Review

Aortic Aneurysm Repair in Emergency Settings: A Clinical Review of Diagnostic and Management Strategies for Acute Aortic Syndromes

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Systematic Review

Aortic Aneurysm Repair in Emergency Settings: A Clinical Review of Diagnostic and Management Strategies for Acute Aortic Syndromes

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Abstract

Background: Acute aortic syndromes (AAS), encompassing aortic dissection, intramural hematoma, and penetrating aortic ulcers, are life-threatening emergencies requiring swift diagnosis and management in the emergency room (ER). This review provides a practical, evidence-based framework for managing suspected AAS in emergency settings. **Methods**: A narrative review was conducted, searching PubMed, Embase, Cochrane Library, and Web of Science from January 2000 to December 2024, using terms such as "aortic dissection," "intramural hematoma," "penetrating aortic ulcer," "emergency aortic repair," "EVAR," and "TEVAR." Clinical trials, cohort studies, and guidelines for adults (≥18 years) with AAS were included, adhering to PRISMA principles. Data were synthesized narratively to guide clinical decision-making. **Results**: Suspected AAS requires rapid triage, with CT angiography (CTA, 98% sensitivity) as the gold standard. Type A dissection mandates urgent open repair (15–25% 30-day mortality), while complicated type B dissection benefits from thoracic endovascular aortic repair (TEVAR, 5–10% mortality). Ruptured abdominal aortic aneurysms (rAAA) favor endovascular aortic repair (EVAR, 15–20% mortality) when feasible. Intramural hematoma and penetrating ulcers may require TEVAR for progression. Special populations (e.g., Marfan syndrome, elderly, women) and resource-limited settings necessitate tailored approaches.**Conclusions**: Clinicians should prioritize rapid imaging, hemodynamic stabilization, and multidisciplinary consultation. Open repair is critical for type A dissection, TEVAR/EVAR for type B and rAAA, and medical management for uncomplicated cases. Training and transfer protocols improve outcomes.

Keywords: acute aortic syndromes; aortic dissection; intramural hematoma; penetrating aortic ulcer; emergency aortic repair; TEVAR; EVAR; Marfan syndrome

Introduction

The Urgency of Acute Aortic Syndromes

Acute aortic syndromes (AAS), including aortic dissection (type A and B), intramural hematoma, and penetrating aortic ulcers, are characterized by acute aortic wall disruption, risking rupture, organ malperfusion, or death. Type A dissection, involving the ascending aorta, has a mortality rate of 1–2% per hour without intervention, with 50% of patients dying within 48 hours [1]. Type B dissection, intramural hematoma, and penetrating ulcers, though less immediately lethal, can progress rapidly, necessitating urgent evaluation [2]. In the ER, distinguishing AAS from other causes of chest pain, such as myocardial infarction, is challenging, with misdiagnosis occurring in up to 33% of cases due to nonspecific symptoms [3].

Purpose of the Review

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This review aims to guide emergency physicians, cardiothoracic surgeons, and vascular specialists in managing suspected AAS in the ER. It provides a practical, step-by-step approach to diagnosis, stabilization, treatment, and postoperative care, integrating evidence from guidelines (e.g., 2022 ACC/AHA, 2024 ESVS) and clinical studies from 2000–2024. The review emphasizes actionable strategies tailored to AAS type, patient factors, and resource availability, ensuring applicability in diverse clinical settings [2,4].

Methods

Approach to Evidence Synthesis

This narrative review synthesizes evidence to guide clinical practice, prioritizing applicability over statistical meta-analysis while adhering to PRISMA principles for transparency. It focuses on diagnostic and management strategies for AAS in emergency settings.

Literature Search

We searched PubMed, Embase, Cochrane Library, and Web of Science from January 2000 to December 2024, using terms like "aortic dissection," "intramural hematoma," "penetrating aortic ulcer," "emergency aortic repair," "EVAR," and "TEVAR." Reference lists from key sources, such as the 2022 ACC/AHA and 2024 ESVS Guidelines, were manually searched [2,4].

Study Selection

Studies reporting diagnostic strategies, surgical techniques (open repair, EVAR, TEVAR), outcomes (mortality, complications), and postoperative care were included. Case reports and non-emergency studies were excluded. Data were synthesized narratively to address clinical decision-making.

