a common cause of self-inflicted over-resuscitation.

9.10 Section VI: Sepsis and Infectious Disease Errors

Sepsis care errors often reflect delayed recognition, delayed antibiotics, or failing to change course when the initial plan is not working.

9.10.1 Delayed Antibiotic Administration

- **Where it usually occurs:** Severe sepsis or septic shock once the diagnosis is reasonably suspected.
- **Why it is dangerous:** Every hour of delay can worsen progression, increase organ dysfunction, and reduce the chance that early treatment reverses shock.
- **How it typically happens:** The team continues workup or discussion while the patient remains untreated.
- **Early warning signs:** Persistent hypotension, rising fever or hypothermia trend, worsening mental status, increasing perfusion failure while antibiotics are still pending.
- **Immediate corrective action:** Administer empiric therapy as soon as severe sepsis or shock is recognized, obtaining cultures first only if doing so does not materially delay treatment.
- **Prevention:** Use the one-hour treatment window as an operational priority in unstable sepsis.

- **Shipboard relevance:** On a ship, delayed access to higher care increases the value of getting the first antibiotic decision right and getting it in early.

9.10.2 Giving Aggressive Fluids Without Watching the Respiratory Cost

- **Where it usually occurs:** Sepsis resuscitation, especially in resource-limited settings.
- **Why it is dangerous:** Fluid may improve pressure but worsen gas exchange and increase the need for ventilatory support the ship may not be able to sustain easily.
- **How it typically happens:** Boluses are repeated based only on blood pressure without watching work of breathing, crackles, oxygen requirement, or overall tolerance.
- **Early warning signs:** Increasing oxygen need, crackles, rising respiratory effort, decreasing SpO2, new distress after fluids.
- **Immediate corrective action:** Pause further fluid, reassess fluid responsiveness, and shift to vasopressor support or other measures if the respiratory cost is becoming unacceptable.
- **Prevention:** Each bolus must be followed by both perfusion and respiratory reassessment.
- **Shipboard relevance:** When ventilation resources are finite, fluid-related respiratory failure can become a major operational problem.

9.11 Section VII: Sedation, Analgesia, and Medication Errors

Medication errors are common because the same drug may have multiple roles, multiple dose ranges, and different consequences depending on context.

9.11.1 Confusing Analgesic and Sedation Doses of Ketamine

- **Where it usually occurs:** Pain control, restraint, procedural sedation, and RSI preparation.
- **Why it is dangerous:** Giving a sedation-range dose when analgesia was intended can oversedate the patient; giving an analgesic dose when full dissociation is needed can create failure and agitation.
- **How it typically happens:** The clinician remembers "the ketamine dose" but not the indication-specific target.
- **Early warning signs:** Inadequate effect, unexpectedly deep sedation, loss of airway, dysphoria, or a dangerous partially dissociated patient.
- **Immediate corrective action:** Stop and reframe the indication. Reassess airway and hemodynamics, and correct the dose strategy based on the actual goal: pain control, dissociation, restraint, or induction.
- **Prevention:** Always pair the drug with the clinical purpose before drawing it up. Write or verbalize the indication-specific dose range.
- **Shipboard relevance:** Fatigue and repeated use over long shifts increase this error risk in prolonged care.

9.11.2 Pushing Sedatives Too Fast

- **Where it usually occurs:** Midazolam, ketamine, opioids, and combined procedural sedation.
- **Why it is dangerous:** Rapid administration increases the risk of apnea, hypotension, chest wall rigidity in some opioid contexts, and abrupt loss of airway control.
- **How it typically happens:** The team is rushing the procedure, the patient is difficult to control, or the provider wants a faster effect than the drug is meant to be given for.
- **Early warning signs:** Immediate drop in respiratory rate, reduced effort, desaturation, hypotension, abrupt oversedation.
- **Immediate corrective action:** Support airway and ventilation immediately, stop further sedative administration, reassess the sequence, and convert to controlled slower dosing once the patient is stabilized.
- **Prevention:** Administration rate is part of the dose. Prepare enough time and monitoring to give sedatives properly.

- **Shipboard relevance:** In limited-monitoring environments, preventing this error is easier than rescuing it.

9.11.3 Dose Stacking During Prolonged Holding

- **Where it usually occurs:** Repeated PRN boluses of opioids, benzodiazepines, or ketamine over hours.
- **Why it is dangerous:** Cumulative respiratory depression, hypotension, obscured neuro exams, and unrecognized delayed oversedation are common results.
- **How it typically happens:** Documentation is incomplete, the exact time of the last dose is unclear, or multiple providers give PRNs without a unified plan.
- **Early warning signs:** Progressively quieter patient, lower respiratory rate, worse oxygenation, unexplained hypotension, reduced responsiveness, confusion about total medications given.
- **Immediate corrective action:** Stop additional dosing, determine the actual cumulative total, support the airway and circulation as needed, and restart only with a clearer schedule or infusion strategy if appropriate.
- **Prevention:** Track exact time, exact amount, and observed effect for every dose. Convert to a more controlled schedule when repeated PRNs are creating confusion.
- **Shipboard relevance:** Long holds and handovers make cumulative errors much more likely than in short shore-based encounters.

9.12 Section VIII: Procedure and Device Maintenance Errors

No invasive procedure is complete at placement. A device that is not monitored should be treated as a device that is already at risk of failure.

9.12.1 Treating Placement as the End of the Job

- **Where it usually occurs:** Any airway, line, drain, catheter, or access device.
- **Why it is dangerous:** A technically successful placement may still fail later due to dislodgement, obstruction, clotting, leak, kinking, or infection.
- **How it typically happens:** The team mentally moves on after successful insertion and fails to assign maintenance checks.
- **Early warning signs:** Unexpected worsening, no output, new resistance, alarms, leakage, visible loosening, unexplained pain or swelling.
- **Immediate corrective action:** Reassess the device function immediately and restore or replace the device if it is no longer doing the job it was placed for.
- **Prevention:** Every procedure should end with a maintenance plan: what will be checked, how often, and by whom.
- **Shipboard relevance:** In prolonged naval care, device burden accumulates and becomes a major source of preventable failure.

9.13 Section IX: Documentation, Handover, and Operational Errors

Extended care is often lost through organizational drift. The patient may have competent bedside treatment but still deteriorate because the team loses track of what has happened, what is due next, or what is getting worse.

9.13.1 Incomplete Documentation of Medications and Interventions

- **Where it usually occurs:** Prolonged holding, multiple providers, repeated PRNs, and evolving procedures.
- **Why it is dangerous:** Incomplete notes lead to duplicate dosing, missed reassessment, poor transfer continuity, and loss of trend recognition.

- **How it typically happens:** The team relies on memory, verbal updates, or partial notes during busy care.
- **Early warning signs:** Confusion about last dose, uncertainty about when a device was placed, repeated interventions without response tracking, inconsistent fluid totals.
- **Immediate corrective action:** Pause and reconstruct the timeline as accurately as possible, then restore disciplined documentation immediately.
- **Prevention:** Document exact times, exact doses, exact device events, and observed response. Precision prevents compounding errors.
- **Shipboard relevance:** With delayed MEDEVAC, the record is part of the treatment. Without it, continuity degrades quickly.

9.13.2 Poor Shift-to-Shift Handover

- **Where it usually occurs:** Any multi-hour or multi-shift hold.
- **Why it is dangerous:** The incoming team may repeat mistakes, miss evolving trends, or assume stability that no longer exists.
- **How it typically happens:** Handover is informal, rushed, or symptom-based rather than problem-based.
- **Early warning signs:** The incoming provider cannot answer what changed, what the main concern is, what may fail next, or what needs checking first.
- **Immediate corrective action:** Stop and perform a structured handover: what happened, what was done, what changed, what is being watched, and what escalation triggers exist.
- **Prevention:** Use a consistent handover structure every time. The handover should always include the active problem list and the next likely failure point.
- **Shipboard relevance:** Fatigue and extended holds make formal handover more important, not less.

9.14 Section X: Do Not Miss High-Consequence Clinical Situations

Some scenarios demand immediate heightened concern because the margin for correction is short. These must remain mentally loaded during ACTT care.

9.14.1 Impending Cerebral Herniation

Falling level of consciousness, new unilateral dilated pupil, Cushing-type physiology, or abrupt neurologic decline should be treated as a narrow rescue window. Immediate action focuses on airway, oxygenation, perfusion, brief rescue hyperventilation only if clearly indicated, and ICP-directed therapy while urgently escalating support.

9.14.2 Recurrent or Persistent Tension Physiology

A patient who improved after decompression can worsen again because the decompression failed, the catheter re-kinked, or definitive drainage is not functioning. Re-worsening oxygenation and hemodynamics after initial improvement should trigger immediate reassessment of the chest intervention.

9.14.3 Occult Deterioration After Sedation

A calmer patient is not always a better patient. Sedation can hide hypoxia, hypoventilation, hypotension, and neurologic decline. Any sedation event must be followed by active monitoring rather than visual reassurance.

9.14.4 Pressor-Dependent Shock With Rising Support Needs

Increasing vasopressor requirements, worsening urine output, and persistent perfusion failure despite apparent blood pressure support indicate a patient drifting toward failure. This should trigger early teleconsultation, re-evaluation of the diagnosis, and reconsideration of what can still be corrected locally.

9.14.5 Delayed Airway Loss in Burn or Inhalation Injury

Airway deterioration can be progressive rather than abrupt. Worsening voice, swelling, secretion burden, and respiratory work should be treated as a warning that the time for controlled airway management may be closing.

