Critical Order Set Change and Critical Limb Ischemia The Case

A 72-year-old woman with a history of severe peripheral vascular disease presented with acute limb ischemia secondary to thrombosis of her left superficial femoral artery. Catheter-directed thrombolysis was performed almost immediately upon arrival to the hospital. The patient was subsequently admitted to the intensive care unit with the catheter device in place.

Per protocol, the admitting resident ordered a heparin drip to prevent thrombosis of the catheter and sheath site. The resident was unaware that the heparin drip order set in the electronic medical record had undergone significant revision and now contained dosing and monitoring options. Because of this change, the resident inadvertently ordered a heparin dose that was too low. The bedside nurse and the pharmacist noticed the low dose, but they assumed that the resident had purposefully selected the dose from the range of options provided in the order set.

As a result, the patient was inadequately anticoagulated. Twelve hours later, she developed extensive thrombosis associated with the catheter and sheath site that extended to the bifurcation of the aorta. The patient ultimately required surgical intervention for critical limb ischemia, including amputation of the contralateral leg above the knee, due to prolonged time without adequate blood flow.

Spotlight: Mistaken Attribution, Diagnostic Misstep The Case

A 45-year-old woman with history of bipolar disorder and schizophrenia presented to the emergency department (ED) with active paranoid hallucinations. In the ED, she was afebrile but had mild tachycardia and a few transient hypoxic episodes. Over the course of a few hours, the hypoxia resolved but the tachycardia persisted. Her agitation and hallucinations impaired her ability to communicate or answer review of systems questions.

The on-call psychiatry resident evaluated the patient and felt she needed hospitalization in the inpatient psychiatric facility. He attributed the persistent tachycardia and the transient hypoxia to her underlying agitation.

The patient was admitted to the inpatient psychiatric facility, and treatment was initiated for agitation and hallucinations. Over the next few days, she required multiple different medications, including benzodiazepines and mood stabilizers (olanzapine), to control her symptoms. These medications caused somnolence and drowsiness, so the patient was bedbound most of the day. She had persistent tachycardia over these few days that continued to be attributed to her agitation and psychiatric disease.

On the morning of hospital day 5, the nurse found the patient to be unresponsive. She had a fever, worsening tachycardia (heart rate 140s), tachypnea, and more severe hypoxia (oxygen saturation 80% on room air). On examination, she had diffuse myoclonus and increased muscle tone. She was barely arousable and confused, and she was transferred to the intensive care unit (ICU) of the regular hospital.

After an evaluation by the critical care provider, a CT scan of the chest revealed bilateral pulmonary emboli that were felt to explain the ongoing tachycardia and hypoxia. She was also diagnosed with neuroleptic malignant syndrome, a rare and life-threatening reaction to some psychiatric medications. It is

characterized by fever, muscular rigidity, myoclonus, and altered mental status, all of which were present in this patient. She was treated with heparin for the pulmonary embolism and supportive care and she slowly improved. After 4 days in the ICU, she was transferred to a regular medical ward. A few days later, she was able to be transferred back to the inpatient psychiatric facility.

A formal root cause analysis of the case found many errors that led to the adverse events. The director of the inpatient psychiatric unit used the case as an opportunity to broadly consider not only medical complications but all of the patient safety issues involving the unit.

Inadequate Preanesthetic Evaluation, Airway Trouble
The Case

Case #1:

A 34-year-old woman was scheduled for a hysteroscopy under general anesthesia. She was morbidly obese but otherwise healthy. The morning gynecology surgery list was overbooked with five cases, a mixture of ambulatory cases and inpatient cases. On arrival at the patient's cubicle, the anesthesiologist found the curtain was drawn around the patient's bed, and she was donning a hospital gown. The anesthesiologist waited for 5 minutes, but as he had other patients to see, he left without performing the preoperative assessment. Once she was taken to the operating room, the anesthesiologist discovered from chart review that the patient had a history of gastroesophageal reflux. After induction of general anesthesia, the patient could be ventilated but her trachea could not be intubated. A supraglottic airway was successfully placed, and surgery proceeded uneventfully under general inhalation anesthesia. The patient had a bruised upper airway, which caused her some discomfort, but she otherwise recovered and was discharged home later that day.

