Ottawa Handbook Of Emergency Medicine

4th Edition

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EMERGENCY MEDICINE OTTAWA

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Preface

Introduction

Dear readers,

This handbook is a student-driven initiative developed in order to help you succeed on your emergency medicine rotation. It provides concise approaches to key patient presentations you will encounter in the emergency department. This guide has been peer-reviewed by staff physicians to ensure evidence is up-to- date and accurate. Based out of Ottawa, our hope is that this resource will benefit clerkship students and help bridge the emergency medicine knowledge gap from pre-clerkship to clinical practice.

Sincerely,
Omar Anjum, BSc, MD
Author and Editor

How to Use this Guide

Topics are subdivided according to **background**, **assessment**, **investigations**, and **management**. 🔍 indicates there are images.
EMOttawa Blog Post: click here on applicable pages to be hyperlinked to a related EMOttawa Blog post for more info on this topic.

Background
This section provides common definitions, pathophysiology, etiology or risk factors for certain conditions. Differential diagnoses are also discussed ("Symptoms Approach" section).
Assessment
Common historical and physical exam features are mentioned here. Diagnostic criteria or techniques/methods used to aid in diagnosis may also be noted.
Investigations
Relevant labs, radiological evaluation and adjunctive tests are mentioned for consideration of diagnostic workup.
Management
General and disease-specific management approaches are discussed. Disposition and discharge criteria may also be noted.

Key References: Used for further reading. Some sources are provided because they are deemed useful.

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Resuscitation

Airway

Decision to Intubate

Failure to maintain or protect airway (e.g. low GCS, airway trauma)
Failure to ventilate/oxygenate (e.g. low or declining SpO_2, rising pCO_2)
Anticipatory (e.g. trauma, overdose, inhalation injury, anaphylaxis, inc. WOB)

Assessment

Difficult Bag-Valve Mask Ventilation "BOOTS"
B = Beard; **O** = Obese; **O** = Older; **T** = Toothless; **S** = Snores/Stridor
Difficult Laryngoscopy
Look for gestalt signs. Evaluate the 3-3-2 rule. Check for signs of obstruction, swelling, trauma. Assess neck mobility. **Upper lip bite test:** Concern if patient cannot bite past vermillion border
Difficult Supraglottic Device "RODS"
R = **R**estricted mouth opening; **O** = **O**bstruction, **O**bese **D** = **D**isrupted or **D**istorted anatomy; **S** = **S**tiff lung or cervical **S**pine

Airway Techniques

Temporizing Measures
Chin lift/jaw thrust, BVM, suctioning, nasal airway, oral airway, LMA
Definitive Airway
Orotracheal/nasotracheal intubation, surgical airway (percutaneous or open cric)

Airway Methods

Rapid Sequence Intubation (RSI)
Awake intubation w/ topicalization
Ketamine-facilitated intubation
Crash airway without meds

Rescue Airways

LMA
Cricothyroidotomy

Rapid Sequence Intubation (6Ps)

Preparation
Prepare equipment and medications, use checklist if available
Pre-Oxygenation
100% FiO_2, employ PEEP valve to improve recruitment
Pre-Treatment (Optional)
Increased ICP: fentanyl 3µg/kg Hypotension: fluids/vasopressors (infusion or push-dose) Acidosis: bicarb (controversial), consider maintaining spontaneous respiration Anxiolysis: midazolam 2-4mg
Positioning
Sniffing position, ramped position if obese, adjust bed height
Paralysis with Induction
Administration of sedative (i.e. Ketamine, Propofol, Etomidate) followed by muscle relaxant if indicated (i.e. Succinylcholine or Rocuronium)
Place Tube with Proof
Intubate patient and confirm tube placement (continuous waveform $EtCO_2$)
Post-Intubation Management
Post-intubation analgesia, ongoing sedation, ventilator management, further resuscitation.

Airway Checklist

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 6.

Breathing

Definitions

Acute respiratory failure = pO_2 <50mmHg +/- pCO_2 >45mmHg
Hypoxic Respiratory Failure
Diffusion problem: pneumonia, ARDS V/Q mismatch: PE, Asthma, COPD Shunt Low ambient FiO_2: high altitude Alveolar hypoventilation
Hypercarbic Respiratory Failure, Normal Lungs
Disorder of respiratory control: overdose, brainstem lesion, CNS disease Neuromuscular disorders: muscular dystrophy, GBS, Myasthenia Gravis, ALS Anatomic: trauma, ankylosing spondylitis, kyphosis/severe scoliosis
Hypercarbic Respiratory Failure, Abnormal Lungs
Increased airway resistance: AECOPD, asthma exacerbation Decreased gas exchange: scarring, IPF

Assessment

Look	Listen	Feel
Mental status, colour, chest wall movement, accessory muscle use Paradoxical abdominal movement	Auscultate for breath sounds Signs of obstruction Air entering or escaping Wheeze and stridor	Tracheal deviation, crepitus, flail segments, chest wounds

Investigations

Labs: CBC, electrolytes, cardiac enzymes +/- D-dimer +/- BNP, VBG
Tests: POCUS, CXR +/- CT Chest

Management of Breathing

Spontaneously Breathing Patient
Nasal prongs Face mask, Non-rebreather face mask High flow nasal oxygenation (i.e. MaxTech)
Temporizing Measures for Inadequate Ventilation
Bag-valve mask +/- nasal airway CPAP/BiPAP: acute exacerbations of CHF, COPD, asthma
Definitive Measures for Inability to Maintain/Protect Airway
Oro-tracheal intubation Surgical airway
Additional Modalities
Needle or finger thoracostomy for tension pneumothorax Chest tube to drain pleural effusion/hemothorax/pneumothorax

Key References: Journal of Critical Care 2016; 34: 111-115. Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 2.

Circulation

Causes of Shock

Hypovolemic Shock	Hemorrhage GI losses	Third spacing Dehydration Over diuresis
Obstructive Shock (Intra-Thoracic)	Pulmonary embolism Cardiac tamponade Tension pneumo	Valvular dysfunction Congenital heart disease Air embolism
Distributive Shock (Vasodilation)	Septic shock Anaphylactic shock Neurogenic shock	Drug overdose Adrenal crisis
Cardiogenic Shock	ACS Cardiomyopathy	Cardiac structural damage Dysrhythmias

Assessment

Clinical symptoms and signs suggestive of shock	
Vitals: ↑HR, ↓BP, ↑RR	High initial lactate
Urine Output <0.5mL/kg/hr	Skin mottling
Capillary refill time >3 secs	Altered mental status

Investigations

Labs: CBC, electrolytes, BUN, Cr, LFTs, TnI, VBG, lactate
Tests: CXR, ECG, POCUS – RUSH exam (cardiac, IVC, lungs, aorta)

Management

Perfusion Goals
Urine Output >0.5mL/kg/h, MAP >65mmHg, improved mentation, improved cap refill time, lactate clearance
Hemorrhagic Hypovolemic Shock: fill the tank
Control hemorrhage (tourniquets, direct compression, pelvic binders) Fluids until blood available, balanced transfusion (1:1:1 of pRBCs:platelets:FFP)
Obstructive Shock: alleviate obstruction
Tension pneumothorax: needle decompression then chest tube Cardiac tamponade: IV crystalloids, pericardiocentesis PE: IV crystalloid, inotropes, thrombolysis
Distributive Shock: source control, squeeze the pipes
Anaphylaxis: Epinephrine IM, IV fluids, antihistamines if symptomatic, corticosteroids Sepsis: Broad-spectrum antibiotics, IV fluids +/- norepinephrine
Cardiogenic Shock: support forward flow
Norepinephrine 0-20µg/min, dobutamine 0-5µg/kg/min Treat underlying cause: cath lab, mechanical circulatory support (IABP, Impella, VAD, ECMO), heart transplant
Cellular Toxins
Antidotes for various toxins (see Toxicology)

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 6.

Trauma Resuscitation

Primary Survey

1. Airway	3. Circulation
Assess patency of airway, look for obstruction (blood, emesis, teeth, foreign body), ensure C-spine precautions, airway management	Assess LOC, signs of shock (HR, BP, skin color, urine output, base deficit), sources of bleeding (external, chest, abdomen, pelvis, femur)
2. Breathing	**4. Disability**
Expose chest, assess breathing, auscultate for breath sounds, rule out tension pneumothorax	GCS assessment Neurological evaluation including pupils

5. Exposure/Environment
Fully expose and assess patient Logroll patient to inspect for injuries, spinous tenderness and rectal exam for high-riding prostate and tone Keep patient warm to prevent hypothermia
Adjuncts
eFAST Exam: subxiphoid pericardial window, perisplenic, pelvic/retrovesical, bilateral anterior lung **Portable X-ray:** chest, pelvis, grossly deformed limbs **ECG:** evaluate for dysrhythmias

Investigations

Bloodwork: CBC, lytes, BUN, Cr, glucose, lactate, INR/PTT, fibrinogen, ß-hCG, tox bloodwork, T+C, U/A

Imaging: CT (selective vs. pan-scan) for stable patients; unstable patients may require emergent OR

Trauma Triad of Death
Coagulopathy Hypothermia Acidosis

Management

General Resuscitation
Immediate hemorrhage control (Stop the Bleed) Blood transfusion: balanced resuscitation to avoid dilutional coagulopathy Tranexamic acid: 1g IV bolus then 1g IV over 8 hours Consider permissive hypotension
Head Trauma
Seizure management/prophylaxis, treat suspected raised ICP, neurosurgical intervention for severe head injury/bleeds
Spinal Cord Trauma
Immobilization, treat neurogenic shock (goal MAP >85), consult spine service
Chest Trauma
Airway management, chest decompression, resuscitative thoracotomy in arrest, surgery for life-threatening injuries
Abdominal Trauma
Laparotomy for hemodynamically unstable and hollow organ injuries
Orthopedic Injuries
Reduce and immobilize when possible, irrigate open fractures, assess for neurovascular and skin compromise, adequate analgesia, consult ortho

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 36. ATLS Manual, ACS – 9th ed, 2012.

Symptoms Approach

Syncope

Definition: sudden and transient loss of consciousness and loss of postural tone accompanied by a rapid return to baseline

Pathophysiology: dysfunction of both cerebral hemispheres or the brainstem (reticular activating system) usually from hypo-perfusion

Differential Diagnosis

Cardiac	**Rhythm Disturbances:** dysrhythmias, pacemaker issues **Structural:** outflow obstruction (aortic stenosis, HOCM), MI **Other CV diseases:** dissection, cardiomyopathy, PE	
Non-Cardiac	**Reflex (neurally mediated)**	**Vasovagal:** sensory or emotional reactions **Orthostatic**: postural related, volume depletion **Situational:** coughing, straining **Carotid sinus pressure:** shaving **Subclavian steal:** arm exercises
	Medications	CCBs, ß-blockers, digoxin, insulin QT prolonging meds Drugs of abuse
	Focal CNS Hypoperfusion	Hypoxia, epilepsy, dysfunctional brainstem

Assessment

History: syncope character (ask about exertion!), cardiac risk factors, comorbidities, medication/drug use, family history, orthostatic symptoms
Rule out seizure/stroke/head injury

Physical Exam: cardiac exam (murmurs, rate), CNS exam

Investigations

Labs: CBC, glucose, lytes, extended lytes, BUN, Cr, CK/TnI, ß-hCG

ECG intervals	ECG rates
Short PR: WPW Long PR: conduction blocks Deep QRS: HOCM Wide QRS: BBB, Vtach, WPW QT intervals: Long QT syndromes	Tachydysrhythmias: SVT, Afib, Vtach, Vfib Bradyarrhythmias: AV conduction blocks, sinus node dysfunction

Management

General
ABCs, monitors, oxygen, IV access
Cardiogenic Syncope
Consult cardiology for workup +/- permanent pacemaker
Non-Cardiogenic Syncope
Benign causes or low-risk syncope: discharge with GP follow-up Consider outpatient cardiac workup
Risk Stratification Prediction Rules
Canadian Syncope Risk Score

Canadian Syncope Risk Score

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 15. CMAJ 2011; 183(15): 1694-1695. CMAJ 2016; 188(12): E298.

Altered Mental Status

Definition: decrease in LOC caused by either diffuse CNS dysfunction (toxic/metabolic causes) or primary CNS disease

Differential Diagnosis

Drugs
Abuse: Opiates, benzodiazepines, alcohol, illicit drugs Accidental: Carbon monoxide, cyanide Prescribed: ß-blockers, TCAs, ASA, acetaminophen, digoxin Withdrawal: Benzodiazepines, EtOH, SSRIs
Infection
CNS: meningitis, encephalitis, cerebral abscess Systemic: sepsis, UTI, pneumonia, skin/soft tissue, bone/joint, intraabdominal, iatrogenic (indwelling lines or catheter), bacteremia
Metabolic
Kidneys: electrolyte imbalance, renal failure, uremia Liver: hepatic encephalopathy Thyroid: hyper or hypothyroid Pancreas: hypoglycemia, DKA, HHS
Structural
Bleeds: ICH, epidural hematoma, subdural hematoma, SAH Brain: Stroke, seizures, surgical lesions, hydrocephalus Cardiac: ACS, dissection, arrhythmias, shock

Assessment

History: collateral from family/friends/EMS, onset and progression, preceding events, past medical history, medications, history of trauma, baseline functional status

Physical Exam: ABCs, primary survey, vital signs including temp and glucose, neuro exam (GCS and focal neurological deficits)

Investigations

Labs: CBC, lytes, glucose, BUN, Cr, LFTs, INR/PTT, serum osmolality, VBG, troponin, urinalysis, toxicology panel, septic workup as needed

Tests: ECG, CXR, CT head

Management

General
Monitors, oxygen, vitals, IV access Airway management for declining GCS and inability to protect airway
Treatment
Treat underlying cause, universal antidotes (**D**extrose, **O**xygen, **N**aloxone, **T**hiamine), broad-spectrum antibiotics, warm/cool, BP control
Disposition
Consider admission for working up underlying cause

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 16.

Headache

Common Types

Migraine: **POUND** (**P**ulsatile, **O**nset 4-72hrs, **U**nilateral, **N**/V, **D**isabling intensity), photophobia/phonophobia, chronic, recurrent, +/- aura
Cluster: unilateral sudden sharp retro-orbital pain, <3 hours usually at night, pseudo-Horner's symptoms, precipitated by alcohol/smoking
Tension: tight band-like pain, tense neck/scalp muscles, precipitated by stress or lack of sleep

Differential Diagnosis

Intra-cranial	Extra-cranial
Bleed: epidural, subdural, subarachnoid, intracerebral hemorrhage **Infection**: meningitis, encephalitis, brain abscess **Increased ICP**: mass, cerebral venous sinus thrombosis	Acute angle closure glaucoma Temporal arteritis Carotid artery dissection CO Poisoning Pregnancy-related headaches

Assessment

History: red flags (sudden onset, thunderclap, exertional onset, meningismus, fever, neurological deficit, AMS), symptoms of increased ICP (persistent vomiting, headache worse lying down and in AM)
Physical Exam: vitals, detailed neuro exam (cranial nerves, gait, coordination, motor/sensory, reflexes), neck for meningeal irritation, eye exam (slit lamp, IOP), temporal artery tenderness

Investigations

Neuroimaging to rule out deadly causes. Most benign headaches do NOT need further investigation. Refer to Ottawa SAH Rule.
LP: if CT head negative (>6h from onset) but strong suspicion of SAH
ESR/CRP: if suspect temporal arteritis

Management

Common Benign Headache Regimen
Fluids: No clear evidence but consider in dehydrated patient **Antidopaminergic**: Metoclopramide 10mg IV **Antihistamine:** Diphenhydramine 25mg IV **Analgesic:** Acetaminophen 1g PO **NSAIDs:** Ketorolac 10-30mg IV or Ibuprofen 600mg PO **Steroids**: Dexamethasone 10mg PO/IV (rebound migraine prophylaxis)
Non-Traditional Uses
Cluster Headaches: oxygen, Sumatriptan, Verapamil **Refractory Headaches:** Magnesium, Lidocaine, Propofol, Ketamine, Valproate **Nerve Blocks**: greater occipital nerve, sphenopalatine block, trigger points

EMOttawa Blog Posts: Migraine, Subarachnoid Hemorrhage, Podcast

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 20. Headache 2016; 56: 911-940.

Head Trauma

Common Injuries

Epidural Hematoma (EDH): Often temporal bone fracture resulting in middle meningeal artery injury; primarily a disease of the young; rare in elderly or children <2 due to tight attachment of dura to skull; temporary improvement in condition with subsequent worsening is highly suggestive

Subdural Hematoma (SDH): most common; disruption of bridging veins; most commonly during acceleration-deceleration injuries; common in pts with brain atrophy (elderly, alcohol) as bridging veins transverse greater distances; slow venous bleeding delays symptoms; 20% present with bilateral SDH

Mild Traumatic Brain Injury (aka Concussion): most often due to direct contact, but also acceleration-deceleration injuries; defined as GCS13-15.