9.15 Section XI: Error Prevention Systems for Shipboard Care

The best way to manage common pitfalls is to design routines that catch them before they become clinical failures. In shipboard care, these systems must be simple, repeatable, and resilient under fatigue.

9.15.1 Pre-Procedure Error Traps

- State the indication out loud before starting.
- Confirm the backup plan and the point where you will abandon the first plan.
- Assign explicit roles for monitoring, medication, airway backup, and documentation.
- Check that all rescue equipment is already open or immediately reachable.

9.15.2 Medication Safety Traps

- Read back the drug name, dose, concentration, route, and indication before administration.
- Check the time and effect of the last dose before giving another.
- Track cumulative totals for sedatives, opioids, acetaminophen, and fluids.
- Treat administration speed as part of the dose, not as an afterthought.

9.15.3 Reassessment Safety Traps

- No major intervention is complete until there is a documented response assessment.
- Build device checks into routine rounds.
- Trend neurologic status, urine output, oxygenation, and infusion needs at set intervals.
- Escalate earlier if the patient is drifting rather than waiting for dramatic collapse.

9.15.4 Handover Safety Traps

- Hand over the active problem list, not just the diagnosis name.
- State what changed, what remains unstable, what may fail next, and what must be checked first.
- Include exact doses, exact times, and all devices in place.
- Define the trigger that should prompt immediate re-contact with higher support.

9.16 What the Learner Should Be Able to Do After This Chapter

- Recognize the most dangerous ACTT-relevant mistakes before they cause major harm.
- Identify early warning signs of airway, perfusion, neurologic, medication, and device failure.
- Take immediate corrective action when a common complication is already occurring.
- Build safer habits around procedures, medications, reassessment, documentation, and handover.
- Reduce error accumulation during prolonged shipboard care when fatigue and delayed evacuation increase operational risk.

9.17 Bridge to the Next Chapter

The next chapter moves from preventing errors to adapting care to the realities of the platform itself. Chapter 10 will focus on shipboard application: matching ideal ACTT practice to actual onboard personnel, equipment, stock, space, movement, and evacuation limitations while preserving the safest possible standard of bridging care.

ACTT Preparation Manual

Chapter 10: Shipboard Application

Royal Canadian Navy Physician Assistant Focus

This chapter converts earlier clinical, procedural, and medication guidance into a shipboard operating framework. The aim is not to restate land-based trauma teaching, but to show how ACTT principles must be adapted when the patient is being managed in a moving naval platform with constrained staff, space, equipment, and evacuation timelines.

10.1 Purpose of This Chapter

- Translate ACTT knowledge into practical shipboard execution.
- Show how ideal trauma and critical care principles change when applied in a naval platform with limited space, limited personnel, ship movement, and delayed evacuation.
- Emphasize adaptation: the correct plan is the one that can be performed safely, monitored reliably, and maintained over time onboard.

Shipboard medicine changes the margin for error. A plan that is technically correct on land may fail at sea if it depends on constant one-to-one observation, unrestricted equipment access, immediate imaging, or rapid transfer to a higher medical echelon. The shipboard clinician therefore has to convert every intervention into a sustainable onboard plan. That includes choosing where the casualty will be managed, how the casualty will be observed, what equipment must remain attached, and what parts of the standard pathway can realistically be supported for the next several hours.

10.2 Why Shipboard Application Deserves Its Own Chapter

- The environment can create risk even after the correct diagnosis and first intervention have been made.
- Operational constraints affect triage, movement, sedation choices, device securement, monitoring intensity, documentation, and when to seek outside support.
- The shipboard clinician often has to bridge the gap between ideal care and sustainable care.

A casualty may survive the first airway intervention, chest decompression, or fluid bolus, then deteriorate later because the environment was not accounted for. Examples include accidental extubation during internal ship movement, a pressor infusion that cannot be monitored closely enough across watch turnover, or a chest tube that becomes kinked after transfer into a smaller compartment. The purpose of shipboard adaptation is to identify those failure points before they occur and redesign the plan around them.

10.3 Core Shipboard Realities That Change Care

- Limited personnel
- Limited diagnostics
- Finite medication and equipment supply
- Delayed MEDEVAC due to distance, weather, or operational posture
- Physical constraints: noise, lighting, ladders, passageways, confined work areas, and ship movement

10.3.1 Limited Personnel

High-acuity care on a ship is rarely delivered with a full land-based trauma team. The PA may have only intermittent assistance, or may need to rely on non-medical personnel for movement, observation, and equipment retrieval. This means the treatment plan must be sized to the available manpower. A drug requiring close titration, a procedure requiring continuous device observation, or a sedation plan that demands constant bedside presence may be technically possible but operationally unsafe if the staffing burden cannot be maintained.

- Assign tasks that only the clinician can do first; delegate everything else early.
- If the plan depends on a dedicated observer, identify that person explicitly rather than assuming availability.
- Reduce complexity when staffing is thin: fewer infusions, fewer nonessential monitoring tasks, more emphasis on trend-based checks that change decisions.

10.3.2 Limited Diagnostics

Shipboard decisions are often made with focused examination, repeat vitals, limited point-of-care tools, and trend recognition rather than full diagnostic workups. The clinician should favor information that changes management. Examples include GCS trend, pupil change, work of breathing, urine output, tube function, and response to a fluid challenge. If a test will not change immediate management, it may be lower priority than reassessment and supportive care.

- Ask whether a test changes the next action before committing time or manpower to it.
- When diagnostics are limited, document trends clearly enough that deterioration can still be recognized.
- Use practical bedside markers: mental status, pulses, capillary refill, oxygen requirement, $EtCO_2$ if available, and device function.

10.3.3 Finite Medication and Equipment Supply

Shipboard stock is not unlimited, and some ACTT-relevant items may not be available at all. The clinician therefore has to think beyond the immediate dose. Every use of oxygen, sedatives, vasopressors, chest drainage equipment, dressings, and IV access supplies should be considered in the context of possible prolonged holding.

- Before committing to a therapy, ask whether it can be safely continued for hours if evacuation slips.
- Use preferred drugs when they are operationally sustainable; use substitutes when the ideal drug is unavailable or creates excessive monitoring burden.
- Track critical consumption early: oxygen, pressor syringes or bags, sedatives, dressings, drainage setup, IV supplies, and backup airway equipment.

10.3.4 Delayed MEDEVAC and Weather/Distance Constraints

At sea, evacuation timing may change after the initial plan is set. Weather, flight limitations, vessel location, deck status, and operational priorities can all delay transfer. The casualty plan must therefore be built on the assumption that transfer may take longer than hoped. Once the patient is initially stabilized, the clinician should deliberately switch from an acute rescue mindset to a sustained holding mindset, with explicit monitoring intervals, re-dosing plans, and handover structure.

10.3.5 Physical Environment

Physical conditions influence both procedural success and ongoing safety. Confined treatment rooms, difficult lighting, noise, vibration, and ship movement all increase the risk of dropped equipment, poor visualization, failed securement, and accidental dislodgement of lines and tubes. Ladders, tight passageways, and narrow compartment access may also make casualty movement itself a medical hazard.

10.4 Converting Land-Based ACTT Principles to Shipboard Practice

The central question in shipboard adaptation is not whether the standard principle is correct, but how to preserve its intent under constraints. The clinician should separate care into three categories: what must still happen no matter what, what must be modified, and what may be deferred without harming the patient.

10.4.1 What Must Still Happen No Matter What

- Airway compromise must still be addressed early.
- Oxygenation and ventilation remain immediate priorities.
- Tension physiology, severe shock, active seizure, and impending herniation still require time-critical intervention.
- Unsafe agitation that compromises care or transport still requires control.
- Life-saving interventions should not be delayed solely because the shipboard setup is inconvenient.

10.4.2 What Must Be Modified

- Monitoring may shift from continuous high-resolution monitoring to scheduled, clinically focused reassessment if resources are limited.
- Procedure setup may need staged preparation: secure the essentials first, then add refinements once the immediate threat is addressed.
- Medication choices may shift toward drugs that are easier to dose, monitor, and maintain onboard.
- Documentation must be simplified enough to sustain, but detailed enough to support trend recognition and handover.

10.4.3 What May Need To Be Deferred

Nonessential diagnostics, low-yield interventions, and nonurgent treatments that consume manpower without changing immediate safety can be deferred. Examples include noncritical reorganization tasks, nonurgent comfort measures during an unstable phase, and procedures that can wait until the casualty is in a safer, better-supported location.

10.5 Shipboard Triage and Prioritization

At sea, not every task can be performed at once. Triage therefore applies not only to patients, but also to tasks. The most dangerous error is allowing lower-yield tasks to consume attention while a higher-risk problem drifts.

10.5.1 Immediate Life Threats

- Airway loss or progressive airway failure
- Severe hypoxia or ventilatory failure
- Shock with worsening perfusion
- Active seizure or postictal airway risk
- Tension pneumothorax
- Impending cerebral herniation

- Catastrophic agitation creating immediate danger

10.5.2 High-Risk But Temporarily Controlled Problems

These are patients who look better after intervention but remain vulnerable. A recently intubated patient, a chest tube patient, a pressor-supported patient, a large-burn casualty, or a TBI casualty under observation may appear stable and still be one failure away from rapid decline. These patients need assigned reassessment rhythm and clear escalation thresholds.

10.5.3 Lower-Priority Tasks That Still Matter

- Documentation, medication preparation for upcoming doses, equipment restocking, comfort care, bedding, and environmental cleanup all remain important.
- These tasks should be done when they do not compete with immediate instability.
- If these tasks are ignored for too long, they later become patient safety issues; the goal is sequencing, not neglect.