Case #2:

A 76-year-old man with recurrent lymphoma and an oral tumor mass at the base of the tongue was booked for a biopsy of this mass under general anesthesia. The patient had a history of hypertension treated with amlodipine. He had not been seen in a preanesthetic assessment clinic. On the day of the surgery, the patient was conscious, alert, and oriented without any stridor or breathlessness. An anesthesiologist came to examine the patient and could not see much of the mass with the patient sitting in a chair, opening his mouth maximally, and sticking out his tongue. The anesthesiologist was unable to locate the patient's head and neck CT scan to further evaluate the mass. The surgeon arrived late and did not communicate about the patient with the anesthesiologist. The anesthesiologist induced general anesthesia, but laryngoscopy and intubation proved extremely difficult as the posterior tongue mass, the size of a small lemon, obscured the view of the larynx. The anesthesiologist kept the patient oxygenated and asleep while attempting to use a fiberoptic bronchoscope to intubate the patient. Another anesthesiologist was called, and together they were able to intubate him with the fiberoptic bronchoscope. The biopsy of the tongue mass was obtained, and the patient was extubated and discharged home later that day.

Written Signout: It Only Works If You Use The Right One
The Case

A 75-year-old man was hospitalized due to a stroke. During the hospitalization, he experienced significant difficulty swallowing, which resulted in an aspiration pneumonia. He then developed hypernatremia (high blood sodium levels) requiring close monitoring and treatment with IV fluids.

The patient was hospitalized at an academic hospital early in the academic year. At this institution, all housestaff received training in safe handoffs using a standardized, validated tool (I-PASS), and the electronic health record (EHR) had a dedicated signout template. However, the primary intern caring for the patient was on his first day of the rotation, as was the night cross-cover intern. Before leaving for the day, the primary intern reviewed the overnight plan with his senior resident and attempted to update the signout template in the EHR. He then verbally signed out to the cross-cover intern, asking her to check the patient's sodium level and replete the patient with IV fluids if the sodium was elevated. The cross-cover intern asked for more specific directions around managing the patient's sodium, and the primary intern assured her that the necessary information was in the written signout. The cross-cover intern was already very busy receiving signout from other interns, so she did not specifically review the detailed written instructions with the primary intern.

Later that evening, the patient's sodium level test result returned at 144 mmol/L (the upper limit of normal). The cross-cover intern checked the written signout, which stated "If Na >142 then give 1 liter half normal saline." The cross-cover intern reviewed this plan with her supervising resident, who agreed; she then wrote an order to give the IV fluids as instructed.

The following morning, the primary team returned and received signout from the cross-cover intern. The primary team's senior resident expressed surprise when she was told that IV fluids had been started overnight and remarked, "He was getting volume overloaded yesterday, so we didn't want any fluids started unless he was definitely hypernatremic. A sodium of 144 mmol/L is fine—you shouldn't have done anything." The cross-cover intern was confused and pointed out that she had followed the written signout instructions. On reviewing the written signout, the primary intern realized that he had accidentally printed a copy of the previous day's signout—it had not been updated. The sodium management plan had actually been changed, but this was not reflected in the printed written signout.

Fortunately, the patient did not experience any adverse consequences as a result of the error. After reviewing the incident, the residency program decided that a senior resident should review the written signout and should be present when interns sign out to each other for the first 3 months of the academic year.

Supervision and Entrustment in Clinical Training: Protecting Patients, Protecting Trainees

The Case

A 65-year-old man was admitted with head and spine trauma after falling from a tree while doing yard work. He presented with poor neurologic function requiring mechanical ventilation. A CT scan of the head and neck showed hemorrhage in his brainstem and cervical spinal cord, and he was admitted to the intensive care unit (ICU). In the ICU, his hemorrhage led to hemodynamic instability, including fluctuating blood pressures and intermittent bradycardia with heart rates as low as 20–30 beats per minute.

The decision was made to obtain a brain and spine MRI. Given the patient's critical condition, hospital policy dictated that he be accompanied by a nurse and a physician to the MRI scanner, which was 10 floors below the ICU. The ICU attending assigned the intern to transport the patient with the bedside nurse. The intern was in his second month of internship, had never done an ICU rotation before, and had never been involved in the transport of a critically ill patient.

The patient was transported to the MRI scanner. Due to some logistical challenges, he was in a holding area for more than an hour. During that time, on two occasions the patient's heart rate fell to 20 beats per

minute, associated with severe hypotension. The intern, who had not been given instructions on how to manage such a scenario, did not know how to respond. Fortunately, the ICU nurse was quite experienced and appropriately administered atropine, with recovery of the heart rate and blood pressure.

The patient was finally placed into the MRI machine safely. Shortly thereafter, a chief resident came down to the MRI scanner and informed the intern that he had to leave the patient to attend a mandatory conference. The intern was hesitant given the patient's severity of illness, but the chief resident insisted that he leave. The chief resident had identified a medical student to sit in the scanner with the patient. Fortunately, there were no other clinical issues, and the patient remained stable. The medical student remained for the 2-hour scan and helped transport the patient back upstairs. Ultimately, the patient was found to have catastrophic bleeding. After discussions with his family, care was withdrawn and he died peacefully.

