DIAGNOSIS AND MANAGEMENT OF

ACUTE CORONARY SYNDROME (ACS)

2022 Update

These guidelines were developed by Intermountain Healthcare's Cardiovascular Clinical Program to guide the diagnosis and treatment of patients presenting to Intermountain Healthcare's emergency departments (ED) with signs and symptoms suggestive of acute coronary syndrome (ACS). Recommendations are based on ACS-probability categories and capabilities of individual facilities. They may need to be adapted to meet the needs of a specific patient and should not replace clinical judgment.

Why Focus ON ACS?

- **Incidence and mortality.** In 2018, it was expected that nearly 720,000 Americans would experience their first myocardial infarction (MI) or die from coronary heart disease. [BEN]
- **Cost.** Between 2012 and 2014, more than $361 billion in direct and indirect costs (14% of total health expenditures) were attributed to coronary vascular disease and stroke. Direct medical costs of cardiovascular disease (CVD) are projected to increase from $318 billion to $749 billion between 2015 and 2035. [BEN]
- **Outcomes are improved when key processes are followed.** Successful reperfusion (percutaneous coronary intervention [PCI] in <90 minutes **OR** fibrinolytic infusion in <30 minutes) usually results in preserved left ventricle function, reduced mortality, and fewer long-term complications. [AMS]

What's new in this update?

- **Updated algorithm** for the diagnosis and treatment of ACS (see page 2).
- **Use of the HEART score, instead of Thrombolysis in MI (TIMI),** to determine the risk of major adverse cardiac events (MACE) (see page 3).
- **HbA1c monitoring** of all STEMI (ST-elevation MI) patients and those with a moderate-to-high probability of ACS or definite unstable angina (see page 2).
- **More frequent monitoring of troponin-I** (see pages 2–3).

WHAT'S INSIDE?

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PROGRAM GOALS & MEASUREMENTS

↓ Time from ED arrival to PCI for all STEMI patients

GOAL: <90 minutes from ED arrival to intervention

↑ % cTroponin-I testing at 0 and 2–3 hours after arrival when appropriate

↑ % HEART score assessment of NSTEMI patients

↑ % of eligible ED patients treated with fibrinolytics within 30 minutes of arrival