10.6 Casualty Location and Movement on the Ship

Where the casualty is managed affects both safety and the ability to continue care. Movement should be deliberate. The best location is the place that gives the highest ratio of access, monitoring, lighting, airway support, and safe securement - not simply the closest location.

10.6.1 Choosing the Best Care Location

- Prefer a location with oxygen, suction, monitoring, lighting, room to work, and stable surfaces for equipment.
- Consider whether the location can safely support prolonged holding if evacuation is delayed.
- In rough conditions, choose a location where the patient and equipment can be secured more reliably.

10.6.2 Movement Risks

Movement may worsen bleeding, spinal instability, hemodynamics, or device security. A patient who is already barely oxygenating or perfusing may not tolerate an unnecessary transfer. Move only when the new location clearly improves care capability or safety.

10.6.3 Preparing for Movement

- Secure all lines, drains, tubes, and dressings before moving.
- Assign one person to airway, one to lines and drains, one to route and obstacles if enough personnel are available.
- Carry immediate rescue equipment during transfer: oxygen, BVM, suction if feasible, emergency meds, and a means to re-secure critical devices.
- Pre-brief likely problems before the move starts.

10.7 Airway and Breathing at Sea

10.7.1 Airway Procedures in Confined or Moving Spaces

Intubation, suctioning, or rescue airway procedures may need to occur where the casualty is found if the airway is failing. In confined or moving spaces, pre-position suction, confirm lighting, clear the floor of loose equipment, and bring the failed-airway backup plan physically into the space before the first attempt. If moving the patient would significantly improve airway conditions and the patient can safely tolerate the move, do so early rather than late.

10.7.2 Intubated Patient Management at Sea

- Check tube depth and securement after every move, repositioning event, or major agitation episode.
- Secure the tube and circuit so that ship movement cannot transmit traction directly to the airway.
- If ventilating mechanically, ensure the ventilator setup is stable and visible enough for repeated checks.
- If manual ventilation is required, explicitly assign who will perform it and for how long.

10.7.3 Oxygen and Ventilation Resource Use

Oxygen planning becomes a logistics issue during prolonged holding. The clinician should identify which patients need the highest oxygen reserve and which can be safely stepped down after reassessment. Oxygen conservation must never become undertreatment, but casual waste can later eliminate options.

10.7.4 Thoracic Devices at Sea

- Chest tubes require aggressive securement, clear drainage positioning, and repeated checks for kinks, clots, and pull tension.
- After movement, reassess for renewed respiratory distress, drainage failure, and recurrent tension physiology.
- In confined spaces, ensure the drainage system remains below the chest when required and is protected from tipping or snagging.

10.8 Circulation and Shock Management at Sea

10.8.1 Fluid Use in a Shipboard Setting

Repeated fluid boluses without reassessment are particularly dangerous at sea because fluid overload increases respiratory burden and may create a problem the ship cannot support. Each bolus should have a reassessment plan linked to perfusion, blood pressure, work of breathing, oxygen requirement, and the overall disease process.

10.8.2 Blood Pressure and Perfusion Monitoring

- Use continuous monitoring when the patient is unstable, on pressors, or actively deteriorating.
- When continuous monitoring is not sustainable, schedule serial manual checks that are frequent enough to change the plan before failure becomes obvious.
- Do not rely on blood pressure alone; trend mental status, capillary refill, pulses, skin signs, and urine output.

10.8.3 Vasopressors at Sea

Pressors can stabilize perfusion, but they create a large monitoring burden. Before starting a pressor, confirm that the line can be watched, the pump can be supported, the concentration is clear, and someone is responsible for ongoing reassessment. A pressor plan that cannot be safely monitored is an incomplete plan.

10.8.4 Access Management

- Protect IV and IO access during movement with deliberate routing and securement.
- Recheck every access site after transfer, repositioning, or patient agitation.
- If temporary access is being used, decide early whether more durable access is needed and feasible.

10.9 Medication Use in the Shipboard Environment

10.9.1 Matching Drug Choice to Monitoring Capacity

Medication selection must reflect the ship's ability to observe the consequences. A sedative that requires continuous airway vigilance, or a pressor requiring constant titration, may be inappropriate if the watch cannot sustain that observation burden. The best medication plan is not simply the one with the best theoretical pharmacology, but the one that can be administered and followed safely.

10.9.2 Matching Drug Choice to Stock

- Know which preferred ACTT drugs are actually onboard.
- If using a substitute, state the trade-offs clearly: slower onset, shorter duration, more hypotension, more respiratory risk, or higher monitoring demand.
- Do not assume a familiar shore-based option will be available in Sick Bay stock.

10.9.3 Medication Conservation Over Time

During prolonged holds, think in total course rather than single dose. Estimate re-dosing needs for analgesia, sedation, antibiotics, and pressors. Avoid wasting critical stock on avoidable duplication, incorrect preparation, or unnecessary PRN use.

10.9.4 Medication Safety in Fatigue and Handovers

- Use explicit time-and-dose charting for every administered medication.
- Confirm concentration before starting or changing an infusion.
- At handover, state what was last given, what effect it had, and when the next reassessment or next dose is expected.
- Use read-back for high-risk medications, especially pressors and sedatives.

10.10 Procedures in the Shipboard Context

10.10.1 Before the Procedure

Before starting a procedure, ask whether the current location is safe enough, whether there is enough room to complete it correctly, whether the patient can tolerate any delay required to improve setup, and whether the backup plan is physically available. It is often safer to pause for 30 seconds to reposition equipment and people than to start immediately with a compromised setup.

10.10.2 During the Procedure

- Expect role compression: one person may have to combine monitoring and procedural assistance.
- Protect the sterile field as much as possible, but do not let perfect sterility block life-saving action in a true emergency.
- Control loose equipment aggressively in a moving environment.

- State each critical step aloud in high-risk procedures so the team remains synchronized.

10.10.3 After the Procedure

At sea, securement and reassessment are often more important than the last technical step of placement. Every procedure should end with a maintenance plan: who checks the device, how often, what counts as failure, and what the rescue response is if the device stops working.

10.11 Shipboard Formulary and Capability Cross-Reference

This manual should be used with an explicit awareness of real Sick Bay capability. Confirmed onboard items support current practice, but non-stocked ACTT medications and equipment still matter for course learning, substitution planning, and understanding what the ideal standard would otherwise be.

- Cross-reference core ACTT medications and equipment with current Sick Bay stock before major exercises or deployments.
- Identify non-stocked but important items so gaps are understood before a casualty occurs.
- For each gap, define whether there is a reasonable substitute, a procedural workaround, or a hard limitation.

10.12 Communication and Team Use of Non-Medical Ship Resources

10.12.1 Using Available Ship Personnel

Not every useful role requires clinical training. Non-medical personnel may support movement, equipment retrieval, observation of a restrained or sedated casualty, route clearance, and basic practical tasks. These roles should be assigned clearly and supervised appropriately.

10.12.2 Communicating With Chain of Command

- State clinical seriousness in concrete terms: unstable, improving, pressor-dependent, ventilated, likely prolonged hold, or urgent evacuation needed.
- Communicate expected manpower burden and whether a dedicated observer or repeated movement support is required.
- State the likely duration of support needs and the operational implications of a high-acuity casualty onboard.

10.12.3 Preparing the Ship for Prolonged Casualty Management

A prolonged casualty may require more than clinical management. The ship may need to allocate space, observer rotation, movement assistance, extra lighting, heating, or reduced tasking around the treatment area. These preparations should start early when a long hold appears likely.

10.13 Teleconsultation and Shore Support in the Shipboard Setting

10.13.1 When To Call Early

- Unstable or high-acuity casualties
- Prolonged holds likely to exceed initial expectations
- Complex airway, burn, TBI, seizure, or pressor-dependent cases
- Situations where shipboard capability is approaching its limit
- Cases where the diagnosis is uncertain but the trajectory is worsening

10.13.2 What Information Must Be Ready

- Concise problem list
- Vital sign and neurologic trends
- Interventions already performed and response
- Current medications, last doses, and active infusions
- Current access and devices
- What the ship can and cannot do from this point forward

10.13.3 How Teleconsultation Changes the Shipboard Plan

Remote support should refine goals, clarify thresholds for re-contact, and help determine whether ongoing holding remains acceptable. It is not simply a request for reassurance. A useful teleconsult should produce specific decisions about what to continue, what to stop, what to monitor most closely, and what change means the current plan is no longer safe.

10.14 Sustaining Safe Care During a Shipboard Hold

10.14.1 Build a Repeatable Reassessment Rhythm

Safe prolonged care depends on rhythm. Assign who checks the airway, who verifies device function, who records vitals, and what interval triggers formal review. If reassessment depends on memory or informal assumption, it will drift under fatigue.

10.14.2 Build a Device Check Rhythm

- Tube check
- Line and access check
- Chest tube and drainage check
- Foley and urine output check
- Dressings and bleeding check
- Monitor and power source check

10.14.3 Build a Medication Rhythm

- Scheduled dosing times written clearly
- PRN indication tied to reassessment criteria
- Infusions reviewed at set intervals
- Running totals for opioids, sedatives, fluids, acetaminophen, and key antibiotics

10.14.4 Build a Handover Rhythm

During a long hold, safe care depends on repeated structured handover. Every handover should state what happened, what was done, what is improving, what is drifting, what may fail next, and what must be checked at the next interval.