Assessment

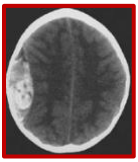
History: LOC, retrograde or anterograde amnesia, alteration in mental state at time of accident (feeling dazed, disoriented or confused), headache, photophobia, dizziness, N/V.

Physical Exam: vitals (assess for Cushing Triad of increased ICP: ↑ BP, ↓ HR, irregular breathing), c-spine for midline boney tenderness, neuro exam for focal neurological deficits

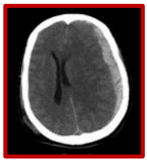
Investigations

Refer to Canadian CT Head Rule in patients with minor head injury to assess appropriate application of the rule.

EDH



SDH



Depending on size, may show midline shift (i.e. uncal herniation, ventricle shift)

EDH
Bi-convex, lentiform Blood pools superior (epi) to dura, unable to cross suture lines
SDH
Crescent shaped Blood pools between dura and arachnoid and is not limited by suture lines, only by dural reflections (i.e. falx cerebri, tentorium, falx cerebelli)

Management

Concussion
Outpatient management for uncomplicated cases: GCS 15, normal exam and CT head 24 hr period of cognitive rest with gradual return to work/play pending resolution of symptoms
Epidural and Subdural Hematomas
Consult neurosurgery for management (i.e. burr hole, craniotomy, decompressive craniectomy) Reduce ICP: raise head of bead to 30°; IV Mannitol 1g/kg over 20 mins or HTS 1.25-5mL/kg over 5 mins; hyperventilation; diuretics Reverse anticoagulation (i.e. give prothrombin complex concentrate if on Warfarin or Xa inhibitors; Praxbind for Dabigatran)

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter 34.

Seizures

Definitions

Seizure: Excessive abnormal neuronal activity associated with alternations in sensory, motor, autonomic and/or cognitive function

Status Epilepticus: unremitting seizure activity >5 mins in duration or recurrent seizure activity without intervening return to baseline

Refractory Status Epilepticus: no termination after 1st-or 2nd-line agents

Psychogenic Non-Epileptic Seizures: functional convulsions not associated with abnormal neuronal activity (usually variable convulsions, pelvic thrusting, forced eye-closure, responding or maintaining normal LOC, no post-ictal phase)

Common Causes:

Metabolic Disturbances	Infections
Hepatic encephalopathy Hypoglycemia or hyperglycemia Hyponatremia Uremia	CNS abscess Encephalitis Meningitis
CNS Lesions	**Intoxication*/Withdrawal**
Brain metastases Anoxia/hypoxia Stroke Arteriovenous malformations CVST Epilepsy Bleeds: SAH, SDH, EDH, ICH	Bupropion* TCAs* Lithium* Alcohol/benzos Anti-epileptic drugs

Assessment

History: triggers, aura, memory before and after incident, appearance of convulsions, post-ictal phase, urinary incontinence, tongue biting, infectious symptoms, sensorimotor symptoms, med non-compliance, recent trauma, pregnancy, EtOH, immunocompromised, H/A, other injuries

Physical Exam: vitals (esp pupils), neuro exam (GCS, nystagmus, tone, reflexes)

Investigations

Blood work: CBC, lytes, BUN, Cr, ß-HCG; if post-ictal confusion, status or first-time seizure add: LFTs, lactate, VBG, drugs of abuse screen, EtOH level, extended lytes, anti-epileptic drug levels (if applicable)

Tests: ECG, non-contrast CT head if first-time seizure, status, persistent focal deficits, change in seizure pattern, or prolonged post-ictal state

Management of Status

1st-Line	IV **Lorazepam** 0.1mg/kg (up to 4mg x2 doses) IM **Midazolam** 0.2mg/kg (up to 10mg x2 doses)
2nd-Line	IV **Keppra** 60mg/kg IV OR IV **Phenytoin or Fosphenytoin** 20mg/kg OR IV **Valproate** 40mg/kg (contraindicated in pregnancy)
Refractory Status	RSI intubation, call ICU IV **Propofol** 2-5mg/kg (infusion 3-5mg/kg/hr) IV **Midazolam** 0.2mg/kg (infusion 0.05-2mg/kg/hr)

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th ed, 2017; Chapter 92.

Shortness of Breath

Definitions

Tachypnea: RR >18 in adults
Hyperpnea: high minute ventilation to meet metabolic demands
Orthopnea: dyspnea lying flat
Paroxysmal Nocturnal Dyspnea: sudden dyspnea at night

Differential Diagnosis

Pulmonary	Cardiac
Airway obstruction Respiratory failure (refer to Type 1 vs Type 2 in "Breathing" section) Anaphylaxis Pulmonary embolism Tension pneumothorax	Pulmonary edema Myocardial infarction Cardiac tamponade Pericardial effusion Arrhythmias
Toxic-metabolic	**Neuro-endocrine**
Toxin ingestion (ASA, organophosphates, CO poisoning) Sepsis Acidosis (DKA, lactic, etc.)	Thyrotoxicosis Guillain-Barre syndrome Amyotrophic lateral sclerosis Multiple sclerosis

Assessment

History: OPQRST, recent travel, trauma, PE risk factors (Wells Criteria, PERC rule), sick contacts
Physical Exam: appearance, signs of respiratory distress, cardiac/resp exam

Investigations

Blood work: CBC, lytes, BUN/Cr, VBG, cardiac enzymes +/- D-dimer
Tests: ECG, POCUS, CXR (portable if unstable)

Management

General
Monitors, oxygen, vitals, IV access, ABCs
Intubate
If not protecting airway or significant respiratory distress
Empiric Treatment
Trauma: ATLS guidelines, decompress tension pneumo **Anaphylaxis:** Epinephrine, fluids, +/- antihistamines, +/- steroids **Cardiac Causes:** see various cardiac sections below **Asthma/COPD:** oxygen, bronchodilators, corticosteroids +/- antibiotics **PE:** DOACs as outpatient, LMWH, tPA for massive PE **Infection:** antibiotics, steroids of obstructive lung disease

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 25.

Chest Pain

Differential Diagnosis

Deadly Six (PET MAC)	Cardiac
Pulmonary embolism **E**sophageal rupture/mediastinitis **T**ension pneumothorax **M**yocardial infarction **A**ortic dissection **C**ardiac tamponade	Pericarditis Myocarditis Endocarditis
Respiratory	**Gastrointestinal**
Pneumonia Pleural effusion Acute chest syndrome (sickle cell) Lung or mediastinal mass	**Esophagus** – Mallory-Weiss tear, esophageal spasm **Stomach** – GERD, dyspepsia/PUD **Pancreas** - pancreatitis **Gallbladder** - biliary colic, cholecystitis, cholangitis
Muscoloskeletal	**Other**
Intramuscular pain Rib pathology	Panic attack Herpes Zoster

Assessment

History: character of pain, cardiac risk factors (see HEART score), PE risk factors (see PERC rule), recent trauma, neuro symptoms
Physical Exam: appearance, cardiac exam, resp exam, neuro screen, vitals + pulse deficits

Investigations

Tests: ECG, CXR +/- CTPA
Labs: CBC, lytes, abdo panel, CK/TnI +/- D-dimer

Management

General	ABCs, monitors, oxygen, vitals, IV access, equipment
ACS	ASA, Nitro (avoid in RV infarct), Clopidogrel/Ticagrelor, UFH, STEMI protocol (PCI vs. thrombolytics)
PE	Anticoagulation +/- thrombolysis for massive PE
Esophageal rupture	Urgent thoracics consult, IV antibiotics, NPO, endoscopy and further imaging
Tension pneumothorax	Needle decompression then chest tube (4th or 5th ICS anterior axillary line)
Tamponade	Pericardiocentesis
Dissection	Urgent vascular consult, reduce BP and HR with IV labetalol, surgery vs. medical management
Disposition	Diagnosis and risk stratification dependent

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 26.

Chest Pain Risk Stratification

HEART Score

Inclusion Criteria	Exclusion Criteria
Patients ≥21 years old presenting with symptoms suggestive of ACS	New STEMI >1mm or other new ECG changes, hypotension, life expectancy <1 year, non-cardiac medical/surgical/psychiatric illness

H = History

0 = slightly suspicious
+1 = moderately suspicious
+2 = highly suspicious

E = ECG

0 = normal
+1 = No ST depression but LBBB, LVH, repolarization changes
+2 = ST depression/elevation not due to LBBB, LVH, or digoxin

A = Age

0 = age <45
+1 = age 45-64
+2 = age ≥65

R = Risk Factors

Risk factors = HTN, hypercholesterolemia, DM, obesity (BMI >30), smoking (current or smoking cessation ≤3 months), positive FHx (parent/sibling with CVD <65yo), atherosclerotic disease (prior MI, PCI/CABG, CVA/TIA, or PVD)

0 = No known risk factors
+1 = 1-2 risk factors
+2 = ≥3 risk factors or history of atherosclerotic disease

T= Troponin (initial)

0 = initial troponin ≤normal limit
1 = initial troponin 1-2X normal limit
2 = initial troponin >2X normal limit

Interpretation	
Scores 0-3: 0.9 – 1.7% risk of MACE within 6 wks Score 4-6: 12-16.6% risk of MACE Score ≥7: 50-65% risk of MACE	Use the **HEART Pathway** (HEART score + delta TnI) to further lower risk of MACE (not prospectively validated but 1% risk of MACE in retrospective data)

PERC Rule

Inclusion Criteria	Exclusion Criteria
Patients where pre-test probability of PE is considered to be low risk (<15%)	Moderate to high risk for PE

Patients can be safely ruled out and do not require further workup if no criteria are positive:

Age≥50, HR≥100, SpO2<95%, hemoptysis, hormone use (OCPs, hormone replacement, estrogen), recent (≤4 weeks) surgery/trauma, prior PE/DVT or unilateral leg swelling

EMOttawa Blog Post

Key References: Neth Heart J. 2008; 16(6): 191-6. J Thromb Haemost 2008; 6(5): 772-80.

Abdominal Pain

Differential Diagnosis

RUQ	Epigastrium	LUQ
Hepatitis Biliary colic Cholecystitis/Cholangitis* Pancreatitis* Pneumonia Pleural effusion PE*	Gastritis Dyspepsia/PUD Duodenitis Pancreatitis* Cardiac – ACS*	Pancreatitis* Gastritis Pneumonia Pleural effusion PE*
Right Flank	**Umbilicus**	**Left Flank**
Colitis Perforation* Obstruction* Renal colic Pyelonephritis AAA*	Colitis Perforation* Obstruction* Aortic dissection* AAA* Early appendicitis	Colitis Perforation* Obstruction* Renal colic Pyelonephritis AAA*
RLQ	**Hypogastric**	**LLQ**
Appendicitis Ectopic pregnancy* PID, TOA Testicular torsion, epididymitis, orchitis Ovarian torsion Renal colic	UTI (Cystitis) Renal colic Obstruction	Diverticulitis* Ectopic pregnancy* PID, TOA Testicular torsion, epididymitis, orchitis Ovarian torsion Renal colic

Can't-Miss Diagnoses*	Risk Factors
Ruptured Ectopic	Hx of STI/PID, recent IUD, previous ectopic, smoking, fallopian tube surgery, tubal ligation
Ruptured AAA	Elderly, hx HTN/DM, smoking, trauma hx
Pancreatitis	Alcohol use, biliary pathology
Cholangitis	Charcot's Triad: fever, RUQ pain, jaundice
Mesenteric Ischemia	Elderly, CAD, CHF, dehydration, infection
Obstruction	Operative or malignant history, elderly
Perforated Viscus	Risk factors for diverticulitis or PUD, malignancy or instrumentation (i.e. colonoscopy)
Comp. Diverticulitis	Elderly, low-fibre diet, Western population

Assessment

History: OPQRST, associated symptoms (N/V, fever, chills, bowel movement, urinary symptoms, pelvic discharge/bleeding)
Physical Exam: abdominal exam +/- pelvic exam, cardiac/resp exam

Investigations

Labs: CBC, lytes, BUN, Cr, LFTs, lipase, lactate, ß-hCG +/- CK/TnI
Tests: ECG, CXR, POCUS
Radiology performed U/S (biliary pathology, ectopic, AAA), CT abdo/pelvis

Management

ABCs, NPO, analgesics, antibiotics, anti-emetics, consult surgery as needed

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 27.

Pelvic Pain

Differential Diagnosis

Gynecological		
Ovaries: Ruptured cyst, abscess, torsion **Fallopian tubes:** Salpingitis, tubal abscess, hydrosalpinx **Uterus:** PID, endometriosis, fibroids **Pregnancy related (1st trimester):** Ectopic pregnancy, threatened abortion, ovarian hyperstimulation **Pregnancy related (2nd-3rd trimester):** Placental abruption, round ligament pain, Braxton-Hicks contractions **Other:** Bartholin abscess		
Urinary Tract	**Urological**	**Other**
Urolithiasis Pyelonephritis Cystitis	Testicular torsion Prostatitis	Sexual or physical abuse

Assessment

History: OPQRST, associated symptoms (vaginal bleeding, discharge, dyspareunia, bowel or bladder symptoms), pregnancy and sexual history

Physical Exam: vitals, abdominal exam

Pelvic exam (assess cervical motion tenderness, adnexal tenderness)

Speculum exam (look for discharge, blood, take samples as needed)

Investigations

Labs: CBC, lytes, BUN/Cr, ß-hCG, +/- vaginal and cervical swabs

Tests: PoCUS – rule out ectopic, free fluid assessment

Formal abdo/pelvic ultrasound

Management

General
ABCs, IV access, analgesia, antiemetics, +/- admit and consult For STIs/PID: safe sex practices, partner testing
Ovarian Cyst
Uncomplicated: analgesia with follow-up Hemoperitoneum or hemodynamically unstable: surgery
Ovarian Torsion/Testicular Torsion
Surgical detorsion or removal
Pelvic Inflammatory Disease
Severe infection: admit with IV antibiotics (Cefoxitin 2g IV q6h IV + Doxycycline 100mg IV q12h x 24 hrs then switch to PO) **Mild-moderate infection:** Ceftriaxone 500mg IM x 1 + Doxycycline 100 PO BID x 14 days

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 33.

Back Pain

Deadly Differential Diagnosis

Spinal	Vascular
Cauda equina and spinal cord compression: Spinal metastasis Epidural abscess/hematoma Disc herniation Spinal fracture with subluxation Meningitis Vertebral osteomyelitis Transverse myelitis	Aortic Dissection Ruptured AAA Pulmonary Embolism Myocardial Infarction

Assessment

History: fracture history, cancer risk, infection risk, steroid use, **red flags** (**BACK PAIN**): **B**owel/Bladder dysfunction, **A**nesthesia (saddle), **C**onstitutional symptoms (night pain, weight loss, fever/chills), **C**hronic disease, **P**aresthesias, **A**ge >50, IVDU/infection, **N**eurological deficits

Physical: vitals + pulse deficits, inspect skin for infection/trauma, abdo exam for AAA, cardiac exam (aortic murmur), MSK lower back exam, neuro exam (lower extremity, reflexes, rectal tone), post void residual

Investigations

Bloodwork: usually not indicated unless suspected infection (CBC, ESR, CRP)

Bedside U/S: rule out AAA, look for bladder distention post-void

PVR: cauda equina syndrome (PVR >200cc has 90% sensitivity for CES)

Management

Cauda Equina Syndrome
Urgent MRI, spine consult, analgesia, IV Dexamethasone
Aortic Dissection
Immediate specialist consultation, IV Labetalol to control HR and BP
Ruptured AAA
Blood resuscitation, immediate OR if unstable
Epidural Abscess or Vertebral Osteomyelitis
MRI to definitively diagnose +/- bone scan (osteomyelitis), broad spectrum antibiotics, orthopedics consult
MSK Back Pain
Analgesia: Acetaminophen, NSAIDs Multidisciplinary approach with GP follow-up

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 35.