↑ % Lipid and HbA1c testing on eligible patients

Indicates an Intermountain measure

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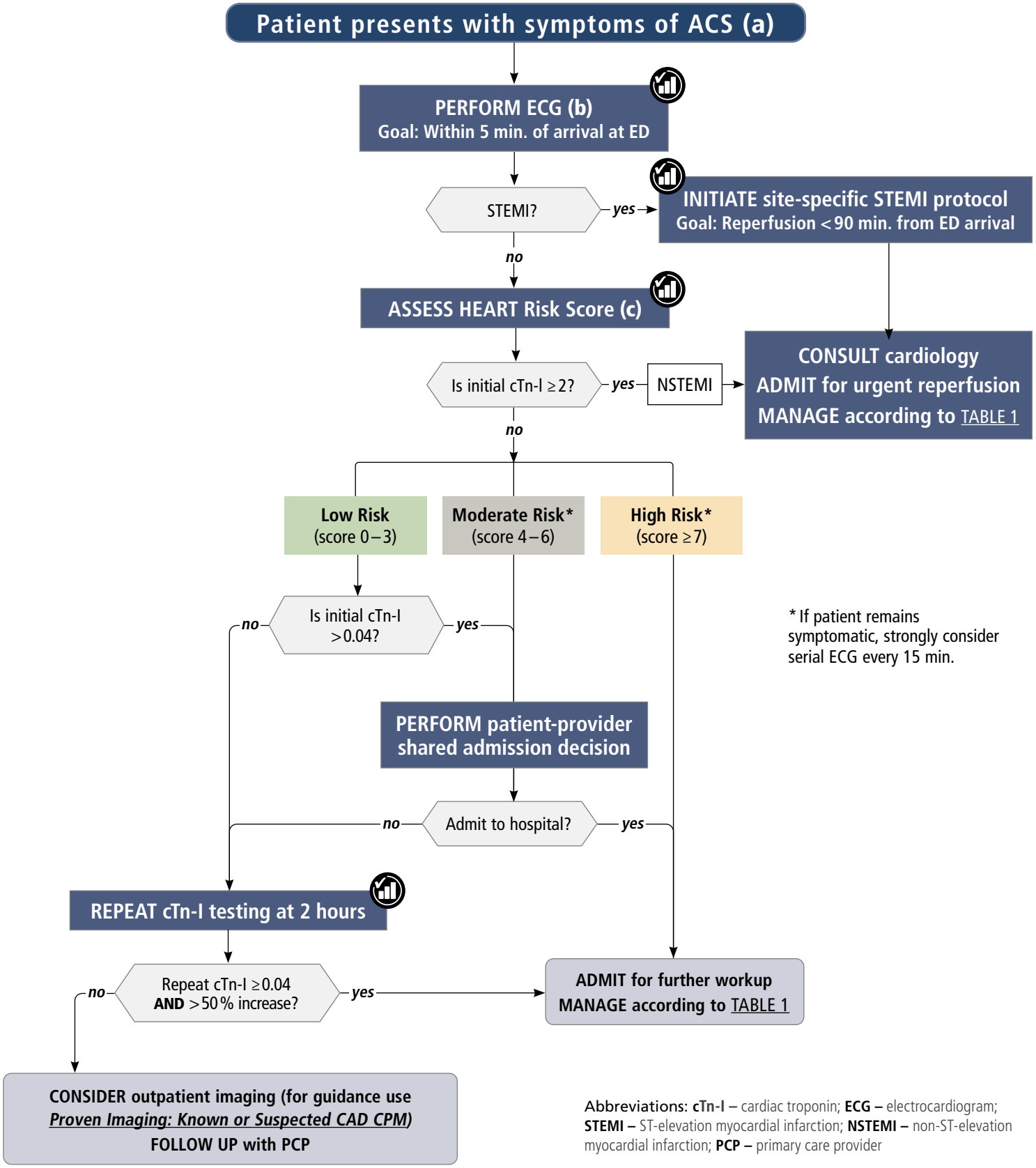
ALGORITHM 1: DIAGNOSIS OF ACUTE CORONARY SYNDROME (ACS)



Abbreviations: **cTn-I** – cardiac troponin; **ECG** – electrocardiogram; **STEMI** – ST-elevation myocardial infarction; **NSTEMI** – non-ST-elevation myocardial infarction; **PCP** – primary care provider

ALGORITHM NOTES

(a) Symptoms of ACS

STEMI	High-probability ACS: (NSTEMI or definite UAP)	Moderate-probability ACS	Low-probability ACS
Typical of or consistent with ischemia/infarction	Strongly suggestive of ischemia/infarction	Strongly suggestive of ischemia	Suggestive but atypical for ischemia

(b) ECG Findings

STEMI	High-probability ACS: (NSTEMI or definite UAP)	Moderate-probability ACS	Low-probability ACS
Ischemic ST elevation at the J point in 2 or more contiguous leads (≥ 2 mm in men or ≥ 1.5 mm in women in leads V2–V3 or ≥ 1 mm in other contiguous chest leads or limb leads) **OR** ST depression in ≥ 2 leads (V1–V4) (may indicate acute posterior MI) **OR** New or presumably new left bundle branch block (LBBB) that obscures ST-segment analysis, with MI symptoms **OR** Rarely, hyperacute T-waves (in very early phase of STEMI, before ST elevation develops) **Note:** Multilead ST depression combined with ST elevation in lead aVR has been noted in left main or proximal left anterior descending (LAD) artery occlusion.	New ST depression ≥ 1 mm **OR** Deep T-wave inversion **Note:** If symptoms persist, strongly consider serial ECG every 15 minutes.	Normal or non-specific, with or without pain. **Note:** Must be normal at 0 and 3 hours from ED arrival, and consider ECG at 6, 12, and 18 hours. If abnormal, continue with "High-probability ACS" column.	Normal or non-specific, with or without pain. **Note:** Must be normal at 0 hours and at 3 to 6 hours from ED arrival. If abnormal, continue with "High-probability ACS" column.