10.15 Common Shipboard Failure Points

10.15.1 Environmental Failure Points

- Insufficient space to perform or maintain the intervention
- Poor lighting causing procedural or monitoring error
- Equipment too far away when the patient deteriorates

- Device dislodgement during movement or rough conditions

10.15.2 Staffing Failure Points

- Assuming more observation capacity than actually exists
- Using sedation or infusions that exceed realistic monitoring capability
- Fatigue-related drift in reassessment and charting

10.15.3 Resource Failure Points

- Oxygen depletion
- Medication depletion
- Insufficient infusion pumps
- Lack of replacement dressing, tubing, or securement supplies

10.15.4 Organizational Failure Points

- Poor communication with command
- Delayed evacuation request or delayed teleconsultation
- Unclear ownership of reassessment tasks
- Incomplete charting during watch turnover

10.16 Practical Shipboard Adaptation Rules

- Simplify to what changes outcomes. If an assessment or intervention will not change management, it is lower priority than supportive care and reassessment.
- Secure everything. At sea, unsecured lines, drains, tubes, and pumps are latent hazards.
- Trend everything important. One normal value matters less than the direction of change over time.
- Escalate earlier than on land. Distance and delay narrow the safe margin.
- Choose sustainable care over theoretically perfect care. The safest plan is the one the ship can continue reliably.

10.17 What the Learner Should Be Able To Do After This Chapter

- Adapt ACTT principles to real shipboard conditions rather than applying land-based protocols rigidly.
- Choose interventions and monitoring plans that are safe, realistic, and sustainable onboard.
- Organize casualty location, movement, equipment, staffing, and communication around patient safety.
- Recognize when the environment itself is now a major source of risk.
- Build a prolonged care routine that survives watch turnover, fatigue, and delayed evacuation.

10.18 Bridge to the Next Chapter

This chapter focuses on adapting clinical care to the ship. The next chapter shifts to the human and organizational side of making that care run reliably: team structure, communication discipline, operational decision-making, and how to maintain coordinated performance under pressure.

Chapter 10 Quick-Use Shipboard Rules

- Treat the environment as part of the casualty, not just the background.
- If a device is placed, a maintenance plan must be assigned immediately.
- If a drug is started, the monitoring burden must be assigned immediately.

- If the casualty is moved, re-check airway, lines, drains, and perfusion immediately afterward.
- If evacuation may be delayed, convert the plan to a prolonged-hold model early, not late.
- If the plan cannot be monitored safely, it is not yet a complete plan.

Chapter 11
Team, Communication, and Operational Practice

Royal Canadian Navy Physician Assistant Focus

11.1 Purpose of This Chapter

This chapter explains how ACTT-level care is executed safely through deliberate team organization. The focus is not only on what clinical actions must be taken, but on how the team communicates, assigns work, reassesses, and maintains control of a high-acuity patient from first contact through prolonged holding.

In the shipboard setting, communication and team structure are not secondary skills. They directly affect airway safety, medication accuracy, procedure success, trend recognition, and escalation timing. The practical aim of this chapter is to turn clinical knowledge into coordinated action under pressure.

11.2 Why This Chapter Matters

In trauma, shock, airway compromise, burns, sepsis, and prolonged holding, many failures occur despite correct knowledge of the underlying condition. The breakdown often happens because no one clearly owns the plan, tasks are assumed rather than assigned, deterioration is not spoken aloud, or handovers omit the detail needed to continue safe care.

At sea, these risks are amplified by reduced staffing, fatigue, interrupted workflow, environmental noise, watch changes, and delayed outside support. For that reason, ACTT-relevant performance must include leadership discipline, closed-loop communication, documentation habits, and realistic workload planning.

11.3 How to Use This Chapter

This chapter should be used as a practical operations guide. During study, the learner should repeatedly ask: Who is leading? What is the current problem list? What is the next action? Who is assigned to reassessment? What would trigger escalation? What must be handed over if another person takes over care?

The goal is to make team function explicit. A good team response is not improvised. It is built from a few reliable habits that are repeated during acute response, procedures, transport, and prolonged casualty management.

11.4 Core Principles of Team-Based ACTT Care

11.4.1 One Clear Clinical Lead

One person must hold the overall clinical plan. The lead may be the person performing a task initially, but once multiple actions are happening at once, someone must maintain the broader view. The lead defines priorities, assigns work, confirms what has and has not been done, and determines when the next escalation step is required.

A frequent failure pattern is that the most senior or most experienced person becomes absorbed in a single procedure and no one is left tracking the whole patient. If that happens, the team should explicitly re-state who now owns the overall plan.

11.4.2 Shared Mental Model

Everyone involved should understand the main diagnosis or working problem list, the immediate threats, the interventions already performed, and the next likely failure point. A shared mental model prevents teams from splitting into parallel but uncoordinated efforts.

When the patient changes, the plan must be re-stated out loud. This is especially important after airway placement, decompression, seizure termination, new hypotension, rising oxygen requirement, or any transition from acute rescue into prolonged holding.

11.4.3 Closed-Loop Communication

Critical instructions should be stated clearly, repeated back, and confirmed when complete. This is especially important for medication dosing, infusion changes, airway steps, device checks, and timed reassessments.

Closed-loop communication reduces silent task failure. It is one of the simplest ways to prevent missed doses, duplicated interventions, and the false assumption that someone else is handling the problem.

11.4.4 Reassessment Is a Team Function

Reassessment should never be assumed. A named person must be responsible for repeat vitals, device checks, fluid and medication timing, and re-evaluation after interventions. The lead should explicitly ask whether the patient is better, worse, or unchanged and whether any new complication has appeared.

Without assigned reassessment, the team tends to focus on the intervention itself rather than on whether it actually fixed the problem.

11.5 Leadership in ACTT-Relevant Scenarios

11.5.1 Responsibilities of the Clinical Lead

The clinical lead should maintain an active problem list, set immediate priorities, decide which procedures and medications are required, and anticipate the next likely deterioration. The lead must also watch the workload of the team. An excellent clinical plan can still fail if it requires more people, monitoring, or continuity than the ship can realistically provide.

In prolonged holding, the lead must ensure the team shifts from rescue thinking to sustained management: scheduled reassessments, medication continuity, trend documentation, and clear trigger points for re-contacting outside support.

11.5.2 Leadership During High-Acuity Interventions

Before RSI, chest decompression, chest tube insertion, seizure escalation, or pressor initiation, the lead should slow the team briefly enough to state the plan, confirm equipment, assign roles, and define the backup plan if the first attempt fails.

The lead should control pace. A rushed team without a stated contingency is more dangerous than a briefly paused team with a clear plan.

11.5.3 Leadership Failure Patterns

Common leadership failures include: no clear lead, task fixation, failure to update the plan when the patient changes, and assuming others are monitoring without assigning it. Each of these is preventable if the team states the lead, states the problem list, and states the next check as well as the next treatment.

11.6 Role Assignment and Task Organization

In a small clinical team, one person may hold multiple functions, but the functions should still be named. Typical roles include clinical lead, airway or procedure operator, medication and equipment support, monitor/recorder, and runner or general support. Clear assignment prevents duplication and omission.

Role assignment should occur before procedures, during deterioration, and again after any major change in acuity. If new personnel enter the scene, roles should be re-declared so that the team does not drift into assumption-based work.

11.6.1 Role Assignment Before a Procedure

Before a procedure, the team should define who performs, who monitors, who passes equipment, who prepares or administers medications, who documents, and who is the immediate backup if the procedure fails. This is not bureaucracy; it is a direct safety step that reduces delay and confusion once the procedure begins.

11.6.2 Preventing Role Drift

Roles blur over time, especially in a 24-72 hour hold. Fatigue, repeated interruptions, and the arrival of additional personnel can cause responsibility to become unclear. The team should re-state responsibilities at set intervals and after each handover.

11.7 Communication During Acute Care

11.7.1 Declaring the Situation Clearly

The first useful communication in an emergency is a concise statement of the problem and the immediate threat. For example: "Severe TBI with falling GCS, airway may be lost soon" or "Suspected tension physiology, decompression now." Vague statements delay action because they force the team to interpret the urgency for themselves.

11.7.2 Giving Clear Clinical Orders

Orders should include the specific action, dose or amount where relevant, route or device if relevant, and timing. "Give ketamine 1 mg/kg IV now" is safe and actionable. "Give some sedation" is not. Ambiguous orders create medication errors, duplicated work, and unnecessary delay.

11.7.3 Calling Out Critical Changes

Falling SpO_2, worsening BP, rising agitation, recurrent seizure activity, increasing pressor requirement, decreasing urine output, and device malfunction should be spoken aloud as soon as they are recognized. Waiting for certainty is often how teams lose the salvage window.

11.8 Pre-Procedure Briefs and Procedure Communication

Every major procedure should begin with a brief verbal plan: what is being done, why it is being done, who performs it, what equipment is ready, what the backup plan is, what the failure trigger is, and what the immediate post-procedure plan will be. This creates alignment before the procedure starts.

During the procedure, key milestones should be called out: medication given, paralysis onset, airway view, tube passed, decompression performed, pleural entry, IO flush confirmed, and so on. Afterward, the team should immediately confirm whether the procedure worked, what changed, and what now needs monitoring.

11.9 Documentation as an Operational Tool

Documentation is part of safe care. In acute care it captures times, findings, medications, procedures, and immediate response. In prolonged holding it becomes even more important because it preserves trends, prevents duplicate dosing, supports handovers, and allows teleconsultation to be based on reliable data rather than memory.

Good documentation includes exact times, exact doses, current drip rates, device placements and checks, neuro trends, fluids in and out, and clear notes on whether the patient improved, worsened, or remained unchanged after each major action.

