

# Emergency Medical Services

## Winter 2023

### Right ventricular failure

*Daniel Adams, MD*

Right ventricular (RV) failure is a frequently missed presentation for patients presenting with cardiogenic shock, and its identification and management in the field is extremely challenging. To some degree, it is almost impossible. That said, there are some specific pearls and pitfalls in managing patients we know could have RV dysfunction, such as right-sided ST Elevation Myocardial Infarction (STEMI) and pulmonary hypertension.

[READ THE STORY](#)

## IN THE FIELD

### Rapid stroke transport

*Michelle Hill, MS, RN, Riverside Stroke Program Coordinator*

*Nirav Vora, MD, OhioHealth System Medical Director for Cerebrovascular Care*

We know stroke is a time-sensitive diagnosis, but what happens when you are faced with a long transport time to reach an appropriate facility? With two treatment options for stroke — thrombolytic or thrombectomy — knowing where to transport your stroke patients is essential.

Thrombolytics can be administered up to four and a half hours from last-known-well. If the patient is eligible for thrombolytics, they should be transported to the closest hospital.

Thrombectomy should be considered on all large vessel occlusion strokes. This is where the stroke severity scale used by your agency — LAMS, VAN or RACE — comes into play. A patient with a large vessel occlusion who is not eligible for thrombolytics and is 30 miles or more from a thrombectomy-capable or comprehensive stroke center should be considered for air ambulance transport.

In August, a rural EMS agency recognized a large vessel occlusion with a Los Angeles Motor Scale (LAMS) score of five. MedFlight was immediately activated and arrived at OhioHealth Riverside Methodist Hospital 90 minutes after the patient was last seen normal. The patient was taken for a thrombectomy, and we quickly opened the vessel 53 minutes after puncture. The patient was discharged home 4 days later.

## CASE STUDY

### Interventional treatment of pulmonary embolus

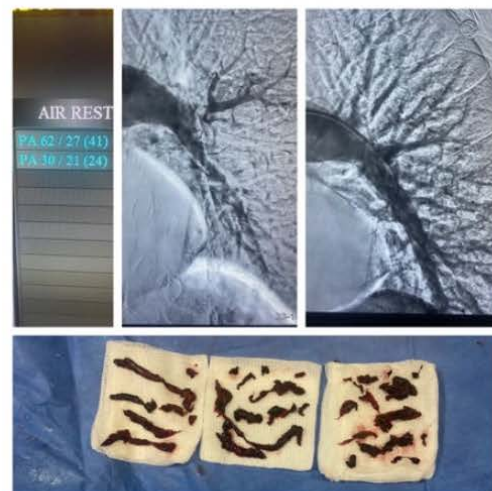
*Nicholas Davakis, MD, FACC*

*Grant Medical Center*

This patient is a 68-year-old gentleman with a long history of hypertension, but no other medical problems. In the week prior to this presentation, he had injured his leg while working in the yard. He experienced several days of shortness of breath and mild pleuritic chest discomfort. These symptoms became severe on the day of admission, prompting him to call 911 for transport to the emergency room. Upon arrival, his blood pressure was 90mm systolic, his O2 sat was 84% on 6 L and his initial evaluation included an abnormal brain natriuretic peptide (BNP) and troponin. He subsequently underwent a pulmonary computed tomography (CT) angiogram which demonstrated a large saddle embolus involving both the right and left pulmonary arteries as well as a right lower extremity deep vein thrombosis (DVT).



An echocardiogram was then performed, demonstrating a dilated hypokinetic right ventricle (RV) with normal left ventricle (LV) size and function. He diagnosed with an intermediate risk pulmonary embolism (PE) and, due to the large amount of thrombus present, was referred for urgent percutaneous pulmonary embolectomy. Upon initiation of the procedure, his main pulmonary artery pressure was elevated at 62/27. The angiogram demonstrated near complete occlusion of his right pulmonary artery, as well as significant thrombus in his left pulmonary artery. The procedure was completed



safely with the removal of a large amount of thrombus after his pulmonary artery pressure decreased to 30/21 and his clinical status improved dramatically.

The patient did remarkably well and was discharged the following morning on Eliquis.



This is an example of an intermediate risk pulmonary embolism (PE) that was an ideal candidate for percutaneous embolectomy. This resulted in a rapid improvement in his clinical status and likely significantly shortened his hospital stay.