A week later, the intern participated in a well-being session for housestaff and discussed the events. He expressed how he was incredibly uncomfortable and felt unequipped to handle the clinical situation. He felt that he had placed the patient's life at risk because of his inexperience. He also reflected that he did not feel comfortable stating his discomfort at the time as he feared he would be labeled as weak by the attending. In addition, he shared the distress he felt when the medical student was assigned to replace him at the patient's bedside—he recognized the student likely had similar insecurities, yet neither one of them felt comfortable saying anything. He also wondered why the nurses and technicians didn't ensure that a more qualified provider was involved.

Coming Up Short: Maintaining Safety in the Face of Drug Shortages

The Case

A 1-month-old preterm infant in the neonatal intensive care unit (NICU) was receiving the standard 500 mL bag of 0.45% sodium chloride (NaCl) with heparin at low rates to maintain IV line patency. The patient developed hyponatremia, and the clinicians recognized the need to deliver a more concentrated sodium solution with less free water. Therefore, the order was given to change the IV fluid to a 500 mL bag of 0.9% NaCl with heparin. However, due to a natural disaster affecting the manufacture and supply chain for IV fluids, very few 0.9% NaCl 500 mL bags were available in the region. The hospital and clinical team were asked to conserve the supply and use alternatives wherever possible, so the order was modified to use 100 mL 0.9% NaCl bags, which were available.

Since the total volume was much smaller, a lower concentration formulation of heparin was required: 100 units/mL compared to the usual concentration of 1000 units/mL. However, the verifying pharmacist discovered that the wrong concentration (1000 units/mL) had been used to compound the fluids. Further investigation revealed that this error had occurred on five other occasions, each committed by different technicians. Fortunately, because a minimal amount of heparin and fluid were infused each day, the error did not adversely affect this patient (or the others). However, the error did lead to the performance of additional blood tests (mostly activated partial thromboplastin time measures).

Diffusion of Responsibility Leads to Danger
The Case

A 70-year-old man was sent to the emergency department (ED) from a nursing facility due to decreased oral intake, fevers, confusion, and falling urine output. On initial evaluation, he was found to be somnolent but arousable on deep stimulation. Laboratory test results revealed acute-on-chronic renal failure, with a serum creatinine of 12.0 mg/dL and potassium of 7.3 mmol/L. The patient's

electrocardiogram showed tall T waves, potentially a precursor of a dangerous arrhythmia due to the hyperkalemia.

The emergency physician initiated medical treatment for the hyperkalemia and consulted the on-call intensivist and nephrologist. The intensivist and nephrologist agreed that the patient required urgent hemodialysis to correct his metabolic abnormalities. The nephrologist asked the intensivist to serially monitor the patient's electrolytes and volume status, continue medical treatment of hyperkalemia, and place a hemodialysis catheter. The nephrologist planned to start dialysis as soon as possible.

Unfortunately, the intensive care unit (ICU) was full and the patient was forced to "board" in the ED. The intensivist was busy with other patients but came down to the ED and placed the dialysis catheter after a few hours. Repeat laboratory test results again demonstrated severe hyperkalemia with persistent electrocardiogram changes. The patient remained confused, likely due to uremia. The emergency physician spoke with the intensivist, who reassured her that the nephrologist had evaluated the patient and that dialysis would be initiated as soon as possible.

On arrival to the ICU approximately 5 hours after the initial labs, the patient was now hypotensive and essentially unarousable. The ICU nurse placed the patient on a cardiac monitor and immediately noticed a sine wave—a dangerous arrhythmia characteristic of severe hyperkalemia. The intensivist came to the bedside promptly, but the patient rapidly went into cardiac arrest. He was intubated and given urgent treatment for hyperkalemia, with restoration of sinus rhythm. At that point, the nephrologist arrived at the bedside and was surprised to find that the patient's hemodialysis had not been started. It turned out that the dialysis nurse had been told to start dialysis after the patient was physically in the ICU and was unaware of the urgency of the situation.

Fortunately, the patient was resuscitated quickly. Hemodialysis was urgently started. The patient did not experience any neurologic consequences from the cardiac arrest and was able to be extubated and transferred to the ward within a few days. He was eventually discharged on hospital day 7 to continue outpatient hemodialysis.