11.9.1 Documentation Failure Patterns

Common failures include missing times, undocumented reassessment, no running total of sedatives or opioids, no trend record, and notes that record what was done without stating what happened afterward. These gaps directly increase risk during shift change and prolonged holding.

11.10 Handover and Transfer of Responsibility

Handover is one of the most dangerous moments in patient care because responsibility can become unclear while the patient continues to evolve. A structured handover should include who the patient is, what happened, what the current problem list is, what has been done, the current status, what may fail next, what must be checked next, and what has not yet been done but may soon be required.

This same structure should be used for shift change, temporary relief, movement to another care space, transfer to a MEDEVAC team, and updates during teleconsultation.

11.10.1 High-Risk Handover Omissions

Common dangerous omissions include the time of the last sedative, current pressor dose, airway status, unresolved device concerns, worsening trends, pending reassessments, and consultant recommendations. These omissions are precisely the details that often determine the next complication.

11.11 Teleconsultation and Remote Clinical Communication

Remote support is a communication task as much as a medical one. Before calling, the team should prepare a concise clinical summary, current vitals, trend data, major interventions already performed, active medications and infusions, onboard capability, and a specific question or decision point.

The most effective structure is simple: state the problem, state the current status, state what has already been done, state what you need help deciding. Long, unstructured chronology without prioritization wastes time and obscures the actual decision point.

11.11.1 Integrating Remote Advice

Once advice is received, it should be converted into bedside tasks. The lead should clarify any ambiguity, assign resulting actions, document the recommendation, and confirm what new trigger should prompt re-contact. Advice that is not translated into explicit tasks is not operationally useful.

11.12 Communication With Chain of Command and Non-Clinical Personnel

Command needs practical information: severity of casualty, likely duration of care burden, evacuation urgency, manpower implications, supply implications, and how the casualty may affect ship routine if prolonged holding continues. This communication should be concise and operationally focused.

Non-clinical personnel can be valuable when used deliberately. They may assist with movement, equipment retrieval, scene control, observation support, or maintaining a safe perimeter around a combative patient. Instructions to non-clinical personnel should be direct and free of unnecessary jargon.

11.13 Team Performance During 24-72 Hour Holding

Acute care teamwork must evolve into sustainable care teamwork. The team should establish a reassessment rhythm, a device check rhythm, a medication timing rhythm, and a handover rhythm. The patient should never be left in a vague "keep an eye on him" state. Someone must know exactly what needs checking, how often, and what finding requires immediate escalation.

Fatigue is a major threat during long holds. Teams should assume that attention will drift unless the system is structured to prevent it. That means written schedules, explicit task ownership, and repeated re-declaration of current priorities.

11.13.1 Re-Declaring Deterioration

If the patient worsens, the team must deliberately switch from maintenance mode back to acute response mode. The lead should say so out loud, restate the immediate threat, and reassign tasks as if starting a new event. Without this reset, teams often continue routine monitoring while the patient is actively failing.

11.14 Operational Practice in Simulations and Real Events

This chapter should also improve performance during course simulations. The same habits that improve real care also improve scenario performance: state findings out loud, verbalize priorities, assign roles early, narrate key interventions, communicate reassessment clearly, and declare escalation points.

Common scenario failures include silence, assumed tasks, no one tracking time or medications, no stated backup plan, and no explicit recognition that the first plan has failed. These are exactly the habits the learner should correct before the course.

11.15 Common Team and Communication Failure Points

The most common failures are predictable: unclear lead, vague orders, no read-back, no documented reassessment, incomplete handover, delayed call for help, and monitoring plans that exceed available staffing. These should be treated as system problems, not isolated personal errors. The solution is to build repeatable habits that make the correct action easier under stress.

11.16 Practical Team Rules for Shipboard Care

The core practical rules are straightforward: say the lead out loud, say the problem list out loud, assign the next check as well as the next treatment, confirm critical tasks closed-loop, and hand over before you think you need to. These five habits prevent a large share of avoidable breakdowns in shipboard acute care and prolonged holding.

11.17 What the Learner Should Be Able to Do After This Chapter

After completing this chapter, the learner should be able to lead or support a coordinated ACTT-relevant team response, assign and maintain clear roles, communicate critical changes clearly, document in a way that preserves continuity, hand over patients safely, and integrate remote support and ship resources into the ongoing care plan.

11.18 Bridge to the Next Chapter

This chapter sets the conditions for safe execution. The next chapter shifts from team execution to study consolidation, rapid review, and practical methods for maintaining readiness before and during the course.

11.19 Quick Operational Checklist

Use the following short checklist during high-acuity events, procedures, and prolonged holding handovers:

- State the lead.
- State the problem list.
- State the immediate priority.

- Assign the next treatment.
- Assign the next reassessment.
- Confirm critical tasks with read-back.
- Document exact times, doses, and responses.
- State what may fail next before handover.

ACTT Preparation Manual
Chapter 12: Study and Review Section

Royal Canadian Navy Physician Assistant Focus

Purpose of this chapter. This chapter turns the manual into a practical study system. It is designed to help you prepare before the course, refresh rapidly before skills stations, consolidate learning during the course, and retain high-consequence material afterward. The emphasis is on recall, sequencing, execution, and safe application under pressure.

12.1 Why this chapter matters

ACTT content is too broad and operationally critical to be learned by passive reading alone. High-acuity performance depends on threshold recognition, quick sequencing, procedural mental rehearsal, and repeated exposure to common error traps.

The study problem is not simply knowing the content. The real requirement is being able to recognize the presentation, state the next action, execute the intervention in the right order, and continue reassessment after the first step. This chapter is structured to support that transition from recognition to action.

Because the course content mixes trauma, airway, critical care, medications, prolonged holding, and shipboard adaptation, the learner needs a repeatable system for deciding what to study first, what to memorize exactly, and what to rehearse as a workflow.

12.2 How to use this chapter

Use this chapter as a study framework rather than a narrative reading section. It should guide how you spend limited review time and help you choose the correct review method for each type of material.

For any topic in the manual, ask: What must I memorize exactly? What must I understand conceptually? What must I be able to perform as a sequence? What is the common failure point after the first intervention? If you cannot answer those questions, the topic is not yet course-ready.

This chapter supports both longer structured sessions and short review blocks. In practice, it should help you move quickly between rapid threshold review, algorithm walkthroughs, procedure rehearsal, medication recall, and prolonged-hold planning.

12.3 Study prioritization strategy

Not all material deserves equal time. The highest priority content is the content most likely to drive immediate survival decisions and the content most likely to fail under stress if it has not been actively rehearsed.

First-priority topics should be mastered first: airway and respiratory emergencies; RSI and failed-airway logic; shock and perfusion targets; TBI management; burn airway and fluid resuscitation; sedation and analgesia dosing; prolonged holding basics; and major numeric triggers. These topics recur across multiple chapters because they are both high-yield and high-consequence.

Second-priority content includes the sepsis pathway, STEMI and fibrinolysis, hypothermia details, chest tube specifics, pericardiocentesis, and detailed antibiotic regimens. These are still important, but they are often more situational or less frequent.

Third-priority content includes lower-frequency rescue nuances, less commonly used medications, finer substitution pathways, and specific equipment variations. These should still be reviewed, but not before the high-frequency core has been made dependable.

12.4 What must be memorized versus what must be understood

Memorization-critical material includes hard thresholds, fixed time windows, drug doses that trigger action, procedural attempt limits, red-flag contraindications, and core formulas. Examples include GCS <= 8, SBP > 110 mmHg in TBI, MAP >= 65 mmHg in septic shock, EtCO2 targets, the Rule of 10s, urine output targets, tenecteplase weight bands, and RSI attempt rules.

Concept-heavy material requires a clear understanding of why a rule exists so that it can be applied safely in context. Examples include why hyperventilation is restricted in TBI, why burn fluids are a starting point rather than a fixed order, why shock type changes fluid-versus-pressor decisions, and why a technically successful procedure can still fail later if it is not maintained.

Sequence-based material should be studied as a workflow rather than as isolated facts. RSI, failed-airway progression, chest tube insertion, sepsis response, TBI neuroprotection, and formal handover all require ordered execution. If the sequence is not stable in memory, performance slows and error rates rise.

12.5 Recommended study order for this manual

The most efficient study order is not simply chapter 1 through chapter 13. Start with the framework chapters to build the mental map: Chapter 2 (Course Framework and Priorities), Chapter 3 (Clinical Domains Overview), and Chapter 8 (Numeric Thresholds and Critical Targets). These establish what matters and what numbers drive action.

Once the framework is in place, move into the high-yield action chapters: Chapter 4 (Major Algorithms and Decision Pathways), Chapter 5 (Advanced Procedures), and Chapter 6 (Medication Reference). These chapters answer what to do, how to do it, and how to medicate the patient safely.

After the action chapters, shift to sustainment and operational chapters: Chapter 7 (Prolonged Holding and Delayed MEDEVAC), Chapter 9 (Critical Errors, Pitfalls, and Do Not Miss Items), Chapter 10 (Shipboard Application), and Chapter 11 (Team, Communication, and Operational Practice). These chapters are what keep the patient safe after the first intervention and what make the plan workable at sea.

Finish with integrated review. Revisit algorithms, medications, thresholds, and pitfalls together rather than rereading linearly. The goal is to connect the material so that one clinical problem automatically triggers the associated threshold, medication, procedural setup, and maintenance burden.

12.6 Study methods by content type

Algorithms are best studied as decision trees: entry condition, first action, branch point, reassessment, escalation. The most useful method is verbal walkthrough. State the presentation, state the first threat, state the first action, then ask what would make you change course.