Vaginal Bleeding

Differential Diagnosis

Non-Pregnant (PALM COEIN)	Pregnant <20w
Polyps **A**denomyosis **L**eiomyoma (fibroids) **M**alignancy **C**oagulopathy **O**vulatory dysfunction **E**ndometrial **I**atrogenic (i.e. drugs, surgery) **N**ot classified	**Cannot Miss**: ectopic pregnancy Other: spontaneous abortion, molar pregnancy, subchorionic hematoma, implantation bleeding
	Pregnant >20w
	Cannot miss: uterine rupture, placenta previa, placental abruption, vasa previa, Other: 'bloody show', cervical lesion, post-partum hemorrhage

Assessment

History: LMP, pregnancy complications, GTPAL, time and duration of bleeding, clots, signs/symptoms of blood loss (ie. anemia sx: fatigue, dyspnea, syncope, soaking; #pads/hr), trauma, past menstrual, reproductive & sexual hx
Physical Exam: Vitals (BP, HR), abdominal exam (localize pain, peritoneal S&S, size of uterus), speculum & bimanual exam (must r/o placenta previa first in 2nd/3rd trimester; cervical os, products of conception, lacerations/trauma, cervical motion and adnexal tenderness), fetal HR monitoring (if >20 wks)

Diagnosis

Labs: Most important: determine if pregnant (qualitative as screening, if positive pursue quantitative b-hCG). CBC, type & screen, INR, PTT, Rh status, U/A
Transabdominal Ultrasound (TAUS): always first step to attempt to confirm intrauterine pregnancy (IUP), if unable, then considered no definitive IUP (NDIUP)
Transvaginal Ultrasound (TVUS): if NDIUP on TAUS, used to confirm IUP
Discriminatory Zone: if b-hCG > 1,500 or b-hCG > 6,000, IUP should be visible on TVUS & TAUS, respectively. If not, suspect ectopic pregnancy.

Management

General

If unstable: resuscitate with blood (O- until crossmatched) and crystalloid

Non-Pregnant

Most can be discharged home with close Gyne follow-up
If unstable: high dose IV conjugated estrogen q4-6h for 24h + Gyne consult + consider TXA
If stable: NSAIDs, short course of TXA during bleeding episodes, OCPs

Pregnant

Rho-GAM in all Rh (-) pts
Spontaneous Abortion:

- **If os is open:** attempt to remove products of conception to relive pain, if unsuccessful consult OB
- **If os is closed, patient febrile, uterus is tender:** suspect **Septic Abortion** - empiric IV Gentamycin & Clindamycin and consult OB
- **If os is closed and uterus is non-tender**: **Threatened Abortion** - expectant management, d/c home with close OB/GP F/U vs. **Missed Abortion** - Misoprostol 800 mcg vaginally or PO or surgical (D+C)
- Emotional Support: recognize trauma/grief accompanying miscarriage

Ectopic Pregnancy (consult OB):

- Expectant if stable and reliable – F/U in 2 days with repeat b-hCG
- Medical: Methotrexate 50 mg/m^2 IM if meets indications – F/U with OB
- Surgical (Dilation and curettage, evacuation, oophorectomy, etc.)

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 31.
EM:RAP C3, 2016; Non-pregnant Vaginal Bleed & Pregnant First Trimester Vaginal Bleeding

Red Eye

Causes of Red Eye

Traumatic	Foreign body Corneal abrasion/ulcer Subconjunctival hemorrhage Caustic contamination Blunt or penetrating trauma	Retrobulbar hematoma Hyphema Orbital compartment syndrome Globe rupture
Non-Traumatic	Acute angle closure glaucoma Retinal ischemia Temporal arteritis Conjunctivitis Keratitis	Episcleritis Scleritis Uveitis Endophthalmitis Cellulitis (orbital or periorbital)

Assessment

History: Check for red flags such as severe pain, persistently blurred vision, proptosis, reduced pupillary light reflex, corneal epithelial defect, ciliary flush, pupils unreactive to light, soft contacts, neonate, immunocompromise

VVEEPPS plus Fundoscopic Exam	
Visual acuity (with correction)	**P**upillary evaluation
Visual fields	**P**ressure determination (IOP)
External exam	**S**lit lamp exam (consider fluorescein)
Extraocular muscle movement	Fundoscopic exam

Investigations

Labs: CBC, ESR/CRP in monocular vision loss (r/o temporal arteritis)
Imaging: CT and US as needed to rule out foreign bodies, orbital cellulitis, fracture, globe pathology. Most red eyes do NOT need further investigation.

Management

Critical Diagnosis – Immediate Intervention

Caustic Contamination: Irrigation with Morgan Lens until tear-film pH = 7.4, outpatient Ophtho
Orbital Compartment Syndrome: Lateral canthotomy and cantholysis, Ophtho
Acute Angle Closure Glaucoma (Goal: IOP <35 or 25% reduction): Timolol 0.5% 1gtt, Apraclonidine 1% 1gtt, Pilocarpine 1% 1gtt q15 mins, Prednisolone 1% 1gtt, Acetazolamide 500mg IV, Mannitol 1g/kg IV, Ophtho

Emergent Diagnosis – Ophthalmology Consult

Penetrating Trauma or Corneal Ulcer or Open Globe: Protect eye, analgesia, IV abx, tetanus prophylaxis. Avoid contact lenses
Keratitis: Topical anesthetic, remove foreign material, discuss abx/antivirals
Episcleritis: Artificial tears and ketorolac drops
Scleritis: NSAIDs, discuss steroids
Anterior Uveitis: 2 drops cyclopentolate 1%, discuss steroids
Endophthalmitis: Admit for IV vancomycin and ceftazidime
Orbital Cellulitis: IV abx with 2nd generation cephalosporin

Urgent Diagnosis – Manage in ED Before Discharge

Foreign Body: Topical anesthetic, removal under slit lamp with swab or 27-gauge needle. Outpatient Ophtho for rust ring removal for metallic objects
Corneal Abrasion: topical anesthetic
Periorbital Cellulitis: Amox/Clav 875 mg PO BID x 10 days

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 19.

Monoarthritis & Polyarthritis

Differential Diagnosis:

Infectious	
Septic Arthritis RFs: young or elderly, low SES, IVDU, alcohol use disorder, DM, skin infections, chronic arthritis, recent intraarticular injections, prosthetic joint, immunocompromised **Gonococcal Septic Arthritis** RFs: young, sexually active, STI hx (poly, asymm) **Lyme Arthritis** (poly, asymm)	
Peri-Articular	**Crystal**
Bursitis, tendinitis, muscle strain	Gout, pseudogout (CPPD)
Musculoskeletal	**Other**
Fractures, injury, osteoarthritis	Hemarthrosis: spontaneous or traumatic, malignancy

Involves multiple joints: RA, OA (knees, hips, spine), SLE, scleroderma, seronegative arthritis, polymyalgia rheumatica, viral arthritides (Gonococcal and Lyme arthritis)

Assessment

History: PMHx, characterize pain, duration of symptoms, associated sx, hx of trauma, septic arthritis RFs

Physical Exam: Systemic: S&S of rheumatic disease; joints: warmth, redness, pain, effusion, deformity, ROM, pain with ROM

Gout	1st MTP, hx of kidney stones
OA	DIPs > PIPs, MCPs, worse with activity and better with rest
Inflammatory (i.e. RA)	MCPs and PIPs > DIPs, pain/stiffness that improves with activity, low grade fever, PMHx or FHx
Septic	Classic triad: fever (only 50% cases), joint pain, effusion

Investigations

Labs: Unable to rule out or diagnose specific etiologies, ↑CRP + ESR or ↑WBC may suggest inflammatory or septic arthritis, ↑serum urate suggests gout

XR: 4 signs of OA: joint space narrowing, subchondral sclerosis, subchondral cysts, osteophytes

Arthrocentesis: Can be diagnostic or therapeutic. Send for cell count & diff, culture, crystal analysis. Avoid if # suspected. Consult ortho if prosthetic joint.

Management

Gout	Do NOT start Allopurinol in acute flares **NSAIDs:** Naproxen 500 mg BID, Ibuprofen 800 mg TID, Indomethacin 50mg TID **Colchicine:** 1.2 mg PO loading dose, then 0.6 mg PO one hour later, then 0.6 mg PO daily until two days after resolution of gout flare. Can use in combo with NSAIDs or standalone **Steroids** (2nd Line): Prednisone 20 mg BID with a tapering dose x 7-10d (rebound gout flare is common with steroid treatment)
OA	**Non-Pharmacological:** weight loss, exercise **Pharmacological:** Tylenol 1 g PO TID, Celecoxib 100mg PO BID **Topical:** NSAIDs, Diclofenac, Capsaicin **Intra-Articular:** steroid or hyaluronic acid (equivocal evidence) **Ortho Referral:** for consideration of joint replacement if failing conservative management
Septic	Requires admission. Empiric IV abx (Ceftriaxone & Vanco) later narrowed based on gram stain and cultures. Often requires arthroscopic joint irrigation or often I&D required for shoulders/hips

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 106. Tintinalli's Emergency Medicine – 9th ed, 2020. Chapter 284.

Selected Emergencies

Anaphylaxis

Definition: life-threatening immune hypersensitivity systemic reaction leading to histamine release, vascular permeability, and vasodilation
Common Triggers: foods (egg, nuts, milk, fruits), meds (antibiotics, NSAIDs), insect bites, local anesthetics, occupational allergens, aeroallergens
Differential Diagnosis: shock (of any etiology), angioedema, flush syndrome, asthma exacerbation, red man syndrome (vancomycin)

Diagnostic Criteria:

Acute onset (minutes to hours) + ANY of the following three:
Involvement of skin +/- mucosa WITH EITHER respiratory difficulty or low blood pressure
Exposure to likely allergen with 2 of 4 signs: **Skin-mucosal involvement** (urticarial, angioedema, flushing, pruritis) **Respiratory difficulties** (dyspnea, wheezing, stridor, hypoxemia, rhinitis) **Low BP** (hypotonia, syncope, pre-syncope, headache, collapse) **GI symptoms** (abdo pain, cramps, N/V)
Low blood pressure after exposure to known allergen

Assessment

General: TREAT FIRST, ABCs, monitors, oxygen, vitals, IV access
appearance, respiratory distress, visualize swelling (lips, tongue, mucous membrane)
History: exposure to any known or likely allergen, co-morbidities, recent medication use, family history, atopy

Management

General Management
If need to protect airway: Ketamine as induction agent **Epinephrine:** 0.3-0.5mg IM (1:1000 conc.) to anterolateral thigh q5-10 mins **Antihistamines:** Benadryl 50mg IV/PO (controversial) **Steroids:** Methylprednisolone 125mg IV/Prednisone 50mg PO (controversial)
Refractory Hypotension
Epinephrine drip 1-10µg/min IV (titrate to desired effect) Consider Norepinephrine 0.05-0.5µg/kg/min
Patients with β-Blockers
If Epinephrine unsuccessful, Glucagon 1-5mg IV over 5-10 mins followed by 5-15µg/min infusion
Disposition
May discharge as early as 2 hours if stable. Education to avoid allergen, consider allergy testing, Epi-pen prescription **Meds at discharge:** may consider 2nd generation antihistamines, steroids not necessary

EMOttawa Blog Posts: Anaphylaxis, Podcast Part 1, Podcast Part 2

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 109. The World Allergy Organization Journal 2011; 4(2): 13-37.

Asthma

Definition: chronic inflammatory airway disease with recurrent reversible episodes of bronchospasm and variable airflow obstruction
Exacerbation Triggers: URTIs, environmental allergens, smoking, exercise

Classification (CAEP/CTS Asthma Severity):

Respiratory Arrest/Fatal
Appearance: altered mental status, cyanotic, decreased resp. effort Vitals: low HR, high RR, low O_2 sat <90% despite oxygen Exam: Silent chest – consider preparing for advanced airway intervention
Severe
Appearance: agitated, diaphoretic, labored respirations, difficulty speaking Vitals: high HR, high BP, O_2 sat 90-95% Exam: worsening resp. distress, exp/insp. wheezing, FEV1 <40% predicted
Moderate
Appearance: SOB at rest, cough, congestion, nocturnal symptoms Vitals: O_2 sat >95% Exam: exp. wheezing, FEV1 40-60% predicted
Mild
Appearance: SOBOE, chest tightness Vitals: O_2 sat >95% Exam: exp. wheezing, FEV1 >60% predicted

Assessment

History: triggers, recent infection, thorough asthma hx including prior exacerbations, hospitalizations + interventions/ICU stays, family history
Asthma Control Criteria: daytime symptoms <4/week, no exercise limitation, no absenteeism, no nocturnal symptoms, rescue puffer <4/week, normal PFT, exacerbations mild/infrequent
Physical Exam: vitals, sign of distress, accessory muscle use, respiratory exam

Investigations: CXR, ECG +/- VBG, +/- PEFR (to estimate FEV1), bloodwork (CBC – infection, lytes – potassium)

Management

Treat Exacerbation ("0.5 - 5 - 50")
Ipratropium bromide 0.5mg neb OR 4-8 puffs via MDI + spacer q20mins x 3 Salbutamol 5mg neb OR 4-8 puffs via MDI + spacer q20mins x 3 Prednisone 50mg PO **NOTE:** MDIs are superior to nebs unless patient too tachypneic to use MDI
Severe Asthma
$MgSO_4$ 2g IV over 30 mins Epinephrine 0.3mg IM then 5µg/min IV infusion Ketamine 1mg/kg (in conjunction with BiPAP)
Respiratory Failure
Consider NIPPV first (BiPAP) Intubate (LAST RESORT): Ketamine 1mg/kg IV + Succinylcholine 1.5mg/kg IV Involve ICU early

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 73. CMAJ 1996; 155(1): 25-37.

Chronic Obstructive Pulmonary Disease

Classifying Severity: based on GOLD Classification

GOLD 1	Mild	$FEV_1 \geq 80\%$ predicted
GOLD 2	Moderate	$50\% \leq FEV_1 < 80\%$ predicted
GOLD 3	Severe	$30\% \leq FEV_1 < 50\%$ predicted
GOLD 4	Very Severe	$FEV_1 < 30\%$ predicted

Risk Factors: smoking (#1), occupational dust, chemical exposure
AECOPD Triggers: viral URTI, pneumonia, environmental allergens or pollutants, smoking, CHF, PE, MI ≥ 80% predicted

Assessment

Cardinal Symptoms: ↑ SOB, ↑ sputum production, ↑ sputum purulence.
Key Elements on History: duration of symptoms, severity of airflow limitation, number of previous episodes (total/hospitalizations), co-morbidities, premorbid functional status, present treatment regimen, previous use of mechanical ventilation, use of home oxygen.
Clinical Signs of Severity: rapid shallow pursed-lip breathing, use of accessory muscles, paradoxical chest wall movements, worsening or new onset central cyanosis, peripheral edema, hemodynamic instability, decreased LOC or confusion, decreased O_2 sat.
Consider PE if deteriorating & not improving with standard COPD therapy.

Investigations

Labs: CBC, electrolytes, VBG, lactate, serologies (triplex, COVID, etc)
Tests: CXR, ECG, pulse oximetry

Management

Follow **GOLD Guidelines** for best practices

Oxygen
Venturi masks (high-flow devices) preferred over nasal prongs **Target SaO_2:** >88% Goal PaO2 = 60-65mmHg
Bronchodilators
SABA: Salbutamol 2.5-5mg via nebulizer or 4-8 puffs via MDI with spacer q15mins x3 PRN **Anticholinergic:** Ipratropium bromide 500µg via nebulizer or 4-8 puffs q15mins x3 PRN
Systemic Corticosteroids
Oral is equivalent to IV in most exacerbations Oral Prednisone 40-60mg for 5-10 days IV Methylprednisolone 125 mg BID-QID (for severe exacerbations or not responding to oral steroids)
Antibiotics
Indication: ≥2 of: 1) ↑ sputum production 2) ↑ sputum purulence 3) ↑ SOB Simple exacerbation: Amoxicillin, 2nd/3rd gen Cephalosporin, Macrolide, Doxycycline or TMP/SMX Complicated exacerbation: Fluoroquinolone or Amoxicillin/Clavulanate
Ventilation
NIPPV such as CPAP or BiPAP (in respiratory acidosis, severe dyspnea/distress)
Intubation
For life-threatening exacerbations, failed NIPPV, altered LOC, severe hypoxemia, cardiovascular instability, respiratory or cardiac arrest

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 74. Am J Respir Crit Care Med 2013; 187(4):347-365.

Myocardial Infarction

Definition: evidence of myocardial ischemia on the spectrum of ACS (unstable angina, NSTEMI and STEMI). Diagnosed by cardiac marker abnormalities and one of: ECG changes or HPI consistent with ACS.