Spotlight: Overdiagnosis and Delay: Challenges in Sepsis Diagnosis

The Case

A 66-year-old man presented to the emergency department (ED) with generalized weakness and nausea. He was noted to be confused but protecting his airway. His blood pressure was low (80/50 mm Hg), and he was started on intravenous fluids and broad spectrum antibiotics with some initial improvement in his symptoms and blood pressure. Laboratory test results revealed a mildly elevated white count, acute kidney injury, and elevated liver function tests. CT scans of his head and abdomen were ordered, and he was admitted to the medical intensive care unit (ICU) with a presumed diagnosis of septic shock.

The patient's blood pressure continued to trend downward to 60/40 mm Hg. Physicians placed a central line and started him on vasopressors. In reviewing the laboratory tests ordered in the ED, the ICU resident noticed that the patient's troponin level had returned markedly elevated. Initial electrocardiogram (ECG) from the ED revealed some T-wave inversions. A repeat ECG in the ICU showed obvious ST segment elevations suggestive of acute myocardial infarction (AMI). At that point, the ICU physicians came to believe that a large AMI was the likely explanation for the patient's low blood pressure on presentation, not septic shock.

The patient was immediately sent to the cardiac catheterization laboratory. He was found to have complete occlusion of the right coronary artery and a stent was placed to alleviate the blockage. He required ionotropic support to maintain cardiac output and was transferred to the coronary care unit in critical condition. He continued to deteriorate and ultimately experienced a cardiac arrest. He could not be revived and died 12 hours after presenting to the ED.

In the end, clinicians realized that the patient had initially been misdiagnosed with sepsis and that his presenting symptoms and exam findings were most likely caused by AMI and cardiogenic shock. Had the correct diagnosis been made earlier, the outcome might have been different.

The Wrong Blade: A Lack of Familiarity With Pediatric Emergency Equipment

The Case

As part of a prospective multicenter cohort study, 58 interprofessional teams—each comprised of 1–2 physicians, 3–5 nurses, and 2–3 nursing assistants or emergency medical technician personnel—were evaluated in their native pediatric or general emergency department (ED) resuscitation bays as they managed a series of 3 simulated critically ill patients (sepsis, seizure, and cardiac arrest). The simulated cardiac resuscitation case was a 5-year-old boy, found pulseless and apneic in the bathtub by a parent. All of the teams used the Broselow system, a proprietary system designed to facilitate finding the appropriate-sized resuscitation equipment for ill and injured children requiring lifesaving interventions.

In the simulation case reviews, it was noted that many of the teams had difficulty with the resuscitation because of a lack of interoperability between the prestocked disposable laryngoscope blades and handles on the Broselow cart with the ED's actual stock of blades and handles. This incompatibility led to significant delays in intubation; at times, it led to actual failure to intubate. For example, the teams, who usually did not recognize the problem with compatibility, spent unnecessary time replacing batteries and the like. Some called for backup airway teams, resulting in delays in treatment. If this case were to actually occur, it is likely that many of the teams would have made significant errors in handling the intubation equipment that would likely have led to patient harm or even death.

Chemotherapy Administration Safety Standards

The Case

A 67-year-old woman with cancer was admitted to the hospital to begin a chemotherapy cycle of IV etoposide (daily for 3 days) and IV cisplatin (a single dose). The chemotherapy order was sent to the hospital's cancer center satellite pharmacy, where the pharmacist entered the order into the computer. She prepared the first doses of etoposide and cisplatin, which were scheduled for administration on a Friday.

Inadvertently, while transcribing the order, the pharmacist switched the duration of therapy for the two agents, entering a single dose of etoposide and 3 days of cisplatin therapy. The patient received the correct doses on the first day (since the transposition didn't affect this); however, the subsequent days' doses were incorrect. The second day of therapy fell on a Saturday, and the satellite pharmacy was closed for the weekend. Doses for day 2 of therapy were therefore prepared in a different pharmacy, by a pharmacist who did not have access to the original chemotherapy order. The weekend pharmacist instead received a computer-generated label for cisplatin, verified the dose was appropriate for the patient's body surface area, and prepared the dose without realizing the patient had already received cisplatin the day before. Thus, cisplatin was labeled and dispensed according to the incorrectly transcribed order.

When the dose reached the bedside, the patient's nurse was in a hurry and bypassed the double-check policy of having a second nurse verify the chemotherapy order prior to administration. The nursing and

pharmacy medication profiles were actually on different systems, so the nursing profile reflected the original correct order while the pharmacy profile reflected the incorrectly transcribed order. The patient ultimately received a second dose of cisplatin instead of the intended dose of etoposide.

