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To Friends of the Department of Medicine

It is my pleasure to introduce myself to you for the first time as Program Director, as I also introduce to you our latest edition of The Medicine Forum. Having done my residency training at Jefferson, I am so proud that the tradition of this journal has continued throughout the years despite new residents, new leadership, and new challenges both locally and globally. Our residents’ commitment to not only patient care, but also to scholarship and inquiry remains outstanding and impactful.

Tradition, coming from the Latin word “tradere”, means to transmit, to hand over, or to give for safekeeping; a definition that feels incredibly plausible to this journal. From year to year, I am constantly impressed by the breadth and quality of work that our residents “transmit” to our friends and alumni encompassing research, humanities, and medical education. In this peer-reviewed publication, each year the new editors and new chief residents are handed over this responsibility with the expectation of garnering new submissions and collating them into an incredible spectrum of learning and ideas. In many ways, this journal is a prism through which we can see all the brilliant differences, perspectives, and talents that comprise our unique residency.

I am grateful to Emily Stewart for being a wonderful mentor and example of how to safeguard many of our wonderful Jefferson residency traditions. Consider this latest edition the first installment in a new chapter at Jefferson, one that promises to celebrate the passion, the talent, the diversity, and the community that our Jefferson residents personify.

It is with great pride I submit to you the 24th edition of The Medicine Forum.

Christopher Henry, MD, FACP

Assistant Professor of Medicine
Program Director, Internal Medicine Residency
Dear Students, Residents, Fellows, Faculty, and Friends of the Forum,

We are honored to present the 24th Annual edition of The Medicine Forum to the Jefferson community. Over the years, it has been remarkable to see the quality and diversity of projects submitted to this forum, and this year is no exception. The Medicine Forum aims to celebrate the scholarly activity among physicians in training at our institution. We hope that this year’s edition will continue to honor this long standing tradition. Despite the uncertainties and stressors that are inherent to working in a hospital, our authors have found the time to produce scholarly work that will diversify and further medical knowledge. For this, we thank them. We also want to thank our supporters for making this journal possible and our readers for their continued interest.

Sincerely from the Editorial Board,

Harrison Bell, MD
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Special Thanks to Tim Flanagan for digital editing and design.
To the Residents,

As your Chief Residents, we would like to take a moment to express our heartfelt congratulations to each and every one of you on your incredible scholarly achievements over the past year. We have been impressed by the quality and diversity of your scholarly work. From interdisciplinary clinical research projects that have been submitted to journals across numerous subspecialties, to contributions to the Health Equity and Quality Improvement Summit, you have all demonstrated a passion for excellence and a commitment to advancing the field of medicine. We are grateful for the opportunity to have worked alongside you and to have witnessed your growth and development as physician scholars. We are confident that your accomplishments will serve as a source of inspiration for future generations of medical professionals.

Once again, congratulations on your achievements, and we wish you all the best in your future endeavors.

Sincerely,

Your Chiefs

Tina Boortalary, MD
Raashi Mamtani, DO
Justin Robbins, MD
Svenja Schneider, MD
TABLE OF CONTENTS

CASE REPORTS

ACHENBACH SYNDROME: A CLASSIC PRESENTATION OF A NOT-SO-COMMON CONDITION
Brandon Pecchia, MD, MS ................................................................. 6

AN EDUCATIONAL CASE FOR APPLYING THE ALVEOLAR-ARTERIAL GRADIENT IN HYPOXEMIA: AN UNDERUTILIZED AND UNDERAPPRECIATED CLINICAL TOOL
Chioma Nwonu, DO, Michael Dong, MD, Dan Kramer, MD ................................................................. 9

A CASE OF BARTONELLA ENDOCARDITIS AND TORRENTIAL AORTIC REGURGITATION LEADING TO CARDIAC ARREST
Brandon Pecchia, MD, MS, Sawyer Kieffer, MD ................................................................. 13

A CASE PRESENTATION OF PERICARDITIS ASSOCIATED WITH HAEMOPHILUS INFLUENZAE BACTEREMIA
Risa Goldberg, MD, Harrison Bell, MD ................................................................. 16

END-STAGE CHRONIC INTESTINAL PSEUDO-OBSTRUCTION RESULTING IN INTESTINAL PNEUMATOSIS
Justin Bilello, MD, Amman Bhasin, MD, Phoebe Chun, MD, Aaron Martin, MD ................................................................. 19

HELPFUL OR HARMFUL? A CASE REPORT OF NUTRITIONAL SUPPLEMENTS CAUSING DRUG-INDUCED LIVER INJURY
Amman Bhasin, MD, Phoebe Chun, MD, Justin Bilello, MD, Manju Ambelil, MD,
Dina L Halegoua-DeMarzio, MD ................................................................. 22

A CASE OF SUSPECTED LISDEXAMFETAMINE (VYVANSE) DRUG-INDUCED LIVER INJURY
Louis Kishfy, MD, Justin Bilello, MD, Monjur Ahmed, MD, Elizaveta Flerova, MD ................................................................. 25
ULTRASOUND EDUCATION

A GUIDE TO POINT OF CARE ULTRASOUND EXAMINATION OF ACUTE DECOMPENSATED HEART FAILURE
Michael Dong, MD, Rebecca Davis, MD, Jonathan Foster, MD, Jillian Cooper, MD, Frances Mae West, MD ................................................................. 28

A GUIDE TO POINT OF CARE ULTRASOUND EXAMINATION OF A PERICARDIAL EFFUSION
Michael Dong, MD, Frances Mae West, MD, Jillian Cooper, MD, Jonathan Foster, MD, Rebecca Davis MD ................................................................. 34

A GUIDE TO POINT OF CARE ULTRASOUND LUNG AND IVC EXAMINATION OF A VOLUME OVERLOADED PATIENT
Michael Dong, MD, Frances Mae West, MD, Jonathan Foster, MD, Rebecca Davis, MD, Jillian Cooper, MD ................................................................. 39

A GUIDE TO POINT OF CARE ULTRASOUND EVALUATION OF PNEUMONIA
Michael Dong, MD, Frances Mae West, MD, Rebecca Davis, MD, Jon Foster, MD, Jillian Cooper, MD ................................................................. 43

A MANUAL FOR ULTRASOUND GUIDED INTRAVENOUS ACCESS: ALLAY YOUR FEARS, ALLEVIATE WITH HUMOR, APPROACH WITH CONFIDENCE
Michael Dong, MD ...................................................................................................................... 46
CASE REPORTS

Achenbach Syndrome: A Classic Presentation of a Not-So-Common Condition

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INTRODUCTION

Also called “acute idiopathic blue finger” or “paroxysmal finger hematoma,” Achenbach syndrome is a benign collection of findings that is often mistaken for more serious conditions. Characteristically presenting with discrete unexplained bruising or discoloration of the volar aspect of one or two fingers, it is a diagnosis that physicians should include on their differential given its innocuous course and excellent outcomes, without need for invasive testing or intervention. The purpose of this case report therefore is to increase awareness of this rare condition, especially among emergency department physicians and internists, in order to minimize the incidence of unnecessary testing, procedures, and psychological burden.

CASE PRESENTATION

Subjective:

A 37-year-old female with a past medical history of hypertension, gastroesophageal reflux disease, and anxiety, presented to the Thomas Jefferson University Hospital emergency department with a few hours of mild throbbing pain, swelling, and darkened discoloration of her right second and fifth digit. She did notice that there was brief whitening of the digits preceding the darkening discoloration. She described the sensation as an uncomfortable feeling “like a rubber band” on her wrist. She also endorsed right hand numbness that extended up the right forearm. She could not identify any specific trigger, including cold exposure or trauma. There was no other bruising or bleeding she noticed. The patient also reported that she had one very similar experience three years prior, involving the first and second digit on the right hand. At that time, she presented to another hospital, where she was evaluated by vascular surgery. She noted that she underwent catheter-directed thrombolysis, was given prednisone and gabapentin, and discharged on aspirin and clopidogrel for a few months.

Upon review of systems, she denied any other paresthesias, subjective fevers or chills, chest pain, palpitations, shortness of breath, or gastrointestinal symptoms. She denied any nailbed changes (including splinter hemorrhages) or fingertip discoloration that she had noticed. She denied any known history of heart disease. She had a history of tobacco use (around 7 pack...
years) but had quit three years prior. She endorsed intermittent social alcohol use, but denied ever using illicit drugs, including intravenous drug use. Besides an unknown type of stroke in her grandmother at an advanced age, she denied any family history of any clotting or bleeding disorders, spontaneous abortions or miscarriages, or myocardial infarctions. She had a family history of prostate cancer in her father, and breast cancer in her maternal grandmother. She had not taken any oral contraceptives in six months and had no other hormonal contraceptive use. She was taking nifedipine for her hypertension. She had no pertinent past surgical history.

Objective:
On presentation, she was slightly tachycardic to 103, and hypertensive to 149/81. Her physical exam was notable for purple, non-blanching discoloration of the palmar surface of the second and fifth digits on the right hand, well demarcated between the proximal and distal interphalangeal joints, with distal sparing (figure 1). There was minimal swelling and tenderness in this region. Her skin was warm and dry, and sensation was intact throughout all dermatomes of her right upper extremity. She had complete ability to flex and extend all fingers. There was no distal finger tenderness or ulceration. Kanavel’s signs for infectious tenosynovitis (preferred flexed positioning, fusiform digital swelling, tendon sheath tenderness, and pain with passive extension) were negative. Pulses were palpable and capillary refill was brisk. The remainder of her physical exam was within normal limits. Her ANA was negative, and CBC, PT/INR, PTT, and ESR were all within normal limits. X-ray of the hand was performed (figure 2), followed by arterial and venous ultrasound of the right upper extremity (figure 3), all of which were normal.

DISCUSSION
As with many medical conditions, there is a common or “textbook” presentation of Achenbach syndrome, and this patient exhibited many of those classic features. This includes blue-purple discoloration most often affecting the right index finger in middle-aged females; sparing of the distal phalanx and nailbed, as well as dorsum of the hand; discontinuous finger involvement; warm and well-perfused digits; absence of any obvious trigger; and most importantly, self-resolution in three to six days requiring no intervention and with no residual sequelae. Prodromal symptoms may be present, including pain and paresthesias. First described by Dr. Walter Achenbach in 1958 – then called “paroxysmal hand hematoma” or “finger apoplexy” – the etiology is not clearly understood, and the only pathologic findings are capillary rupture. No biopsy or intravascular intervention is needed. With fewer than 100 cases reported in the medical literature, the diagnosis is clinical, based on the common features, as routine testing (including immunologic) is usually unremarkable.

For this patient, hand surgery was consulted, who fortunately recognized the signs and symptoms fitting the description of Achenbach syndrome. Although initially given oxycodone, the patient was soon advised of the benign nature of the condition, and was discharged home with reassurance and acetaminophen for pain relief. She was encouraged to return to the emergency department if her symptoms worsened or failed to resolve; and otherwise advised to follow up with her primary care provider. No subsequent medical records documented persistence or further intervention that she required.
While it is indeed a benign condition, it is necessary nonetheless to rule out more critical diagnoses that require further work up and treatment, including acute limb ischemia, fracture, thromboembolic phenomena, cellulitis, septic thrombi, hypotenar hammer syndrome, and acrocyanosis, among others. In addition to good history taking and physical exam, the patient should generally receive radiographs, an arterial and venous ultrasound of the extremity with doppler, and basic lab work to help rule out infection, signs of systemic inflammation, or immunologic disease. The patient in this case did not have especially convincing familial or personal concerns for thrombosis or bleeding, nor signs or symptoms of systemic illness or infection. Achenbach syndrome is often misdiagnosed as Raynaud’s, as they both include finger discoloration with a higher propensity in females, and can both present with a preceding pale phase. Raynaud’s however is more often chronic and episodic, frequently in response to a temperature trigger that improves with rewarming, and can be related to immunologic disease. For the patient in this case, there was no cold exposure or stress trigger to bring about this issue, and the specific geographic pattern of her presentation was less fitting. Thromboangiitis obliterans usually occurs with tobacco exposure, resulting in ulceration and gangrene of the digits. Although the patient in this case was a prior smoker, this diagnosis is much less common in females, and she had no ulceration or arterial occlusions. Hypotenar hammer syndrome is often seen in males and is the result of repetitive palmar trauma (denied by this patient), such as with occupational overuse. Systemic vasculitis may be more difficult to differentiate, but often has intense pain and necrosis, and the patients typically have lab changes not present in this case.