(c) HEART Risk Score for NSTEMI/UAP[FRI]

This score predicts the short-term risk of subsequent mortality, new/recurrent MI, or severe ischemia for patients with NSTEMI or unstable angina pectoris (UAP). A higher score may warrant a higher ACS probability and more aggressive treatment. **Diagnosis of STEMI is primarily based on ECG findings, and rapid reperfusion is the goal for all STEMI patients, regardless of estimated mortality.**

HEART composition	Score	
History	Highly suspicious	**2**
	Moderately suspicious	**1**
	Slightly suspicious	**0**
ECG	Significant ST depression	**2**
	Nonspecific polarization disturbance	**1**
	Normal	**0**
Age	≥ 65 years	**2**
	45–64	**1**
	≤ 44	**0**
Risk factors	≥ 3 risk factors or history of atherosclerotic disease	**2**
	1–2 risk factors	**1**
	No risk factors	**0**
Troponin-I (cTn-I)	> 2 x normal limit	**2**
	1–2 x normal limit	**1**
	< normal limit	**0**

How to score:	
Scores 0–3: 0.9–1.7 % MACE over next 6 weeks	Low Risk
Scores 4–6: 12–16.6 % MACE over next 6 weeks	Moderate Risk
Scores ≥ 7: 50–65 % MACE over next 6 weeks	High Risk

Notes:

- **Critical actions**: Do not use this classification if new ST elevation requiring immediate intervention or clinically unstable patient.
- **MACE** is defined as all-cause mortality, MI, or coronary revascularization.
- **Risk factors:** Diabetes mellitus (DM), current or recent (< 1 month) smoker, hypertension, hyperlipidemia, family history of coronary artery disease (CAD), and obesity.

TABLE 1: Management of ACS

Diagnosis		STEMI (ST-elevation MI)		High-probability ACS Non-ST-elevation MI (NSTEMI) **OR** definite unstable angina pectoris (UAP)	
Admit status		Cath lab / CCU / ICU		CCU / ICU	
Goal		**Urgent** reperfusion		**Rapid** reperfusion	
Patient criteria		**If ≤ 90 minutes:**	**If > 90 minutes:**	**For onsite urgent or early invasive intervention (< 12 hours after onset of symptoms)**	**Elective invasive intervention or transport patient (ideally <48 hours after onset of symptoms)**
Emergency Department	**Initial diagnostics and therapeutics**	• **PERFORM** ECG. • **ARRANGE** for immediate percutaneous coronary intervention (PCI).[1] (See STEMI Power Plan in iCentra.)	• **PERFORM** ECG. • **GIVE** fibrinolytic in ≤ 30 minutes (see TABLE 3). **Do not give GPI (GP IIb/IIIa inhibitor) with fibrinolytic.** • **TRANSFER** immediately to interventional center for PCI.	• **PERFORM** serial ECG every 15 minutes. • **ARRANGE** for possible percutaneous coronary intervention (PCI) (immediately for ongoing chest pain or hemodynamic instability).	• **PERFORM** serial ECG every 15 minutes. • **TRANSFER** to interventional center immediately if ongoing pain or within 24 hours (≤ 12 hours preferred).
	Drugs Contraindications (see pages 6–7)	• Aspirin, NTG, and O_2 • Atorvastatin (80 mg) • Heparin bolus only (see TABLE 4) • Morphine PRN	• Aspirin, NTG and O_2 • Atorvastatin (80 mg) • Clopidogrel: – Age <75: 300 mg PO – Age ≥75: 75 mg PO • Enoxaparin (see TABLE 5) • Morphine PRN • GPI or anticoagulant per cardiologist (e.g., for high clot burden) **GPI is contraindicated with TNKase.**	• Aspirin, NTG, and O_2 • Atorvastatin (80 mg) • Heparin bolus only (see TABLE 4) • Morphine PRN	• Aspirin, NTG, and O_2 • Atorvastatin (80 mg) • Enoxaparin (see TABLE 5) **or** Heparin (see TABLE 6) • Tirofiban[5] or $P2Y_{12}$ agent per cardiologist (see TABLE 7) • Morphine PRN
Cath Lab[2]	**Drugs**	**SELECT one:** • Clopidogrel 600 mg • Ticagrelor 180 mg • Prasugrel[2] 60 mg PO (loading doses) **AND** • Anticoagulant: heparin or bivalirudin May consider GPI per cardiologist (e.g., for high clot burden)		**SELECT one:** • Clopidogrel 600 mg • Ticagrelor 180 mg • Prasugrel[2] 60 mg PO (loading doses) **AND** • Anticoagulant: heparin or bivalirudin May consider GPI per cardiologist (e.g., high clot burden	**SELECT one:** • Clopidogrel 600 mg • Ticagrelor 180 mg • Prasugrel[2] 60 mg PO (loading doses) **AND** • Additional enoxaparin per guideline
Hospital-Based Care	**Diagnosis**	**STEMI, NSTEMI, and UAP**			
	Initial testing	• **PERFORM** ECG at 6, 12, and 18 hours after admission. • **PERFORM** troponin-I testing at 6, 12, and 18 hours after admission. • **SCHEDULE** lipid and HbA1c for morning after admission.			
	Drugs as needed	• Oral beta blocker[3]: **PRESCRIBE** at discharge post-MI or if ejection fraction (EF) < 40 % • ACE inhibitor (ACEI) or ARB: **PRESCRIBE** when blood pressure becomes stable (required for EF < 40 %). • Aspirin: **PRESCRIBE** 81 mg per day.		• Aldosterone blocker: **CONSIDER** if EF <40% and symptomatic heart failure or diabetes are present. **CONSIDER** contraindications and follow up. • $P2Y_{12}$ inhibitor for at least 12 months[4]: **PRESCRIBE** one of the following: clopidogrel (75-150 mg/day for 1 week followed by 75 mg/day) **OR** ticagrelor (90 mg twice daily) **OR** prasugrel (10 mg/day)[2].	