## FAST FACTS

*Daniel Adams, MD*

Right ventricular failure is nearly impossible to diagnose in the field.

Pearls:

Right sided STEMI:

- Avoid nitroglycerin
- Gentle fluid boluses are okay
- Adhere to the ABCs
- Ensure aspirin is given
- Get to a percutaneous coronary intervention capable center asap

Patient with a history of pulmonary hypertension:

- Avoid hypotension, and use vasopressors\* to target a MAP >65
- Avoid aggressive fluid boluses unless history suggests volume depletion
- Avoid intubation if at all possible
- If there is an infusion pump – do not manipulate
- If there is an indwelling infusion catheter – do not use it
- Get to the patient’s primary pulmonary hypertension treatment facility if at all possible

Pulmonary embolism:

- Adhere to the ABCs
- Avoid aggressive fluid boluses unless history suggests volume depletion
- Avoid hypotension, and use vasopressors\* to target a MAP >65
- Avoid intubation if at all possible
- Consider the shock index as an indicator of progressive shock and need for emergent transport

## SERVICE LINE FEATURE



### Annual Trauma Conference Awards

*Stacey Wickham MS, BSN, CCRN-K, TCRN*

At the start of every annual Trauma Care conference, the trauma team presents awards to the EMS and referring partners who have shown outstanding care. While the OhioHealth Trauma Network knows that all care that takes place before the trauma center is vital to positive outcomes in our patients, these cases went above and beyond.

The Minutes to OhioHealth Trauma award is presented to our EMS partners inside “the belt” that have low transport times to an OhioHealth Trauma Center. The Rural EMS award is given to agencies outside “the belt” in a rural setting. Finally, the Golden Hour award is presented to a referring partner. [Case studies attached](#). This year’s winners are:

- Minutes to OhioHealth Trauma award – Columbus Fire Medic 6
- The Rural EMS award – Portsmouth Fire
- Golden Hour award – Southern Ohio Medical Center

OhioHealth Trauma Network appreciates and values the great work our referring and EMS partners do for our patients every day.

## EDUCATION UPDATE

*Barbara Dean, BSN, RN, Paramedic  
Program Manager*

COVID-19 has presented many challenges for our EMS providers trying to obtain continuing education. We have resources available to provide you the opportunity to learn on your schedule.

Visit [OhioHealthEMS.com](https://OhioHealthEMS.com) or use the QR code below for a list of our online education opportunities. If you would like to schedule training via Webex or visit for onsite training, send a request to [EMS@OhioHealth.com](mailto:EMS@OhioHealth.com).



## DIRECTOR'S CORNER

*Holly Herron, DNP, RN, CNP*

This past year, the Trauma Care 2022 Conference was held both virtually and in person. This allowed us to reach a greater audience who would otherwise have not been able to attend on December 15 and 16, 2022, at the Hilton at Easton. The topics presented were diverse and outstanding. We hope you were able to attend.

Watch out for a full calendar of face-to-face regional conferences, “Night Out” lectures and “Drive-Thru” EMS continuing education.

Our annual Ohio EMS Conference will be held May 22 and 23, 2023, in celebration of National EMS Week. The first day of the conference will be held at the Greater Columbus Convention Center both in-person and online. The second day of the conference will be VIRTUAL ONLY. If you are not a member of our email list, we invite you to join us to receive EMS continuing education offerings and announcements at [EMS@OhioHealth.com](mailto:EMS@OhioHealth.com). We hope you have a happy new year!

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*Please visit [OhioHealthEMS.com](https://OhioHealthEMS.com) for more information about our EMS programs.*

# OhioHealth Emergency Medical Services

NEWSLETTER FOR EMS PROFESSIONALS

## Right ventricular failure

*Daniel Adams, MD*

Right ventricular (RV) failure is a frequently missed presentation for patients presenting with cardiogenic shock, and its identification and management in the field is extremely challenging. To some degree, it is almost impossible. That said, there are some specific pearls and pitfalls in managing patients we know could have RV dysfunction that we will discuss in the following segment (e.g. right sided STEMI, pulmonary hypertension, pulmonary embolism).