While it has been known to recur in some people, as with this patient, the prognosis for Achenbach syndrome is excellent. Given this patient’s prior presentation at another hospital and subsequent involved workup, possibly unnecessary intervention (although outside records were unavailable), and not risk-free pharmacotherapy, the importance of recognizing this syndromic presentation and including it in the differential is key. It is not routinely included in medical school curricula and, as seen in this case, is rare enough that emergency department providers and even vascular surgeons may not recognize it. As more cases are documented, the informed internist and emergency medicine provider should be aware of this condition, know basic testing to perform to rule out more severe disease, and be able to provide assurance to their patients of its benign nature without the need for extensive testing or invasive procedures.

REFERENCES

An Educational Case for Applying the Alveolar-Arterial Gradient in Hypoxemia: An Underutilized and Underappreciated Clinical Tool

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INTRODUCTION

The Alveolar-arterial gradient, commonly known as the A-a gradient, measures the difference in the oxygen concentration in the alveoli and the arteries across the capillary membrane in the lung. In an ideal system, the A-a gradient would be zero because there would be perfect equilibrium as oxygen diffuses and equalizes across the alveolar and arterial sides of the capillary membrane. However, there is a physiologic A-a gradient because of the differences in perfusion and ventilation in the apical and basilar regions of the lungs. Because this relationship exists, the changes in the A-a gradient have clinical utility in guiding the differential diagnosis of hypoxemia.

The A-a gradient is calculated from the equation:

\[ \text{A-a Gradient} = \text{PAO}_2 - \text{PaO}_2 \]

PAO2 is the partial pressure of oxygen in the alveoli, and PaO2 is the partial pressure of oxygen in the artery. The partial pressure of oxygen in the alveoli can be calculated from the alveolar gas equation:

\[ \text{PAO}_2 = (\text{Patm} - \text{PH}_2\text{O}) \times \text{FiO}_2 - \text{PaCO}_2 / \text{RQ} \]

\[ \text{PaO}_2 = \text{measured directly from an arterial blood gas (ABG).} \]

The expected, "normal", physiologic A-a gradient also changes based on age and can be estimated from the equation:

\[ \text{A-a gradient} = (\text{Age} + 10) / 4 \]

In this case, we describe the clinical benefit and practical application of the A-a gradient and alveolar gas equation in elucidating the etiology of hypoxemia. It is a fast, effective, inexpensive tool that can provide great diagnostic utility and save patients from more invasive or costly tests.

LEARNING OBJECTIVES

1. Recognize the 5 mechanisms of hypoxemia.
2. Calculate an Alveolar-arterial gradient using the alveolar gas equation.
3. Apply the Alveolar-arterial gradient in a clinical setting to narrow the differential for hypoxemia.

CASE PRESENTATION

The patient is a 63-year-old man with a past medical history of a cerebrovascular accident, coronary artery disease with myocardial infarction, alcohol use disorder, hypertension, anxiety, and chronic pain.

The patient was admitted to a hospital medicine service with altered mental status and acute hypoxemic and hypercapnic respiratory failure. The altered mental status was due to alcohol withdrawal and polysubstance use (opioids, benzodiazepines). The respiratory failure was believed to be due to aspiration pneumonia. The patient’s outpatient medications were notable for alprazolam 1 mg three times daily and oxycodone 30 mg three times daily, which were continued this admission. With treatment of his alcohol withdrawal and pneumonia, his mental status returned to baseline. However, the patient continued to have persistent hypercapnia and hypoxemia of an unclear etiology. He...
had computed tomography angiography imaging that demonstrated no pulmonary embolism but did show atelectasis bilaterally. He was transferred to the Pulmonary service for further workup, with anticipation that he would need more invasive testing such as bronchoscopy and concern that further worsening could lead to intubation and mechanical ventilation.

After transfer to the Pulmonary service, several blood gases were obtained:

An ABG was drawn while the patient was awake on 3 liters of oxygen by nasal cannula with a normal respiratory rate:

- pH 7.31, PaCO$_2$ 80 mmHg, PaO$_2$ 58 mmHg
- PAO$_2$ = (760 - 47) X 0.32 - 80/0.8 = 128.8
- PaO$_2$ from ABG = 58
- A-a gradient = 128.8 - 58 = 70.8
- Expected physiologic A-a gradient for his age = (63 + 10) / 4 = 18

An ABG was drawn overnight while the patient was on bilevel positive airway pressure (BIPAP) at 32% FiO$_2$:

- pH 7.33, PaCO$_2$ 61 mmHg, PaO$_2$ 128 mmHg
- PAO$_2$ = (760 - 47) X 0.32 - 61/0.8 = 151.91
- PaO$_2$ from ABG = 128
- A-a gradient = 139.4 - 128 = 23.9

DISCUSSION

What does hypoxemia with a high A-a gradient signify?

There are five mechanisms of hypoxemia: Ventilation and perfusion mismatch, right-to-left shunt, diffusion impairment, hypoventilation, and a low inspired partial pressure of oxygen (PO$_2$). The patient has an A-a gradient of 70.8, which is far greater than 18, the physiologic A-a gradient expected for his age. An elevated A-a gradient already narrows our differential for hypoxemia because it is only consistent with a ventilation and perfusion mismatch, right-to-left shunt, and diffusion impairment.

Ventilation and perfusion (V/Q) mismatch is the most common etiology of hypoxemia, with many potential causes. A low V/Q ratio suggests that perfused lung is not ventilated appropriately. Causes include pulmonary edema, pneumonia, atelectasis, asthma, COPD, bronchiectasis, and acute respiratory distress syndrome. As more alveolar units are lost or cannot be ventilated, the ventilation decreases more significantly than the perfusion, and the shunt physiology worsens. The lungs will attempt to compensate by vasoconstricting areas of poor ventilation and vasodilating areas with good ventilation to find a more balanced V/Q ratio. High V/Q ratios suggest that ventilation is greater in proportion than perfusion, for example, in pulmonary embolism. This process leads to dead space in which ventilated lung does not perform the appropriate gas exchange. Notably, hypoxemia due to V/Q mismatch improves readily with supplemental oxygen.

The two other mechanisms of hypoxemia with an elevated A-a gradient are a right-to-left shunt and diffusion impairment. A right-to-left shunt is caused by a patent foramen ovale, pulmonary arteriovenous fistulas, or any intrapulmonary shunt. An intrapulmonary shunt can occur when ventilation is significantly lost in a well-perfused lung region. Diffusion impairment occurs when oxygen transport across the alveolar wall is delayed. This happens due to decreased alveolar surface area for diffusion or fibrosis of the barrier. Notable causes of diffusion impairment include emphysema and interstitial lung disease. While this may not often cause significant resting hypoxemia, it can lead to profound desaturations in severe cases due to increased cardiac output leading to short transit time of red blood cells across alveolar capillaries. Clinically, in a right-to-left shunt, the hypoxemia does not respond to supplemental oxygen. In diffusion impairment, supplemental oxygen does improve hypoxemia.

A large A-a gradient rules out two etiologies of hypoxemia. A low inspired PO$_2$ is a mechanism of hypoxemia with a normal A-a gradient. Common causes of this would be the high altitude and scuba diving. Hypoventilation is another etiology of hypoxemia with a normal A-a gradient. It can be caused by decreased respiratory drive, chest wall rigidity, neuromuscular weakness, upper airway obstruction, and obstructive lung disease.

What etiology of hypoxemia does our patient have?

Our patient has a high A-a gradient, which, as defined above, narrows our differential to V/Q mismatch, right-to-left shunt, and diffusion impairment. Now we can use our history and other diagnostic tests to narrow the etiologies further. An echocardiogram with a bubble study ruled out a right-to-left shunt. Because the agitated saline bubbles did not reach the left side of the heart, we know there was no intracardiac or intrapulmonary shunt. A diffusion restriction etiology such as ILD or emphysema was inconsistent with the history and his computed tomography (CT) imaging.
The differential for V/Q mismatch has a wide array of causes, as we described. In this case, the patient still had significant hypoxemia despite treating his pneumonia with appropriate antibiotics. The patient was transferred with the anticipation that he may have an atypical infection or require a more specialized and invasive workup, such as bronchoscopy or high-resolution CT imaging.

The two A-a gradients and alveolar gas equations we presented were crucial factors in elucidating the diagnosis and guiding our management. The two blood gases were drawn within a 24-hour period, with the first blood gas drawn while the patient was resting on 3L oxygen, and in the second scenario, the patient was resting while on BIPAP with 3L oxygen. The A-a gradient was significantly elevated to 70.8 in the first setting, and in the second, the A-a gradient was nearly normalized at 23.9.

Physiologically, in our patient, BIPAP had a great effect on keeping the alveoli ventilated and maximizing alveolar recruitment. Because this intervention alone was able to resolve the A-a gradient and impressively improve oxygenation, our differential was thus further narrowed to processes that filled or collapsed alveoli, such as pulmonary edema and atelectasis. On our physical exam, the patient examined as hypovolemic yet had rales in the bases. He was also often sedentary and lying in bed with poor posture. Thus, atelectasis was highest on our differential.

We implemented a plan for the patient to frequently walk the halls, increase the use of the incentive spirometer, and improve the management of his secretions with nebulizers and chest physiotherapy. With these non-invasive and practical measures, the patient’s oxygen requirement and hypoxemia resolved within the next two days, and he was discharged home on room air. He was able to avoid unnecessary further antibiotics, imaging, and bronchoscopy.

Why was the patient hypercapnic, and how does that impact the A-a gradient and alveolar gas equation?

While atelectasis may explain the patient’s hypoxemia, it does not explain the degree of hypercapnia. The patient’s PaCO2 levels were in the 60-80 mmHg range, and he had elevated serum bicarbonate suggesting that he chronically retains CO2. In a patient without prior lung disease, chronic hypercapnia would be very unusual. However, his medication history is notable for a combination of prescribed opiates, benzodiazepines, and recreational alcohol. His opiate and benzodi-azepine regimen was continued inpatient, leading to continued hypercapnia and likely worsening his severe atelectasis.

After transfer to the Pulmonary service, the opiates and benzodiazepines were weaned, the patient’s respiratory drive improved significantly, and his hypercapnia resolved. Notably, hypoventilation and subsequent hypercapnia will lead to hypoxemia, and it is a mechanism of hypoxemia with a normal A-a gradient. Within an alveolus, if the partial pressure of any one gas increases, then the partial pressure of the other gases must decrease. The partial pressure of oxygen in the alveolus (PAO2) can be significantly reduced if the partial pressure of carbon dioxide is high.