1. **Immediate Cath/PCI:** On-site cath lab or transferable to interventional center in <60 minutes from ED to receiving hospital cath lab. **REFER** to STEMI orders: Primary PCI or STEMI orders: Fibrinolytic Pathway.
2. **Clopidogrel, prasugrel, and ticagrelor:** **CONSIDER** platelet function testing for all ACS and high-risk elective PCI patients; see *Antiplatelet Guidelines*. Prasugrel: **CONSIDER** delay until after angiography for NSTEMI/UAP. **AVOID** if cerebrovascular accident (CVA) or transient ischemic attack (TIA) history. Can use for patients <75 years and >60 kg. (**CONSIDER** 5 mg daily for patients >75 years or <60 kg.)
3. **Oral beta blocker (BB):** **GIVE** within 24 hours for patients without signs of heart failure (HF), low-output, risk for cardiogenic shock, or other relative contraindications. **AVOID** IV BB except in STEMI patients with hypertension or tachyarrythmias and without signs of HF, low-output, risk for cardiogenic shock, or other relative contraindications.
4. **$P2Y_{12}$ inhibitor:** May discontinue earlier, especially for bare metal stent, if patient is at high bleeding risk.
5. **Tirofiban:** **CONSIDER** discontinuing 4–6 hours after clopidrogrel load or 2–4 hours after prasugrel/ticagrelor **OR** **CONSIDER** infusing up to 18 hours for highest risk cases.

TABLE 1: Management of ACS (continued)

Diagnosis		Moderate-probability ACS	Low-probability ACS
Emergency Department		• **PERFORM** serial ECG every 15 minutes. • **ORDER** cTroponin-I. • **ADMIT** for further workup.	• Outpatient care • REFER to ***Proven Imaging: Known or Suspected CAD CPM*** to determine if imaging is appropriate.
Hospital-Based Care	**Initial Diagnostics and Therapeutics**	• **MANAGE** symptoms. • **OBSERVE** telemetry for arrhythmia. • If ongoing chest pain, **MANAGE** as definite UAP in TABLE 1. • **OBTAIN** serial troponin-I as described in TABLE 2 below to determine if more invasive treatment or imaging may be indicated.	
	Initial drugs	• Aspirin, nitroglycerin, and O_2. • Enoxaparin (see TABLE 5) or heparin (see TABLE 6). • Oral beta blocker[2]. • Morphine PRN.	
	Ongoing drugs	• Statins. • ACE inhibitor (or ARB) when blood pressure becomes stable (required for EF < 40 %). • Aldosterone blocker if EF < 40 % and symptomatic HF or DM. • If PCI, $P2Y_{12}$ inhibitor for at least 12 months for bare metal stent or drug-eluting stent.[3] Dosing:[1] (**SELECT one**) – Clopidogrel (75 mg/day) – Ticagrelor (90 mg twice daily) – Prasugrel (10 mg/day)[1]	