Differential Diagnosis

Stable Angina
Transient episodic chest discomfort secondary to myocardial ischemia Precipitated by exertion or emotion, lasts <15 mins, relieved by rest or nitro
Unstable Angina
Angina with minimal exertion or at rest, new-onset angina, angina post MI/PCI/CABG, worsening change from baseline angina, increased duration of pain or threshold, or decreased response of previously effective angina meds
NSTEMI
Infarction without ST elevation
STEMI
Infarction with ST elevation: ≥1mm STE in 2 contiguous leads For V1-V3 leads: >1.5mm for females; >2.5mm for males under 40; >2mm for males over 40 Posterior MI: new STE ≥0.5mm in V7-V9

Assessment

History: character of pain, associated symptoms (diaphoresis, radiating pain, vomiting, and exertional pain have highest likelihood ratios for acute MI)
Classic Risk Factors: male, smoking, diabetes, HTN, FHx, dyslipidemia
Atypical Features in: women, elderly, diabetics, non-Caucasians, dementia
Complications of AMI: arrhythmias, cardiogenic shock, papillary muscle rupture, pericarditis, stroke
Physical Exam: vitals, cardiac exam, resp exam, pulses, signs of complications

Investigations: ECG (ST-T changes, new BBB, pathological Q waves), CXR
Labs: CBC, lytes, cardiac enzymes

Management

General
ABCs, monitors, oxygen, vitals, IV access **Pain control:** NTG (avoid for RV infarcts) or Morphine if resistant to NTG
ACEi, β-blockers, Statins
Atorvastatin 80mg PO in STEMI. Do NOT delay transfer to cath lab for statin No role for initiating ACEi or β-blocker in the ED ACEi, β-blocker + statins likely to be initiated during hospital admission (<24-48 hrs from time of presentation)
Antiplatelet Therapy
ASA 325mg chewed Clopidogrel 300mg PO OR Ticagrelor 180mg PO (if going for primary PCI)
Antithrombotic Therapy
Primary PCI: UFH 4000 Units (max) then 12 U/kg/hr **Fibrinolytics:** Enoxaparin or Fondaparinux IV bolus then SC dose daily
Goals
Primary PCI: within 90 mins of hospital arrival **Lytics:** <12 hours of symptoms or cannot get to PCI centre within 120 mins, given within 30 mins of hospital arrival

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 78. Circulation 2013; 127:00-00.

Congestive Heart Failure

Etiology: CAD, HTN, valve abnormalities, cardiomyopathy, infarction, pericardial disease, myocarditis, cardiac tamponade, metabolic disorders (i.e. hypothyroidism), toxins, congenital

Precipitants of CHF Exacerbation

Cardiac	Medications
Ischemia, dysrhythmias, mechanical complications (i.e. papillary muscle rupture)	Forgot meds, negative inotropes (CCB, ß-blocker), NSAIDs, steroids
High Cardiac Output	**Other**
Anemia, infection, pregnancy, hyperthyroidism	Lifestyle (high salt intake), renal failure, PE, HTN

Assessment

Symptoms	Signs
Left-sided: SOB, PND, fatigue, orthopnea, angina, syncope, altered mental status, cough + wheeze (pulmonary congestion) **Right-sided:** fatigue, abdominal distension, leg swelling, weight gain, nocturia	**General:** tachypnea, tachycardia, hypertension, hypotension, weak pulses **Left-sided:** hypoxia, crackles, wheezes, S3 or S4 **Right-sided:** pitting edema, JVP elevation, hepatomegaly, ascites

Investigations

Labs: CBC, electrolytes, AST, ALT, BUN, Cr, Troponin, BNP (or NT-proBNP)

Tests: CXR, ECG, PoCUS (systolic function, pulmonary edema)

Management

General
ABCs, monitors, 100% O_2 non-rebreather facemask, vitals, IV access, position upright, +/- Foley catheter, treat precipitating factor Morphine 1-2mg IV prn
First-line
Nitroglycerin 0.4mg sl q5min (if sBP>100) +/- topical nitroglycerin patch (0.2-0.8mg/h) Furosemide: double home dose, 20mg IV if furosemide naive
Second-line
Double furosemide dose **Think Sympathetic Crashing Acute Pulmonary Edema (SCAPE):** Nitroglycerin infusion if hypertensive (start 100µg/min & titrate) **Think Cardiogenic Shock** if hypotensive (sBP<90): Norepinephrine 2-12µg/min or Dobutamine 2.5µg/kg/min

Key References: Canadian Journal Cardiology 2007; 23(1): 21-45. Circulation 2009; 119: 1977-2016. Journal of Cardiac Failure 2010; 16(6): e134-156

Cardiac Dysrhythmias

Causes:

Enhanced Automaticity: MI, drugs, toxins, lyte imbalances
Triggered Activity: Torsades de Pointes, post-MI reperfusion
Re-entry: VT and SVT

Main Classifications

Bradydysrhythmias and AV Conduction Clocks
1º = prolonged PR interval **2º (Mobitz I) =** gradual PR interval prolongation then QRS drop **2º (Mobitz II) =** PR interval constant with QRS drop **3º =** P wave and QRS complex unrelated, PP and RR intervals constant
Supraventricular Tachydysrhythmias (Narrow QRS)
Regular rhythm: Atrial: sinus tachycardia, atrial tachycardia, atrial flutter AV: SVT (AVNRT > AVRT), junctional tachycardia **Irregular rhythm:** Atrial: atrial fibrillation, multifocal atrial tachycardia, SVT w/ aberrancy
Ventricular Tachydysrhythmias (Wide QRS)
Regular rhythm: Ventricular tachycardia, SVT w/ aberrancy **Irregular rhythm:** Ventricular fibrillation, polymorphic VT, Afib with WPW

Assessment

Unstable Patient: altered mental status, respiratory distress, hypotension, syncope, chest pain with acute MI, signs of CHF, shock
Stable Patient: light-headedness, SOBOE, palpitations, mild anxiety

Management

General: monitors, oxygen, continuous monitoring, IV access
Initial Approach: ABCs, treat symptomatic & unstable patients immediately
*See detailed **ACLS Algorithms**

Bradycardia Algorithm
Atropine 0.5mg IV bolus q3-5mins x 6 +/- infusions: Dopamine 2-10µg/kg/min OR Epi 2-10µg/min If ineffective: transcutaneous pacing, prepare for IV pacing Type II 2º AV block OR 3º AV block: transcutaneous pacing
Tachycardia Algorithm
Synchronized cardioversion (with premedication)
Atrial Fibrillation/Atrial Flutter
Synchronized cardioversion (higher risk of stroke if rhythm >48 hrs and patient not anticoagulated)
VF/pVT
Shock-CPR-pulse rhythm check cycles, Epinephrine 1mg IV q3-5mins, consider Amiodarone 300mg IV bolus with 2nd dose 150mg IV
PEA/Asystole
CPR, airway support, IV access, Epinephrine 1mg IV q3-5mins

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 86+87. NEJM 2012; 366(23): 2198-2206. *BMJ* 2000; 320: 854-857.

Pericarditis & Myocarditis

Definitions

Pericarditis: Inflammation of the pericardial sac surrounding the heart
Myocarditis: Inflammation of the cardiac muscle

Causes

Idiopathic	Most common, often presumed viral
Infectious	Viral, bacterial including TB, fungal
Post-injury	Trauma, surgery, MI, radiation, aortic dissection
Iatrogenic	Post-vaccine, drugs
Systemic disease	Uremia, RA, SLE, scleroderma, malignancy

Assessment

History: **Pericarditis:** non-exertional, pleuritic pain, worse when supine and improves leaning forwards/sitting up, fevers, myalgias, dyspnea, diaphoresis, syncope or presyncope, recent viral illness. **Myocarditis:** presents mainly with CHF symptoms including dyspnea on exertion, bilateral leg swelling
Physical Exam: vitals (fever, BP, HR, RR), pericardial friction rub in pericarditis
Diagnosis of Pericarditis: ≥2 of: characteristic chest pain, friction rub, ECG changes, pericardial effusion on ultrasound

Investigations

Pericarditis	Myocarditis
Labs	
↑ CRP, ESR, WBC though not needed for diagnosis	Highly suggestive with elevated troponin, though negative troponin does not rule it out.
ECG	
4 Stages of Acute Pericarditis: 1) Hours to days: PR depression, diffuse ST segment elevation 2) 1-3 weeks: PR and ST normalization, T wave flattening 3) 3 weeks: T wave inversion 4) >3 weeks: Normalization of ECG	Sinus tachycardia, widened QRS, low voltages May have: prolonged QTc, AV block, or anterior MI pattern
Ultrasound	
Used to identify the presence of a pericardial effusion	Reduced LVEF, global hypokinesis, regional wall motion abnormalities, may see a pericardial effusion
CXR	
May see cardiomegaly if a pericardial effusion is present	

Management

General
Treat underlying cause
Pericarditis
Most can be managed as outpatient **NSAID:** Ibuprofen 600mg PO TID (+ PPI) until symptom free, taper over 2-4 wks **Colchicine** 0.6mg BID x 3 months (↓ risk of recurrence = NNT 5) Steroids: autoimmune, uremic diseases (consult cardiology)
Myocarditis
Admission under cardiology Supportive: treat arrhythmias and CHF symptoms Complications: ventricular dysrhythmias, LV aneurism, CHF, dilated CM

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 72.
Tintinalli's Emergency Medicine – 9th ed, 2020. Chapter 55.

Deep Vein Thrombosis

Definition: formation of a blood clot in a deep vein, most commonly in the legs or pelvis

Massive Ileofemoral DVT: **Phlegmasia Alba Dolens (PAD)** or "painful white/milky leg": venous thrombosis progresses to massive DVT, but without ischemia as collateral veins are spared. **Phlegmasia Cerulea Dolens (PCD)** or "painful blue leg"**:** occurs following PAD when ischemia ensues, worsening congestion and edema, eventually progressing to gangrene

Risk Factors: venous stasis (surgery or trauma), vessel injury (surgery or trauma), hypercoagulability (inherited thrombophilia, active malignancy, pregnancy, OCPs, prior PE/DVT)

Differential Diagnosis: chronic venous insufficiency, cellulitis, muscle strain/tear, Baker's cyst, hematoma, claudication/ischemia, intra-abdominal compression, unrecognized trauma

Assessment

Hallmarks of DVT include unilateral erythema, swelling, warmth and limb tenderness (especially with palpation of posterior calf and popliteal fossa)

Modified Wells Criteria for DVT	
+1 Active malignancy (treatment within 6 months or palliative)	
+1 Paralysis, paresis, or recent immobilization of lower limb	
+1 Bedridden >3 days or major surgery in last 12 weeks	
+1 Tenderness along deep venous system	
+1 Entire leg swollen	
+1 Calf swelling >3cm compared to asymptomatic side	
+1 Pitting edema in symptomatic leg	
+1 Superficial non-varicose veins	
+1 Previous DVT	
-2 Alternative diagnosis as or more likely than DVT	
Interpretation and Further Workup	
DVT unlikely (low risk) Score <2	Order D-Dimer: If negative (<500) = no DVT If positive (≥500) = obtain leg Doppler US
DVT likely (high risk) Score ≥2	Obtain leg Doppler US ± D-dimer* *D-dimer still useful in case of negative US, as negative US with positive dimer in this sub-group warrants repeat US to ensure below knee clot has not progressed to above knee

Investigations: CBC, BUN, Cr, electrolytes, D-dimer, INR/PTT
Leg doppler – standard 3-point compression tests

Management

DVT
Preferred Outpatient Therapy: DOACs (Apixaban 10mg BID x7 days then 5mg BID or Rivaroxaban 15mg BID x3 weeks then 20mg daily)
DVT + Cancer or Pregnancy: LMWH (Enoxaparin 1mg/kg SC)
Renal Impairment: Unfractionated Heparin 70-80 U/kg
Consult Thrombosis for outpatient management

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 88. J Thromb Haemost 2008; 6:772-80. NEJM 2003; 349(13):1227-35.

Pulmonary Embolism

Definition: results most commonly after a clot formed hours-weeks earlier in deep veins of leg dislodges and travels through venous system into right ventricle and then into pulmonary vasculature. Occasionally, a clot originates spontaneously in pulmonary vasculature

Risk Factors: see DVT risk factors above

Differential Diagnosis: ACS, costochondritis, rib fracture, spontaneous pneumothorax, pneumonia, pericarditis, COPD/asthma

Assessment

Hallmark symptoms include sudden onset of dyspnea and pleuritic chest pain

Massive PE: hypotension, cardiac arrest, bradycardia (HR <40) with shock

Submassive PE: no hypotension, evidence of RV strain (on POCUS, CT or elevated BNP, ECG changes), or myocardial necrosis (elevated troponin)

Wells Criteria for PE	Interpreting Wells Criteria	
+3 Signs + symptoms of DVT **+3** PE = #1 diagnosis **+1.5** HR >100 **+1.5** Immobilization ≥3 days OR surgery in past 4 weeks **+1.5** Hx DVT/PE **+1** Hemoptysis **+1** Active cancer (treatment within 6 months or palliative)	**Two-Tier** Low: ≤4 High: >4	**PE unlikely** Order D-Dimer: **If negative** (<500) = no PE **If positive** (≥500) = CTPA **PE likely** Obtain CTPA
PERC (PE Rule-out Criteria)	**Age-Adjusted**	
Essentially rules out PE (i.e. <2% chance of PE) if **PERC Negative** (NO high-risk features below) and low pre-test probability. **High-Risk Features:** Age≥50, HR≥100, SpO2<95%, hemoptysis, hormone use, recent (≤4 weeks) surgery/trauma, prior PE/DVT or unilateral leg swelling If PE not ruled out with PERC, apply Wells Criteria	D-dimer levels rise naturally with age, even in otherwise healthy patients. For patients >50, **Age x 10** validated as safe D-dimer cut-off. For example, for a 62-year-old patient, 620 (62 x 10) is validated as the D-dimer threshold. Therefore D-dimer <620 rules out PE.	
YEARS Algorithm		
Simplifies Wells score into 3 features most predictive of PE: 1. Clinical signs of DVT 2. Hemoptysis 3. PE as most likely diagnosis **0 YEARS** items: D-dimer threshold **<1,000** excludes PE **≥1 YEARS** item: D-dimer **<500** required to exclude PE		

Management

PE
See DVT management above; tPA reserved for massive PE (50mg IV over 20 minutes, followed by another 50mg IV if no improvement)

EMOttawa Blog Posts: PE in Pregnancy, D-Dimer in PE

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th ed, 2017; Chapter 78. JAMA 2014;311(11):1117-1124. Lancet 2017; 390(10091):289-297.

Gastrointestinal Bleeding

Risk Factors: medications (NSAIDs, anticoagulants), excessive vomiting, bleeding disorders, malignancy, alcohol use, ulcer history, H. pylori

Differential Diagnosis

Upper GI bleed (proximal to Ligament of Treitz)
Peptic ulcer disease (gastric > duodenal)
Gastritis/esophagitis
Esophageal varices
Mallory-Weiss tears
Gastric cancer
Lower GI bleed (distal to Ligament of Treitz)
Colitis (inflammatory, infectious, ischemic)
Anorectal pathology (hemorrhoids, fissures, proctitis)
Angiodysplasia
Diverticulosis
Malignancy

Assessment

History: blood quantity/quality, symptoms of anemia (fatigue, SOB, chest pain), Hx liver disease, medication review, smoking/EtOH, bleeding disorders, constitutional symptoms
Beware mimics: Pepto-Bismol, iron ingestion can cause dark stools
UGIB: hematemesis, coffee ground emesis, melena, BRBPR if brisk UGIB
LGIB: hematochezia, BRBPR
Physical Exam: ABCs, vitals, inspect nasal-oral cavity, abdominal exam, DRE

Investigations

Labs: CBC, lytes, INR/PTT, BUN, Cr, lactate, VBG, T+S/T+C
Tests: ECG, CXR +/- CT if indicated for LGIB

Management

General
ABCs, monitors, oxygen, vitals, 2 large bore IVs, reverse any anticoagulation, GI consult
Intubate early if suspect unprotected airway or risk of aspiration
Transfusion threshold: Hb <70, Plt <50, or hemodynamically unstable or with active bleeding
UGI Bleed
Pantoloc 80mg IV bolus then 8mg/h infusion (or intermittent BID dosing)
Octreotide 50µg IV bolus then 50µg/h infusion – for suspected variceal bleeding
Ceftriaxone 2g IV: for suspected variceal bleeds, prevention of SBP
Tranexamic acid: hemodynamically unstable patients (no clear evidence)
Balloon tamponade: crashing GI bleeding patient
LGI Bleed
NPO, IV fluids, manage underlying etiology (i.e. Abx, steroids)
Colonoscopy to evaluate cause of bleeding

EMOttawa Blog Posts: Upper GI Bleeds, Podcast

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 30.