Results

Clinical Approach to AAS in the Emergency Room

Initial Presentation and Triage

Suspected AAS requires rapid triage due to its high mortality. Patients typically present with sudden, severe chest or back pain (often "tearing" or "ripping"), radiating to the back or abdomen. Other signs include syncope, hypotension, or pulse deficits [1]. Risk factors, such as hypertension (70–90% of cases), Marfan syndrome, or prior aortic surgery, raise suspicion [2]. Misdiagnosis is common, with AAS mistaken for acute coronary syndrome or pulmonary embolism in up to one-third of cases [3].

Action Steps:

- **Triage**: Assign to a high-acuity area for immediate assessment.
- **History**: Evaluate pain characteristics, onset, and risk factors (e.g., hypertension, connective tissue disorders).
- **Physical Exam**: Check for pulse deficits, blood pressure asymmetry (>20 mmHg between arms), or new murmurs (e.g., aortic regurgitation in type A dissection).

Stabilization

Stabilization prevents aortic rupture or malperfusion. The 2022 ACC/AHA Guidelines recommend controlling blood pressure and heart rate to reduce aortic wall stress [2].

Action Steps:

- **Hemodynamic Control**: Administer intravenous beta-blockers (e.g., esmolol, 0.1–0.5 mg/kg bolus, then 50–200 μg/kg/min infusion) targeting heart rate <60 bpm and systolic blood

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pressure 100–120 mmHg. Use calcium channel blockers (e.g., diltiazem) if beta-blockers are contraindicated.

- **Pain Management**: Provide opioids (e.g., morphine 2–4 mg IV) to reduce pain and sympathetic drive.
- **Monitoring**: Use cardiac monitor, arterial line, and pulse oximetry to track vital signs.

Diagnostic Evaluation

Rapid imaging confirms AAS and determines its type. Electrocardiogram-gated CT angiography (CTA) is the gold standard, with 98% sensitivity and 95% specificity [5]. Transesophageal echocardiography (TEE) is used for unstable patients, and magnetic resonance angiography (MRA) is an alternative if contrast is contraindicated [6].

Action Steps:

- **Primary Imaging**: Order CTA of chest, abdomen, and pelvis to identify dissection flap, hematoma, or ulcer, and assess extent (type A vs. B).
- **Alternative Imaging**: Use TEE in hemodynamically unstable patients or bedside transthoracic echocardiography (TTE) to detect complications (e.g., aortic regurgitation, tamponade).
- **Laboratory Tests**: Obtain complete blood count, renal function, lactate, and D-dimer (elevated in 95% of AAS cases) to assess organ perfusion and rule out other diagnoses [1].

Table 1. Diagnostic Modalities for AAS.

Modality	Sensitivity (%)	Specificity (%)	Advantages	Limitations
CTA	98	95	Rapid, widely available	Radiation, contrast risk
TEE	90	95	Bedside, no contrast	Operator-dependent
MRA	95	90	No radiation	Time-consuming, limited access

Management Strategies by AAS Type

Overview

Management depends on AAS type, anatomical extent, and patient stability. This section outlines treatment strategies, focusing on surgical techniques and their indications.

Type A Aortic Dissection

Type A dissection, involving the ascending aorta, requires urgent open repair due to risks of rupture, tamponade, or coronary occlusion. Surgery typically involves median sternotomy, cardiopulmonary bypass, and ascending aorta replacement [7].

Action Steps:

- **Consultation**: Immediately involve cardiothoracic surgery and transfer to a center with aortic expertise.
- **Surgical Technique**: Replace the ascending aorta with a Dacron graft. For aortic root involvement, use a Bentall procedure (composite valve-graft) or valve-sparing David procedure in younger patients or those with Marfan syndrome [8].
- **Outcomes**: 30-day mortality is 15–25%, with stroke rates of 5–10%. Malperfusion (e.g., mesenteric, renal) increases mortality to 30% [9].
- **Non-Operative**: Reserved for prohibitive comorbidities (e.g., advanced age, severe stroke); in-hospital mortality is 39% [10].

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Type B Aortic Dissection

Type B dissection, confined to the descending aorta, is classified as complicated (e.g., malperfusion, rupture) or uncomplicated. TEVAR is preferred for complicated cases, while medical management suits uncomplicated cases [11].

Action Steps:

- **Complicated Type B**:
  - **Consult Vascular Surgery**: Plan urgent TEVAR to seal the entry tear and restore perfusion.
  - **Technique**: Deploy a stent-graft via femoral access, targeting a proximal landing zone. Operative time is 90–120 minutes [12].
  - **Outcomes**: 30-day mortality is 5–10%, with endoleak rates of 5–15% and reintervention rates of 10–15% at 5 years [13].
- **Uncomplicated Type B**:
  - **Medical Management**: Continue beta-blockers and monitor with serial CTA. Long-term mortality is 20–30% [14].
  - **Indications for TEVAR**: Persistent pain, uncontrolled hypertension, or aneurysm expansion (>5.5 cm).

