

# A wolf in another wolf's clothing: point-of-care ultrasound in a patient with an acute exacerbation of chronic obstructive pulmonary disease

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Patients often present to hospital, and to the Intensive Care Unit (ICU) in particular, in situations that render them unable to provide an accurate (or any) clinical history to facilitate diagnosis. These patients also typically have multiple, serious medical co-morbidities, which further makes diagnosing and initiating an appropriate treatment difficult. Furthermore, the investigations performed to optimally diagnose acute critical medical conditions are often only possible in remote locations in the hospital or only available during regular daytime work hours, both of which are a concern with critically ill patients.

Point of care ultrasound (POCUS) is a tool well described in critical care and peri-operative literature that alters management and improves patient care. It is used as an adjunct to physical exam and basic laboratory

investigations to answer a specific clinical question and direct management [1]. We present a case in which POCUS was used in a critically ill patient and resulted in a significantly different approach to treatment.

## Case

A 61 year-old female was transferred from a community emergency department to the Intensive Care Unit (ICU) at Kingston General Hospital (KGH) with the diagnosis of an acute exacerbation of chronic obstructive pulmonary disease (COPDE). She presented in extremis with severe respiratory distress and decreased level of consciousness and was sedated and intubated to facilitate safe transfer. This was preceded by a 3-day history of fever and increased sputum production, for which she had been started on an antibiotic by

her family physician. The patient had a medical history significant for COPD, schizophrenia and a non-specific seizure disorder.

Tests from the referring hospital showed a Troponin I of 2.27 (normal range 0.000 to 0.060 µg/L), as well as an electrocardiogram (ECG) suspicious for Wellens' sign (Figure 1). Wellens' sign, biphasic or deeply inverted t-waves in leads V2 and V3, is a marker of critical left anterior descending (LAD) coronary artery stenosis that predicts both mortality and coronary artery disease that is often refractory to medical management alone [2]. Cardiology was consulted and initially suspected demand ischemia resulting in the increased troponin. Nonetheless, the patient became more difficult to stabilize, with increasing fluid and vasopressor (norepinephrine and epinephrine) requirements.