Immediately after the cisplatin had been administered, the nurse reread the original order, recognized the error, and contacted the pharmacy and physician. In subsequent days, the patient's renal function began to deteriorate, and she required hemodialysis several times during the hospitalization. Luckily, the patient recovered and no longer needed dialysis by the time of discharge.

In response to the event, the hospital established a policy requiring original chemotherapy orders to be used as a double check following initial doses and reviewed strategies to improve interoperability of the technology involved in the processing and administration of chemotherapy orders.

Steroids and Safety: Preventing Medication Adverse Events During Transitions of Care
The Case

A 73-year-old woman with a history of nonsmall cell lung cancer with metastases to the brain was admitted to the hospital with a few weeks of cough and generalized weakness. After a complete evaluation, she was found to have multiple medical issues including Pneumocystis jiroveci pneumonia (PJP pneumonia), invasive pulmonary aspergillus, diffuse myopathy (muscle weakness), and gastrointestinal bleeding from peptic ulcer disease.

During medication reconciliation, it was discovered that 2 months prior to this illness, the patient had been prescribed dexamethasone (4 mg every 6 hours, equivalent to ~100 mg of prednisone per day, a very high dose of steroids) to reduce the brain swelling associated with the cancer. The intention had been to taper off the steroids a few weeks later, after she received radiotherapy for her brain metastases. However, the corticosteroids were never tapered, and she had continued to take high-dose steroids for more than 2 months.

The hospitalist, oncologist, and endocrinologist all believed that all of her acute issues were a result of the steroids. She was treated with antibiotics, the steroids were tapered, and she had no further gastrointestinal bleeding. However, because of the multiple complications, she required hospitalization for more than a week and was discharged to a skilled nursing facility for ongoing physical therapy. She remained at the nursing facility for more than 2 months before returning home.

A formal case review identified several issues that led to the errors and adverse events. Multiple providers were involved in her care (oncologist, radiation oncologist, primary care provider), and no one took ownership over the dexamethasone prescription. The patient lived far away from the hospital where she was receiving care. The patient and family spoke predominantly Tagalog, and there may have been miscommunication related to the language discordance.

The hospitalist caring for the patient wondered about the frequency of errors and adverse events related to corticosteroids and what individuals and institutions could do to prevent these errors.

Mixup Beyond the Medication Label
The Case

An 80-year-old man was admitted to a hospital for recurrent hypoglycemia. He had been seen at another hospital 2 weeks earlier for a similar episode, with a glucose level of 26 mg/dL. He was treated and released without a diagnosis at that time. Despite extensive diagnostic workup during the current

admission, physicians could not identify the cause of hypoglycemia. Once his glucose level normalized, he was discharged home.

Approximately 2 weeks after the second discharge, the patient experienced another severe hypoglycemic episode and was admitted to a different hospital. At this time, his glucose level was 36 mg/dL; concurrent insulin level was 36.7 mIU/L (normal fasting level

However, the consulting endocrinologist recommended the family bring in all of the patient's medication bottles. The family returned with 12 different medications, none of which were labeled as an oral hypoglycemic agent. The resident used the codes on each pill to identify them and discovered that one bottle labeled as "doxazosin (Cardura)" actually contained the sulfonylurea, glimepiride (Amaryl) 4 mg. The patient had no history of diabetes, which likely suggested a pharmacy filling error. He had no further hypoglycemic episodes once this error was identified and corrected.

An Untimely End Despite End-of-Life Care Planning

The Case

A 76-year-old man was admitted to the intensive care unit (ICU) after a cardiac arrest and loss of cardiac function for about 15 minutes. Afterward, the patient displayed worsening neurological status and a CT scan revealed diffuse brain edema and anoxic injury. The ICU team initiated conversation with the patient's family to establish goals of care.

After extensive discussions, the family agreed to a DNR [do not resuscitate] order for the patient, but they wanted more time before making a decision about transitioning to comfort care. The patient continued to decline, with loss of brain stem reflexes. After another week of conversations with the ICU team, including consultation from the palliative care service, the family decided to discontinue life-sustaining therapies and agreed to comfort measures and terminal extubation. Orders were written and the respiratory therapist and the patient's nurse were informed.

However, within a half hour of these actions, the family asked to speak with the ICU resident, reversed their prior decision, and stated that they wanted more time before transitioning to comfort measures. The ICU resident, who had been involved in the prior conversations, canceled the terminal extubation orders. However, this occurred at the end of shift, and the resident did not verbally communicate the order change to other members of the team. Another nurse who had been involved in the previous conversations found the canceled orders after the resident left, thought this was an error, and asked another physician, who was also unaware of the change in plans, to reinstate the terminal extubation orders. The patient was extubated. When the patient's daughter arrived shortly thereafter, she was very upset to find her father extubated. Eventually, the senior ICU team members were able to intervene and speak with the daughter to explain and apologize for the lack of communication. The patient died within few hours.