Procedures are best studied as indication, setup, landmarks, ordered steps, confirmation, complications, and aftercare. Mental rehearsal is particularly useful. If possible, narrate the procedure out loud and include the backup plan and the failure trigger, not only the ideal technical steps.

Medications should be studied by indication first, then dose, then preparation and administration, then monitoring and common errors. Drug cards, grouped comparisons, and route-and-dose recall drills are more effective than reading a long list repeatedly.

Numeric targets should be reviewed as number-to-action links. The useful question is not just What is the number? but What does this number make me do? Threshold tables and rapid-fire drills work well here.

Prolonged-hold content is best studied as a maintenance cycle: reassessment rhythm, device maintenance, medication continuity, and escalation triggers. This material is learned best through planning drills framed around 1-hour, 6-hour, and 24-hour checkpoints.

12.7 Scenario-based self-testing framework

Short immediate-action scenarios should be used to test recognition and first-step decision-making. Useful examples include the GCS-dropping trauma patient, suspected tension pneumothorax, combative head-injured casualty, septic hypotension, and the patient with impending airway burn swelling.

Procedure-trigger scenarios should ask whether the procedure is indicated, what must be prepared, who should do what, and what the backup plan is. Examples include failed airway, tube thoracostomy after decompression, IO after failed IV access, and Foley placement in burn resuscitation.

Medication-selection scenarios should test drug choice, dose, preparation, administration, and required monitoring. High-value examples include active seizure, procedural sedation, pressor-dependent hypotension, STEMI with delayed PCI, and pain control during prolonged holding.

Prolonged-hold scenarios should test trend thinking. Ask what must be trended, what is likely to fail next, what needs re-dosing, and what change would make holding no longer safe. Examples include an intubated burn patient, a pressor-supported septic patient, a TBI patient with worsening pupils, and a chest-tube patient with declining oxygenation.

12.8 Rapid review tools

A 1-minute review should be used for the smallest high-yield refresh. Limit it to airway triggers, shock targets, key drug doses, and red-flag pitfalls. The point is not to feel prepared; it is to reactivate the most failure-prone information quickly.

A 5-minute review should cover one system cluster only. Examples include a TBI block, a burn block, a sepsis block, an RSI block, a sedation block, or a prolonged-hold essentials block. Keep the review structured: triggers, first actions, key drugs, common failures.

A pre-scenario review should focus on what is likely to matter in the next exercise: likely algorithm, likely equipment, likely drugs, likely failure points, and likely handover moments. This is the most practical way to use the manual immediately before course activity.

An end-of-day consolidation review should identify what felt slow, what thresholds were forgotten, what sequence broke down, and what needs another pass. This is more effective for retention than rereading everything that was covered that day.

12.9 Building recall under stress

Stress degrades memory retrieval and sequence control. The study method therefore has to include spoken recall, not just silent reading. Saying the sequence out loud helps stabilize action order for airway plans, procedures, medication administration sequences, and handovers.

Practice next-step thinking. Repeatedly ask: What is the next action? What would make me change course? What must I reassess after this? This mirrors ACTT performance more closely than fact-recognition questions.

Practice failure thinking as well. Ask: What if this does not work? What if the patient worsens? What is my backup plan? This is especially important for airway, chest procedures, pressor support, and prolonged holding because these are the areas in which the first intervention can appear to work and then fail later.

12.10 Review by likely course-relevant themes

Review in clusters rather than isolated facts. The airway cluster should include airway thresholds, RSI, failed airway, post-intubation sedation, oxygenation and ventilation targets, and tube securement. The value of this cluster method is that it mirrors the way airway problems actually present and evolve.

The shock cluster should include shock recognition, fluids versus blood versus pressors, perfusion targets, reassessment after bolus, and vasopressor pitfalls. The learner should be able to move from recognition to a resuscitation and monitoring plan without pausing to rebuild the system from scratch.

The TBI cluster should include GCS, BP targets, EtCO2 targets, herniation signs, hypertonic saline or mannitol use, seizure control, and repeated neuro checks. The core aim is neuroprotection through avoidance of secondary injury.

The burn cluster should include airway decisions, TBSA, the Rule of 10s, urine output targets, escharotomy triggers, and prolonged fluid adjustment. This cluster is particularly important because the initial formula is only the start of the management task.

The sedation and analgesia cluster should include ketamine, midazolam, hydromorphone, fentanyl, morphine, dosing separation, airway risk after sedation, and re-dosing safety over time. This is a high-risk cluster because drug success and drug harm can look very similar early on.

The prolonged-holding cluster should include reassessment rhythm, device maintenance, medication continuity, trend recognition, documentation, and escalation triggers. This cluster is what prevents the patient from being lost after successful initial stabilization.

12.11 Common study errors

Reading without retrieval practice is one of the most common failures. Recognition of familiar text can create false confidence, but ACTT performance requires recall without prompts. Use active recall after each section: close the page and state the main triggers, actions, and pitfalls.

Memorizing details without action context is another major error. If the fact is not linked to what it changes clinically, it is less likely to be usable under stress. Tie every number, drug, and procedural step to the question: What would this make me do?

Studying rare details before high-yield basics creates a weak operational foundation. Master high-frequency and high-consequence content first. Rare rescue nuances are useful only after the common critical pathways are stable.

Reviewing procedures without rehearsing the sequence is inefficient. Knowing the equipment list or the indication is not enough. The step order, confirmation, complication recognition, and post-procedure maintenance burden must all be part of the rehearsal.

Ignoring pitfalls and maintenance tasks produces fragile learning. Many learners remember the first intervention but not what causes later deterioration. Always review reassessment, device checks, medication timing, and common failure points alongside the initial treatment.

12.12 Practical course-prep review structure

A short review session should include one rapid threshold review, one algorithm, one procedure, one medication cluster, one pitfall cluster, and one brief self-test. This structure keeps the session balanced and prevents overfocusing on one comfortable topic.

A longer review session should include one major system block, one procedure walkthrough, one medication comparison set, one prolonged-hold scenario, one handover drill, and one error review. This format better reflects how the course integrates technical and operational content.

A final pre-course review should concentrate on airway, shock, TBI, burns, sedation, prolonged holding, major thresholds, and common pitfalls. The goal immediately before the course is to stabilize the high-yield core, not to relearn every chapter from scratch.

12.13 Using this manual during the course

Before skills stations, review indications, key steps, failure triggers, complications, and post-procedure priorities. This is the fastest way to prime technical performance without overloading yourself with low-yield detail at the last minute.

Before scenario work, review likely algorithms, threshold triggers, communication structure, and likely next deterioration. This keeps you focused on progression and reassessment rather than only the first intervention.

After scenarios or teaching blocks, review what was missed, what felt slow, what thresholds were forgotten, and what sequence broke down. Those identified weak points should directly shape the next study block. The manual is most useful when it is used to close specific performance gaps, not only to reread familiar material.

12.14 End state for the learner

After working through this chapter, the learner should be able to study the manual deliberately and efficiently, prioritize the highest-yield material first, and distinguish between memorization, conceptual understanding, and sequence rehearsal.

The learner should also be able to use active recall and scenario practice to improve retention, build faster bedside recognition, and convert passive reading into more reliable execution under stress.

The intended end state is not perfect recall of every line. It is dependable performance on the high-consequence tasks most likely to matter during ACTT training and in shipboard casualty care afterward.

12.15 Rapid review checklists

One-minute review checklist

- State the airway threshold that triggers definitive airway planning.
- State the TBI blood pressure target.

- State the septic shock MAP target.
- State the TBI EtCO2 target and the temporary herniation target.
- State one common ketamine dosing distinction and one common airway pitfall.

Five-minute system review checklist

- Choose one system only: TBI, burns, sepsis, RSI, sedation, or prolonged holding.
- State the key trigger values.
- State the first intervention.
- State the next branch point.
- State the most likely complication or failure point.
- State what must be rechecked after the intervention.

Pre-scenario checklist

- Identify the likely dominant algorithm.
- Identify the likely procedure and backup plan.
- Identify the likely medication cluster.
- Identify the most likely deterioration path.
- Identify what must be communicated aloud first.

Bridge to the next chapter. This study and review framework should make the rest of the manual more usable under time pressure. The next chapter shifts from study method to rapid-access reference material in the quick reference appendices.

Chapter 13: Quick Reference Appendices

Rapid-access tools for ACTT review, execution, and shipboard use

13.1 Purpose of This Chapter

This chapter converts the detailed manual into a fast-use toolkit. The intent is to reduce scan time during preparation, scenario work, and real clinical events by presenting the material in compact forms: algorithm cards, procedure checklists, drug tables, threshold tables, prolonged-hold checklists, and shipboard aids. It is designed for rapid retrieval, not full teaching.

13.2 How to Use These Appendices

Use these pages when you need the exact trigger, the next step, the dose, the reminder for setup, or the immediate reassessment target. They support quick refresh before a skill station, fast reference during a long hold, and structured handover preparation. They do not replace the detailed chapters; they distill them.

13.3 Design Rules for Fast Retrieval

Every appendix should answer one operational question quickly. Keep attention on what changes decisions: thresholds, actions, doses, cautions, and what must be checked next. If the patient is unstable, use the appendix to orient action, then return to the detailed chapter if time permits.

Appendix A: Major Algorithm Summary Sheets

These summary sheets are compressed action maps. Each one should be read as: recognize, intervene, reassess, escalate.