As a reminder, the A-a gradient and alveolar gas equation are:

\[ \text{A-a Gradient} = \text{PAO}_2 - \text{PaO}_2 \]
\[ \text{PAO}_2 = (\text{Patm} - \text{PH}_2\text{O}) \cdot \text{FiO}_2 - \text{PaCO}_2 / \text{RQ} \]
\[ \text{PaO}_2 \text{ is measured from an ABG} \]

Using the alveolar gas equation, you can see that a higher PaCO2 leads to a lower PAO2, and thus the gradient between PAO2 and PaO2 will be smaller and trend toward normal. In our case, the patient’s degree of atelectasis was severe enough that the A-a gradient remained elevated despite the hypercapnia.1

TAKE HOME POINTS

- The alveolar gas equation can help you narrow your mechanisms of hypoxemia. An elevated A-a gradient is consistent with a ventilation and perfusion mismatch, right-to-left shunt, and diffusion impairment. A normal A-a gradient suggests hypoventilation or a low inspired PO2.

- Supplemental oxygen will improve oxygenation in V/Q mismatch, hypoventilation, and diffusion impairment. It will not improve oxygenation in hypoxemia due to right-to-left shunt.

- Hypercapnia affects your alveolar gas equation by reducing the A-a gradient because it decreases the PAO2.

- In our calculations, there is an assumption for the FiO2 depending on the oxygen delivery device. For example, a patient on oxygen via a nasal cannula will also be breathing ambient air with 21% FiO2 through the mouth and thus the fraction of inspired oxygen can be lower than what would be estimated by the liters per minute of oxygen going through
the nasal cannula. FiO₂ is more precisely controlled with certain devices such as venturi masks, non-rebreathers, continuous positive airway pressure and non-invasive ventilation machines with face masks.

- Calculating the Alveolar gas equation is fast, cost-effective, and minimally invasive. It provides a wealth of information that can guide your management. Our patient avoided further invasive testing, radiation exposure, and medical costs because our alveolar gas equations, arterial blood gases, and A-a gradient calculations provided a clear explanation of our patient’s hypoxemia and hypercapnia.

REFERENCES


A Case of *Bartonella* Endocarditis and Torrential Aortic Regurgitation Leading to Cardiac Arrest

Brandon Pecchia, MD, MS¹, Sawyer Kieffer, MD¹

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**INTRODUCTION**

Infective endocarditis can be difficult to diagnose, especially when blood culture-negative. We describe a case of a patient who presented with signs and symptoms of new, acute decompensated heart failure who was found to have culture-negative endocarditis, a large, mobile aortic valve mass, and torrential aortic regurgitation. Although the patient remained clinically stable during early admission and was planned for surgical correction of the valvular pathology, he suffered abrupt clinical decompensation which resulted in cardiac arrest. Postmortem serologies were found to be positive for *Bartonella henselae* and *Bartonella quintana*.

**CASE PRESENTATION**

**Subjective:**

A 53-year-old male with a past medical history of opioid use disorder on suboxone, anxiety, and normocytic anemia, was transferred to Thomas Jefferson University Hospital with a week and a half of progressive dyspnea with exertion and lower extremity edema. He endorsed orthopnea, paroxysmal nocturnal dyspnea, and intermittent substernal chest pain while recumbent. He denied subjective fevers or chills, current chest pain, or shortness of breath at rest. He denied a history of smoking or alcohol use. He endorsed prior fentanyl insufflation, last use about one month prior, but denied having ever used intravenous drugs. The patient had been undomiciled for the past few months.

**Objective:**

Upon presentation, the patient was afebrile, with a heart rate of 77, blood pressure of 121/60, and saturating 94% on 2L nasal canula (not on home oxygen). Physical exam showed a slightly anxious and unkempt male, who appeared older than stated age. Cardiac exam was notable for a III/VI diastolic murmur and II/IV systolic murmur, both loudest at the right upper sternal border, and jugular venous distension. Lungs were clear to auscultation bilaterally. He had trace bilateral lower extremity edema.

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Platelets and bilirubin were normal. Urine drug screen was negative. Multiple sets of blood cultures had no growth.

*Figure 1:* TEE, midesophageal aortic valve long axis view: with aortic vegetation (1.3cm x 0.6cm) extending into the aorta (left), and prolapsing into the left ventricular outflow tract (right).
A transthoracic echocardiogram (TTE) showed new, severe aortic regurgitation and possible bicuspid aortic valve, and could not rule out the possibility of a vegetation. A subsequent transesophageal echocardiogram (TEE) confirmed a bicuspid aortic valve and showed torrential aortic regurgitation (an extreme variety of severe regurgitation) and a large, calcified, mobile mass (1.3 x 0.6 cm) which prolapsed in and out of the left ventricular outflow tract (figures 1-3).

The patient was aggressively diuresed and underwent surgical evaluation for valve replacement, which included infectious disease consultation for the mobile density on the aortic valve. Given negative blood cultures, the infectious disease team recommended holding antibiotics and beginning the workup for culture-negative endocarditis, including Bartonella serologies.

The Code:

The night prior to his cardiac arrest, the patient was fully oriented, with stable vital signs on 3L oxygen via nasal cannula. He was noted to have intermittent episodes of shortness of breath, and panic attacks that resulted in brief oxygen desaturations when he removed his nasal cannula. Anxiety had been an ongoing issue throughout the hospitalization and was routinely remedied with 1mg oral lorazepam. He also developed his first fever that night, to 101.1 F. He was started empirically on intravenous vancomycin and piperacillin-tazobactam.

The morning of his cardiac arrest, the patient was seen by the physician team at bedside. He was lethargic and only oriented to self. He endorsed shortness of breath, despite normal oxygen saturation on 3L nasal cannula. STAT labs showed a normal lactate and VBG of 7.35/37, but his overnight labs revealed an acute rise in transaminases, as well as an increase in white blood cell count and a decrease in serum sodium (Table 1). Shortly after, the patient became acutely agitated and could not be reoriented. He attempted to stand up, visibly short of breath, became bradycardic to the 30s, and lost consciousness. Found pulseless, chest compressions were promptly initiated, and a code blue was called. Telemetry monitoring revealed pulseless electrical activity (PEA) and advanced cardiovascular life support (ACLS) protocol was followed. Ventilation via bag-valve mask was difficult, and the first two attempts at intubation were unsuccessful, due in part to blood in the airway. With both anesthesia and otolaryngology teams present, the third attempt was successful with two-attending intubation using video laryngoscopy, and was confirmed by bilateral breath sounds, capnography, and robust color change of the patient.

The anesthesia team expressed their continued concern for active pulmonary hemorrhage, however, and bronchoscopy was pursued, which showed copious bright red blood originating from the left mainstem bronchus. An attempt was made to bypass the bleeding with right mainstem intubation, though he was found to have right lower bronchus bleeding as well. Greater than 1 liter of blood was suctioned during laryngoscopy and bronchoscopy. The endotracheal tube was ultimately retracted to the level of the carina while ACLS continued. Though resuscitation was attempted for over 30 minutes, the patient continued to have PEA arrest without successful return of spontaneous circulation (ROSC). Blood transfusion was thought to be of low utility given rapid bronchopulmonary hemorrhage, lack of ROSC, and time it would take to begin transfusion. No other reversible causes were identified, and patient death was pronounced. Three days post-mortem, the patient’s blood serologies returned positive for B. henselae and B. quintana IgG and IgM, at which point he met the diagnostic threshold of “definite” infective endocarditis by Duke criteria. His major criterion was evidence of endocardial involvement on TEE; and his minor criteria were fever, predisposing heart condition (bicuspid aortic valve), serologic evidence of active infection with organism consistent with infective endocarditis, as well as (suspected) vascular phenomena.
DISCUSSION

Cat scratch disease and Trench fever may come to mind when one thinks of Bartonella, however it is a rapidly rising cause of culture-negative endocarditis, which often goes undiagnosed due to difficulties in detecting the species. The organism is characterized by indolent growth and the ability to form biofilms which, together with its characteristic intraerythrocytic propagation, increases the risk for infection of heart valves, and the ability to evade the immune system and systemic antibiotics. The patient in this case had both of the two most common causes of Bartonella-induced endocarditis: B. quintana, and B. henselae, with the former accounting for approximately 75% of cases of Bartonella endocarditis.

B. henselae often occurs in patients who have an underlying valvular condition, while B. quintana most frequently occurs with louse exposure in the homeless population. Interestingly, the patient had an underlying valvular condition and was recently unhoused, and subsequently tested positive for both species of Bartonella. The patient had denied any cat exposure, and no known louse or flea bites, though did endorse previously having “mites” in his bedding. Though traditionally reported in patients with HIV and in other immunocompromised states, B. quintana has since been well-documented in people without any known immunodeficiency. Of note, the patient had previously tested negative for HIV one year prior to admission, but had not been retested at the time of the present admission.

Current treatment recommendations vary and are not based on randomized trial data. Suggested treatments include a two-drug regimen, often rifampin and doxycycline for three months. Given the risk of nephrotoxicity with aminoglycosides (as well as immune-complex glomerulonephritis seen in Bartonella endocarditis), a less preferred alternative is an aminoglycoside in combination with either a beta-lactam, a macrolide, or a tetracycline.

We can only speculate what may have occurred in this intriguing case, as the patient’s family declined autopsy. Multiple signs suggest that the patient may have had showering of septic emboli from his endocarditis, such as his acute hepatocellular pattern of liver injury within 24 hours, and rapid-onset encephalopathy. However, metabolic confounders such as hyponatremia and azotemia may have also contributed to his change in mental status. Regarding his pulmonary hemorrhage, again, we can only speculate. CT scan of his chest two days prior to cardiac arrest showed “mild background pulmonary edema” and “lower cervical and mediastinal lymphadenopathy, nonspecific and likely reactive.” The lymphadenopathy may have been related to B. henselae, as seen in cat scratch disease, perhaps with a more disseminated infection than anticipated, leading to alveolar hemorrhage. Though rare, there have even been reports of bronchopulmonary manifestations of bacillary angiomatosis.

A case such as this prompts providers to ask what could have been done differently. Could it have been detected earlier? Should any unhoused individual with endocarditis have Bartonella higher on their differential? Specific to this case, would earlier antibiotic management have made any difference? It seems unlikely given the extensive treatment course and the fastidious nature of the Bartonella species. The patient did develop an acute kidney injury, so had his results come back sooner, rifampin and doxycycline may have been considered as a treatment for him while awaiting definitive valvular surgery. Given the vegetation size and degree of symptomatic valvular dysfunction, he was tentatively planned for surgery, but unfortunately was still undergoing preoperative evaluation at the time of his rapid clinical decompensation. Earlier surgical intervention may have been the only way to increase the chance of survival, though time did not allow for that in this patient.

REFERENCES

A Case Presentation of Pericarditis Associated with Haemophilus Influenzae Bacteremia

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INTRODUCTION

Acute pericarditis, or inflammation of the pericardial sac, is a clinical condition which can often be attributed to a variety of underlying etiologies, including infection, autoimmune disease, trauma, and malignancy. While viral infections are commonly implicated in the etiology of pericarditis, bacteria known to be associated with pericarditis include staphylococcus species, streptococcal species, tuberculosis, and in children, Haemophilus influenzae. Here we present a rare case of pericarditis in an adult male patient which occurred in association with Haemophilus influenzae bacteremia.