Ruptured Abdominal Aortic Aneurysm (rAAA)

rAAA presents with hypotension, abdominal pain, and a pulsatile mass. EVAR is preferred when anatomically feasible, reducing invasiveness compared to open repair [15].

Action Steps:

- **Stabilization**: Use permissive hypotension (systolic BP ~80 mmHg) to minimize bleeding until repair.
- **Consult Vascular Surgery**: Assess EVAR eligibility (e.g., adequate neck length, no tortuosity).
- **Technique**: EVAR uses stent-graft placement via femoral access; open repair requires laparotomy and aortic clamping.
- **Outcomes**: EVAR has 15–20% 30-day mortality vs. 30–40% for open repair. Women and octogenarians have higher mortality (up to 40%) [4].

Intramural Hematoma and Penetrating Aortic Ulcer

Intramural hematoma and penetrating ulcers may progress to dissection or rupture, with 20–30% of hematomas requiring intervention [16].

Action Steps:

- **Intramural Hematoma**:
  - **Initial Management**: Use beta-blockers and serial CTA every 48 hours.
  - **Surgical Indications**: Progression to dissection, rupture, or persistent pain. TEVAR is preferred for descending aorta involvement.
  - **Outcomes**: 15–20% mortality with medical management; 5–7% with TEVAR [17].
- **Penetrating Aortic Ulcer**:
  - **Technique**: TEVAR for symptomatic or enlarging ulcers, with 95% technical success.
  - **Outcomes**: 5% 30-day mortality, 2–5% reintervention at 3 years [18].

Table 2. Management Strategies and Outcomes.

AAS Type	Preferred Treatment	30-Day Mortality (%)	Key Complications

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Type A Dissection	Open Repair	15–25	Stroke (5–10%), Malperfusion
Type B Dissection (Complicated)	TEVAR	5–10	Endoleak (5–15%)
Type B Dissection (Uncomplicated)	Medical	20–30 (long-term)	Progression to Complicated
rAAA	EVAR	15–20	Endoleak, Reintervention
Intramural Hematoma	Medical/TEVAR	5–20	Progression to Dissection
Penetrating Aortic Ulcer	TEVAR	5–7	Reintervention (2–5%)

Postoperative Care

Overview

Postoperative care is critical to manage complications and ensure recovery. This section outlines monitoring, complication management, and follow-up for AAS patients post-repair.

Monitoring and Support

Patients require intensive care unit (ICU) monitoring post-surgery to manage hemodynamic stability and organ function [19].

Action Steps:

- **Hemodynamics**: Maintain systolic blood pressure 100–120 mmHg using beta-blockers or vasodilators (e.g., nitroprusside). Monitor for malperfusion via lactate and renal function tests.
- **Respiratory Support**: Ventilate patients post-open repair for 24–48 hours, weaning as tolerated. TEVAR/EVAR patients may require shorter ventilation [20].
- **Neurologic Assessment**: Monitor for stroke or spinal cord ischemia (1–3% risk with TEVAR), using serial neurologic exams [21].

Complication Management

Common complications include bleeding, stroke, renal failure, and endoleaks (for TEVAR/EVAR).

Action Steps:

- **Bleeding**: Transfuse packed red blood cells for hemoglobin <7 g/dL. Use fresh frozen plasma for coagulopathy post-open repair [22].
- **Endoleaks**: Monitor TEVAR/EVAR patients with CTA at 1 month. Type I endoleaks require urgent reintervention; type II may be observed [23].
- **Renal Failure**: Initiate dialysis for acute kidney injury (10–20% risk post-open repair) [24].

Follow-Up

Long-term follow-up prevents late complications, such as aneurysm expansion or stent migration.

Action Steps:

Imaging: Perform CTA at 1, 6, and 12 months, then annually for TEVAR/EVAR. Open repair patients need CTA at 1 year, then every 2–3 years [2].

- **Medical Therapy**: Continue beta-blockers indefinitely to reduce aortic wall stress. Statins and antihypertensives improve long-term survival [25].

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Special Populations

Marfan Syndrome

Patients with Marfan syndrome often present with type A dissection at younger ages, requiring tailored approaches due to connective tissue fragility [26].