Abdominal Aortic Aneurysm Screening

The Case

A 76-year-old man with history of coronary artery disease (status post prior coronary artery bypass grafting), severe heart failure, diabetes, hypertension, and an extensive smoking history was admitted to the hospital with worsening shortness of breath. As part of his medical evaluation, he underwent a transthoracic echocardiogram that demonstrated severe aortic stenosis, felt to be the likely cause of his shortness of breath and worsening heart failure. The cardiology team was consulted and recommended cardiac catheterization to further assess the patient's condition. However, when the interventional

cardiologist performed the catheterization, she could not advance the catheter and an aortogram revealed that the patient had an abdominal aortic aneurysm (AAA) measuring almost 9 cm in diameter.

Given the size of the AAA and the high risk of rupture, the patient was sent emergently for surgical repair. His postoperative course was complicated by multiple strokes, a myocardial infarction requiring repeat catheterization, and a catheter-associated urinary tract infection. He was discharged from the hospital to a skilled nursing facility several weeks after surgery. Because of his multiple comorbid medical conditions, he was deemed not to be a candidate for aortic valve replacement. He died 5 months later in hospice care.

Primary Workaround, Secondary Complication

The Case

A young adult with a progressive neurological disorder presented to a hospital emergency department (ED) from a nursing home with a dislodged gastrojejunostomy (GJ) tube. The patient had a history of multiple GJ tube dislodgements over the prior several months. When the GJ tube was dislodged, nursing home staff inserted a Foley catheter into the ostomy and inflated the Foley bulb in the stomach to maintain patency. The distal portion of the Foley catheter was tied in a loose knot but not otherwise secured (Figure 1). The catheter was in place on arrival to the ED. When the patient was taken to interventional radiology for GJ tube placement (Figure 2), there was no Foley noted; a new GJ tube was successfully inserted.

The patient was discharged back to the nursing home but readmitted 2 days later with fever and increasing abdominal distention. An abdominal CT scan showed an obstructing foreign body in the small bowel, initially thought to be a retained segment of the previously dislodged GJ tube. Surgical consultation was obtained, but nonsurgical intervention was recommended due to the patient's neurological condition. The patient continued to deteriorate despite volume resuscitation, broad spectrum antibiotics, and attempts to reduce the small bowel obstruction nonsurgically. After discussion with the patient's family, comfort measures were instituted on the fourth hospital day, and the patient died shortly thereafter.

The patient's family requested an autopsy in order to determine the cause of death. At autopsy, the entire Foley catheter—with inflated balloon and distal knot—was found to be obstructing the small bowel (Figure 3). The catheter appeared to have been pulled into the small bowel by peristalsis.

A root cause analysis (RCA) revealed several missed opportunities to have prevented the patient's unfortunate outcome. First, when the Foley catheter was initially inserted through the ostomy and inflated, the potential for peristalsis to pull the Foley catheter bulb into the stomach despite the distal loose knot was not adequately considered. A more appropriate method would have been a T-clamp or similar device instead of a loose knot to secure the catheter. Second, when the patient arrived in the ED, an opportunity to further secure the Foley catheter externally was missed. Third, when the patient was in interventional radiology and the Foley catheter was not in place, an opportunity to search for the Foley catheter was missed. It was assumed that the Foley had been removed pending the procedure. Finally, the radiologist did not consider that the obstructing body might be the Foley catheter and not the retained segment of the previously dislodged GJ tube.

The results of the RCA were disclosed to the patient's family. Although they were grateful that a thorough analysis had been performed and measures would be implemented to prevent these errors, they remained concerned about the decision to insert a Foley catheter through the GJ tube site. Since this took place at

the nursing home, it fell outside the hospital RCA's jurisdiction. However, hospital safety leaders realized that this practice was common for hospitalized patients as well, potentially putting many patients at risk.

Don't Pick the PICC

The Case

A 63-year-old man with diabetes mellitus complicated by retinopathy, neuropathy, and nephropathy; glaucoma; and stage IV chronic kidney disease was admitted to the hospital with an ulcer on the bottom of his right foot. Physical examination revealed a 2 cm clean-based ulcer below the fifth metatarsal head of the right foot. No surrounding swelling or erythema was present, but the ulcer could be probed to the underlying bone. An MRI was highly concerning for osteomyelitis, and a bone biopsy showed chronic inflammation with cultures positive for methicillin-sensitive *Staphylococcus aureus*. An infectious diseases consultant recommended therapy with 6 weeks of intravenous ceftriaxone to be given via outpatient parenteral antimicrobial therapy.