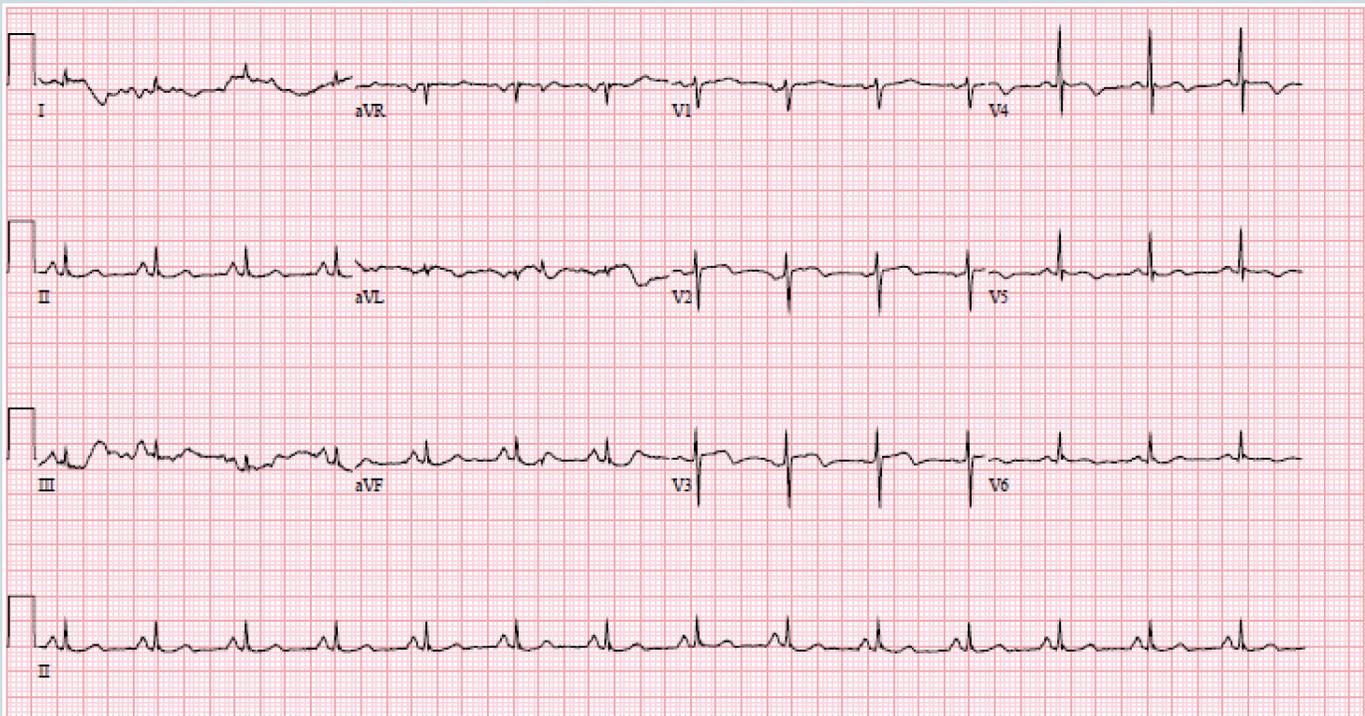


Figure 1. Electrocardiogram showing subtle biphasic t-waves, one of the presentations of Wellens' sign, in leads V2 and V3.

Table 1. Summary of POCUS indications, views and interpretation based on clinical question.

Assessment Goal	Clinical Condition	PLAX	PSAX	Apical 4-Chamber	Subcostal 4-Chamber & IVC
LV Size and Function	<ul style="list-style-type: none"> <li>•Myocardial Infarction and/or Ischemia</li> <li>•Heart Failure</li> </ul>	Yes	Yes	<ul style="list-style-type: none"> <li>•Yes</li> <li>•Size – Ratio of RV:LV and composition of apex</li> </ul>	Yes
RV Size and Function	<ul style="list-style-type: none"> <li>•Pulmonary Embolism</li> <li>•COPD</li> <li>•Pulmonary Hypertension</li> </ul>	Limited	Limited	Yes	Yes
Volume Status (Hypovolemia)	<ul style="list-style-type: none"> <li>•Sepsis</li> <li>•Hemorrhage</li> <li>•Under-resuscitated</li> </ul>	No	<ul style="list-style-type: none"> <li>•Yes</li> <li>•Mid-papillary view shows LV cavity systolic obliteration (“kissing paps”)</li> </ul>	No	<ul style="list-style-type: none"> <li>•Yes</li> <li>•IVC view shows &lt;2cm IVC w/ &gt;50% collapse with respiration</li> </ul>
Pericardial Effusion		Yes – best view to distinguish pericardial from pleural effusion	Yes	Yes	Yes

A POCUS exam was performed which revealed a moderate-to-severely hypokinetic left ventricle (Online Video S1). This video was forwarded to the interventional cardiologist, and the patient was taken for an urgent cardiac catheterization, revealing an 80% stenosis in the LAD and a 70% stenosis in the proximal circumflex that had predisposed the patient to type II cardiac ischemia. A drug-eluting stent was placed in the former, a bare metal stent in the latter and the patient returned to the ICU and was rapidly weaned off norepinephrine and epinephrine.

### Discussion

This case demonstrates a classic late night ICU admission – unstable, multiple co-morbidities and a presumed diagnosis from the primary physician with a wide differential that could be contributing to her presentation. In the context of borderline investigations (Troponin and ECG changes) and hemodynamic instability including difficulty oxygenating and ventilating, neither a primary respiratory nor cardiac etiology could be adequately ruled out.

POCUS was required in this case to enhance our understanding of the etiology of her hemodynamic instability, arming us with more definitive evidence to compel interventional cardiology to activate the Acute Coronary Syndrome (ACS) Protocol.