### RIGHT VENTRICLE PHYSIOLOGY

Management of RV failure requires an understanding of right ventricular anatomy and physiology. The RV is a thin walled, compliant chamber that pumps against low resistance pulmonary vessels in healthy persons. Because of this, it is not nearly as strong as the more robust left ventricle (LV) counterpart, but it doesn't have to be unless pulmonary artery pressures are elevated (e.g. acute pulmonary embolism, pulmonary hypertension, and other pathologic conditions noted below). In addition, about a quarter of the RV output stems from LV contraction, relying on the LV for support. That said, in instances where there is an acute or acute on chronic elevation in pulmonary vascular resistance, the increased load the weaker RV has to pump against can quickly cause it to go into failure, leading to shock. Lastly, because the pressures in the RV are low compared to the LV, right coronary artery perfusion is maintained in both systole and diastole. The opposite is true of the LV, where coronary perfusion dominates in diastole alone because of the higher pressures achieved during systole. In instances where RV pressures are elevated and perfusion is dependent on diastolic flow alone, systemic hypotension can compromise right coronary perfusion further, leading to worsening RV function and shock. To summarize, anything increasing the resistance against which the RV has to pump can dramatically impact RV function.

What is most important about the above consideration is that when there is excess pressure the RV has to pump against, acute mismanagement can lead to complications. The heart is contained within a constrained space by the pericardium. This introduces the concept of ventricular interdependence, where if one chamber is dilated, the relationship between RV and LV geometry changes. In RV failure, an acute or acute on chronic increase in pulmonary vascular

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resistance and/or ventricular volume leads to RV distension. This causes the interventricular septum to bow towards the left, worsening not only RV function as it longitudinally squeezes and relies on the interventricular septum to generate force but can impede cardiac output from the LV. In this scenario, the more dilated the RV, the worse this physiology becomes, and it can lead to hemodynamic instability manifested as systemic hypotension. As the patient becomes more hypotensive, right coronary perfusion is compromised, worsening RV dysfunction, and a “death spiral” ensues that can be difficult to overcome. Where we can fail these patients, then, is by giving them our standard fluid resuscitative measures if they are not truly hypovolemic. At the same time, we fail them by not “defending the MAP” (mean arterial pressure) in alternative ways (e.g. early administration of vasopressors, like norepinephrine, if your local protocol allows). Lastly, we can worsen the situation by not reversing conditions that can exacerbate the pulmonary vascular resistance making it more difficult for the RV to squeeze.

Things that can increase the resistance against which the RV must pump we can potentially have an impact on are:

- Hypoxemia
- Hypercapnia
- Acidosis

In general, then, adherence to standard ABCs is important here. Ensure that the patient is adequately oxygenated and ventilating as you would normally do. One caveat, however, is **if you are concerned about a patient having RV failure be warned that intubating these patients comes at the potential risk of hemodynamic collapse and cardiac arrest.** With the introduction of positive pressure after intubation, the pulmonary vascular resistance is increased, which can quickly cause clinical deterioration.

### Key points to remember:

- If patients are volume overloaded in general, **avoid aggressive IV fluids**
- If RV failure is a concern, **avoid intubation if possible**
- Pay attention (as always) to the ABCs (**avoid hypoxemia and hypercapnia**)
- **Ensure adequate perfusion** (“defend the MAP,” goal MAP >60-65 mmHg)

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### PATIENT PRESENTATION

While right ventricular failure is a less common presentation for heart failure cases presenting to the emergency room, mortality is high, and early recognition is critical. Common presenting symptoms unfortunately overlap with multiple other pathologic conditions, as do physical exam findings. Common symptoms include:

- Chest pain
- Fatigue
- Peripheral edema
- Lightheadedness
- Syncope

Patients with pre-syncope or syncope are of particular concern, as it can represent decompensation of their underlying disease state or pathologic process that exacerbates right ventricular function (e.g. dysrhythmia, valvular heart disease). Outside of a quick history and physical, your ability to recognize right ventricular failure in the field is going to be limited. ECG may be of help, and specific findings per diagnosis will be discussed below.

### DISEASE SPECIFIC PRESENTATION AND MANAGEMENT

#### *Right sided STEMI*

Presentation: typical for ACS (chest pain, shortness of breath, diaphoresis, nausea, etc.)