The interventional radiology team was consulted to place a peripherally inserted central catheter (PICC) line for antibiotic therapy. They attempted the placement multiple times in the right brachial vein but failed. The line was then successfully placed in the left brachial vein. The patient's nephrologist was not consulted prior to placing the PICC line. The patient was discharged and completed 6 weeks of antibiotics and wound care, with healing of the osteomyelitis and ulcer. The PICC line was then removed.

Five months later, the patient was seen by his nephrologist and was found to have worsening renal function and hyperphosphatemia. Dialysis access planning was initiated, but unfortunately, when the patient was evaluated by a vascular surgeon, he was found not be a candidate for arteriovenous fistula placement (the safest and most effective form of dialysis access). He was thought to have poor vein quality due to the many venipuncture attempts during the PICC line placements several months previously. Instead of a fistula, the patient had an arteriovenous graft placed, and dialysis was initiated 3 months later.

The patient's nephrologist referred the case to interventional radiology and hospital medicine for review given the preventable complication. The groups collaborated to develop a protocol to review renal function in patients who have requests for PICC lines, with nephrology approval required before any long-term venous access can be placed in patients with stage III–V chronic kidney disease.

"The Ultrasound Looked Fine": Point-of-Care Ultrasound and Patient Safety

Case & Commentary—Part 1

A 51-year-old man with history of congestive heart failure (ejection fraction 35%–40%), end-stage renal disease on hemodialysis, and mechanical mitral valve replacement (on warfarin) presented with a 2-day history of shortness of breath. He also noted that since the night before, he was no longer able to hear his mitral valve click (which he could normally easily hear at bedtime).

On admission, his vital signs were normal and his lungs were clear. There were no cardiac murmurs or extra heart sounds, and he had no lower extremity edema. His chest radiograph showed no pulmonary edema, and his electrocardiogram showed no evidence of ischemia. The physician in the emergency department (ED) performed a bedside point-of-care cardiac ultrasound and interpreted it as having a stable low ejection fraction, some evidence of volume overload, and a mechanical mitral valve that was in place without regurgitation. The ED reported these findings to the hospitalist who admitted the patient with a presumed diagnosis of volume overload.

A point-of-care ultrasound (POCUS) is an ultrasound examination performed at the bedside using a portable ultrasound machine, typically used when a health care provider seeks to answer a focused question or set of questions. The process involves a few steps: the clinician performs the examination, interprets the images obtained, and integrates that interpretation into patient care. The use of the term POCUS throughout this commentary is designed to maintain clarity and simplicity. Other terms, often used interchangeably, such as *emergency ultrasound*, *bedside ultrasound*, *focused ultrasound*, or *limited ultrasound* will not appear here. The scope of the examination distinguishes POCUS from a traditional comprehensive *consultative* ultrasound examination performed in the echocardiology laboratory or in the radiology department.(1) In the United States, most consultative examinations are performed by technologists (not clinicians) and are complete examinations of the organ or organs of interest, thus distinguishing them from the *limited scope* of a POCUS examination.

As a field, POCUS was initially led by emergency medicine, but now many medical specialties use POCUS for a wide spectrum of applications, including trauma, pregnancy, evaluation of the abdominal aorta, biliary tract, urinary tract, cardiothoracic system, and procedural applications.(1) Emergency medicine and critical care medicine specialists have authored most of the literature on POCUS. Moreover, since 2012, emergency medicine accreditation requires that residents achieve competency in POCUS.(2,3)

The characteristics of POCUS (time efficient, portable, reproducible, and safe from ionizing radiation) have led it to be used in emergent, urgent, and nonemergent settings. A landmark resolution passed by the American Medical Association in 1999 (Resolution 802 and policy H-230.960) stated that ultrasound is "within the scope of practice of appropriately trained physicians" and that each specialty should decide the necessary training requirements for sonography competency.(4) Consequently, departments utilizing POCUS are typically responsible for oversight and compliance with specialty-specific standards. Individual department POCUS leadership should be responsible for timely quality assurance review of POCUS examinations and for providing feedback to providers in accordance with the specialty-specific guidelines and credentialing policies.(5)