CASE PRESENTATION

A 53-year-old male with hypertension, hyperlipidemia, poorly controlled type 2 DM (insulin dependent though noncompliant with home medications), crack cocaine use presented to the ED with several days of shortness of breath with associated pleuritic chest pain that was not affected by positional changes. The shortness of breath developed suddenly four days prior to admission in conjunction with the pleuritic chest pain and a dry cough. His vital signs on admission were notable for temperature of 97.3 degrees Fahrenheit, heart rate of 138 beats per minute, blood pressure 113/77, respiratory rate 18 breaths/minute, and oxygen saturation of 96% on room air. Labs on admission were significant for troponins (Troponin T Hs) of 16-->18, erythrocyte sedimentation rate >130 mm/hr, and c-reactive protein of 44.70 mg/dL. White blood cell count was 18.4 B/L with a hemoglobin of 11.4 g/dL, and platelets of 328 B/L and hemoglobin A1c of 9.7. The urine drug screen was positive for cocaine. EKG was notable for diffuse anterolateral and inferior ST elevations with frequent atrial ectopy (Figure 1). This progressed during hospitalization to both paroxysmal atrial fibrillation and atrial flutter.

A CT angiogram of his chest to rule out pulmonary embolism (PE) was negative but did show a small pericardial effusion with pericardial thickening and mediastinal fat stranding with small mediastinal lymph nodes concerning for acute pericarditis. Echocardiogram showed an ejection fraction of 60% with a small to moderate pericardial effusion. No tamponade physiology was present (Figure 2).

Figure 1: EKG
Our patient was unique in that his pericarditis was thought to be associated with Haemophilus influenzae (H. flu) bacteremia. H. flu is a gram-negative coccobacilli that causes many different pathologies, especially in the pediatric population. These include otitis media, meningitis, cellulitis, and upper respiratory tract infections. Vaccination against H. flu type b is offered to children in a 3-4 dose series, but the vaccine does not protect against other strains of H. flu, and those that are unvaccinated and immunocompromised are also at increased risk for this disease.5 While very rare, a few case reports have shown H. flu pericarditis in immunocompetent individuals (confirmed through pericardiocentesis).5,6 In fact, an older case report in CHEST did describe two cases of pericarditis in association with H. flu bacteremia.6

In our patient, the risk of pericardiocentesis outweighed the benefits secondary to the small size of the effusion. Therefore, it cannot be definitively stated that his pericarditis was purely secondary to Haemophilus influenzae without pericardial fluid bacterial isolation.

However, clinicians must be quick to recognize this condition, as untreated pericarditis can result in devastating complications including cardiac tamponade and constrictive pericarditis.1,3 In addition, patients with pericarditis have an increased risk for development of recurrent pericarditis.2

Diagnosis of pericarditis is made with a combination of detailed history taking, physical exam findings, lab work, and imaging. Patients with pericarditis will almost always present with chest pain, which may be alleviated by sitting up and leaning forward, and may present with fever, dyspnea, and cough. While a pericardial friction rub is almost 100% specific for pericarditis, its sensitivity is much more variable.1 EKG changes vary with different stages of pericarditis, but include diffuse ST segment elevation, ST depression in AVR or V1, PR depression, and T wave inversions.4 Lab work is less specific but includes leukocytosis, elevated troponins, and elevated inflammatory markers (ESR, CRP). Chest X-ray is often normal, but ultrasound and CT imaging may show evidence of pericardial effusion and/or inflammation. Guidelines for diagnosing pericarditis involve meeting at least two of the four criteria as follows: 1- chest pain; 2- pericardial friction rub; 3- EKG changes including ST elevations/PR depressions; 4- new or worsening pericardial effusion.1 If a pericardial effusion is large enough, a pericardiocentesis should be performed for diagnostic and often therapeutic purposes.

In our patient, the risk of pericardiocentesis outweighed the benefits secondary to the small size of the effusion. Therefore, it cannot be definitively stated that his pericarditis was purely secondary to Haemophilus influenzae without pericardial fluid bacterial isolation. However, the patient was treated under clinical suspicion and objective evidence that H. flu was the likely underlying etiology of pericarditis. He improved rapidly with targeted antibiotic treatment towards H. flu, his chest pain resolved, his effusion remained stable on ultrasound, and he was discharged to a substance use disorder treatment facility. One month after discharge, he presented to the infectious disease clinic and was feeling almost completely back to his baseline after finishing his antibiotic course two weeks prior to that visit.
CONCLUSION

Our case report is one of only a few others in the literature that demonstrates a possible association between H. flu and pericarditis in an otherwise immunocompetent adult. Clinicians must be astute in recognizing pericarditis as a potential cause of chest pain, as prompt treatment can reduce the risk of life-threatening complications.

REFERENCES


End-Stage Chronic Intestinal Pseudo-Obstruction Resulting in Intestinal Pneumatosis

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ABSTRACT

Chronic intestinal pseudo-obstruction (CIPO) is a rare gastrointestinal motility disorder that presents with symptoms, physical exam, and imaging findings of mechanical bowel obstruction without an anatomical obstruction. Multiple etiologies, including enteric or extrinsic neuropathic dysfunction, myopathic dysfunction, or dysfunction of the interstitial cells of Cajal, cause CIPO's pathogenesis. The presentation of CIPO may be idiopathic or caused by underlying diseases. The most common presentation is abdominal pain, bloating, and distension. Here, we present a patient with an end-stage case of CIPO who failed medical therapy. Her distension progressed over a decade, requiring emergency surgery due to intestinal pneumatosis.

INTRODUCTION

The enteric nervous system (ENS) has many responsibilities, including controlling gut musculature, secretory glands, and lymphatic blood vasculature. The delicate coordination of this system, colloquially referred to as the “brain-gut interaction,” is paramount to the success of the gastrointestinal tract. Chronic intestinal pseudo-obstruction (CIPO) represents an intestinal motility failure that highlights the importance of a functional ENS and the impact on patient quality of life and healthcare costs.

CIPO is a rare disorder that presents on a spectrum of severity. The estimated prevalence of 0.80 per 100,000 with an incidence of 0.21 per 100,000. CIPO is caused by enteric or extrinsic neuropathic dysfunction, myopathic dysfunction, or dysfunction of the interstitial cells of Cajal. The presentation of CIPO may be idiopathic or caused by underlying diseases. Sequelae of CIPO include anorexia, abdominal pain, small intestinal bacterial overgrowth, and malabsorption.

Patients with CIPO present with clinical symptoms of intestinal obstruction without evidence of a mechanical obstruction; typically, patients suffer from bloating, abdominal pain, and vomiting. Radiologic imaging reveals air-fluid levels within distended bowel loops. Patients often require enteral or parental nutrition and opioid pain control with increased morbidity and mortality. Management of CIPO necessitates a multidisciplinary team requiring supportive therapy, including nutritional and electrolyte supplementation and judicious pharmacotherapeutic medications.

CASE REPORT

A 40-year-old female with a history of AIGD (Autoimmune Gastric Dysmotility) complicated by CIPO presented to our medical center with several days of abdominal pain. On presentation, she described increased bloating and cramping abdominal pain. Vital signs and laboratory studies were within normal limits. She was admitted to the gastroenterology (GI) floor service for further management.

The patient has had long-standing abdominal bloating and pain dating back a decade. Full laboratory, endoscopic, and imaging workup was completed during initial GI outpatient visits to rule out irritable bowel disease, mechanical bowel obstruction, celiac disease, and infectious etiology. Ultimately, the patient was diagnosed with AIGD via a positive voltage-gated potassium channel antibody causing CIPO.

The patient rapidly became dependent on parental nutrition due to cachexia and the inability to tolerate oral nutrition. The patient was trialed on multiple medications to improve small bowel motility over several years, including metoclopramide, neostigmine, pyridostigmine, and prucalopride, with minimal response. Given the patient’s bowel stasis, she also suffered from severe nausea and bloating. She was treated with multiple courses of rifaximin for presumed concomitant small intestinal bacterial overgrowth with little improvement. She ultimately required a venting gastrostomy tube placement, which was complicated by persistent peristomal leakage causing skin breakdown and significant pain. She was started on high-dose proton pump inhibitor therapy and octreotide with little improvement.
emergently taken to the surgical intensive care unit. After discussions between the gastroenterology team, the colorectal surgery team, and the patient, the decision was made to proceed to the operating room for abdominal exploration with possible resection of non-viable bowel and ileostomy creation. While in the operating room, the small bowel was found to be massively distended (up to eight centimeters) with boggy, fibrinous exudate; however, the small bowel was completely viable without evidence of ischemia or need for resection. On inspection of the distal ileum, there was tapering to a normal caliber of the final ten centimeters. Ultimately, the decision was made to create a palliative loop ileostomy for possible distal decompression, given the patient’s persistent abdominal pain, lactic acidosis, and imaging findings. The colon was inspected but also showed no signs of ischemia.

Finally, given the failure of medical management, the patient was referred to another academic hospital for consideration of a small bowel transplant. Unfortunately, many complications and hospitalizations prevented the patient from undergoing transplant evaluation. She had numerous admissions from 2013 through 2023 for pain control, bacteremia, fungemia, gastrostomy site skin breakdown, and failure to thrive.

During the patient’s most recent admission, she was evaluated emergently at the bedside for sinus tachycardia and abdominal pain, unresponsive to pain control. Given concern for bowel perforation, she was emergently sent for CT scan with intravenous contrast that revealed diffuse intestinal pneumatosis and portal venous air.

Given the patient’s extreme distension, it was thought that her increased intraabdominal pressure was limiting blood supply to the small bowel. The patient was emergently taken to the surgical intensive care unit. After discussions between the gastroenterology team, the colorectal surgery team, and the patient, the decision was made to proceed to the operating room for abdominal exploration with possible resection of non-viable bowel and ileostomy creation.

While in the operating room, the small bowel was found to be massively distended (up to eight centimeters) with boggy, fibrinous exudate; however, the small bowel was completely viable without evidence of ischemia or need for resection. On inspection of the distal ileum, there was tapering to a normal caliber of the final ten centimeters. Ultimately, the decision was made to create a palliative loop ileostomy for possible distal decompression, given the patient’s persistent abdominal pain, lactic acidosis, and imaging findings. The colon was inspected but also showed no signs of ischemia.

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**Figure 1:** Computerized tomography (CT) imaging of the abdomen and pelvis demonstrating disease progression from 12/2013 to 2/2023. A) Coronal CT 12/16/2013 with unremarkable bowel gas pattern. B) Coronal CT 8/10/2014 with multiple distended small bowel loops and distension of the stomach. C) Axial CT 7/6/2017 with multiple loops of dilated large and small bowel with no discrete transition point. D) Axial CT 1/26/2023 with markedly diffuse small bowel dilation. E & F) Axial and coronal CT 2/26/2023 demonstrating severe small bowel obstruction with superimposed bowel ischemia with multiple foci of intramural, mesenteric venous and portal venous air.
The small bowel was decompressed during the procedure, and eight liters of enteric contents were evacuated. An additional two liters of enteric contents were evacuated via a nasogastric tube. Ultimately, operative and pathology findings did not demonstrate ischemic bowel or mesenteric ischemia. Unfortunately, the patient’s distension and abdominal pain were not significantly improved post-operatively despite the palliative surgical intervention.

DISCUSSION

Though CIPO is a rare disease, it remains the leading cause of intestinal failure, with a significant burden on the healthcare system. While this patient’s case may show a typical disease progression and representation of common complications over time, it also highlights intestinal pneumatosis, a rare complication of end-stage CIPO, in a patient who has failed all medical therapy. Further research and medical training devoted to improving diagnostic acumen, therapies, and quality of life in patients with CIPO is needed.

There are no diagnostic tests or pathognomonic findings unique to CIPO. The median time to diagnosis is eight years after symptom onset, and patients typically undergo multiple unnecessary surgeries and procedures in this interim. During this time, patient quality of life is poor, with many dependent on parental nutrition, unsuccessful trials of expensive medications, and developing a dependence on narcotics for pain. As a result, patients with CIPO have frequent hospital admissions, prolonged lengths of stay, and a high-cost burden in the healthcare system. A standardized diagnostic approach is needed to promptly identify underlying disease and pathology to alleviate patient suffering.