1. **Clopidogrel, prasugrel, and ticagrelor:** **CONSIDER** platelet function testing for all ACS and high-risk elective PCI patients; see ***Antiplatelet Guidelines***. Prasugrel: **CONSIDER** delay until after angiography for NSTEMI/UAP. **AVOID** if CVA or TIA history. Can use for patients < 75 years and > 60 kg. (**CONSIDER** 5 mg daily for patients > 75 years or < 60 kg.)
2. **Oral beta blocker (BB):** **GIVE** within 24 hours for patients without signs of HF, low-output, risk for cardiogenic shock, or other relative contraindications. **AVOID** IV BB except in STEMI patients with hypertension or tachyarrhythmias and without signs of HF, low-output, risk for cardiogenic shock, or other relative contraindications.
3. **$P2Y_{12}$ inhibitor:** May discontinue earlier, especially for bare metal stent, if patient is at high bleeding risk.

TABLE 2. Inpatient Serial Troponin Guideline

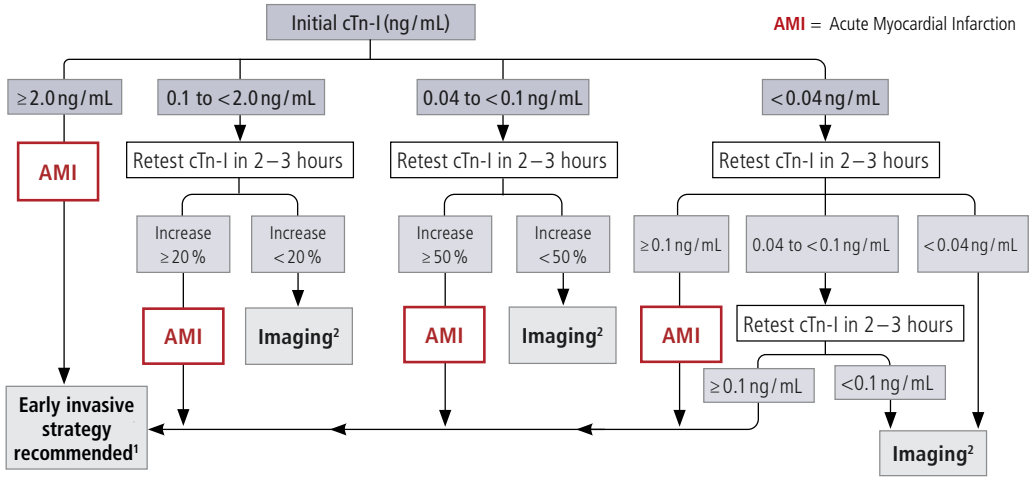
May or may not be elevated at 0 hours; typically elevated at 6 hours post-event onset.

Initial diagnosis and reperfusion decision must be made immediately, before troponin-I results are available.

Non-AMI causes of elevated cTn-I

The conditions below can also elevate cTn-I. Elevated cTn-I, even with a non-AMI cause, brings higher clinical risk.

- Heart failure
- Viral or stress cardiomyopathy
- Myocarditis, pericarditis
- Trauma
- Stroke
- Subarachnoid hemorrhage
- Malignancy
- Pulmonary embolism
- Infiltrative diseases
- Toxicity or sepsis
- Renal failure
- Ablation procedures



1 ADMIT to hospital. Begin aspirin and enoxaparin therapy. **CONSIDER:** Beta blocker, tirofiban (if ongoing chest pain), left heart catheterization.
2 SELECT most appropriate imaging test based on patient-specific factors. See ***Proven Imaging for Known or Suspected CAD*** CPM.