Exam findings: jugular venous distension (JVD), hypotension, peripheral edema

ECG findings: ST elevation in II/III/aVF, disproportionate ST elevation in III > II, ST elevation in V1 coupled with ST depression in V2, right sided ECG with ST elevation in V4R >1 mm

Management:

- Aspirin
- **Avoidance of nitroglycerin (may precipitate profound hypotension)**



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- Oxygen for SpO<sub>2</sub> >92% (avoid hyperoxemia)
- Immediate transfer (preferably to a percutaneous coronary intervention capable facility)
- Gentle fluid boluses can be used in management of hypotension

Pearls: It is never wrong to treat these patients as you would any other suspected STEMI other than for the fact that **nitroglycerin should be avoided**. Standard aspirin dosing applies, and oxygen saturations to maintain an SpO<sub>2</sub> >92% is indicated. Targeting higher oxygen saturations is associated with worse outcomes. Get the patient to a hospital capable of percutaneous coronary intervention asap if able! While IV fluid boluses in the below pathologic conditions can worsen the situation, in right sided STEMI the pulmonary vascular resistance remains low, so cautious fluid boluses can be given here with less significant consequences.

### *Pulmonary hypertension*

Presentation: chest pain, shortness of breath, pre-syncope or syncope, known history of pulmonary hypertension

Exam findings: JVD, right upper quadrant tenderness, peripheral edema

ECG findings: normal ECG, right axis deviation, R/S >1 mm in V<sub>1</sub>, R wave > 7 mm in V<sub>1</sub>, rSR' complex in V<sub>1</sub> with R' > 7 mm, qR complex in V<sub>1</sub>, ST segment depressions or T wave inversions in V<sub>1</sub>-V<sub>3</sub> or II/III/aVF, right bundle branch block, P wave >2.5 mm in lead II (P pulmonale)

Management:

- Adherence to standard **ABCs**
- **Avoidance of aggressive fluid resuscitation** if evidence of volume overload
- **Early use of vasopressors** (preferably norepinephrine) as dictated by EMS protocol
- **Avoidance of intubation** if at all possible

Because patients with pulmonary hypertension are high risk, a quick assessment of the medications they are taking chronically should be determined, in addition to where the patient receives their medical care. **These patients are best managed at a hospital specializing in pulmonary hypertension**, and immediate transport to their home facility, if appropriate, should be considered.

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Common medications utilized in pulmonary hypertension include the following:

- IV epoprostenol (Veletri)
  - This medication is administered via a tunneled chest catheter
- Treprostinil
  - This medication can be oral (Orenitram), IV via a tunneled catheter (Remodulin), or through a smaller subcutaneous pump that looks like an insulin pump (Remodulin)
- Tyvaso and Iloprost
  - Both inhaled medications via specialized devices
- Ambrisentan (Letaris)
- Macitentan (Opsumit)
- Bosentan (Tracleer)
- Sildenafil
- Tadalafil
- Riociguat (Adempas)

Sildenafil, Tadalafil, and Riociguat all act via the nitric oxide pathway. Sildenafil and Tadalafil are the same medication (but different doses) as Viagra and Cialis. **Nitroglycerin is absolutely contraindicated with all three of these medications even in the setting of active chest pain and can lead to acute hypotension.**

Pearls from our Pulmonary Hypertension expert at Riverside Methodist Hospital, Dr. Gorbett: “Realize that all Emergency Departments are not created equal. Riverside Methodist Hospital and Ohio State University (main campus) have the expertise on site for patients with this acute on chronic disease state. The patient or the patient’s family often know where the patient needs to go – listen to them. If there is an infusion pump for pulmonary hypertension medications, do nothing to it and get the patient to a capable ER immediately. If the patient has a dedicated infusion line (e.g. Groshong), do not touch it, disconnect the pump, draw blood, or use it, even for ACLS drugs, as

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this could bolus residual medication into the patient and be fatal.”

### *Acute pulmonary embolism*

Presentation: chest pain, shortness of breath, leg swelling, recent surgery, known prior pulmonary embolism or deep vein thrombosis

Exam findings: tachycardia, tachypnea, hypotension, unilateral leg swelling

ECG findings: sinus tachycardia, right bundle branch block, right axis deviation, dominant R wave in V1, P wave in lead II >2.5 mm (P pulmonale), S1Q3T3 (deep S wave in V I, Q wave in lead III, inverted T wave in lead III), atrial tachydysrhythmias (e.g. atrial fibrillation or flutter)

Management:

- Adherence to standard ABCs
- **Avoidance of aggressive fluid resuscitation** unless history indicates volume depletion
- **Early use of vasopressors** (preferably norepinephrine) as dictated by EMS protocol
- **Avoidance of intubation** if at all possible

**Pearls: The shock index (HR/SBP) can be used to identify patients who are at high risk for rapid clinical deterioration.** If pulmonary embolism is suspected and the patient’s shock index is greater than 1, the patient is likely at risk, and early management with thrombolytics and/or catheter directed thrombectomy may be required. The peripheral vascular cardiology team at Riverside Methodist Hospital is a leader in catheter directed therapies that can benefit your patients significantly. In instances where a patient is in shock and suffers a cardiac arrest, the multidisciplinary team at Riverside Methodist Hospital has other life-saving therapies (e.g. VA ECMO) that can be utilized as a last resort in the dying patient.