The inception of gut transplantation in the 1990s has added another dimension to the management of CIPO to offer patients nutritional autonomy and improved quality of life. Further research devoted to developing a multidisciplinary team approach, including surgeons, nutritionists, gastroenterologists, and pain management specialists, can improve quality of life and more rapidly identify transplant candidacy.

While current treatment aims to alleviate symptoms, new therapies targeting the ENS may be on the horizon as further advances within stem-cell therapy, pharmacology, and surgical techniques continue. These advancements are pivotal to avoiding poor outcomes, such as this patient’s case.

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Disclosures:
Author contributions: J. Bilello wrote the manuscript, reviewed the literature, and is the article guarantor. P. Chun and A. Bhasin wrote the manuscript and reviewed the literature. A. Martin revised the manuscript.

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Informed patient consent was obtained for case report.
Helpful or Harmful? A Case Report of Nutritional Supplements Causing Drug-Induced Liver Injury

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INTRODUCTION

Herbal supplement-induced liver injury represents a growing concern in the body of drug-induced liver injury (DILI) literature, with recent studies in mainland China, Iceland, and the United States reporting estimated rates of herb/dietary supplement-induced liver injury (HILI) between 1.16-6.38 per 100,000 (Björnsson et al., 2013; Shen et al., 2019; Vega et al., 2017). Notably, a recent 2020 study demonstrated an increasing prevalence of hepatotoxicity secondary to herbal and dietary supplements in the US and worldwide (Zheng et al., 2020). Recognizing the hepatotoxicity of various supplements is crucial, given the increasing usage of dietary and herbal supplements and the lack of regulation of herbal supplements in the United States.

HRP-AID is marketed as a twice-daily “immune system booster” to reduce the intensity and frequency of cold sore outbreaks. The product ingredients include 200 mg ascorbic acid, 20 mcg cholecalciferol, 20 mg a-tocopherol, 10 mg pyridoxine HCl, 50 mcg methylcobalamin, 25 mg zinc citrate, 70 mcg selenium, 250 mg L-lysine, 50 mg Astragalus extract (Astragalus membranaceus), 50 mg Echinacea (Echinacea purpurea), 50 mg garlic powder (Allium salivum), 50 mg natural caffeine (coffee arabica), 50 mg olive leaf extract Oleuropin 20% (Olea Europaea), 50 mg oregano powder (Thymus capitatus), 50 mg of elderberry extract (Sambucus nigra) and 50 mg Red Panax ginseng extract (Panax ginseng). A literature review demonstrates that this is the first reported case of DILI secondary to HRP-AID supplementation.

CASE PRESENTATION

A 27-year-old woman with a past medical history of genital herpes presented with three days of acute onset abdominal pain, nausea, vomiting, generalized weakness, and jaundice. Further history revealed that she is a Liberian immigrant who immigrated to the United States nine years prior to work as a healthcare aide. She noted no history of prior liver disease or family history of liver disease, cirrhosis, hepatic malignancy, or any recent travel or sick contacts at home, socially, or work. However, she reported that her partner, who frequently travels to Liberia, had a history of “a liver ailment” treated a few years prior. The patient also denied a history of any prior blood transfusions, tattoos, or intranasal or intravenous drug use. Her social history was notable for drinking one glass of wine weekly.

Upon further questioning, the patient revealed that she takes no prescribed medications. She takes 1-2 ferrous sulfate pills when fatigued, particularly after menses. Furthermore, daily over the past month, she noted that she had been using two tablets of Prodigy Life HRP-AID supplements and lemon balm tea (100% Melissa Officinalis).

The patient’s lab work was notable for significant abnormalities with AST 6597, ALT > 5000, alkaline phosphatase of 92, total bilirubin of 17.1, direct bilirubin of 9.3, INR of 2.7, ferritin > 7000, and a MELD-Na score of 29. The patient underwent a CT abdomen, abdominal ultrasound, and MRCP. These imaging studies revealed normal hepatic echogenicity with no acute abnormalities. These studies indicated acute hepatic inflammation. The patient was admitted to the intensive care unit for further management and treated with intravenous N-acetylcysteine and oral Vitamin K.

The patient’s total and direct bilirubin levels peaked at 52.2 and 46 before down-trending to 30.6 & 28.2, respectively. The autoimmune panel was negative for antinuclear, anti-smooth muscle, mitochondrial M2, liver kidney microsomal antibodies, alpha-1 antitrypsin, ceruloplasmin, and celiac panel. The infectious workup was positive for hepatitis B surface antigen, hepatitis B...
core antigen, hepatitis Be antibody, and a hepatitis B viral PCR load of 21.9. The hepatitis B surface antibody was negative, indicating a chronic hepatitis B infection. Hepatitis A, C, D, and E were negative, ruling out possible acute co-infection or superinfection. Entacavir was initiated for the treatment of chronic hepatitis B. A liver biopsy was negative for fibrosis but showed evidence of acute hepatitis with moderate lobular inflammation, cholestasis, and lobular disarray with acidophil bodies suggestive of DILI.

Unfortunately, one month after discharge from the hospital, the patient was readmitted after she was evaluated at an outpatient visit. She was persistently nauseous with jaundice on physical exam. The patient had remained abstinent from herbal supplements. Labs on admission were notable for AST 2534, ALT 2244, ALP 196, total bilirubin 10.5, INR 1.3. A liver transplant workup was completed during this admission. She underwent a repeat liver biopsy, which was definitively conclusive for DILI. She was discharged from the hospital as her labs and symptoms improved with supportive care.

**DISCUSSION**

Here, we present the first case of DILI secondary to HRP-AID. The Roussel Uclaf Causality Assessment Method (RUCAM) score, a metric utilized to determine the probability of causality between a particular agent and resultant liver injury (Hao et al., 2014), was five, correlating to "possible" causality.

The mechanism of action between HRP-AID supplementation and liver injury is unclear. An obfuscating factor is that the supplement contains various components. Some ingredients are associated with liver injury in the literature. There have been reports of jaundice and liver injury resembling copper and iron overdose secondary to zinc toxicity, usually in supplement overuse ("StatPearls," 2022). Similarly, echinacea is a rare cause of clinically apparent liver injury (Xu et al., 2021). Case reports have described episodes of hepatitis and jaundice but with complete rapid recovery after stopping the supplement (Lawrenson et al., 2014). Ginseng has been associated with liver injury, mainly when used with other potentially

![Figure 1: Liver biopsy pathology slides demonstrating acute hepatitis pattern of injury, likely suggestive of DILI. A) Trichome stain with no significant increase in fibrosis, ruling out chronic liver disease. B) 10x view illustrating moderate portal and lobular inflammation, C) 40x view of lobules with enhanced visualization of acidophil bodies present, D) 20x view highlighting lobular activity with cholestasis and scattered acidophil bodies.](image-url)
hepatotoxic medications due to its effect on cytochrome P450 enzymes (Laube & Liu, 2019; Mateo-Carrasco et al., 2012), although there have been reports of isolated ginseng-associated liver injury (Lin et al., 2018). Many of these agents may have contributed to the patient’s liver injury. There is a possible role for synergism between several potentially hepatotoxic agents.

This patient’s liver injury was attributable to using HRP-AID supplements after ruling out other causes of acute liver injury. Chronic hepatitis B infection was unlikely to be causing the level of acute liver inflammation seen on the biopsy, given the patient’s low viral load (Seto et al., 2018). Similarly, the patient’s concurrent use of lemon balm was an unlikely cause of the patient’s significant liver injury. No case reports of lemon balm-related liver injury exist in the current literature; lemon balm is hepatoprotective in animal models of liver disease (Kim et al., 2020). Thus, it was reasonable to assume that the patient’s liver injury was attributable to her usage of HRP-AID supplements.

In conclusion, our HRP-AID supplementation-induced liver injury case expands on the growing knowledge of the causes of DILI. This case highlights the importance of obtaining a comprehensive social history, including herbal and dietary supplements. Clinicians should maintain a high suspicion for DILI secondary to alternative causes, including supplementation use, after ruling out common causes of acute liver injury. Clinicians must familiarize themselves with potential hepatotoxic supplements, remembering that drug-induced liver injury may occur secondary to several potentially hepatotoxic substances taken concurrently.

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Author contributions:

A. Bhasin & P. Chun wrote the manuscript, reviewed the literature, and are the article guarantors. J. Bilello wrote the manuscript and reviewed the literature. D. Halegoua revised the manuscript. M. Ambelil provided the pathology slides and analysis.

Financial disclosure:

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Informed patient consent was obtained for case report.
A Case of Suspected Lisdexamfetamine (Vyvanse) Drug-Induced Liver Injury

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INTRODUCTION

Amphetamines are a well-established cause of liver injury though the typical presentation is that of illicit drug abuse rather than liver injury occurring in a prescribed setting. Lisdexamfetamine (Vyvanse) is one of the most commonly prescribed stimulant medications used for the treatment of Attention Deficit Hyperactive Disorder (ADHD). The authors were only able to find a single case of lisdexamfetamine-related drug-induced liver injury (DILI) occurring in the pediatric population in their review of the literature. Here we present a case of suspected lisdexamfetamine DILI in an adult patient.

CASE DESCRIPTION

A 47-year-old male presented with several days of abdominal pain and nausea.

His past medical history included gastroesophageal reflux disorder, Barrett’s Esophagus, and ADHD. Notable past surgical history included a hemorrhoidectomy. Home medications included lisdexamfetamine and omeprazole. He did not take any herbal or supplement medications. He had no personal or family history of liver disease.

Figure 1: A. Hepatocyte swelling in Zone 3. B and C. Zone 3 hepatocellular and canicular cholestasis with swelling and feathery degeneration of hepatocytes. D. Portal tracts with mild mixed inflammatory infiltrate. Bile duct damage and inflammation are minimal, and there is no bile duct proliferation.
On exam, his vitals included a heart rate of 91 beats per minute, blood pressure of 137/86 mmHg, and temperature of 36.2 °C. Abdominal exam revealed right upper quadrant tenderness to palpation. Labs revealed a total bilirubin of 4.0 mg/dL, alkaline phosphatase of 135 IU/L, aspartate transaminase of 217 IU/L, alanine transaminase of 189 IU/L. Peak values for those labs were 12.1 mg/dL, 248 IU/L, 291 IU/L, and 543 IU/L, respectively. Other labs included an international normalized ratio of 1.16 and a platelet count of 342,000/uL. The patient underwent a thorough serologic evaluation to assess for underlying liver disease. The workup, which included assessing for autoimmune, infectious, and metabolic etiologies for his presentation, was unrevealing.

During his hospital course, the patient underwent a right upper quadrant abdominal ultrasound, computed tomography of the abdomen and pelvis, hepatobiliary iminodiacetic acid scan, and magnetic resonance imaging abdomen with magnetic resonance cholangiopancreatography. In turn, imaging demonstrated cholelithiasis with mild thickening of the gallbladder without findings of cholecystitis and with a normal-appearing biliary tree. The patient’s liver function tests continued to rise, so he ultimately underwent a liver biopsy (Figure 1). The liver biopsy revealed cholestatic hepatitis with zone 3 hepatocellular and canalicular cholestasis consistent with DILI.

Lisdexamfetamine was held during his hospital stay and ultimately discontinued on discharge, given concern for DILI. His liver function tests are slowly improving as an outpatient.