Stroke

Common Syndromes

ACA Stroke
Contralateral motor + sensory deficits (Leg > face/arm) Bowel and bladder incontinence Impaired judgement/insight
MCA Stroke
Contralateral motor + sensory deficits (Face/arm > leg) Contralateral hemianopsia; gaze preference towards lesion Aphasia (dominant) or neglect (non-dominant)
PICA Stroke (Wallenberg Syndrome)
Pain/temperature loss on contralateral side + ipsilateral face Ipsilateral Horner's-like syndrome "Deadly Ds": dysphagia, diplopia, dysarthria, dysphonia

Assessment

History: time of onset (usually abrupt), LOC (usually normal or non-significant decrease), focal symptoms, headache (pain more suggestive of hemorrhagic stroke or dissection), functional baseline (dictates treatment)
Stroke Mimics: seizure, migraine, syncope, metabolic derangements, sepsis, tumor, functional neurological disorder (conversion disorder), seizure (i.e. Todd's paralysis)
Physical Exam: vitals (close attention to BP), neuro (NIHSS scale), cardiovascular exam (dissection, arrhythmias, valvular pathology), look for comorbidities

Investigations

Labs: CBC, lytes, extended lytes, glucose, BUN, Cr, INR, PTT
ECG: rule out Afib
Neuroimaging: acute stroke protocol (CT/CTA immediately)

Management

General
ABCs, monitors, oxygen, vitals, IV access +/- intubation (declining GCS, evolving symptoms, or presumed hemorrhagic transformation) **BP control:** lower if HTN severe (>220/120), BP <185/110 if giving tPA **Consult neurology,** admission to stroke unit
Antiplatelet Therapy
Don't give acutely, start ASA +/- Clopidogrel daily once discharged
Stroke Time Windows (consult FAST-ED app)
<4.5 hrs: tPA 0.9mg/kg (max 90mg, 10% bolus, 90% over 1 hr) **<6-24 hrs:** Endovascular Therapy (EVT) for large vessel occlusion (i.e. carotid, MCA, basilar) Discuss with stroke team
Stroke Prevention
Primary: stratify based on $CHADS_2$ (stroke risk with Afib), Ottawa TIA Risk Score, prescribe ASA vs. DOACs **Secondary:** 28 days of ASA + Clopidogrel in minor stroke (NIHSS 0-3), oral anticoagulation started 1-2 weeks post-stroke if Afib, ASA otherwise

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 101. NEJM 1995; 333:1581-1588. AMJ Neuroradiol 2001; 22:1534-1542. Int J Stroke 2020; 15(6): 689-698. NEJM 2018; 378(1):11-21. NEJM 2018; 378: 708-718.

Transient Ischemic Attack

Definitions

TIA Definition (Canadian Stroke Best Practices)
A brief episode of neurological dysfunction caused by focal brain, spinal cord or retinal ischemia without imaging evidence of acute infarction, typically resolving within one hour.
Very High-Risk TIA
All TIAs with symptom onset **within 48 hours**
High-Risk TIA
Symptom onset **between 48 hours and 2 weeks** with the following symptoms: Motor or speech disturbance
Moderate-Risk TIAs
Symptom onset **between 48 hours and 2 weeks** with the following symptoms: Sensory loss, vision loss Posterior circulation stroke: binocular diplopia, dysarthria, dysphagia, ataxia
Low-Risk TIAs
All TIAs with symptom onset **greater than 2 weeks**

Assessment

History: time of onset, differentiate between motor, speech, vision disturbances and posterior circulation symptoms
Physical Exam: vitals, neuro exam, cardiovascular exam (dissection, arrhythmias, valvular pathology), look for comorbidities

Investigations

Labs: CBC, lytes, extended lytes, glucose, BUN, Cr, INR, PTT
ECG: rule out Afib
Neuroimaging: all TIAs (non-contrast CT head in ED), moderate-risk (±CTA head & neck), high- to very high-risk (+ CTA head & neck)

Management

General
ABCs, monitors, oxygen, vitals, IV access
High-Risk TIA features
Loading dose: Clopidogrel 300mg PO + ASA 160mg PO Dual antiplatelet therapy: Clopidogrel 75mg PO + ASA 81mg PO daily x 21-28 days Monotherapy (after 21 days): ASA 81mg PO daily
Low-Risk TIA features
ASA 81mg PO daily
Disposition
Stroke clinic follow-up within 3 weeks Risk stratification: $CHADS_2$ (stroke risk with Afib), Ottawa TIA Risk Score Outpatient carotid dopplers or CT angiogram +/- endarterectomy

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 101. Canadian Stroke Best Practices, 2018. Stroke 2018; 49:2278-2279. Int J Stroke. 2019; 14(7) 756-751.

Wound Management

Definitions:

Primary Closure: closure immediately (via sutures or staples)
- Leads to faster healing and best cosmetic result
- Best for wounds within 8 hrs of presentation or face wounds within 24 hrs

Secondary Closure: wound heals naturally, without surgical closure
- Best for small partial thickness avulsions or fingertip amputations.

Delayed/Tertiary Closure: initial wound cleansing/dressing followed by packing, then primary closure after 72 hrs
- Best when patients present late (>24 hrs) or contaminated crush wounds

Closure Techniques: simple interrupted/running suture is most common method of closure in the ED. Other methods include: staples; horizontal mattress; hair apposition (all good for scalp lacs) and vertical mattress (gaping, deep wounds); tape or glue.

Assessment

Suture Types:

Absorbable	**Non-Absorbable** (more common in ED)
Braided: • Vicryl • Vicryl Rapide **Monofilament:** • Monocryl • Fast absorbing gut • Chromic gut	**Braided:** • Ethibond • Silk **Monofilament:** • Ethilon (Nylon)

Wound Preparation:

1) Debridement 2) Wound Cleansing 3) Irrigation

Suture Sizes:

3-0 sutures on **Three** places: chest, abdomen, back
4-0 sutures on **Four** extremities: arms and legs
5-0 sutures where you have **Five** fingers: hands
6-0 sutures **(S)ensitive** areas: face, genitals

Timing of Removal:

Face: 3-5 days
Scalp & arms: 7-10 days
Tunk, legs & dorsal hands/feet: 10-14 days
Palms & soles: 14-21 days

Management

Antibiotic Prophylaxis	Indicated in gross contamination, severe crush injuries, open fractures, wounds involving joints (including MCP, i.e. "fight bites") or cat bites, intra-oral lacs, immunocompromised (DM, CKD, chronic steroid use) Ideal Abx: Keflex or Clavulin (bites)
Tetanus Prophylaxis	Give DTaP booster unless last booster was within 10 yrs Given ASAP but can be given days-weeks following injury

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter 52. Emerg Med Clin N Am 2007; 25:23-39.

Diabetic Emergencies

Definitions

DKA	HHS
Predominantly Type 1 DM Insulin deficiency + stressor → counter-regulatory hormone excess → ↑ lipolysis (ketoacidosis) and osmotic diuresis (dehydration) **Serum glucose:** >16 mmol/L **Other labs:** HCO_3<15, pH <7.3 **Onset:** hours to days **Features:** dehydration, often young	Predominantly Type 2 DM Relative insulin deficiency + stressor → counter-regulatory hormone excess → osmotic diuresis (dehydration) **Serum glucose:** >30 mmol/L **Onset:** days to weeks **Features:** severe dehydration, hyper-osmolality, often elderly with AMS
Stressor (7 Is): Infection, Infarction, Intoxication, Insulin (dose changed/missed), Incision (surgery), Initial (diagnosis), Impregnated	

Assessment

History: N/V, abdominal pain, polyuria/polydipsia, weakness, anorexia
Physical Exam: rapid, deep breathing (Kussmaul) respirations, tachycardia, ileus, acetone breath

Investigations

Labs: glucose, urine/serum ketones, ß-hydroxybutyrate, CBC, lytes, extended lytes, glucose, BUN, Cr, VBG, lactate +/- cultures, ß-HCG, cardiac enzymes (if indicated)

Management

Fluid Resuscitation

NS 1-2 L over 1 hours
Change to D5½NS when BG <16

Insulin

Short acting insulin Regular
Infusion of 0.1 U/kg/h (goal = lower BG by 4-5)
Once gap closed: continue infusion x 1 hr but overlap + switch to SC insulin

Electrolyte Replacement

Potassium
- K <3.3 mmol/L: hold insulin and give 40mmol/L KCl
- K 3.3-5 mmol/L: give 20-30mmol/L KCl
- K >5 mmol/L: re-check K in 1-2 hours

Phosphate: Low phosphate can be replaced if severe levels or metabolic disturbances (muscle weakness, paralysis, rhabdomyolysis)
Sodium: Pseudohyponatremia common due to dilutional decrease

Disposition

Admission if: first time presentation, comorbidities, unable to close gap, iatrogenic complications (ARDS, cerebral edema, fluid overload), or DKA/HHS due to stressors listed above (i.e. need to manage MI or sepsis in hospital)
Education: diet, insulin administration, fluid replacement

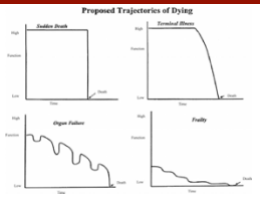
EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 118.

End-of-Life Care

Trajectories of Dying:

Sudden death (15%): i.e. cardiac arrest, trauma
Terminal illness (30%): predictable decline in 6 months or less i.e. cancer or terminal AIDs
Organ failure (30%): gradual decline with intermittent exacerbations i.e. COPD, CHF
Frailty (30%): gradual decline, lingering course over many years i.e. dementia



Palliative Performance Scale (PPS) & Eastern Cooperative Oncology Group (ECOG) Performance Status:

Stable	PPS 70-100%
Transitional	PPS 40-60%
End-of-Life	PPS <30%, bedbound
Grade	**ECOG**
0	No restrictions, able to carry on pre-disease performance
1	Restricted physically strenuous activity, able to carry out light/sedentary work
2	Ambulatory, able to carry out self-care, unable to carry out working activities, up >50% waking hours
3	Capable of only limited self-care, confined to bed/chair >50% waking hours
4	Completely disabled, cannot carry out self-care, totally confined to bed/chair
5	Death

Investigations

Consider discontinuation of cardiac monitoring, vital signs and bloodwork and minimization of IV fluids. Given presenting symptoms of the patient and their goals of care, further investigations are at times appropriate. Discontinue only meds and devices (i.e. catheters, NG tubes) not contributing to patient comfort.

Symptom Management

Agitation/ Delirium	**Haloperidol** 0.5mg-1mg SC/IV q2h PRN - if severe add **Methotrimeprazine** 12.5-25mg SC q4h PRN - if severe add **Midazolam** 0.5-1mg SC/IV q30min PRN
Pain/ Dyspnea	**Opioid Naive:** SC route preferred over IV (due to longer $t_{1/2}$) - **Morphine** 1-2mg SC/IV q30min PRN OR - **Hydromorphone** 0.2-0.4mg SC/IV q30min PRN If patient on regular oral opioid medication, convert current regime to SC dosing: **Morphine:** 10mg (PO) = 5mg (SC/IV) *equals* **Hydromorphone:** 2mg (PO) = 1mg (SC/IV) **O2 -** if hypoxic or for patient's comfort **Fan blowing** – improves patient comfort
Secretions	Re-position, reassure family that secretions not causing distress **Glycopyrrolate** 0.4mg SC/IV q4h PRN
Nausea/ Vomiting	**Metoclopramide** 5-10mg SC/IV q4h PRN (contraindicated in bowel obstruction) OR **Haloperidol** 0.5-1mg SC/IV q4h PRN

EMOttawa Blog Posts: Palliative Care Part 1, Part 2, GOC Discussion

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2017; Chapter e9. J Palliat Med 2018. 21(11):1651-1661. J Palliat Care. 1996; 12(1):5-11. CJEM 2020 22(5) 626-628.

Sepsis

Definitions

Sepsis	
Life threatening organ dysfunction caused by a dysregulated host response to infection with a qSOFA score ≥ 2	
Septic Shock	
Vasopressor requirement to maintain a MAP ≥65 Serum lactate ≥2mmol/L in the absence of hypovolemia	
Clinical tools to aid in sepsis recognition	
SIRS	2 or more of: T <36 or >38.3 | HR >90 | RR >20 or CO_2 <32 | WBC <4 or >12
qSOFA	2 or more of: GCS <15 | RR ≥22 | sBP <100

Assessment

History: associated symptoms, full review of systems, comorbidities
Physical Exam: vitals, volume status, look for a focus (respiratory, urine, abdomen, skin, blood, brain, permanent lines)

Investigations

Full Septic Workup: CBC, lytes, extended lytes, BUN, Cr, LFTs, VBG, lactate, INR/PTT, blood C+S, urine C+S, ECG, CXR
RUSH Exam: heart (PSL, 4 chamber), IVC view, Morrison's and splenorenal views, bladder window, aorta, pneumothorax

Management

General
Monitors, oxygen, vitals, 2 large bore IVs Early antibiotics (within 1 hour), crystalloids (RL > NS) Endpoints: MAP >65, capillary refill time, lactate clearance, urine output
Resuscitation
Crystalloids: Ringer's Lactate for patients with hypotension or lactate ≥4 **Vasopressors:** Norepinephrine 5-10µg/min (if not fluid responsive), Vasopressin 0.04 U/min (if moderate doses of NE being used) **Steroids:** if refractory to fluids + pressors or on chronic steroids
Antibiotics
Empiric treatment: Pip-Tazo 3.375g IV +/- Vancomycin 1-1.5g IV Respiratory: Ceftriaxone 2g IV + Azithromycin 500mg IV Urinary: Ceftriaxone 2g IV + Tobramycin 3-5mg/kg (single dose) Meningitic doses: Ceftriaxone 2g IV + Vancomycin 2g IV + Dexamethasone 10mg IV (within 1 hr of Abx) +/- Acyclovir 1g IV (for HSV encephalitis)
Disposition
Admission to medicine +/- ICU (if requiring vasopressors or intubated)

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 6. NEJM 2001; 345(19): 1368-77. JAMA 2016; 315(8): 801-10. Crit Care Med 2017; 45(3): 486-552. JAMA 2019; 321(7): 654-664. AJRCCM 2019; 199(9): 1097-1105.

Acid-Base Disorders

Etiology of Acid-Base Disorders

Respiratory Acidosis (Acute)	Airway obstruction Pulmonary disease Thoracic trauma	CNS depression Neuromuscular disorders Toxicologic (opioid OD)
Respiratory Alkalosis	Hyperventilation Panic attack Pulmonary disease Hyperthyroidism	Pregnancy Sepsis Sympathomimetics Salicylate toxicity
Elevated Anion Gap Metabolic Acidosis (CATMUDPILES)	**C**O poisoning **A**minoglycosides **T**heophylline **M**ethanol **U**remia **D**KA	**P**araldehyde **I**ron, **I**soniazid **L**actic acidosis **E**thanol, **E**thylene glycol **S**alicylate toxicity
Normal Anion Gap Metabolic Acidosis (HARDUP)	**H**yperalimentation **A**cetazolamide use **R**enal tubular acidosis	**D**iarrhea **U**retero-enteric fistula **P**ancreatic fistula
Metabolic Alkalosis	Vomiting, NG suction Diuretics Massive transfusion	Hyperaldosteronism Hypercortisolemia Hypoalbuminemia Hypercalcemia

Investigations

Labs: CBC, Cr, lytes, extended lytes, TSH, VBG, lactate, tox screen. For suspected: DKA/AKA, add add B-hydroxybutyrate; ASA overdose, add salicylate level; ingestion, add toxic alcohol screen

Imaging: Consider based on type of acid-base disturbance and suspected cause, i.e. CXR for suspected pulmonary disease

Disorder	pH	PCO_2	HCO_3^-	Expected Compensation*
Resp. Acidosis	↓	↑	↑	↑ HCO_3^- = 0.1 ΔPco_2 (acute) ↑ HCO_3^- = 0.4 ΔPco_2 (chronic)
Resp. Alkalosis	↑	↓	↓	↓ HCO_3^- = 0.2 ΔPco_2 (acute) ↓ HCO_3^- = 0.5 ΔPco_2 (chronic)
Metab. Acidosis	↓	↓	↓	↓ Pco_2 = ~1 ΔHCO_3^-
Metab. Alkalosis	↑	↑	↑	↑ Pco_2 = ~1 ΔHCO_3^-

*Inappropriate compensation indicates a second acid-base disorder

Anion Gap: Na – (Cl^- + HCO_3^-); Normal AG = 8 – 12; ↑ likely metabolic acidosis
If metabolic acidosis is present, calculate a delta gap and use Winter's formula
Winter's Formula: pCO2 = 1.5HCO3 + 8 +/-2 (for metabolic acidosis)

Management

Acute Respiratory Acidosis = PCO_2 > 40 mm Hg, pH < 7.35
Relieve airway obstruction, treat underlying cause, supplemental O_2 if hypoxic Non-invasive or mechanical ventilation as needed
Respiratory Alkalosis = PCO_2 < 38 mm Hg, pH > 7.45
Find and treat underlying cause
Metabolic Acidosis = HCO_3^- < 24 mmol/L, pH < 7.35
Find and treat underlying cause
Metabolic Alkalosis = HCO_3^- > 40 mmol/L, pH > 7.45
Rarely causes dangerous alkalemia. Find and treat underlying cause

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 116.