## FINAL THOUGHTS

Your job in the field is incredibly more difficult than what we have to do in the hospital – we have all the tools at our disposal, including rapid diagnostics. In the field, we cannot expect that our pre-hospital providers will be able to diagnose right ventricular failure outside of the true right sided STEMI. That said, focusing on what you can impact is potentially lifesaving: **adhere to the**

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**ABCs (i.e. avoid hypoxemia and hypercapnia), avoid aggressive fluid resuscitation unless there is evidence of hypovolemia, and ensure adequate systemic perfusion with vasopressors if your EMS protocol allows (choice #1 is norepinephrine). If there is an infusion line, DO NOT use it to make any adjustments. If there is an infusion line, DO NOT use it to infuse medications (you could accidentally bolus medications leading to hemodynamic collapse). Never hesitate to contact medical direction for help, as these patients, when sick, are some of the sickest.**

Thank you for all you do as our front-line providers! If you have any questions, reach out any time, [Daniel.Adams@OhioHealth.com](mailto:Daniel.Adams@OhioHealth.com).

# OhioHealth Trauma Network

OhioHealth Trauma Network Rural EMS Award & Golden Hour Award  
Urmil Pandya Md, FACS  
Medical Director Trauma And Acute Care Surgery  
OhioHealth Grant Medical Center

# OhioHealth Trauma Network Rural EMS Award

## Scene

- 39 year old male shooting victim
- On arrival patient lying on porch
- GCS 15, Pink, warm & dry
- GSW noted L groin , moderate blood loss noted

# OhioHealth Trauma Network Rural EMS Award

Scene con't

- Direct pressure placed to wound, moved to medic
- Wound packed then direct pressure applied
- Unable to obtain IV access, IO placed, vitals monitored throughout transport.

# OhioHealth Trauma Network Rural EMS Award

Scene con't

- Placed on non rebreather mask
- 200 ml Fluids en route
- 23 min from dispatch to arrival to referring hospital.



# Golden Hour Award

## Referring Hospital

- Arrives to Referring Hospital ED with 410 shotgun wound to L groin (14:49)
- EMS holding direct pressure on arrival, pt has deteriorated to gray in color. Gen Surgery notified
- 14:52 1<sup>st</sup> unit PRBC infusing

# Golden Hour Award

Referring Hospital con't

- 14:59 Units 2 & 3 PRBC hanging
- Pressure dropped to 40/20, never lost pulse
- General/Vascular Surgery took immediately to OR for damage control surgery.
- 15:15 MTP initiated in OR

# Golden Hour Award

## Referring OR

- L femoral vein transected ( 6 cm segment), Lac to femoral artery
- Femoral artery lac repaired and art line inserted
- L femoral vein repaired with saphenous vein graft, suture multiple branches EBL 2L
- To SICU post op where resuscitation was continued @ approximately 2100.

# Golden Hour Award

## Referring Post OP

- Pt hypothermic post op with Bair hugger placed
- MTP continued in ICU for coagulopathy to stabilize for transfer to OhioHealth Grant Trauma due to patient depleting blood resources at referring.
- Pt transported via MedFlight on vent and sedated remaining stable during transport.
- Total products at Referring
  - 10 PRBC; 7 FFP; 3 cryo; 2 platelets

# Golden Hour Award

## GMC Trauma Bay

- Exam completed on arrival , admitted to SICU
- No indication for further surgery at time of admission
- MTP discontinued and TEG obtained
- Monitored compartments of LLE
- Ortho and Vascular consulted.

# Golden Hour Award

## Hospital Course

- Ortho recommended non operative management and local wound care at surgical site
- Vascular planning on CT angio on HD 3
- Transferred to Trauma Step down HD 1
- Worked with and cleared therapy for discharge
- Discharged to home HD 7

# OhioHealth Trauma Network Rural EMS Award

Presented To

**Portsmouth Fire**

# Golden Hour Award

Presented to

**Southern Ohio Medical  
Center**