**DISCUSSION**

This case highlights a novel presentation of DILI associated with lisdexamfetamine. On review of the literature, the authors were unable to find a previously described association in the adult population.

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"Phone stack" – Akash Patel, DO
ULTRASOUND EDUCATION

A Guide to Point of Care Ultrasound Examination of Acute Decompensated Heart Failure

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LEARNING OBJECTIVES
1. Learn the technique for cardiac ultrasound.
2. Identify and interpret the cardiac ultrasound findings consistent with left heart systolic failure.
3. Recognize early-point septal separation (EPSS) and Kimura’s cardiopulmonary limited ultrasound evaluation (CLUE) as techniques for assessing reduced left heart ejection fraction.

INTRODUCTION

A patient presents with dyspnea on exertion, orthopnea, and lower extremity edema. They have a prior history of coronary artery disease and reported episodes of chest pain three months ago. They did not seek medical evaluation at the time and have had no chest pain recently. In this setting, there is a high clinical suspicion of heart failure with concern for ischemic heart disease. The gold standard for diagnosis of heart failure is a formal transthoracic echocardiogram. Bedside point of care ultrasound (POCUS) is a tool that can provide essential information without delay in diagnosis.

A study by Razi et al. in 2011 investigated whether internal medicine residents with limited training (20 practice studies) could use POCUS to identify systolic heart failure with handheld ultrasound machines. They identified heart failure with reduced EF < 40% with a sensitivity and specificity of 94%.1 At their institution, obtaining results from a formal echocardiogram took 22 hours on average.

It is important to recognize the limited scope of cardiac POCUS. The goal of cardiac POCUS is to answer key clinical questions, and ideally, questions that can be simplified into binary outcomes. For example, is the left heart larger than the right heart? Is there a pericardial effusion present? Is the right heart dilated? Does the E-point septal separation (EPSS) suggest a reduced left heart ejection fraction?2

Using the previous example, an internal medicine resident with limited training would not be able to make a determination of valvular dysfunction, segmental wall motion abnormalities, estimation of pulmonary artery systolic pressures, and nuanced evaluation of ejection fraction. However, many valuable clinical findings can be made with cardiac POCUS, and validated techniques such as EPSS and the CLUE protocol are effective at assessing for reduced left heart ejection fraction.

TECHNIQUE

The Cardiac POCUS includes four views plus an IVC exam.
1. The parasternal long axis (PLAX) is obtained at the second intercostal to the left of the sternum, with the probe indicator directed at the patient’s right shoulder.
   
a. The most anterior chamber is the right ventricle (RV) and right ventricular outflow tract (RVOT).

b. Deep to the RV is the left ventricle (LV). The left ventricular outflow tract (LVOT) leads to the aortic valve and aorta. The left atrium (LA) and mitral valve lead into the left ventricle.

c. The deepest structure identified is the thoracic aorta.

d. TIP: set your depth to the thoracic aorta.

e. TIP: the RVOT, aorta, and left atrium should be 1:1:1 in size. If one of those structures is significantly different, it may suggest that you are off-axis or that there is abnormal pathology.

2. The parasternal short axis (PSAX) is obtained at the same position as the PLAX but with a 90-degree rotation of the probe indicator towards the patient’s left shoulder.
   
a. The ideal view will be at the level of the papillary muscles. The papillary muscles should be equal in size, which indicates that you are on the appropriate axis.
3. The apical 4-chamber (A4C) is obtained at the apex of the heart with the indicator pointed in the same axis as the PSAX.
   a. After obtaining the PSAX, slide the probe down the length of the heart, and when you reach the apex, tilt the probe so that it is pointing up the long axis of the heart.
   b. A 5-chamber view can be obtained by fanning your probe and capturing the aortic valve and LV outflow tract.

4. The subxiphoid view (SXI) is obtained by imaging from under the sternum with the probe held horizontally and the probe indicator directed to the patient’s left.
5. The Inferior vena cava (IVC) view is obtained by first identifying the right atrium on the subxiphoid view, then rotating the probe 90 degrees so that the probe indicator is directed caudally.

Findings Consistent with Acute Decompensated Left Heart Failure

1. Left heart ventricular dilation in multiple views and with decreased fractional shortening of the left ventricular walls. A symmetric reduction in the volume of the ventricle of 30% is associated with an ejection fraction of at least 50%.

![Image of Inferior vena cava view](image1)

![Image of Left heart ventricle views](image2)
2. **Measurement of the Early-point septal separation.**

   Early-Point septal separation (EPSS) is an objective method of estimating left ventricular ejection fraction. Visualization of the mitral valve is optimized in the parasternal long axis. M-mode is centered on the anterior leaflet of the mitral valve as it moves toward the interventricular septum. A few cardiac cycles are measured, then freeze the frame and use the calipers to measure the EPSS. The EPSS is calculated as the distance between the endpoint of the mitral valve leaflet motion and the septum. If the anterior leaflet of the mitral valve moves within 1 Dong Ultrasound Cardiac fig 8 0.7cm of the septal wall, the patient’s EF is assumed to be greater than 55%. A distance greater than 1.0cm is consistent with a reduced EF.

3. **Bilateral B-lines are consistent with pulmonary edema.** In the Cardiopulmonary Limited Ultrasound Evaluation (CLUE) protocol for reduced left ventricular ejection fraction, only the bilateral apical lungs are assessed.⁵
4. A Plethoric IVC: Dilated IVC > 21mm with less than a 50% decrease on inspiration.

4. Kimura et al. in 2011 created the CLUE protocol, which combines four views to predict if there is a reduced left heart ejection fraction. Using only the parasternal LV long-axis, subcostal IVC, and two apical lung views, the protocol assesses LV dysfunction, LA enlargement, IVC plethora, and B-lines in the lung apices. When evaluating LV ejection fraction < 40%, the CLUE protocol had a sensitivity of 69%, specificity of 91%, and accuracy of 89%.

Acknowledgments:
The ultrasound images were acquired by Dr. Saati, Dr. Cooper, Dr. Foster, and Dr. Dong.

REFERENCES
ULTRASOUND EDUCATION

A Guide to Point of Care Ultrasound Examination of a Pericardial Effusion

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LEARNING OBJECTIVES

1. Learn the technique for cardiac point of care ultrasound.
2. Identify and interpret the cardiac ultrasound findings consistent with pericardial effusion.
3. Identify and interpret the cardiac ultrasound findings consistent with cardiac tamponade.

TECHNIQUE

The Cardiac POCUS includes four views plus an IVC exam.

INTRODUCTION

A patient presents with pleuritic chest pain, dyspnea, and a recent viral illness. They have no prior cardiac or pulmonary history. Their X-ray on admission demonstrates no pulmonary findings and an enlarged cardiac silhouette, and their EKG is low voltage with electrical alternans. Ultrasound is an effective modality for identifying pericardial effusion and cardiac tamponade while at the same time evaluating for other causes, such as heart failure. Often patients with symptomatic pericardial effusion present with non-specific symptoms. While a “formal” transthoracic echocardiogram remains the gold standard for diagnosis, a bedside point of care ultrasound (POCUS) cardiac evaluation can significantly decrease the time to diagnosis and trigger an order for an urgent “formal” echocardiogram.¹ A retrospective study by Hanson and Chan in 2021 found that POCUS led to an expedited average time to diagnosis of 5.9 hours compared to >12 hours with other imaging. Those with a symptomatic pericardial effusion identified by POCUS had a significantly decreased time to treatment; time to pericardiocentesis of 28.1 hours compared to > 48 hours with other diagnostic modalities.²

The POCUS cardiac exam can be further used to monitor the patient’s response to therapy and identify a change, such as cardiac tamponade.³
1. The parasternal long axis (PLAX) is obtained at the second intercostal to the left of the sternum, with the probe indicator directed at the patient’s right shoulder.
   a. The most anterior chamber is the right ventricle (RV) and right ventricular outflow tract (RVOT).
   b. Deep to the RV is the left ventricle (LV). The left ventricular outflow tract (LVOT) leads to the aortic valve and aorta. The left atrium (LA) and mitral valve lead into the left ventricle.
   c. The deepest structure identified is the thoracic aorta.
   d. TIP: set your depth to the thoracic aorta.
   e. TIP: the RVOT, aorta, and left atrium should be 1:1:1 in size. If one of those structures is significantly different, it may suggest that you are off-axis or that there is abnormal pathology.

2. The parasternal short axis (PSAX) is obtained at the same position as the PLAX but with a 90-degree rotation of the probe indicator towards the patient’s left shoulder.
   a. The ideal view will be at the level of the papillary muscles. The papillary muscles should be equal in size, which indicates that you are on the appropriate axis.
3. The apical 4-chamber (A4C) is obtained at the apex of the heart with the indicator pointed in the same axis as the PSAX.

   a. After obtaining the PSAX, slide the probe down the length of the heart, and when you reach the apex, tilt the probe so that it is pointing up the long axis of the heart.

   b. A 5-chamber view can be obtained by fanning your probe and capturing the aortic valve and LV outflow tract.

4. The subxiphoid view (SXI) is obtained by imaging from under the sternum with the probe held horizontally and the probe indicator directed to the patient’s left.
5. The Inferior vena cava (IVC) view is obtained by first identifying the right atrium on the subxiphoid view, then rotating the probe 90 degrees so that the probe indicator is directed caudally.

**Findings Consistent with Pericardial effusion**

1. Fluid around the heart on the parasternal long axis, which is visualized as an anechoic stripe surrounding the heart.

2. Tamponade: a paradoxical movement of the RV free wall in which the RV wall moves towards the septum in diastole. During diastole, the RV should be filling; if the RV free wall is collapsing inwards, it can lead to hemodynamically significant decreases in preload.
3. Hemopericardium: In this case, the effusion surrounding the heart also has a more echogenic characteristic, representing blood.

4. Plethoric IVC: a clinically significant pericardial effusion will lead to a plethoric IVC, meaning the IVC is dilated > 21mm in diameter and is not decreasing with respiration. A plethoric IVC is 97% sensitive for cardiac tamponade.

Pitfalls and Pearls

1. The subxiphoid view is the most sensitive for detecting a pericardial effusion because it can visualize dependent fluid when the patient is upright or reclined. The subxiphoid view is also used for pericardiocentesis.

2. Echo features of tamponade include systolic right atrial collapse and early diastolic right ventricle collapse. Making this determination is beyond the scope of our POCUS curriculum. Any imaging concerning tamponade should trigger a STAT formal echocardiogram, cardiology consult, and conversation with your attending.

3. Small pericardial effusions can also cause tamponade physiology.

4. In addition to the POCUS study, remember your physical exam! Beck’s triad is a combination of muffled heart sounds, hypotension, and jugular vein distention. You can also evaluate for a pulsus paradoxus.

Acknowledgments:
The ultrasound images were obtained by Dr. Saati, Dr. Foster, Dr. Cooper, and Dr. Dong.

REFERENCES


A Guide to Point of Care Ultrasound Lung and IVC Examination of a Volume Overloaded Patient

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LEARNING OBJECTIVES

1. Learn the technique for lung point of care ultrasound.
2. Identify and interpret the lung ultrasound findings that would be consistent with volume overload.
3. Learn the technique for inferior vena cava (IVC) point of care ultrasound.