ENT Emergencies - Vertigo

Important Causes

Benign Paroxysmal Positional Vertigo (BPPV)
Short lived (20-30 secs) vertigo brought on by lying down, turning over or getting out of bed. Resolves when still. **No spontaneous nystagmus.**
Vestibular Neuritis
Hours or days of constant severe vertigo, worse with head movements. Difficult with gait. **Spontaneous or gaze evoked nystagmus** in first few days. Resolves over a few weeks.
Posterior Circulation Stroke
Can present similar to vestibular neuritis. May have focal paresthesia, weakness, headache or neck pain, and Deadly Ds: dysarthria, diplopia, dysmetria, dysphonia, dysphagia.
Vestibular Migraine
Often under-diagnosed. Multiple episodes of dizziness lasting minutes to days. History of migraines. Half of the episodes have either typical migraine headache, and/or associated photophobia/phonophobia.

Other less common causes: Meniere's, Multiple Sclerosis, labyrinthitis, other central causes (cerebellar hemorrhage, PICA stroke, head trauma)

Assessment

Positional Testing (Dix-Hallpike or Roll Test): if short episodes initiated with head movement and without spontaneous or gaze evoked nystagmus
HINTS Exam: if constant vertigo and nystagmus present
Central Cause: neuro exam, gait and coordination exam

Dix-Hallpike Test (diagnose posterior-canal BPPV)
Head turned 45^{o} to one side while patient sitting. Patient moved to supine position with head hanging over edge of bed. Observe for vertical upward or rotatory nystagmus. Repeat with patient looking 45^{o} in other direction.
Roll Test (diagnose horizontal-canal BPPV)
Patient initially supine, head on bed. Turn head 90 ^{o} to one side, observe for horizontal nystagmus. Both sides will show horizontal nystagmus.
HINTS Exam (differentiate vestibular neuritis vs. posterior stroke)
Must have all three to be diagnosed vestibular neuritis: **Head Impulse:** corrective saccade as examiner turns head away from direction of spontaneous nystagmus **Nystagmus:** unidirectional horizontal/rotatory nystagmus **Test of Skew:** no vertical or slanted eye movements on cover-uncover test

Management

Peripheral
Epley's Maneuver for PC BPPV, Gufoni for HC BPPV Consider steroids for vestibular neuritis (evidence poor)
Central
Neuroimaging, neuro consult +/- stroke management

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 19.

ENT Emergencies

Epistaxis

Causes: trauma (nasal, digital, facial), URI, allergies, low humidity, polyps, foreign body, idiopathic causes (familial), systemic causes (atherosclerosis, anticoagulation, pregnancy, coagulopathies, diabetes, liver disease)

Assessment: visualize nares + oropharynx for active bleeding

Labs: CBC, INR/PTT +/- cross+type

Management

General
ABCs, vitals, volume assessment **Initial step:** compress cartilaginous part of nose x 20 mins **Next step:** compress with Lidocaine/Epinephrine/decongestant-soaked pledget +/- topical TXA +/- Silver nitrate if able to identify site
Anterior Bleeds (90% Little's area/Kesselbach's plexus)
Anterior packing: nasal tampon, rhino rockets or Vaseline gauze pack Apply anterior pack to active side first, if ineffective, pack both nares
Posterior Bleeds
Epistat or Foley catheter. Apply traction once inserted. Keflex x 5 day course or until pack removal to prevent TSS

Pharyngitis

Etiology: viruses (rhinovirus, adenovirus), bacterial (Group A Strep)

Assessment

History: odynophagia, URI symptoms, complications are rare (ie. rheumatic fever)

Physical Exam: vitals, ABCs, red flags

Can't Miss Diagnoses
Peritonsillar abscess: muffled voice, uvular deviation
Retropharyngeal abscess: drooling, airway compromise
Tracheitis: may be confused with croup, stridor, labored breathing
Epiglottitis: fever, stridor, rapidly progressive swelling

Modified Centor Criteria	
Age	**Tonsillar exudates = +1**
3-14 years old = **+1**	**Tender anterior cervical lymph nodes = +1**
15-44 years old = **0**	**Temp >38°C = +1**
>44 years old = **-1**	**Absent cough = +1**

Management: fluids, antipyretics, single dose Dexamethasone may reduce pain/duration.

Antibiotics reduce symptoms by 16 hours. They do NOT reduce incidence of suppurative complications.

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 23+72.

Electrolyte Disturbances

History: review of systems, neurologic symptoms (headache, lethargy, weakness, muscle cramps, ↓ LOC, personality changes, seizures), comorbidities, infection, intake + losses, past history of electrolyte disturbances

Hyperkalemia: [K] >5.5 mmol/L

Causes
Pseudohyperkalemia (#1), chronic renal failure, acute acidosis, medications* (ACEi, NSAIDs, K-sparing diuretics, Digoxin, Septra), cell death (rhabdo, burn/crush injuries, hemolysis, tumour lysis syndrome)
ECG Changes
Peaked T waves → PR prolongation → loss of P waves → widened QRS → sine wave
Management
Protect: 1 amp CaCl or 3 amps Ca gluconate (*if ECG changes noted) **Shift:** 1-2 amps D50W + 10 U regular insulin, albuterol nebs +/- bicarbonate (if acidotic) **Excrete:** fluids, Lasix, PEG3350 +/- dialysis if critical K or unable to excrete

Hypokalemia: [K] <3.5 mmol/L

Causes
Renal losses (diuretics), non-renal losses (vomiting, diarrhea), metabolic alkalosis
ECG Changes
Loss of T waves → U waves → prolonged QT → TdP, VTach, Vfib
Management
Replace: KCl 10-20mmol/hr IV or KCl 40-60mmol PO q2-4hrs HypoMg: $MgSO_4$ 500mg/h IV to ensure K being driven into cells

Hyponatremia: [Na] <135 mmol/L

Causes
Hypo-osmolar most common - hypervolemic (CHF, cirrhosis, nephrotic syndrome), euvolemic (SIADH), hypovolemic (adrenal insufficiency, vomiting, diarrhea, diuretics, poor PO fluid intake)
Management
Known acute (<24-48 hrs) [Na]<120 or symptomatic (↓ LOC, focal neurological symptoms): max Na 8mmol/L in 24 h to prevent central pontine myelinolysis **Dose option:** IV 3% saline 100cc IV over 10 mins (if seizing)

Hypercalcemia: [Ca] >2.6 (corrected for albumin)

Causes
Malignancy (breast, lung, kidney, multiple myeloma), hyperPTH, granulomatous diseases, meds (thiazides, Li, estrogen, vitamin A/D toxicity)
ECG Changes
Short QT, ST elevation, bradyarrhythmias, AV block
Management
Bolus NS until normal perfusion, then infusion to 200cc/hr with goal of urine output 2L/day. Lasix to promote diuresis, bisphosphonates and calcitonin.

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 117.

Urologic Emergencies

Renal Colic

Risk Factors: hereditary (RTA, G6PD deficiency, cystinuria, oxaluria), lifestyle (minimal fluid intake, excess vit C, oxalation, purines, calcium), meds (loop diuretics, acetazolamide, topiramate), medical conditions (UTI, IBD, gout, DM, hypercalcemia), obesity

Assessment

History: unilateral flank pain +/- radiating to groin, "writhing" in pain, N/V, trigonal irritation (frequency, urgency)

Physical Exam: vitals (fever, HR, RR), abdominal exam, CVA tenderness

Investigations: CBC, urinalysis, β-hCG (females)

CT
Vast majority do NOT need CT imaging **Relative indications:** first presentation of renal colic, complicated renal colic, elderly patients, suspicion of a serious alternative diagnosis
Ultrasound 🔍
Most helpful in detecting hydronephrosis (98% sensitivity)
KUB
Plain X-rays are neither sensitive nor specific for detection of renal stones. KUB may be used to follow stone progression.

Management

General	IV NS if clinically dehydrated
N/V	Zofran 4-8mg IV
Analgesia	Morphine 6mg IV + Ketorolac 30mg IM/IV or Naproxen 500mg PO
MET	Tamsulosin 0.4mg PO OD x3 weeks (large stone >4mm or distal stones)
Disposition	Can be safely discharge with appropriate GP/urology follow-up
Urology consult	Intractable pain, infected stone, compromised renal function (single kidney, transplanted kidney, bilateral obstruction)

UTI and Pyelonephritis

Causes: E. coli (85%), Klebsiella, Proteus, Saprophyticus

Assessment

History: UTI (frequency, urgency, dysuria, hematuria), pyelo (fever/chills, flank pain, N/V), associated vaginitis/cervicitis symptoms, sexual history

Investigations: urine dipstick, urine R+M, urine C+S +/- CBC, BUN, Cr

Management

Uncomplicated UTI
Septra DS PO BID x 3 days Macrobid 100mg BID x 5 days If suspected STI: Levofloxacin 500mg PO daily x 7d + CTX 250mg IM x1
Complicated UTI/Uncomplicated Pyelonephritis
Ciprofloxacin 500mg PO BID or Septra DS PO BID x 10-14 days Consider US/CT imaging for complicated UTI
Complicated Pyelonephritis
Ceftriaxone 1g IV q24h

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 99. NEJM 2014; 371(12):1100-10. Cochrane DB Syst Rev 2014;4:CD008509

Environmental Injuries

Hypothermia (T <35°C)

Causes: ↑ heat loss (EtOH, environmental), ↓ thermogenesis (hypothyroidism, hypoglycemia, adrenal insufficiencies), impaired thermogenesis (toxins, CNS lesions, SC injury)

Risk Factors: low SES, age extremes, drug OD, psych comorbidities

Assessment

Mild (32° – 35°C): excitation response (↑ HR/BP/RR, shivering)

Moderate (28° – 32°C): physiologic slowing, NO shivering, AMS, ataxia

Severe (24° – 28°C): dysrhythmias (brady>slow Afib>Vfib>asystole), irritable myocardium (avoid invasive heart procedures), fixed/dilated pupils

Investigations

Labs: CBC, lytes, BUN, Cr, VBG, lactate, INR/PTT, glucose

Tests: ECG (Osborne waves), pCXR (aspiration, pulmonary edema)

Management

General
Monitors, O_2, IV access, vitals, esophageal or Foley temp Remove wet clothes, rewarming strategies
Cardiac Arrest
Modified ACLS protocol (pulse checks 60 mins, shock x3 cycles then wait >30°C, withhold Epi until >30°C then double interval until >35°C
Passive Rewarming (T >32°C)
Cover patients with insulating blanket, let body generate heat
Active Rewarming (T <32°C)
Warming blankets, radiant heat, place extremities in 45°C water Non-invasive: warm IVF (42°C), warm O_2 Invasive: heated irrigation (pleural, stomach, peritoneal, bladder), dialysis, ECMO

Heat Stroke (T >40.5°C)

***Differentiated from heat exhaustion by AMS/elevated LFTs**

Classic/Non-Exertional: elderly, heat waves, indoors with no AC

Exertional: young athletes, runners

Assessment

Classic: dry/hot skin, not always dehydrated, HIGHER mortality

Exertional: diaphoretic, profound dehydration, more morbidities (liver failure, renal failure, DIC, lactic acidosis)

Management

General	
Monitors, cooled IV fluids, rapid evaporative cooling Antipyretics NOT effective (as not a hypothalamus problem, can also make DIC/liver failure worse)	
Treat Symptoms	
Shivering: Midazolam 2mg IV **Seizures:** Lorazepam 2mg IV	**Rhabdomyolysis:** IVF, Lasix, NaHCO3 **Hyperkalemia:** protect, shift, eliminate

EMOttawa Blog Posts: Hypothermia Part 1, Part 2

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 138+139. Resuscitation 2015;95:148-201.

Orthopedic Injuries – Upper Limb

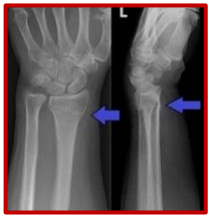
Assessment

History: mechanism of injury, associated neurological symptoms, blood loss
Exam: ABCs +vitals, look + feel, active and passive ROM, neurovascular status, assess bleeding/open fractures, skin tenting, complications of compartment syndrome, examine joint above and below fracture
Investigations: radiographs as clinically indicated

Upper Limb

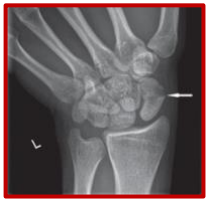
Distal Radius Fracture: FOOSH. Several fracture patterns. Colle's fracture is most common (distal radial fracture with dorsal displacement, volar apex angulation, and is extra-articular).
Exam: "dinner fork deformity" if dorsally angulated as in Colle's fracture.
Management: hematoma block, reduction to restore radial length and correct dorsal angulation. Success of reduction depends on several factors (intra- vs. extra-articular, comminution, quality of cast mold).

Colle's Fracture



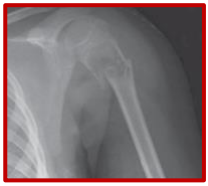
Scaphoid Fracture: 15-40yo with FOOSH. High complication rate (5-40% with AVN/non-union).
Exam: limited wrist/thumb ROM, snuff box tenderness, axial loading of 1st MC, pain to scaphoid tubercle volarly.
Management: thumb spica splint for suspected fractures (even if negative X-ray) x 6-12 weeks, repeat imaging in 10 days.

Scaphoid Fracture



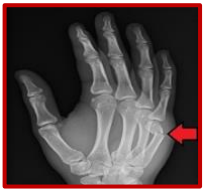
Proximal Humeral Fracture: high energy trauma (young), FOOSH (elderly). Neer classification to determine 1/2/3/4 part fracture. Separate part if displaced > 1cm or >45° angulation.
Management: minimally displaced (sling or cuff-and-collar immobilization), displaced GT or 2/3/4 part in younger patients (ORIF)

Proximal Humeral Fracture



Boxer's Fracture: blow on distal-dorsal aspect of closed fist. Volar angulation of neck of 5th metacarpal into palm.
Management: closed reduction if angulation >40°. If stable, ulnar gutter splint for 4-6 weeks.

Boxer's Fracture



Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 44, 45, 51, 58.

Orthopedic Injuries – Lower Limb

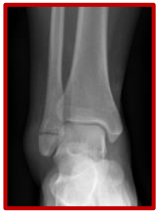
Assessment

History: mechanism of injury, associated neurological symptoms, blood loss
Exam: ABCs +vitals, look + feel, active and passive ROM, neurovascular status, assess bleeding/open fractures, skin tenting, complications of compartment syndrome, examine joint above and below fracture
Investigations: radiographs as clinically indicated, use decision rules for ankle/foot/knee to guide assessment

Lower Limb

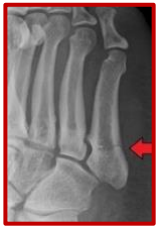
Ankle Fracture: inversion/eversion injury. Risk-stratification based on Weber's classification.
Weber A: below syndesmosis – typically stable
Weber B: at level of syndesmosis – can be unstable
Weber C: above level of syndesmosis – always unstable
Management: non-operative (non-WB BK cast), operative (most of Weber Type B/all Type C)

Weber A Fracture



Jones Fracture: Stress injury. Midshaft 5th MT fracture (>15mm from proximal end of 5th MT). High incidence of non-union.
Management: non-WB BK cast x6 weeks.

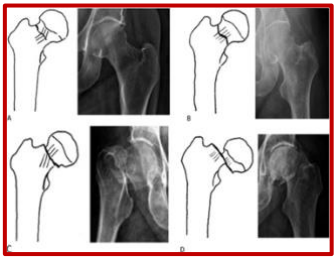
Jones Fracture



Pseudo-Jones Fracture: Traumatic injury. Proximal tubercle of 5th MT (<15mm from proximal end of 5th MT). Non-union is uncommon.
Management: protective weight bearing in stiff soled shoe or boot.

Hip Fracture: fall (elderly), direct force to hip, rotational force.
Garden I: incomplete, valgus impacted
Garden II: complete, non-displaced
Garden III: complete, partially displaced
Garden IV: complete, fully displaced
Exam:
shortened/abducted/externally rotated leg, painful ROM
Management: Elderly may get hemi or total hip arthroplasty. Young adults get ORIF.

Garden Classification



Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 51+58. Clin Orthop Relat Res. 2018 Feb; 476(2): 441-445.