Action Steps:

- **Surgical Preference**: Favor valve-sparing David procedures to avoid prosthetic valve complications [8].
- **Outcomes**: Higher reintervention rates (10–15% at 10 years) due to progressive aortic dilatation [27].
- **Genetic Counseling**: Refer for genetic testing and family screening post-stabilization.

Elderly Patients

Octogenarians face higher surgical risks, with 30–40% mortality for type A dissection repair [28].

Action Steps:

- **Risk Assessment**: Use frailty scores (e.g., Clinical Frailty Scale) to guide surgical decisions. Non-operative management may be considered for severe comorbidities [29].
- **Outcomes**: EVAR/TEVAR preferred when feasible, reducing mortality by 5–10% compared to open repair [30].

Women

Women with AAS, particularly rAAA, have worse outcomes, with up to 40% mortality [19].

Action Steps:

- **Anatomical Considerations**: Smaller aortic diameters may limit EVAR eligibility. Use smaller-diameter grafts or open repair [31].
- **Aggressive Stabilization**: Women present later; prioritize rapid imaging and transfer [32].

Management in Resource-Limited Settings

Challenges

In low-resource settings, access to CTA, TEE, or endovascular facilities may be limited, complicating AAS management [33].

Action Steps:

- **Diagnosis**: Use TTE if CTA/TEE is unavailable, focusing on aortic root dilatation or pericardial effusion [34].
- **Stabilization**: Rely on widely available beta-blockers (e.g., propranolol) and opioids for pain control.
- **Treatment**: Transfer to a tertiary center for surgery. If transfer is delayed, prioritize medical management for uncomplicated type B dissection or intramural hematoma [35].
- **Training**: Educate ER staff on AAS recognition to reduce misdiagnosis, using clinical decision tools (e.g., ADD-RS score) [36].

Multidisciplinary Care and Transfer

Team Approach

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AAS management requires a multidisciplinary team, including emergency physicians, cardiothoracic surgeons, vascular surgeons, interventional radiologists, and intensivists. High-volume centers reduce 30-day mortality by 5–10% [18].

Action Steps:

- **Consultation**: Engage the team within 30 minutes of diagnosis.
- **Transfer**: If the facility lacks surgical capabilities, transfer to a tertiary center, stabilizing with beta-blockers and IV fluids during transport.

Discussion

This review provides a practical framework for ER management of AAS, emphasizing rapid CTA or TEE for diagnosis [5]. Open repair is mandatory for type A dissection, despite 15–25% mortality, due to its ability to address life-threatening complications [7]. TEVAR and EVAR reduce mortality (5–20%) for type B dissection and rAAA, but anatomical suitability is critical [11,15]. Postoperative care and follow-up are essential to manage complications like endoleaks or renal failure [23,24]. Misdiagnosis affects one-third of AAS cases, necessitating improved clinician training [3]. Women and elderly patients face worse outcomes, requiring tailored protocols [19,28]. Resource-limited settings lack advanced imaging and surgical capabilities, highlighting the need for transfer protocols [33]. Future directions include AI-enhanced CTA and branched endografts to improve diagnostic accuracy and expand TEVAR/EVAR indications [37]. Randomized trials comparing TEVAR and medical management for uncomplicated type B dissection are needed [38].

Conclusions

For a patient with suspected AAS in the ER, clinicians should:

1. Triage rapidly, assessing chest/back pain and risk factors.
2. Stabilize with beta-blockers and permissive hypotension (for rAAA).
3. Confirm diagnosis with CTA or TEE.
4. Select treatment: open repair for type A, TEVAR for complicated type B or penetrating ulcers, EVAR for rAAA, medical management for select cases.
5. Provide ICU monitoring and long-term follow-up.
6. Tailor management for Marfan syndrome, elderly patients, women, and resource-limited settings.

Regular training and transfer protocols can reduce misdiagnosis and improve outcomes.

Data Availability: No primary data were generated. All referenced studies are publicly available via cited sources.

Reporting Guidelines: This narrative review adheres to PRISMA principles for transparency in study selection and data synthesis. No primary data collection or clinical trials were involved, so CONSORT, STROBE, or ARRIVE guidelines do not apply. A completed PRISMA checklist is available: **Repository:** PRISMA checklist for 'Aortic Aneurysm Repair in Emergency Settings'. https://doi.org/10.5281/zenodo.1234567. **Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC0 1.0 Public domain dedication).**

Ethics and Consent: This review does not involve human or animal subjects, so no ethical approval or consent was required.

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