INTRODUCTION

A patient presents with dyspnea, hypoxia, and lower extremity edema. Their history is notable for recent high salt intake and non-compliance with diuretics, and their lungs have rales bilaterally. Clinically, we can diagnose a heart failure exacerbation with pulmonary edema. However, we often rely on X-ray and computed tomography (CT) imaging to support the clinical diagnosis and explore the etiology of the hypoxia and dyspnea to narrow the differential. Ultrasound is an effective modality for identifying pulmonary edema and pleural effusions while at the same time ruling out other etiologies such as pneumonia and pneumothorax. With bedside point of care ultrasound (POCUS), there is no radiation risk and no delay in obtaining imaging. A systematic review and meta-analysis study by Maw et al. published in 2019 found that lung ultrasound diagnosis of pulmonary edema in the setting of clinical suspicion for acute decompensated heart failure had a pooled sensitivity of 0.88 and specificity of 0.93. In comparison, studies assessing X-ray imaging for the diagnosis of pleural effusions vary, but the sensitivity ranges from 0.33-0.94, and the specificity ranges from 0.7-1.0. On posterior-anterior chest radiography, it is estimated that >200cc of fluid is needed to cause blunting of the costophrenic angle. In comparison, ultrasound could detect as little as 5cc of fluid in the pleural space, and it allowed the detection of >100cc of fluid with 100% sensitivity.

The ultrasound examination of the IVC can also be used to estimate right atrial pressure. It can be used as an objective data point for assessing volume overload in the appropriate clinical context. The 2010 guidelines for echocardiographic assessment of the right heart by Rudski et al. use an IVC diameter and collapsibility with inspiration to estimate the right heart pressure. IVC diameter of 2.1cm and collapse of the IVC with inspiration are the two criteria used to estimate the right atrial pressure.

While the POCUS lung and IVC exam may not change your plan to initiate diuresis for the patient, it can help you monitor the patient’s response to diuresis over their hospital course. The REVERSE Falls protocol developed by Dr. Ahmar uses the number of B lines on lung ultrasound and the diameter of the IVC in successive scans to guide diuresis management.

Kimura et al. in 2011 created the Cardiopulmonary Limited Ultrasound Evaluation (CLUE) protocol, which combines four views to predict if there is a reduced left heart ejection fraction. Using only the parasternal LV long-axis, subcostal IVC, and two apical lung views, the protocol assesses LV dysfunction, LA enlargement, IVC plethora, and B-lines in the lung apices. When evaluating LV ejection fraction < 40%, the CLUE protocol had a sensitivity of 69%, specificity of 91%, and accuracy of 89%. It is a validated protocol that can also help in your evaluation of a volume overloaded patient.
**TECHNIQUE**

**Lung**

When performing lung ultrasonography, there should be at least 6 points of imaging: bilateral mid-clavicular 2nd intercostal, bilateral 6th intercostal anterior axillary line, and bilateral PLAPS points or pleural bases. The probe indicator should be directed caudally at all six points. The imaging windows are between rib spaces.

In this healthy lung parenchyma ultrasound image, A-lines are normal imaging artifacts that reflect and repeat the pleura-air interface. The top line is the pleura, where lung sliding would be seen. The black spaces flanking the lung tissue are shadows behind the ribs. Sound cannot pass through bone and thus causes acoustic shadowing.

**IVC**

The Inferior vena cava (IVC) view is obtained by first identifying the right atrium on the subxiphoid view, then rotating the probe 90 degrees so that the probe indicator is directed caudally. Ideally, the hepatic vein should be visualized as merging with the IVC. Measurement of the IVC diameter should be 2cm from where the IVC and hepatic vein join. The patient should be asked to either “sniff” or take an inspiratory breath. While inspiring, there should be an assessment of whether the IVC diameter decreased by > 50%.
Findings Consistent with Volume Overload

1. Bilateral and diffuse B lines

B lines are vertical “comet tail” streaking artifacts that extend from the pleura. Bilateral, diffuse B lines are a very sensitive finding for pulmonary edema. While B lines artifacts are not specific for pulmonary edema, a diffuse distribution in the setting of other exam findings of volume overload increases the specificity.

2. Pleural effusion

In pleural effusion, the lung tissue can be compressed and there can be atelectatic lung. The hydrostatic pressure from the effusion will fold and condense the lung tissue, and this abnormal lung tissue can be visualized floating in the effusion, similar to a jellyfish.

3. Pleural effusion

Pleural effusions are hypoechoic spaces best seen at the pleural bases while the patient is sitting upright. Pictured here is a large pleural effusion that appears filled with simple, transudative fluid (there are no hyperechoic residues or septations to suggest a complicated effusion). However, a thoracentesis and fluid sampling would be needed for confirmation. The “spine sign” points out the thoracic spine. The thoracic spine is well visualized in pleural effusions because the fluid provides an excellent medium for sound travel. In healthy lungs, the air disrupts sound transmission, thus preventing the spine from being imaged.

4. Plethoric IVC
This patient’s IVC is >21mm in diameter and did not decrease by 50% with inspiration. This estimates a severely elevated right atrial pressure of >15mmHg, per Rudski et al.

**Pitfalls and Pearls**

1. **B** lines are a non-specific finding. B lines are caused by an interstitial lung process, which thus disrupts the A-line artifacts seen in healthy lung tissue. However, this fluid could be due to pulmonary edema, as in heart failure, or due to inflammatory fluid or pus, as in pneumonia.

2. The presence of B lines will tell you that there is not a pneumothorax at that location. The presence of air between the visceral and parietal lung pleura would prevent B lines from being visualized because of that new air interface.

3. If you have a unilateral effusion, examine the lower lung lobes for consolidation. If there is a consolidation, then ultrasound the effusion thoroughly to identify signs of exudate or septations that may suggest an empyema, which would require sampling and drainage of that fluid.

4. The IVC evaluation alone is not a substitute for a comprehensive volume exam. There are also clinical conditions that confound the IVC evaluation. For example, tricuspid valve pathology, such as regurgitation can lead to a dilated IVC even in a hypovolemic state. A pericardial effusion or tamponade can also lead to a plethoric IVC.

5. When using the IVC to aid in your volume exam, the most practical information comes from whether it is plethoric (>21mm diameter and not decreasing with inspiration) or flat (<21mm diameter and collapsing with inspiration). By Rudski’s criteria, a plethoric IVC described in this way would estimate a right atrial pressure of >15mmHg; the flat IVC would estimate a right atrial pressure of 3.

**Acknowledgments:**
The ultrasound images were acquired by Dr. Saati, Dr. Cooper, Dr. Foster, and Dr. Dong.
A Guide to Point of Care Ultrasound Evaluation of Pneumonia

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LEARNING OBJECTIVES

1. Learn the technique for lung point of care ultrasound.
2. Identify and interpret the lung ultrasound findings that would be consistent with pneumonia.

INTRODUCTION

A patient presenting with fever, hypoxia, productive cough, and leukocytosis can be diagnosed with pneumonia without any imaging findings. However, we often rely on X-ray and computed tomography (CT) imaging to support the clinical diagnosis. Ultrasound is an effective imaging modality for identifying pneumonia without delay and radiation risks.1,2 A meta-analysis by Ye et al. in 2015 found that ultrasound diagnosis of pneumonia had a pooled sensitivity of 0.95 and a pooled specificity of 0.9, which is superior to X-ray imaging which had a pooled sensitivity of 0.77 and a similar pooled specificity of 0.9.3 This study used CT imaging as a gold standard for comparison.

TECHNIQUE

When performing lung ultrasonography, there should be at least 6 points of imaging: bilateral mid-clavicular 2nd intercostal, bilateral 6th intercostal anterior axillary line, and bilateral PLAPS points or pleural bases. In a study by Danish et al., a 6 point ultrasound lung exam has a sensitivity of 76% and a specificity of 100% in diagnosing an alveolar consolidation.4 There are different protocols for increasing the sensitivity; our institution recommends assessing in 16 zones if there are no localizing rales or rhonchi on auscultation. If there are localizing sounds, your exam should initially focus on that site.

The probe indicator should be directed caudally at all points. The imaging windows are between rib spaces. In this healthy lung parenchyma ultrasound image, A-lines are normal imaging artifacts that reflect and repeat the pleura-air interface. The top line is the pleura, where lung sliding would be seen. The black spaces flanking the lung tissue are shadows behind the ribs. Sound cannot pass through the bones and thus cause acoustic shadowing.
Findings Consistent with pneumonia

1. Unilateral B lines

B lines are vertical reverberation artifacts caused by subpleural fluid. "Comet tails" or vertical lines are seen extending from the pleural line. In pulmonary edema, B lines are usually bilateral. Unilateral B lines can suggest pneumonia.

2. Consolidation sign

Healthy lung parenchyma will create imaging artifacts such as A-lines because the pleura-air interface disrupts the sound wave transmission. Consolidated lung leads to pus or fluid replacing those previously air-filled alveoli, thus leading to a loss of the A-line artifacts. Instead, the lung tissue looks more similar to solid organs such as the liver or spleen. These images have a lower lobe consolidation, and the consolidated lung looks similar in echogenicity to the adjacent spleen or liver. The diaphragm is used as a landmark to identify the lung bases. The "Spine sign" is another supporting imaging finding. Usually, the thoracic spine vertebral bodies are not able to be visualized because of the air-filled lung scattering the sound waves. However, when the ultrasound waves travel through a dense substance like pneumonia, they can easily reach the spine, resulting in an image.
3. **Air bronchograms**

The air bronchograms within the “solid” appearing lung would be consistent with air-filled bronchi penetrating areas of alveoli filled with pus and fluid.

4. **Plankton sign**

In this image, the “static” or “snowy” appearing substance is exudate within a pleural effusion and is termed the “Plankton sign”. The Plankton sign can be seen in parapneumonic effusions or empyema. The thoracic vertebral bodies are clearly visualized in this “Spine sign”, often used as an indirect finding to support a pleural effusion.

**Pitfalls and Pearls**

1. B lines are a non-specific finding. B lines are caused by an interstitial lung process, which thus disrupts the A-line artifacts seen in healthy lung tissue. However, this fluid could be due to pulmonary edema, as in heart failure, or due to inflammatory fluid or pus, as in pneumonia.

2. A lack of lung sliding is not specific to pneumothorax. Inflammation related to pneumonia can cause the visceral and parietal lung pleura to become fixed to one another, thus abolishing normal lung sliding.

3. Consolidated lung in the setting of an effusion could represent atelectasis rather than pneumonia. However, air bronchograms within the consolidated area would point toward pneumonia.

4. If you have a unilateral effusion in the setting of a consolidation, ultrasound the effusion thoroughly to identify signs of exudate or septations that may suggest an empyema, which would require sampling and drainage of that fluid. The “Plankton sign” further supports an exudative effusion.

5. An ultrasound diagnosis of pneumonia can be made with focal B lines. A consolidation sign is not necessary.

**Acknowledgments:**

The ultrasound images were acquired by Dr. Saati, Dr. Cooper, Dr. Foster, and Dr. Dong.

**REFERENCES**


A Manual for Ultrasound Guided Intravenous Access: Allay your Fears, Alleviate with Humor, Approach with Confidence

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INTRODUCTION

“Hey, can you help get IV access on a patient? The nurses have tried many times already.”

If this message fills your heart with trepidation, it may be because you do not have a systematic approach to ultrasound guided intravenous catheter (IV) placement or any prior training in this procedure. At our institution, after failed nursing attempts, the responsibility for obtaining IV access may fall on the physician. Early in the year, this physician may be an intern who has limited experience with IV access, let alone ultrasound guided IV placement. They may have previously undergone a brief training course using a low-fidelity gel model simulation. However, this form of training is often insufficient and impractical. The purpose of this manual is to allay your fears and anxieties and teach a systematic approach to ultrasound guided IV access. It is a guide that provides technical tricks and steps learned from several hundred hours of experience. And because we all know how enjoyable it is to read a dry step-by-step instruction manual, this guide is written in a humorous light for your reading pleasure.