TABLE 3. TNKase Dosing Instructions (see *Tenecteplase (TNKase) clinical guideline*)

Weight (kg)	Dose (IV bolus over 5 seconds)	Notes	Indications	Contraindications
<60	30 mg	• **Do not give if GPI (GP IIb/IIIa inhibitor) was given** (e.g., abciximab, eptifibatide, or tirofiban). • Also, begin enoxaparin with TNK bolus (see table 5 below).	• ECG showing **ANY** of the following: – Ischemic ST elevation (>1 mm) in 2 or more contiguous leads – Hyperacute T-waves – Signs of acute posterior MI or LBBB obscuring ST segment analysis with MI history • History of ACS • Pain/symptoms within the past 24 hours with or without ongoing symptoms	• Previous hemorrhagic stroke at any time; other strokes or cerebrovascular events within 1 year • Known intracranial neoplasm • Active internal bleeding (does not include menses) • Suspected aortic dissection
60–69	35 mg			
70–79	40 mg			
80–89	45 mg			
>90	50 mg			

Cautions and relative contraindications

- Severe, uncontrolled hypertension on presentation (>180/110 mmHg) or history of chronic severe hypertension
- History of CVA or known intracerebral pathology
- Current warfarin therapy (INR >2–3); known bleeding diathesis
- Current therapy with direct oral anticoagulant (DOAC)
- Recent trauma, prolonged CPR (>10 minutes), or major surgery (<3 weeks)
- Non-compressible vascular punctures
- Recent (within 2–4 weeks) internal bleeding
- Age >75 years
- Pregnancy
- Active peptic ulcer

TABLE 4. STEMI/NSTEMI: Unfractionated Heparin Bolus Only for Patients Going to the Cath Lab

Weight (kg)	IV bolus dose (60 units/kg)
<46	2500 units
46–52	3000 units
53–61	3500 units
62–70	4000 units
71–80	5000 units
81–90	5500 units
>90 (based on kg)	6000 units max if PCI with GPI; 8000 units max if PCI without GPI

Notes:

- **UFH (unfractionated heparin) contraindications:** Active major bleeding; recent or planned epidural anesthesia; known or suspected heparin-induced thrombocytopenia (HIT). For HIT, **DO NOT** use heparin or low-molecular-weight heparin (LMWH); use a direct thrombin inhibitor.
- **Cautions:** Thrombocytopenia (platelets <100,000/mm^3) or bleeding diathesis; recent internal bleeding or uncontrollable active bleeding (admission or transfusion in past 30 days); recent surgery (within the past 2 weeks), major trauma or thrombotic stroke; acute peptic ulcer disease.

TABLE 5. Enoxaparin Dosing Instructions (see *Enoxaparin guideline*)

Age (years)	Fibrinolytic STEMI		NSTEMI	
	CrCl ≥30 mL/min	CrCl <30 mL/min	CrCl ≥30 mL/min	CrCl <30 mL/min
<75	30 mg IV bolus followed 15 min. later by 1 mg/kg subcut **every 12 hours** (max 100 mg first 2 doses)	30 mg IV bolus followed 15 min. later by 1 mg/kg subcut **once daily** (max 100 mg first 2 doses)	1 mg/kg subcut **every 12 hours**	1 mg/kg subcut **once daily**
≥75	**No bolus.** 0.75 mg/kg subcut **every 12 hours** (max 75 mg first 2 doses)	**No bolus.** 1 mg/kg subcut **once daily** (max 75 mg first 2 doses)		

Notes:

- **Contraindications:** Hemodialysis; active major bleeding; recent or planned epidural or dural anesthesia; known or suspected HIT; weight >190 kg or women <45 kg and men <57 kg.
- **Lab monitoring:** Draw a baseline BMP, aPTT STAT (include CBC, PT/INR if not done in last 24 hours); draw CBC every other day while hospitalized; monitor BMP if clinical situation suggests risk of renal function decline.
- **Cautions:** Thrombocytopenia (platelet count <100,000/mm^3) or known bleeding diathesis; recent internal bleeding or uncontrollable active bleeding (hospital admission or transfusion in last 30 days); recent (within the previous 2 weeks) surgery, major trauma, or thrombotic stroke; acute peptic ulcer disease.