Toxicological Emergencies

Differential Diagnosis

"Hot and Crazy" (DIMES)
Drug-related: sympathomimetics (cocaine, amphetamines, caffeine, PCP, ketamine), anticholinergics, ASA, SS/NMS/MH, EtOH withdrawal **I**nfection: meningitis, encephalitis, sepsis **M**etabolic: hypoglycemia, uremia, electrolytes, thyrotoxicosis, pheo **E**nvironmental: heat stroke **S**tructural: ICH
"Low and Slow" (ABCDO)
ADHD tablets (clonidine) **B**-blockers **C**alcium-channel blockers **D**igoxin **O**piates/**O**rganophosphates

Common Toxidromes

Anticholinergics	
Vitals: hyperthermia, tachycardia **Signs:** mydriasis, dry skin **Symptoms:** agitation, hallucination, constipation, urinary retention "dry as a bone, red as a beet, blind as a bat, mad as a hatter, hot as a hare"	Antidepressants Antihistamines Antipsychotics Antispasmodics Atropine Carbamazepine
Cholinergics	
Vitals: hypotension, bradycardia **Signs:** miosis, diaphoresis, seizures **Symptoms:** urination, bronchospasm, vomiting, diarrhea	Organophosphates Nerve gas Mushroom Anticholinesterase
Sympathomimetics	
Vitals: hyperthermia, tachycardia, HTN **Signs:** mydriasis, diaphoresis, seizures **Symptoms:** agitation, anxiety	Amphetamines Cocaine LSD Ephedrine
Sedative/Hypnotics	
Vitals: hypothermia, hypotension, bradypnea **Signs:** respiratory depression, miosis (opioids), altered LOC	EtOH, BZDs, GHB Opioids (morphine, heroin, fentanyl) Barbiturates

Basic Approach (ABCDE)

Airway	Intubate early if impending airway compromise
Breathing	Think metabolic derangements if low RR
Circulation	Ensure patient is well perfused
Detect and Correct	Consider universal antidotes (**D**extrose, **O**xygen, **N**aloxone, **T**hiamine), correct vitals, correct signs (i.e. seizure), consider decontamination/enhanced elimination
Emergency Antidotes	Specific antidotes and treatments

Vascular Emergencies

Ruptured AAA

Risk Factors: FHx, HTN, PVD/CAD, DM, connective tissue disease, smoking

AAA <5cm	AAA 5cm - 7cm	AAA >7cm
0.3% risk of rupture/yr	10% risk of rupture/yr	20% risk of rupture/yr

Assessment

Classic Triad: acute onset back/abdo/flank pain + hypotension (with or without syncope) + pulsatile abdominal mass

Other Presentations: syncope, UGIB/LGIB, high output CHF, ureteral colic, bowel obstruction symptoms, neurological symptoms

Tests: PoCUS to detect AAA (>3cm), ECG, CT aortogram (if stable)

Management

General

ABCs, monitors, oxygen, vitals, IV access
STAT vascular surgery consult

Resuscitation

IV crystalloids, blood (aim for systolic BP 90 – 100mmHg)
Massive transfusion protocol

Urgent Surgical Intervention

Open surgery with graft replacement or endovascular aneurysm repair

Post-op Complications

Infection: graft contamination or hematogenous seeding
Ischemia: Spinal cord ischemia, CVA, visceral ischemia, erectile dysfunction
Aortoenteric fistula: commonly presents as GI bleeding
Endo Leak: blood flow outside of the graft lumen

Acute Arterial Occlusion

Definition: acute embolus or arterial thrombosis, true emergency as irreversible damage can occur within 6-8 hours

Risk Factors: atherosclerosis, MI with LV thrombus, Afib, valve stenosis, stent/grafts

Assessment

History (6Ps): **P**ain, **P**aresthesia, **P**allor, **P**olar (cold), **P**ulselessness, **P**aralysis (late finding)

Investigations: Doppler probe to leg with proximal BP cuff – perfusion pressure <50mmHg, ABI <0.5

Management

STAT vascular surgery consult

Immediate heparinization with 4000 IU bolus
Revascularization (i.e. embolectomy) vs. CT angiogram (depends on if emboli from Afib vs. secondary to PVD)

Psychiatric Emergencies

Background: ask every patient **MOAPS: M**ood (depression, mania), **O**rganic (EtOH, drug use), **A**nxiety (worries, obsessions, phobias), **P**sychosis (hallucinations or delusions) and **S**uicidal/homicidal thoughts

Suicide Risk Factors: **SAD PERSONS: S**ex (male); **A**ge (<19 or >45); **D**epression or hopelessness; **P**revious attempts or psychiatric care; **E**tOH/substance use (excessive); **R**ational thinking loss; **S**ocial supports lacking; **O**rganized suicidal plan or serious attempt; **N**o spouse; **S**ickness

Assessment

Depression	Schizophrenia
≥5 sx (≥1 must be ↓ mood or interest) for 2+ wks. **MSIGECAPS:** **M**ood low **S**leep increased or decreased **I**nterest decreased **G**uilt or worthlessness **E**nergy decreased **C**oncentration decreased **A**ppetite increased or decreased **P**sychomotor retardation / agitation **S**uicidal ideation	≥2 sx (of which ≥1 must be a, b or c) each present for >1 month; 6 months altered behaviour required to make dx a) **Hallucinations** b) **Delusions** (bizarre or non-bizarre) c) **Disorganized speech** (i.e. frequent derailment or incoherence) d) **Grossly disorganized**/catatonic **behaviour** e) **Negative symptoms** (i.e. flat affect, avolition, alogia)
Generalized Anxiety	**Mania**
≥3 of 6 sx majority of days for 6+ months. **BE SKIM:** **B**lank mind/difficulty concentrating **E**asily fatigued **S**leep disturbance **K**eyed up/on-edge/restless **I**rritability **M**uscle tension	≥3 sx with euphoria; ≥4 sx with irritable mood for 1+ wk. **GST PAID:** **G**randiosity **S**leep (decreased need for) **T**alkative/pressured speech **P**leasurable activities with painful consequences **A**ctivity ↑(goal-directed)/agitation **I**deas (flight of) **D**istractable

Investigations

Labs: CBC, lytes, B12, Vit D, TSH, BUN, Cr, LFTs, serum EtOH & Tylenol level, urine tox

Safety Assessment

1. Do you have any **thoughts** that life isn't worth living?
2. Do you have a **plan** to take your life?
3. **Imminence/Means:** When do you plan to complete this plan? Do you have the means available to complete this plan?
4. **Protective Factors** What prevents you from carrying out this plan?
5. **Future Orientation:** What are your plans after you leave hospital?
6. **Hopefulness**: Do you think you can get better? Are you improving?
7. **Assess Previous Attempts:** organization/lethality, no remorse after, attempt isolated location, affairs in order (will, belongings given away)

Management

Depression	1st line: SSRIs, SNRIs, NDRIs, CBT, Behavioural Activation
Anxiety	1st line: SSRIs, SNRIs, CBT, Pregabalin (GAD),
Schizophrenia	1st line: atypical antipsychotics (Paliperidone, Aripiprazole, Olanzapine, Risperidone, Quetiapine)
Mania	1st line: mood stabilizers (Lithium, Valproic Acid), atypical antipsychotics (Quetiapine, Aripiprazole)

EMOttawa Blog Post

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice - 9th ed, 2017; Chapter 100.

Thyroid Emergencies

Types of Thyroid Emergencies

HYPERthyroidism	HYPOthyroidism
Graves' disease Toxic multinodular goiter Toxic adenoma Thyroiditis (autoimmune, postpartum, amiodarone, infectious, traumatic)	Hashimoto's thyroiditis Drug-induced (lithium, amiodarone) Insufficient dietary iodine Central hypothyroidism (hypothalamic or pituitary dysfunction, brain injury, mass)

Thyroid Storm: Severe thyrotoxicosis. Pyrexia (40-41ºC), tachycardia, altered mental status, cardiovascular collapse, hypotension, abdominal pain, and signs of hyperthyroidism (lid lag, goiter, ophthalmopathy, tremor)l **Burch and Wartofsky Score** can help distinguish between true Thyroid Storm vs Thyrotoxicosis
Myxedema Coma: Life-threatening event precipitated by stress in untreated hypothyroidism. Hypothermia (<36 ºC), altered mental status, hypotension, hypoventilation, bradycardia, acute precipitating illness, and signs of hypothyroidism (dry skin/hair, reduced reflexes, bradykinesia, facial edema).

Assessment

History: constitutional symptoms, thyroid disease, recent acute illness, altered mental status, skin and hair changes, palpitations or bradycardia, abdominal pain, dyspnea, cold or heat intolerance, medications, recent surgery
Physical Exam: vitals, cardiac exam, ophthalmologic exam, neck exam for thyroid enlargement, dysphagia, dysphonia

Investigations:

Labs: can help identify underlying trigger: CBC, TSH, free T3 & T4, ECG, glucose, VBG, troponin, b-hCG (pregnancy can trigger thyrotoxicosis), septic workup (common trigger for myxedema coma)
Tests: ECG; POCUS: assess cardiac fn, rule out pericardial effusion; consider CT head if signs of trauma or focal neuro deficits

TSH	Free T_4	Free T_3	Disease
Low	High	High	Hyperthyroidism
Low	Normal	Normal	Subclinical hyperthyroidism
Low	High	Normal	Thyroiditis
Low	Low	Low	Central hypothyroidism
High	Low	Low	Hypothyroidism
High	Normal	Normal	Subclinical hypothyroidism

Management

Thyroid Storm

***β*-adrenergic blockade:** Propranolol 60-80mg PO or 1mg IV, Esmolol infusion (if CHF)
Inhibit thyroid synthesis: PTU 1g PO or Methimazole 30mg PO
Block thyroid release: SSKI 1-2 drops PO TID, Lugol's 5-7 drops PO TID (1hr after PTU/Methimazole)
Inhibit T_4 to T_3 conversion: Hydrocortisone 300 mg IV
Supportive: volume resuscitation, cooling measures, anxiolytics, consider bile acid sequestrants, treat underlying precipitant
Consult: ICU and Endo

Myxedema Coma

Resuscitation: fluid resuscitation, broad spectrum antibiotics, airway support
Thyroid Hormone Replacement: T_4 400 mcg IV and T_3 20 mcg IV
Steroids: Hydrocortisone 100 mg IV
Supportive: passive rewarming

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 9th ed, 2018; Chapter 120.

Pain Management

Reflex Responses to Pain: ↑ HR, RR and BP, ↑ metabolic rate and O_2 consumption, ↓ urinary and gastric tract tone (urinary and bowel retention)
General Approach: patient-centred, target specific pain syndromes, and use non-pharmacological and pharmacological approaches

Non-Opioid Analgesics

Acetaminophen	
First line foundational analgesia Combine with NSAIDs to improve efficacy	Tylenol 975mg PO
NSAIDs	
Ibuprofen and Naproxen: best safety profile and least side effects **Ketorolac:** helpful in acute painful condition **Topical NSAID preparations:** added analgesia for acute MSK and joint pain If prescribing NSAIDs, consider concomitant PPI therapy in patients with higher risk of GI bleeds	Ibuprofen 400 – 800mg PO Naproxen 500mg PO Ketorolac 10 – 30mg IM/IV
Ketamine	
Sub-dissociative doses are effective for analgesia Administer over 20 minutes to minimize risk of emergence reaction	Ketamine 0.1 – 0.3mg/kg IV Over 20 mins
Regional and Local Nerve Blocks	
Useful in lacerations, acute fractures requiring reduction or operation, and headaches (i.e. occipital neuralgia)	Lidocaine + Epi Max 7mg/kg Lidocaine – Epi Max 5mg/kg Bupivacaine Max 2.5-3mg/kg

Opioid Analgesics

Morphine	
Pros: less abuse potential, palliative care pain, cancer pain, dosing range well known Cons: active metabolites may accumulate in renal insufficiency	PO: 0.5mg/kg IV/SC: 0.1mg/kg
Hydromorphone	
Pros: easier titration, more equipotent, better tolerated in renal insufficiency Cons: initial dosing range unclear, more side effects	PO: 1-2mg IV/SC: 0.5-1mg
Fentanyl	
Pros: most effective for acute pain (fractures, trauma) Cons: abuse potential, overdose potential, long ½ life	IV/SC: 25-50µg

Gabapentinoids

Pregabalin & Gabapentin	
Ideal for neuropathic pain	Pregabalin: 50mg PO TID upto 300mg/day Gabapentin: 300mg PO TID upto 2400mg/day

Key References: Rosen's Emergency Medicine: Concepts and Clinical Practice – 8th ed, 2014; Chapter 3. 2017 Canadian Guideline for Opioids for Chronic Non-Cancer Pain. Source: http://nationalpaincentre.mcmaster.ca/guidelines.html

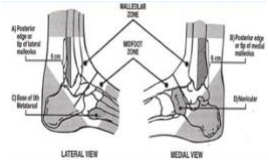
Clinical Decision Rules

Canadian CT Head Rule for Minor Head Injury

Inclusion Criteria	Exclusion Criteria
Head injury resulting in witnessed LOC/disorientation or definite amnesia; initial ED GCS >13; injury within 24hrs	Minimal head injury, obvious penetrating skull injury, acute neurological deficits, unstable vital signs assoc. with major trauma, seizure prior to ED assessment, bleeding disorder, pregnant
High Risk Criteria (neurological intervention)	
GCS <15 at 2 hrs after injury, suspected open or depressed skull fracture, signs of basal skull fracture, vomiting >2 episodes, age >65	
Medium Risk Criteria (for brain injury on CT)	
Amnesia before impact >30 mins, dangerous mechanism	

Ottawa Ankle Rules

Inclusion Criteria
Adult patient (ALSO been validated in pediatrics), any mechanism of blunt ankle injury
Exclusion Criteria
Age <18, pregnant, isolated skin injury, injury >10 days, reassessment of same injury



Ankle X-ray only required if
Bony tenderness at A OR B OR inability to take 4 complete steps in ED
Foot XR only required if
Bony tenderness at C OR D OR inability to take 4 complete steps in ED

Ottawa Knee Rules

Inclusion Criteria	Exclusion Criteria
Adult patient, blunt knee injury, "knee" = patella, head/neck of fibula, proximal 8cm of tibia and distal 8cm of femur	Age <18, pregnant, isolated skin injury, injury older than 7 days, return for reassessment, AMS, paraplegic, multi-trauma
Knee X-ray only required if	
Age >55 OR isolated patellar tenderness OR fibular head tenderness OR inability to flex 90º OR inability to take 4 complete steps in ED	

Ottawa SAH Rule

Inclusion Criteria	Exclusion Criteria
Alert patients >15, new severe atraumatic headache, max intensity within 1 hr	New neurological deficits, prior aneurysm, prior SAH, known brain tumors, chronic recurrent headaches (>3 headaches of same character/intensity for >6 months)
CT is indicated if any criteria are present	
Neck pain/stiffness, witnessed LOC, age >40, onset during exertion, thunderclap headache, limited neck flexion on examination	

Key References: BMJ 2010; 341:c5204. Ann Emerg Med 1992; 21(4):384-390. Ann Emerg Med 1995; 26(4):405-413. Lancet 2001; 357(9266):1391-6.

Risk Stratification Scales

Canadian Syncope Risk Score

Inclusion Criteria	Exclusion Criteria
Age >16, present to ED with syncope within 24 hours	Prolonged (>5 min) LOC, AMS, witnessed seizure, major trauma, intoxication, language barrier, head trauma

Clinical Evaluation	Investigations	ED Diagnosis
-1 Vasovagal predisposition **+1** Hx heart disease **+2** sBP<90 or sBP>180	**+2** Elevated TnI **+1** QRS axis <-30° or >100° **+1** QRS >130ms **+2** Corrected QT>480ms	**-2** Vasovagal syncope **+2** Cardiac syncope

Interpretation	**Total score = -3 to 11** **Score of 0** = 1.9% risk of serious adverse event within 30d **Score of 11** = 83.6% risk of serious adverse event within 30d

Ottawa Heart Failure Risk Scale

Inclusion Criteria	Exclusion Criteria
Age >50, symptoms consistent with CHFe (acute SOB, fluid retention, underlying cardiac abnormality) and/or response to diuretics	O_2 <85%, HR>120, sBP<90, confusion, ischemic chest pain, acute STEMI on ECG, prognosis of weeks (due to chronic disease), arrival from LTC

Initial Assessment	Investigations	Walk Test
+1 Hx of stroke or TIA **+2** Hx of intubation for respiratory distress **+2** HR >110 on ED arrival **+1** SaO_2 < 90% on EMS or ED arrival	**+2** New ischemic changes on ECG **+1** BUN>12mmol/L **+2** HCO_3>35mmol/L **+2** Elevated TnI **+1** ProBNP>5µg/L	**+1** SaO_2<90%, HR>110 during 3-min walk test, or too ill to walk

Interpretation	**Total score = 0 to 15** **Score of 0** = 2.8% risk of serious adverse event within 14d **Score of 9** = 89% risk of serious adverse event within 14d

Ottawa TIA Risk Score

Inclusion Criteria	Exclusion Criteria
Age >18, ED diagnosis of TIA	Confirmed stroke, decreased LOC, presentation >7 days following onset of most recent TIA

Clinical Findings	Investigations
+2 First TIA (in lifetime) **+2** Symptoms >10 min **+2** History of carotid stenosis **+3** Already on antiplatelet therapy **+1** History of gait disturbance **+1** History of unilateral weakness **-3** History of vertigo **+3** Initial triage diastolic BP >110mmHg **+1** Dysarthria or aphasia (history of examination)	**+2** Afib on ECG **+1** New or old infarction on CT **+2** Platelet count >400 **+3** Glucose >15

Interpretation	**Total score = -3 to 14** **Score of 0** = 0.04% risk of stroke within 7d **Score of 14** = 27.6% risk of stroke within 7d

Key References: CMAJ 2016; 188(12):E289-298. AEM 2017; 24(3):316-327. Stroke 2014; 45(1):92-100.