### Scanning Technique

There are five views commonly used in a cardiac POCUS examination: parasternal long axis (PLAX), parasternal short axis (PSAX), apical 4-chamber, subcostal 4-chamber and inferior vena cava (IVC). The PLAX and PSAX are typically the easiest to acquire given the ease of maintaining transducer contact, proximity of cardiac structures and readily identifiable landmarks. However, in clinical scenarios where time is limited, best practice is to target high-yield views such as the apical 4-chamber and, in particular, the subcostal 4-chamber view. The subcostal 4-chamber allows assessment of virtually all elements of the clinically focused exam [3]. A low-frequency transducer with a small footprint (head size) marries the need for 15-20cm of depth

penetration with the ability to fit between the intercostal spaces to optimize the image. A detailed description of scanning technique is well described and beyond the scope of this case report, but can be found in this practical approach to point-of-care echocardiography by Walley et al [1].

### Interpretation of Findings

The goal-directed echocardiographic examination aims to determine the etiology for hemodynamic instability or respiratory failure by answering one (or more) of the following questions: 1) Left ventricular (LV) size and function, 2) right ventricular (RV) size and function, 3) volume status and 4) presence of pericardial effusion. These goals, interpretations and correlated clinical conditions are summarized in Table 1.

#### Left Ventricular Size and Function

Each of the four views obtained in POC echocardiography (combining subcostal 4-chamber and IVC views into one category) gives subjective information regarding LV function, obtained by observing the global function of the LV and assessing it

for uniformity and kinesis (hypo-, hyper-kinetic or normal function) [4]. The LV is considered hyperdynamic and underfilled if the papillary muscles touch or come close to touching in the PSAX mid-papillary view (“kissing papillary muscles” sign) [5].

#### *Right Ventricular Size and Function*

The RV is best assessed in the apical or subcostal 4-chamber view as either normal, moderately or severely dilated based on the ratio of RV to LV size. A normal RV is less than two-thirds the size, a moderately dilated RV is equal in size and a severely dilated RV forms the apex of the heart and is greater in size than the LV [6].

#### *Volume Status*

In addition to the “kissing papillary muscle” sign in the PSAX view, volume status is best assessed in the subcostal IVC view. This allows visualization of the IVC as it enters the right atrium (RA), using the liver as an acoustic window. The diameter of the IVC is measured approximately 3 cm from the junction of the RA and IVC during normal tidal volume breathing and during sniffing. Normovolemia is noted when the IVC is greater than 2 cm and the change in diameter is less than 50% with sniffing. If the IVC is less than 2 cm or shows greater than 50% collapse with sniffing, the patient is judged to be hypovolemic and will likely be fluid responsive. The assessment of volume status using IVC measurements is only valid in spontaneously breathing patients, and interpretation is limited in ventilated patients [7].

#### *Pericardial Effusion*

Finally, each of the views can be used to assess for the presence of a pericardial effusion, but it is best appreciated in the subcostal 4-chamber view as the liver provides an excellent acoustic window. A pericardial effusion appears as a hypoechoic strip posterior, anterior or surrounding the heart. The effusion will be first seen posterior to the heart, as this is the dependent region in a supine patient (usually a minor effusion), then will gradual

increase to surround the heart and be visualized in the anterior pericardial space (moderate to severe). The epicardial fat pad is often mistaken for an effusion, but can be distinguished from fluid accumulation as it a) often appears granular, not purely hypoechoic and b) is observed on the anterior surface of the heart without significant posterior accumulation [8].

#### **Conclusion**

POCUS is rapidly becoming an essential tool in the critical care setting. Given the frequent combination of hemodynamic instability, multiple co-morbidities and a broad differential in any given patient, accurate diagnosis is greatly facilitated by a goal-directed cardiovascular assessment [9]. Here we present a case in which POCUS was used to diagnose an acute coronary event in lieu of borderline ancillary tests (ECG, troponin) and enabled swift intervention and stabilization.

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