Algorithm	Entry trigger	Immediate actions	Branch points	Reassess
Airway failure / severe AMS	GCS 8 or less, inability to protect airway, major facial trauma, complete or impending obstruction	Oxygen, suction, positioning, monitor, pre-oxygenate, prepare RSI or go directly to surgical airway if oral route is not viable	Difficult airway: one attempt. Non-difficult airway: two attempts if oxygenation holds. Failed airway moves immediately to rescue/surgical airway	EtCO2, chest rise, bilateral breath sounds, tube depth, post-intubation sedation, ventilation target
Combative patient	Unsafe agitation, violent behavior, severe AMS interfering with care	Verbal de-escalation first, then physical control if required, obtain O2 and monitoring if possible, check glucose when feasible	Chemical restraint if unsafe despite verbal control. Escalate to airway pathway if still dangerous or cannot maintain safety	Airway, breathing, SpO2, sedation effect, occult causes such as hypoxia, hypoglycemia, TBI, sepsis

TBI management	Suspected head injury with reduced GCS, abnormal pupils, seizure, worsening LOC	Protect airway if needed, avoid hypoxia, maintain SBP above 110 mmHg, elevate head, treat fever and seizures, avoid hypotonic fluids	If herniation signs appear, brief hyperventilation to EtCO2 around 30 mmHg plus hypertonic saline or mannitol if appropriate	Serial GCS, pupils, BP, oxygenation, EtCO2, seizure recurrence, neurologic trend
Burn management	Large TBSA burn, inhalation injury, circumferential burn, electrical burn	Assess airway early, estimate TBSA, start Rule of 10s, consider Foley, target urine output, protect temperature, control pain	Increase or decrease fluids by 25 percent based on urine output. Early airway for major inhalation injury or greater than 40 percent TBSA	Urine output, airway swelling, distal perfusion, edema progression, temperature, respiratory status
Hypothermia	Cold exposure with reduced temperature, altered consciousness, or arrest	Prevent further heat loss, handle gently, stage by core temperature, start appropriate rewarming	Stage IV arrest uses modified arrest logic with limited epinephrine/defibrillation until meaningful rewarming	Core temperature, rhythm, perfusion, rewarming progress, transport options including ECMO window
Sepsis / septic shock	Suspected infection plus poor perfusion, hypotension, or mental status change	Access, initial crystalloid if tolerated, early antibiotics, source-directed assessment, pressor preparation if refractory	Stop reflex fluid if respiratory burden rises. Start norepinephrine when hypotension persists after initial resuscitation	MAP, urine output, perfusion, oxygen need, fever curve, pressor requirement
STEMI / fibrinolysis	Ischemic symptoms plus STEMI ECG and PCI delay beyond practical window	Confirm ECG pattern, screen contraindications, prepare tenecteplase, give adjunct antiplatelet and anticoagulant therapy	If fibrinolysis contraindicated, shift to supportive care and urgent evacuation planning	Bleeding, neurologic change, reperfusion arrhythmias, persistent ischemia
Tension pneumothorax	Respiratory distress with unilateral absent breath sounds, hypotension, JVD, or arrest concern	Immediate needle thoracostomy if suspicion is high, do not wait for perfect confirmation	If no improvement, reassess site, device, and alternate causes. If temporary improvement only, proceed to chest tube	Breathing, BP, breath sounds, repeat tension signs, chest tube readiness

Appendix B: Procedure Checklists

These checklists are built as Ready - Perform - Confirm - Maintain tools. They are not substitutes for training, but they help preserve sequence discipline.

Procedure	Ready / perform essentials	Confirm / maintain
RSI	Indication confirmed; team roles assigned; suction, oxygen, laryngoscopy, tube, bougie, rescue airway ready; meds drawn up; attempt limit and failed-airway trigger stated	EtCO2, chest rise, breath sounds, tube depth, secure tube, begin ongoing sedation and ventilatory targeting
Surgical cricothyroidotomy	Rescue airway indication, landmarks identified, scalpel/hook/tube/suction ready	Ventilate, confirm with EtCO2 and chest rise, secure firmly, monitor bleeding and patency
Needle cricothyroidotomy	Temporary cannot-intubate/cannot-oxygenate bridge only; 14G catheter and adapter ready	Confirm oxygenation response and move immediately toward definitive airway
Needle thoracostomy	Tension suspected, 14G 3.25-inch catheter, correct site identified	Look for decompression effect, reassess vitals and breath sounds, prepare chest tube
Chest tube thoracostomy	Indication, correct tube size, sterile supplies, drainage system, local anesthesia/sedation if time allows	Check drainage, bubbling/output, tube position, securement, ongoing function checks
IO access	2 failed IV attempts or time-critical access need, proper site identified, flush and securement ready	Easy flush, no extravasation, pressure-assist if needed, monitor site and pain
Foley catheter	Need for strict urine output or retention relief, no urethral injury concern	Urine return, balloon in correct position, secured drainage bag, output charting
Pericardiocentesis	Strong tamponade concern, best approach selected, ultrasound if available	Aspiration with hemodynamic response, continued monitoring, urgent transfer planning
Shoulder reduction	Neurovascular exam first, analgesia/sedation plan, chosen technique and backup	Reduction confirmed clinically, repeat neurovascular check, sling/immobilize, pain control

Appendix C: Medication Quick Reference Tables

The drug tables below are built around the bedside questions: why am I giving this, how much, how do I give it, and what do I need to watch?

Sedation and Analgesia

Drug	Primary use	Adult dose	Administration	Key caution
Ketamine	Analgesia, procedural	Pain: 0.1-0.2 mg/kg IV/IO slow.	Slow IV push. Differentiate pain	Airway, SpO2, EtCO2, BP/HR.

	sedation, combative patient, induction	Sedation: 1 mg/kg IV/IO or 4-5 mg/kg IM	dose from dissociative dose	Rapid IV push can depress breathing; avoid using alone for RSI
Midazolam	Sedation, anxiolysis, seizure rescue, ketamine adjunct	Sedation: 1-2.5 mg IV/IO. Seizure: 5 mg IV/IO/IM q5 min until controlled	Slow IV push; may repeat based on response	Respiratory depression, hypotension, cumulative sedation, especially with opioids
Hydromorphone	Preferred prolonged-care opioid for moderate/severe pain	0.5-1 mg IV for opioid-naive adults; reassess before repeat dosing	Titrate slowly in small increments	Respiratory depression, oversedation, hypotension; track cumulative effect
Fentanyl	Rapid analgesia, short-acting pain control	25-100 mcg IV/IO	Give slowly; OTFC only for selected awake patients if applicable	Fast push can cause respiratory depression or chest wall rigidity
Morphine	Alternative opioid when other options unavailable	2.5-10 mg IV/IO depending on patient and context	Slow titration	Higher hypotension and histamine/pruritus burden

RSI and Airway Medications

Medication	Role	Use	Practical note
Ketamine	Induction	1 mg/kg IV/IO typical ACTT reference point	Hemodynamically useful induction option; pair with paralytic in RSI
Succinylcholine	Paralysis	Follow local directive / weight-based dosing	Rapid onset, shorter duration; check major contraindications
Rocuronium	Paralysis	Follow local directive / weight-based dosing	Longer duration; useful when succinylcholine not suitable
Post-intubation sedation	Maintain comfort and tube tolerance	Continue ketamine / midazolam / analgesia as indicated	Do not leave newly intubated patient unsedated

Pressor and Hemodynamic Support

Drug	When used	Dose / start point	Key note
Norepinephrine	First-line pressor in septic/vasodilatory shock	2-4 mcg/min to start, titrate to effect	Infusion pump required; monitor MAP, perfusion, and IV site closely; extravasation can cause tissue injury
Epinephrine	Anaphylaxis, cardiac arrest, infusion for	0.3-0.5 mg IM for anaphylaxis; 1 mg IV	Avoid concentration confusion; dosing

	shock	q3-5 min arrest; infusion per protocol	changes by indication
Phentolamine	Extravasation rescue	5-10 mg diluted for local infiltration	Use promptly if vasopressor extravasation occurs

Neuro, Seizure, and ICP Medications

Drug	Trigger	Dose	Key note
Midazolam	Active seizure termination	5 mg IV/IO/IM q5 min until seizure stops	Protect airway and reassess for repeat seizure
Levetiracetam	Seizure loading / maintenance support	2000 mg IV/IO over about 15 min	Useful after acute seizure control in TBI or recurrent seizure risk
Hypertonic saline 3%	ICP support / impending herniation	250 mL bolus over about 20 min	Monitor sodium and neurologic response
Mannitol	Alternative ICP-lowering agent	1 g/kg IV over about 20 min	Avoid when hypotensive or actively bleeding

Cardiovascular Emergency Medications

Drug	Use	Dose	Key note
Tenecteplase	STEMI with delayed PCI and no absolute contraindication	30/35/40/45/50 mg by weight band	Reconstitute gently; do not shake; IV push over 5 seconds
Enoxaparin	Adjunct after fibrinolysis	30 mg IV bolus then 1 mg/kg SQ q12h in appropriate patients	Check age and renal caveats
Heparin	Alternative adjunct anticoagulation	Weight-based bolus then infusion	If monitored, target PTT about 50-70 seconds
Clopidogrel	Antiplatelet adjunct	300 mg PO load, or 75 mg in selected previously-treated patients	Account for bleeding risk and timing

Sepsis and Antibiotic Quick Reference

Scenario	Regimen	Timing	Key note
Unknown source	Ceftriaxone 2 g IV q24h + Metronidazole 500 mg IV q12h	Start within 1 hour in severe sepsis / shock	Good broad initial coverage while source remains unclear
Pneumonia	Ceftriaxone 2 g IV q24h + Azithromycin 500 mg IV q24h	Start early once suspected source established	Monitor respiratory burden and ongoing sepsis response
CNS / meningitis	Ceftriaxone 2 g IV q12h + Ampicillin 2 g IV q4h + Dexamethasone + Acyclovir	High consequence; do not delay without reason	Track neuro status closely