TABLE 6. Unfractionated Heparin (NSTEMI)

Initial dosage and infusion rate of unfractionated heparin (standard concentration of 100 units / mL) in NSTEMI

Weight (kg)	Bolus dose (units)	Infusion rate (units / hour)
< 46	2500	500
46 – 52	3000	600
53 – 61	3500	700
62 – 70	4000	800
70 – 77	4000	900
Over 77 kg	4000	1000

Monitoring and adjustment of unfractionated heparin in NSTEMI

Steps

- Draw baseline aPTT* STAT (include CBC, PT / INR if not done in last 24 hours).
- Give initial dosage as directed in top half of this table (above).
- Use aPTT testing to monitor and adjust dose as per table below.

aPTT (in sec)	Heparin	Infusion rate	Labs
< 40	Bolus 3000 units	Increase by 100 units / hour	aPTT every 6 hours x 2
40 – 49	None	Increase by 50 units / hour	
50 – 70	None	No change	aPTT per protocol**
71 – 85	None	Decrease by 50 units / hour	aPTT every 6 hours x 2
86 – 100	Hold for 30 minutes	Decrease by 100 units / hour	
101 – 150	Hold for 30 minutes	Decrease by 150 units / hour	
Over 150	Hold for 1 hour	Decrease by 300 units / hour	

*aPPT= activated partial thromboplastin time

** After 2 consecutive aPTTs in the therapeutic range of 50 – 70 seconds, draw aPTT daily in AM.

TABLE 7. Tirofiban (Aggrastat) Dosing for ACS or PCI Treatment

Creatinine clearance	Dosing regimen name	Bolus dose[1,2]	Infusion dose
≥ 60 mL / min	Standard dose	25 mcg / kg over 2 – 5 minutes	0.15 mcg / kg / min
< 60 mL / min	Renal dose	25 mcg / kg over 2 – 5 minutes	0.075 mcg / kg / min

1. The pump library is set up to deliver the bolus and maintenance infusion.
2. Obtain platelet count 3 hours after initial tirofiban bolus.
3. Consider discontinuing 4 – 6 hours after clopidogrel load or 2 – 4 hours after prasugrel / ticagrelor OR CONSIDER infusing up to 18 hours for highest risk cases.

Notes:

Contraindications:

- Active internal bleeding or bleeding diathesis in past 30 days
- History of intracerebral hemorrhage (ICH), arteriovenous malformation (AVM), aneurysm, intracranial neoplasm, or thrombocytopenia after prior tirofiban exposure
- Stroke in past 30 days or any history of hemorrhagic stroke
- Severe hypertension (systolic > 180 or diastolic > 110)
- Major surgery or trauma in past 30 days
- Concurrent use of other parenteral GB IIB / IIIA inhibitors and / or thrombolytics
- Acute pericarditis
- History or signs of aortic dissection

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This CPM presents a model of best care based on the best available scientific evidence at the time of publication. It is not a prescription for every physician or every patient, nor does it replace clinical judgment. All statements, protocols, and recommendations herein are viewed as transitory and iterative. Although physicians are encouraged to follow the CPM to help focus on and measure quality, deviations are a means for discovering improvements in patient care and expanding the knowledge base. Send feedback to David Min, M.D., Intermountain Healthcare Interim Chief of Cardiology, Intermountain Medical Center Heart Institute (David.Min@imail.org).

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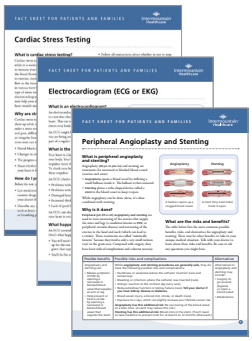
PATIENT AND PROVIDER RESOURCES

Physicians can order Intermountain patient education booklets and fact sheets (available in English and Spanish) for distribution to their patients from Print It!.

Fact sheets:

- *Cardiac Stress Testing (English)/(Spanish)*
- *Electrocardiogram (ECG or EKG) (English)/(Spanish)*
- Peripheral *Angioplasty and Stenting* (English)/*(Spanish)*



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