PREPARATION

Review your patient’s indications and risks. Though the procedure is relatively benign, reviewing a few key details is essential.

1. Is there any reason NOT to use a limb: Do they have a limb alert because of end-stage renal disease? Cellulitis or abscesses in one of the limbs? Superficial or deep vein thrombosis? Axillary lymph node dissection from breast cancer?

2. What is their bleeding risk? While you can perform this procedure while the patient is on anticoagulation or antiplatelet agents, knowing their bleeding risk will help you weigh the risks and benefits of repeated attempts or attempts on veins near an artery. Not that you’ll need more than one attempt, of course. And always confirm with the bedside nurse before you start.

Obtain your supplies. You will need an IV start kit (containing chlorhexidine/alcohol, Tegaderm, tourniquet, and tape), IV extension tubing, saline flush, ultrasound jelly (sterile lubricant jelly is a great alternative), and your IV catheter.

1. The length of your IV catheter is an important detail. Increasing the length of the catheter that rests in the vessel will increase the lifespan of the IV and reduce the risk of infiltration. Therefore, I almost always use the 48mm “long” IVs rather than the standard 30mm “short” IVs.

2. The size of your catheter is also important. An 18 gauge IV is considered a “large bore” IV, which you may need if the indication for access is acute blood loss, for example. I would not use anything smaller than a 20-gauge IV, though.

MEETING THE PATIENT

This is a critical juncture. One of the most challenging steps in placing an ultrasound IV is making the patient feel at ease. At this point, the patient has been “stuck” a dozen times, and they will be quite frustrated at anyone who walks through their door holding a needle. You have the fortune of being that person who walks in and says they will stick the patient more times. Therefore, our introduction to the patient and the first words we say will carry considerable weight.

Here are some common things we say, and this is how the patient interprets them:

What we think we say: “Hi, I’m here to do an IV for you.”

What they hear: “Hi, I’m another health professional who doesn’t even introduce themselves by name, and I’m going to torture you again.”
What we think we say: “It’s not going to hurt at all.”
What they hear: “It’s definitely going to hurt, and I’m lying to you.”

What we think we say: “Let me try to put an IV in you.”
What they hear: “I have no confidence that I’ll be able to put an IV in you.”

What we think we say: “I’m good at IVs.”
What they hear: “I’m bad at IVs.”

What we think we say: “I think I’m in the vein.”
What they hear: “I totally missed the vein.”

Here are suggestions that I have found work well:

“Hello, my name is ______. It’s a pleasure to meet you; I am one of the physicians called to help with difficult IV access. I’m sorry to hear that you’ve had a tough time recently. Your doctors specially requested that I come to help you with an ultrasound guided IV.”

“I’m one of the best in the hospital.”

- I find that saying this helps put them at ease in 90% of cases. 10% of the time, they are skeptical and unamused.

“This is going to be a big poke. 1, 2, 3, OUCH!”

- I find that saying “OUCH” loudly distracts them from the stick.

VENOUS ANATOMY: WHAT ARE MY OPTIONS?

1. **Upper arm Cephalic vein:**
   This vein runs over the bicep and is isolated from other arteries and nerves. It is often ~0.5cm deep and runs straight up the arm. It is best in obese patients and patients with thick arms. It may not be present in thin patients and especially in older patients.

2. **Upper arm Basilic vein:**
   This vein runs medial to the brachial neurovascular bundle (closer to the triceps muscle). It is isolated from arteries and nerves and runs straight. It is one of the largest diameter veins in the arm and often is ~1cm in depth.

3. **Lower arm cephalic vein:**
   This vein runs from the antecubital fossa down the midline of the arm, an extension of the upper arm cephalic vein. It is ~0.5-1cm in depth and does not have any directly adjacent arteries.

4. **Upper arm brachial vein:**
   There is a brachial vein to the left and right of the brachial artery. The brachial vein on the lateral side of the brachial artery is often not a good target because your needle would have to pass through the edge of the biceps muscle and run too close to the nerve. The brachial vein on the medial side of the artery is usually an appropriate target. Still, it is located adjacent to the artery and at times can be under the bicep muscle. Extra care must be taken to confirm the vein and the needle approach.

5. **Antecubital veins:**
   There are usually 1-3 veins in the antecubital fossa surrounding the distal brachial artery before they split into the lower arm vessels. These veins are shallow and easily accessible. However, it is difficult for the patient because every time they bend their arm, it will alarm their infusion pump for downstream obstruction.

6. **Radial veins:**
   Two veins are on either side of the radial artery. It is a less ideal location because it runs deeper in the arm, sometimes under the muscle, and is directly adjacent to an artery.
**TECHNIQUE**

1. Position the patient and bed appropriately. You are young, and you must save your back! Make sure you raise the bed and position the patient’s arm so that your hands rest comfortably in a neutral position while performing the procedure. I find that an optimal position is for the patient to be completely supine, with their arm extended out 90 degrees and their hand supinated.

2. Use the vascular probe on the ultrasound machine. Minimize the depth on the ultrasound machine so that the image on the screen is as large as possible. Optional: turn on the “centerline” or “guideline” to help you visualize the needle entry.

3. Identify a vein that is between 0.5 to 1.5cm in depth and runs linearly for at least the length of your catheter. Identify other structures, such as arteries and nerves. Make sure you understand the direction of the vein; For a beginner, it can be helpful to mark the path of the vein on the skin so that you can ensure the direction of your needle entry lines up with the course of the vein.

   **TIP:** Hold your ultrasound probe in your non-dominant hand and your needle in your dominant hand.

4. Apply the tourniquet proximal to your target location.

   **TIP:** Prolonged use of a tourniquet will increase the risk of infiltration of that vessel, even if you cannulate the vein perfectly. If the patient has a history of IV infiltrations and the target vein is large, I recommend against using the tourniquet.

5. Insert your needle bevel up at a 45-degree angle to the probe and in line with the vessel’s path. Hold the probe perpendicular to the skin. I always insert the needle ~0.5cm deep at first. The ultrasound beam cannot properly visualize the needle tip if the needle is too shallow on insertion.

   **TIP:** Always have as much contact with the patient as possible during this procedure. Bracing your
hand against their skin stabilizes you in relation to the patient; thus, their unintentional movements will lead to fewer changes in your position. Even while holding the needle and ultrasound probe, you should endeavor to rest the side of your palm or a couple of fingers against the patient.

**TIP:** With the hand holding the needle, I use the 5th digit to pull the skin taut before I insert the needle. If your patient has ‘loose’ skin with poor skin turgor, your needle entry in the skin can cause you to shift position by several centimeters. With your probe holding the skin on one end, your finger pulls the skin taut from the other end, and thus you create a patch of smooth skin for your needle entry.

6. Finding your needle tip is the hardest part. Move the ultrasound probe to overlap with the insertion site at the skin. Then move proximally up the arm (and away from the needle) slowly while “nudging” the needle.

**TIP:** It is easiest to see the needle tip when the tip is in motion. By “nudging” the needle, you are not advancing the needle, but applying repetitive and gentle forward pressure to deflect the soft tissue. The needle is ideally deflecting tissue without causing any trauma or moving forward. On ultrasound, you can see a “V” deflection of soft tissue with the bright needle tip at the center of the “V.”

**TIP:** As you slowly move down the length of the needle away from the needle insertion site, you will see tissue deflection even before you have reached the tip. I advise you to keep moving your probe systematically in this manner until you see NO deflection at all. This is the point where you know you have moved beyond the tip of the needle. Then move the probe slowly back towards the needle again, and the first point of tissue deflection you see MUST be the most distal tip of the needle. After you find your needle tip, you can purposefully advance the needle while directly visualizing it.

7. Once you find the needle tip... **DO NOT LOOK DOWN AWAY FROM THE SCREEN!** This is the most common rookie mistake. You just spent so much time finding your needle tip, so trust in your hands and proprioception and glue your eyeballs to the screen. Advance your needle and ultrasound probe at the same rate to always keep your needle tip on the center of the screen and guide the needle into the vessel.

**TIP:** Commonly, when you look down at the needle and away from the screen, you will slightly and unconsciously move either your hand holding the ultrasound probe or your needle and thus lose your position.

**TIP:** When I see my needle tip first in the vessel, I do not immediately look down for the “flash” of blood in the IV catheter. This is one of the most critical junctions in the procedure, and you need to ensure you don’t lose your position.

8. When you have a “Target Sign” with the needle tip in the center of the vessel, drop the angle of your needle to match the vessel’s direction. In most vessels, this means you are flattening your angle considerably. Then advance the needle through the vessel for another few millimeters to ensure your needle path is lined up perfectly with the vessel.

**TIP:** At this point, I will stabilize my needle hand and look down to confirm that I have the “flash of blood.”

Drop your ultrasound probe and with that free hand, slowly advance the catheter. Because you have lined up the needle path with the path of the vessel, the catheter should be advancing down the center of the vessel, and there is a far lower risk of you advancing the catheter through the back wall of the vessel.
There should be no resistance. If you feel resistance while advancing the catheter, stop and re-ultrasound your position.

9. When the catheter is fully advanced, click the needle retract button and put the retracted needle aside. Attach the IV extension tubing and pull back on the flush to confirm easy blood return. When you flush the IV with the saline, make sure the tourniquet is off. Flushing against a vein with a tourniquet on can cause damage to the vein and infiltration of the IV.

10. Ideally, you will image the vein in the longitudinal axis and visualize your catheter in the vein. When you flush the saline, it should be seen as a slightly echogenic fluid appearing at the tip of your catheter and moving up the vein.

CLEANUP

1. Breathe a sigh of satisfaction and contentment and announce your success to the patient.

2. Confirm that the tourniquet has been removed.

3. Make sure to dispose of your sharps and trash in the appropriate containers.

4. Dress the IV with the start kit Tegaderm and use extra tape to secure the Tegaderm and the IV extension tubing.

   TIP: You can never use too much tape. If the patient is at risk of pulling out their IVs, ask the nurse to put a sleeve over the arm to protect the IV.

5. Lower the patient’s bed to its lowest level and ensure all the bed rails are in the upright position with all the patient’s limbs within the bed.

6. Inform the nurse of your success.

   TIP: Even if the IV placement was easy, tell everyone in earshot that it was very hard. Bask in the compliments.

   TIP: If you’ve properly cleaned up your mess and positioned the bed appropriately, you’ll earn many brownie points on that nursing unit.

7. Write a short note documenting the procedure, including the vein, the number of attempts, and any complications.

8. Clean the ultrasound machine and return it to where it belongs. Take good care of the ultrasound machines; they are more expensive than a resident physician’s yearly salary.

FINAL WORDS

Absorb and apply this knowledge and become a master of ultrasound guided IVs! This is one of the relatively few things we do as Internal Medicine physicians that can provide instant satisfaction and relief for the patient. I also find ultrasound guided IV placement to be a delightful task. In recent years during the pandemic, healthcare providers have created many barriers between ourselves and patients, such as physical barriers (gowns, masks), fear of entering rooms because of anxieties about contracting COVID, and reliance on EMRs and computers. Ultrasound guided IVs are a way for me to break down barriers and return to the bedside to provide a service to the patient. It gives me an opportunity to listen to a patient’s story and build rapport. The time you spend in the room talking and connecting will build trust, especially when you cap off the conversation with a pronouncement that you successfully placed their IV, and they do not have to undergo any more sticks.

I write this manual and reflection in a humorous light, but as with all procedures, ultrasound guided IV placement should be conducted with thoughtfulness and preparation. Always respect your patients, approach every interaction with consideration and grace, and bring positive energy to the bedside.

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