Skin / soft tissue	Cefazolin 2 g IV q8h or Clindamycin 300 mg IV q6h in selected purulent cases	Choose regimen by presentation	Reassess source control needs
Open / penetrating TBI	Ertapenem 1 g IV q24h + Moxifloxacin 400 mg PO q24h, or ceftriaxone-based alternative	Special contamination-focused pathway	Useful to flag when course knowledge exceeds current stock

Reversal and Rescue Medications

Drug	Role	Dose	Key note
Naloxone	Opioid reversal	0.4-2 mg IV/IM/IN; titrate slowly if possible	Avoid abrupt full reversal when partial reversal will restore breathing
Flumazenil	Selected benzodiazepine reversal only	0.2 mg IV over 15 seconds initially	Avoid in chronic benzodiazepine users due to seizure risk
Protamine	Heparin / partial enoxaparin reversal	Dose by amount and timing of anticoagulant exposure	Use when bleeding complication makes reversal necessary
Ondansetron	Nausea / vomiting control	4 mg ODT/IV/IM	Useful after opioids, ketamine, or systemic illness
Diphenhydramine	Allergy, pruritus, dystonia	25-50 mg IV/IM/PO	Adds sedation burden; use deliberately

Appendix D: Numeric Threshold and Target Tables

Parameter	Target / threshold	Why it matters / action
GCS	8 or less	Prepare for definitive airway / airway reassessment
SpO2	Above 95 percent in key neuro-risk patients	Increase oxygen support; reassess airway / ventilation
EtCO2 (TBI target)	35-40 mmHg	Adjust ventilation to neuroprotective range
EtCO2 (herniation rescue)	About 30 mmHg, temporary only	Brief rescue hyperventilation while applying other ICP measures
Tidal volume	6 mL/kg predicted body weight (range 5-8)	Set lung-protective ventilation
SBP in TBI	Above 110 mmHg	Support cerebral perfusion
MAP in septic shock	65 mmHg or higher	Titrate pressor support
ONSD	Greater than 5.2 mm	Supports concern for elevated ICP in context

Serum sodium with hypertonic therapy	145-160 mmol/L	Guide ICP-support strategy, avoid overcorrection
Rule of 10s	TBSA percent x 10 = mL/hr, plus 100 mL/hr per 10 kg above 80 kg	Set initial burn fluid rate
Urine output, adult burn	30-50 mL/hr	Titrate burn fluids
Urine output, electrical / crush burn	70-100 mL/hr	Higher target to protect kidneys
Burn fluid adjustment	25 percent up or down	Change rate based on urine output response
Major burn airway trigger	More than 40 percent TBSA or major inhalation injury	Plan early airway control
Hypothermia stages	I 32-35C; II 28-32C; III below 28C with vitals; IV absent vitals	Stage drives management
Warmed IV fluids	About 38-42C	Support active rewarming
ECMO transfer benchmark	Within 6 hours in salvageable hypothermic arrest	May justify prolonged resuscitation
Sepsis crystalloid start	30 mL/kg over first 3 hours if appropriate	Initial septic resuscitation, then reassess
Antibiotic window	Within 1 hour in severe sepsis / shock	Do not delay unnecessarily
STEMI threshold	ST elevation over 1 mm in 2 contiguous leads plus ischemic symptoms	Activate STEMI pathway
PCI delay threshold	More than 90 minutes	Fibrinolysis becomes practical option if eligible
Acetaminophen maximum	4000 mg per day	Avoid hepatotoxic total dosing
Needle thoracostomy device	14G, 3.25-inch catheter	Use appropriate decompression equipment
Chest tube suction setup	Negative 20 cm H2O	Standard Pleurivac reference point
IO switch rule	After 2 failed IV attempts or more than 90 seconds in urgent need	Do not lose time pursuing failed peripheral access

Appendix E: Critical Errors and Do Not Miss Lists

- Airway pitfalls: repeated intubation attempts beyond the declared limit; no backup plan; incomplete tube confirmation; no post-intubation sedation; weak securement in movement or burns.
- Resuscitation pitfalls: blind repeated fluid boluses; wrong fluid choice in TBI; starting pressors before clarifying shock physiology; trusting a better blood pressure while perfusion worsens elsewhere.
- TBI pitfalls: untreated hypoxia, hypotension, or fever; routine hyperventilation; missed subtle neurologic decline; weak seizure follow-up.
- Burn pitfalls: delayed airway control in inhalation injury; treating the Rule of 10s as a fixed order; poor urine output tracking; missed circumferential compromise.
- Medication pitfalls: wrong dose for the indication; administration too fast; dose stacking; missing cumulative totals; concentration confusion during fatigue.

- Prolonged-hold pitfalls: no reassessment rhythm; no device maintenance plan; poor handover; slow deterioration missed because no one owns the trend.

Do Not Miss High-Consequence Situations

- Impending cerebral herniation: falling LOC, pupil asymmetry, Cushing-type change.
- Recurrent or persistent tension physiology after partial improvement.
- Occult deterioration after sedation: a quieter patient may be hypoxic, hypoventilating, or hypotensive.
- Pressor-dependent shock with rising support needs and worsening urine output.
- Delayed airway loss in burn / inhalation injury as edema progresses.
- A long-hold patient who looks stable but is drifting in trend data.

Appendix F: Prolonged Holding Checklists

These tools convert initial stabilization into a 24-72 hour maintenance plan.

Checklist	Critical items
Initial hold conversion	Airway status, breathing plan, perfusion plan, pain/sedation plan, active problem list, monitoring plan, escalation triggers
Reassessment cycle	Mental status, airway, breathing, SpO2 / EtCO2 if available, HR/BP/perfusion, temperature, urine output, pain/agitation, device function, trend review
Device maintenance	Airway device checks, line checks, IO/IV site checks, chest tube checks, Foley checks, dressing and wound checks
Medication continuity	Last dose, next dose due, infusion settings, cumulative totals, remaining stock, adverse effects, monitoring burden
Escalation triggers	Worsening oxygen need, rising pressor need, neuro decline, recurrent tension signs, uncontrolled pain/agitation, recurrent seizure, inability to monitor safely

Appendix G: Shipboard Application Aids

Aid	Quick rule
Care location selection	Does the location provide oxygen, suction, lighting, monitoring access, space to work, and safety in ship movement?
Casualty movement	Secure every line, tube, and drain; assign movement roles; pre-brief the route; bring rescue gear; reassess before and after movement.
Resource sustainability	Estimate oxygen endurance, medication stock, infusion pump availability, suction access, and staffing for ongoing observation.
Shipboard adaptation rules	Simplify to what changes outcomes; secure everything; trend everything important; escalate early; choose sustainable care over ideal but unsustainable care.

Appendix H: Team and Communication Tools

Tool	Contents
Pre-procedure brief	What is being done, why now, who performs, what is the backup plan, what is the failure trigger, what must be monitored afterward
Acute care roles	Lead, airway, med/procedure support, monitor/recorder, runner/support. In small teams, one person may carry more than one role, but each role still needs to be named.
Handover template	Who the patient is; what happened; what was done; current status; what may fail next; what must be checked next
Teleconsultation call template	Problem summary, key trends, current interventions, onboard limits, specific question or requested decision support

Appendix I: Study and Rapid Review Tools

- High-yield first-pass review: airway, shock, TBI, burns, sedation, prolonged holding, major thresholds.
- One-minute review: critical airway triggers, top shock targets, highest-risk drug doses, red-flag pitfalls.
- Five-minute system reviews: TBI, burns, sepsis, RSI, sedation, prolonged holding.
- Scenario prompts: What is the next action? What threshold is driving this? What could fail next? What must be reassessed?

Appendix J: Onboard Stock and Substitute Cross-Reference

Use this appendix to bridge ideal ACTT knowledge with current Sick Bay resources. This is not meant to narrow learning to onboard stock only; it is meant to make gaps visible and help with substitution planning.

Category	Reference note
Confirmed onboard examples from uploaded formulary	Acetaminophen, Acyclovir, Ampicillin, Azithromycin IV, Cefazolin, Ceftriaxone, Clopidogrel, Dexamethasone, Enoxaparin, Lidocaine 2%, Metronidazole IV, Ondansetron, Protamine, Sodium bicarbonate, among others
Important ACTT drugs not clearly confirmed onboard	Examples may include Tenecteplase, Norepinephrine infusion stock, Hypertonic saline 3%, Mannitol, Levetiracetam, selected induction/paralytic agents, depending on actual loadout
Substitution rule	If a preferred drug is unavailable, note the substitute, what changes in monitoring burden, and what clinical limitations that substitute introduces

13.15 Suggested Layout Strategy Within the Appendices

For true quick use, each topic should remain easy to scan. One topic per page is preferable when practical. Tables, checklist blocks, and clearly labeled subheads are more useful here than long paragraphs. The purpose is speed, not completeness.

13.16 What the Learner Should Be Able to Do After This Chapter

After using these appendices, the learner should be able to find the key number, dose, checklist, or trigger rapidly; use condensed tools to support safe execution; refresh critical material before procedures or scenarios; and support prolonged holding, handover, and shipboard decision-making with less hesitation and fewer memory errors.

13.17 End State of the Manual

This final chapter turns the manual into a working toolkit. The complete manual should now function in four ways: as a teaching resource, as a study system, as a practical bedside reference, and as a shipboard-adapted support tool for delayed MEDEVAC care.