Advanced Cardiac Life Support

Electrical Cardioversion

Indications
Paroxysmal SVT Atrial fibrillation/Atrial flutter Ventricular Tachycardia
Pre-medication
Midazolam 1-5mg +/- fentanyl 50-200µg Propofol 50-150mg IV Ketamine 0.25-1.5mg/kg IV Etomidate 20mg IV
Synchronized Cardioversion
pSVT/Aflutter: 150J biphasic or 300J monophasic Vtach/Afib: 200J biphasic or 360J monophasic

Atrial Fibrillation or Atrial Flutter

General	
Assess ABCs if stable, monitors, O_2, vitals, IV access, ECG	
Unstable	**Chest pain, SOB, LOC, low BP, CHF, AMI**
Cardioversion (200J biphasic or 360J monophasic)	
Stable	
1. Rate control if HR >120	
Narrow Complex: Diltiazem 20mg IV or Verapamil 2.5-5mg IV or Metoprolol 5mg IV or Amiodarone 150mg over 10 mins or Digoxin 0.5mg IV **Wide Complex (WPW or BBB):** Procainamide 30mg/min to 17mg/kg or Amiodarone 150mg over 10mins	
2. Rhythm control	
Afib <48 hours: cardioversion if non-valvular Afib, not anticoagulated AND CHADS-65 0-1. If CHADS-65 > 1 then needs cardioversion within 12 hours. **Afib >48 hours:** anticoagulate 3 weeks prior to and 4 weeks after cardioversion. Alternatively long-term rate control with ß-blockers or CCB	

Ventricular Fibrillation/Pulseless Ventricular Tachycardia

General
Intubate, ventilation, early IV/IO access to administer medications Treat reversible causes: hypovolemia, hypoxia, acidosis, hyper/hypokalemia, hypothermia, toxins, ischemia
Shock-CPR-Shock Cycles
1. Shock first (200J biphasic or 360J monophasic) **If defibrillator not immediately available start CPR,** then shock ASAP 2. High quality CPR for 2 min Push hard (2-2.4 inches) and fast (100-120/min), complete chest recoil, minimize interruptions, avoid excessive ventilations (10/min), change compressors q2min, monitor end-tidal CO_2 3. Shock
Drugs Provided during CPR
Epinephrine: 1mg IV q3-5min **Amiodarone:** 300mg IV bolus (preferred), 150mg IV (2nd dose) **Lidocaine** for refractory VF: 1.5mg/kg IV q3-5min (max 3mg/kg) **Magnesium sulfate** for polymorphic VT: 2g IV

Advanced Cardiac Life Support

Wide Complex Tachycardia (85-95% = VT)

General	
Assess ABCs if stable, monitors, O_2, vitals, IV access, ECG, CXR	
Unstable	**Chest pain, SOB, LOC, low BP, CHF, AMI**
Prepare for synchronized cardioversion (200J biphasic or 360J monophasic) Consider premedication	
Stable	**Consider cardioversion (as meds only revert VT 30% of the time)**
Procainamide: 20-50mg/min (max 17mg/kg) **Amiodarone:** 150mg over 10 mins (repeat x2 PRN) **Magnesium sulfate** for polymorphic VT: 2g IV *Avoid multiple antidysrhythmics sequentially (to prevent proarrhythmogenic effects). If one fails, go to electrical cardioversion.	

Paroxysmal Supraventricular Tachycardia (AVnRT, AVRT)

Unstable	**Chest pain, SOB, LOC, low BP, CHF, AMI**
Synchronized cardioversion (150J biphasic or 300J monophasic) Consider premedication	
Stable	
Vagal Manoeuvres **Adenosine:** 6mg IV over 3 secs (1st dose), 12mg IV (2nd dose) **Diltiazem:** 20mg IV over 2 min (1st dose), 25mg IV (2nd dose)	

Pulseless Electrical Activity or Asystole

General
Intubate, ventilation, early IV/IO access to administer medications, PoCUS
Management
1. Ongoing CPR **2.** Treat reversible causes: **5Hs** (**H**ypovolemia, **H**ypoxia, **H**ydrogen acidosis, **H**yper/hypokalemia, **H**ypothermia) and **5Ts** (**T**oxins, **T**amponade, **T**ension pneumothorax, **T**hrombosis – coronary, **T**hrombosis – pulmonary) **3.** Epinephrine 1mg IV q3-5mins

Bradycardia (HR <60)

General	
ABCs, monitors, O_2, vitals, IV access	
Unstable	**Chest pain, SOB, LOC, low BP, CHF, AMI**
Atropine 0.5mg q3-5min (max 3mg) – Not effective for 3° heart block Transcutaneous pacing → Transvenous pacing Consider infusions: Dopamine 2-10µg/kg/min OR Epinephrine 2-10µg/min	
Stable	
1° AV block or Type I 2° AV block: Observe Type II 2° AV block or 3° AV block: transcutaneous pacing → transvenous pacing	

Point of Care Ultrasound

Definitions

Hyperechoic: object is more echogenic (brighter) than surrounding tissue
Hypoechoic: object is less echogenic (less bright) than surrounding tissue
Isoechoic: object has same echogenicity than surrounding tissue
Anechoic: object has absence of echoes within it
Near field: area closer to probe **Far field:** area farther from probe

Recommended Probe Selection

	Abdo	Cardiac	Lung	Gyne	Soft Tissue	MSK
Curvilinear	+	-	+	+	-	-
Phased Array	+	+	+	-	-	-
Linear	-	-	+	-	+	+
Intracavitary	-	-	-	+	-	-

Ultrasound Artifacts

Acoustic shadowing: shadow distal to reflective surface (i.e. bone, gallstone)
Acoustic enhancement: posterior enhancement due to transmission through a fluid filled structure
Edge artifact: refraction of U/S waves due to two different propagation speeds
Reverberation artifact: sound bouncing between highly reflective surfaces and probe (i.e. metal needle)

Cardiac

Clinical questions: Is there a pericardial effusion? Is there cardiac activity? Is the LV function reduced? Is there RV strain?
Exam:

Parasternal Long Axis: assess LV function
Fractional shortening <30% indicates reduced LV function Assessed by the difference in LV diameter between end diastole and systole. **E-point septal separation >7mm** indicates reduced LV function Assessed by looking at the septal slap between anterior mitral valve leaflet and septum. **Fractional shortening ~100% or EPSS ~0mm** indicates hyperdynamic LV Can be seen when ventricles are "kissing" or empty
Parasternal Short Axis: assess LV function, some indication of RV function
Fractional shortening <30% indicates reduced LV function **RV larger than LV or "D-shaped" LV** may indicate RV pressure overload
Apical 4 Chamber View: assess RV function
RV = LV or RV > LV suggests right heart strain
Subxiphoid View: assess pericardial effusion
Anechoic area first appearing between pericardium and RV, can expand to encompass all 4 chambers

AAA

Clinical questions: Is there an abdominal aneurysm?
Exam: Transverse view using curvilinear probe, max AP diameter >3cm may indicate AAA. Does not necessarily provide information of whether it is ruptured or not.

Key References: Boyd, Jeremy S., et al. "EMERGENCY ULTRASOUND." *The Atlas of Emergency Medicine, 4e* Eds. Kevin J. Knoop, et al. New York, NY: McGraw-Hill.

Point of Care Ultrasound

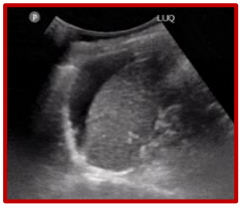
eFAST

Clinical questions: Is there evidence of pneumothorax or free fluid in the abdomen?

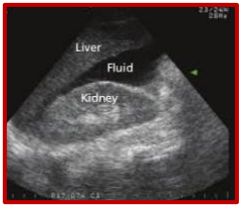
Exam: Curvilinear probe to look at RUQ, LUQ, and suprapubic areas. Free fluid will appear anechoic, collects early near the caudal edge of liver (RUQ).

Right and left thorax views using cardiac or curvilinear probe. Absence of lung sliding in pneumothorax.

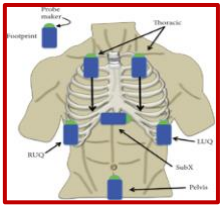
Positive LUQ



Positive RUQ



eFAST Views



Lung

Clinical questions: Is there pneumothorax? Is there hemothorax or pleural effusion?

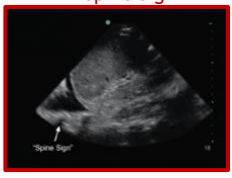
Exam: Curvilinear probe along mid axillary line at the level of diaphragm

Mirror sign – interface between liquid and air-filled thorax will create a highly reflective surface for sound. Absent mirror sign in fluid-filled thorax (i.e. in hemothorax or pleural effusion).

Spine sign – visualized when anechoic or hypoechoic fluid is present in the pleural space.

Lung sliding – shimmering appearance of pleura, "ants marching on a log". Absent lung sliding may indicate pneumothorax.

Spine Sign



First Trimester

Clinical questions: Is there an intrauterine pregnancy?

Exam: Curvilinear probe along midline sagittal view

Diagnosis of IUP on POCUS
Confirm **bladder-uterine juxtaposition** to identify the uterus
Gestational sac within the uterus Circular anechoic intrauterine area surrounded by thickened echogenic rim
Yolk sac OR fetal pole visualized within the gestational sac Yolk sac is circular structure with hypoechoic centre within the gestational sac Fetal pole is a small mass at the margin of yolk sac present between 5-6 weeks
Myometrial mantle >8mm Uterine tissue surrounding gestational sac

EMOttawa Blog POCUS Manual

Key References: Boyd, Jeremy S., et al. "EMERGENCY ULTRASOUND." *The Atlas of Emergency Medicine, 4e* Eds. Kevin J. Knoop, et al. New York, NY: McGraw-Hill.

Approach to the Chest X-Ray

Step 1: Confirm details: patient name, date of birth, MRN, date/time image was taken, previous imaging available (for comparison)

Step 2: Assess image quality using the mnemonic **RIPE**
Rotation: medial aspect of each clavicle should be equidistant from spinous processes & spinous processes vertically oriented against vertebral bodies
Inspiration: 8-9 posterior and 5-6 anterior ribs both lung apices, costophrenic angles and lateral rib edges bilaterally
Projection: note if the film is AP or PA (more common). AP films magnifies heart and widens mediastinum
Exposure: spinous processes should be visible posterior to the heart

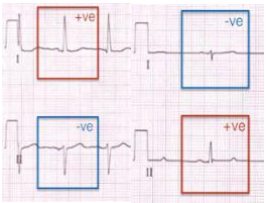
Step 3: Assess the CXR for pathology using the **ABCD approach**

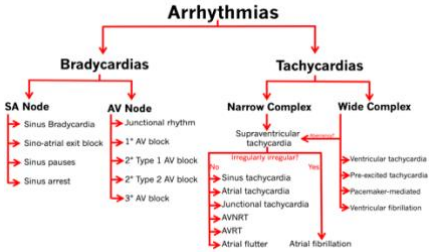
Airway	**Trachea:** deviation (suggests tension pneumo) **Carina:** NG tube should bisect carina if correctly placed **Bronchi:** right bronchus is wider, shorter, more vertical **Hilar structures:** major pulmonary vasculature & major bronchi, left hilum usually superior to right, assess for hilar masses (hilar asymmetry), lymphadenopathy (LNs should not be visible in healthy pts)
Breathing/ Bones	**Lungs:** ensure lung markings are present from hilum to chest border (absence indicates pneumothorax), pulmonary edema (peribronchial cuffing, Kerley B lines, septal lines), increased airspace opacification (consolidation/malignant lesion) **Pleura:** if visible indicates pleural thickening (mesothelioma), increased opacity when fluid (hydrothorax), blood (hemothorax) or air and fluid (hydropneumothorax) accumulates in pleural space which appears as area of opacification **Ribs:** fractures
Cardiac	**Heart size:** cardiomegaly (PA cardiothoracic ratio >0.5) due to valvular heart disease, cardiomyopathy, pulmonary HTN or pericardial effusion **Heart borders:** well defined, silhouette sign suggests pneumonia, RA makes up majority of right & LV majority of left heart borders **Mediastinum:** widening can indicate aortic dissection
Diaphragm	**Right hemidiaphragm:** usually higher than left **Silhouette sign:** indicates pneumonia **Costophrenic angles:** blunting suggests pleural effusion or consolidation **Flatting:** of diaphragm in hyperinflation (COPD/asthma) **Free air:** indicates pneumoperitoneum and suggests bowel perforation, best seen under right hemidiaphragm **Gastric bubble:** best seen under left diaphragm, don't confuse with pneumoperitoneum

Key References: Life in the Fast Lane. ABC of Chest X-ray Interpretation. 2020 https://litfl.com/abc-of-cxr-interpretation/.

Approach to the ECG

Step 1: Rate: divide 300 by # of large squares between QRS complexes
Step 2: Rhythm: If regular - RR interval should be constant. If irregular - assess if regularly irregular or irregularly irregular. Sinus Rhythm 3 requirements: upright p wave in leads II and V1, p wave before every QRS, QRS before every p wave
Step 3: Axis: Normal QRS axis when the QRS deflection is positive in leads I & II. **Left Axis Deviation (LAD)**: QRS deflections have "left each other" (deflections point away from each other in leads I and II) & **Right Axis Deviation (RAD):** QRS deflections are "right for each other" (deflections point towards each other).





Step 4: Alphabet:

p waves	**Assessed in:** leads II (monophasic) and V1 (biphasic) **Duration:** <120ms or 3 small squares **Enlargement:** LA (wider p wave) or RA (taller p wave) **Absent:** sinus pause, sinus arrest, A fib
QRS complex	**Narrow:** <120ms; supraventricular in origin **Wide:** >120ms; ventricular in origin or due to aberrant conduction of supraventricular rhythm (i.e. BBB, hyperK)
T waves	**Abnormalities: Peaked -** hyperK; **Hyperacute -** asymmetrically broad, early STEMI (prior to ST changes or Q waves); **Inverted -** normal in peds, STEMI, BBB, RVH & LVH ("strain pattern"), PE ("S1Q3T3"), HOCM (deep T inversions in precordial leads), raised ICP; **Biphasic or Flattened -** hypoK, STEMI
PR interval	**Reflects:** conduction through the AV node **Duration:** 120-200ms **PR <120ms:** indicates pre-excitation (i.e. accessory pathway) between atria & ventricles (i.e. WPW) or AV nodal rhythm **PR >200ms:** indicates 1st or 2nd degree heart block
QT interval	**Measured in**: leads II, V5 or V6 **Duration:** normal QT is less than 1/2 the proceeding RR interval **QTc:** allows comparison of QT values at varying HRs; calculated using **Bazett Formula** (QTc QT//RR); prolonged if >440ms (males) or >460ms (females) **Prolonged QT:** increases risk of ventricular arrythmias, especially Torsades de Pointes
ST segment	**STEMI:** ≥2mm ST elevation (females) or ≥1mm (males) in ≥ 2 contiguous leads **Patterns of ST Elevation in STEMI:** septal (V1-V2), anterior (V3-V4), lateral (I, aVL, V5, V6), inferior (II, III, aVF) **Other Causes of ST Elevation:** Benign Early Repolarization, Brugada Syndrome, Pericarditis, LBBB, LV aneurysm

Key References: Life in the Fast Lane. ECG Library Basics. 2020 https://litfl.com/ecg-library/
Arrhythmia Summary Image: Dr. Mouhannad Sadek, University of Ottawa Heart Institute

End