Substantial high-quality literature supports the use of POCUS for diagnosis. Most of the evidence has involved emergency medicine providers performing ultrasound in the ED. For cardiac ultrasound, emergency medicine providers can accurately make diagnoses (when compared to reference standards) in the evaluation of pericardial effusion, chamber size, left ventricular function, and thoracic aneurysm. When performed by trained providers, POCUS examinations are accurate and time efficient for many aspects of patient care including diagnosis, monitoring, and procedural guidance.(6-12) For example, POCUS physicians are accurate in the evaluation and measurement of the abdominal aorta for aneurysm.(13) Emergency physicians can evaluate women in the first trimester of pregnancy, confirm an intrauterine pregnancy, and facilitate a decreased length of stay in the ED.(14) Emergency physicians can evaluate patients presenting with symptoms concerning for acute cholecystitis and facilitate a decreased length of stay when the examination is negative.(15) When evaluated by physicians using the focused assessment of sonography in trauma, patients are taken to the operating room faster.(16)

The literature offers relatively few descriptions of typical errors or pitfalls in cardiac POCUS. In fact, the common error in POCUS actually is not using POCUS when indicated. From our experience, we have observed some common limitations and pitfalls. At first, it may be difficult to obtain images that are interpretable on cardiac POCUS due to the patient's acute presentation, the patient's body habitus, experience of the sonologist, or limitations of the machinery. Aspects of the patient's habitus that may present a challenge include (but are not limited to) obesity, abnormality of the bony thoracic cage, and a distended abdomen.(17,18) Pathologic processes such as hyperinflated lungs, subcutaneous emphysema, and pneumothorax will distort ultrasound images. Mistaken interpretations may occur if the orientation of

the transducer with the orientation marker on the screen is reversed. Pleural fluid may be mistaken for pericardial fluid. Finally, blood, clotted blood, and pericardial fat may appear similarly echogenic on cardiac POCUS.(17) In general, errors and pitfalls can occur with any acquired skill, with any procedure, and with any technology. For POCUS, novice sonographers may be less skilled in obtaining good ultrasound windows. High-quality ultrasound images are essential for accurate interpretation.

In the current case, the use of POCUS examination was appropriate to evaluate the ejection fraction (global left ventricular function). Volume overload would typically be determined after a POCUS evaluation of the heart, lungs, and inferior vena cava—not by a cardiac POCUS examination alone. A credentialed provider could comment upon visualization of the mitral valve; however, a POCUS cardiac examination does not extensively evaluate the valves as this requires more advanced skill. The hospitalist should not have considered an emergency department POCUS a complete examination, particularly with regard to the review of the mechanical valve. In this patient, one with a prosthetic heart valve stating he was short of breath and no longer hearing his mitral valve click, a complete echocardiogram was clearly indicated. Moreover, the physical examination findings confirmed a lack of valvular click. The emergency department POCUS was a reasonable first test, and its findings correctly reassured the clinicians that the patient was stable and that an emergent consultation and echocardiogram were not necessarily indicated. Reasons for ordering an emergent consultative echocardiogram include, but are not limited to, hemodynamic instability or concern for a structural abnormality such as a valve or a cardiac mass.

Case & Commentary—Part 2

On admission, the hospitalist's physical examination had the same findings as the one conducted by the ED provider. The hospitalist did not repeat a POCUS. Reassured by the report from the ED provider, the hospitalist also did not think a formal transthoracic echocardiogram was indicated—despite the complex cardiac history, the patient's report of not hearing the mitral valve click, and the fact that no murmur or extra heart sounds could be auscultated. Without another clear cause for the shortness of breath, the hospitalist was comfortable with the presumed diagnosis of volume overload, and the patient underwent hemodialysis that day with removal of 1.9 liters of fluid. He tolerated the procedure well, felt better, and requested to go home. He was discharged later that day.

Less than 12 hours later, the patient returned critically ill and in cardiogenic shock. An emergency formal transthoracic echocardiogram in the ED found a thrombosed mitral valve, leading to acute mitral stenosis and cardiogenic shock. He required a central line and vasopressors to maintain his blood pressure and underwent emergency mitral valve replacement. He survived the procedure but had an extended course in the intensive care unit. He was discharged to a skilled nursing facility one week later.

Review of the case concluded that the initial ED ultrasound should not have been used as an assessment of mitral valve function. A review of the ED POCUS showed evidence of the mitral valve thrombosis. However, the ED provider was not expected to have identified this finding, as assessment of valvular function is outside the scope of bedside point-of-care cardiac ultrasound. Given the clinical presentation, the hospitalist should have ordered a formal transthoracic echocardiogram during the first admission to the hospital.

It is difficult to determine a single cause for this patient's adverse event; patient care errors are often multifactorial. The patient stated he was not hearing a click. Neither the emergency provider nor the hospitalist auscultated a mechanical sound. Yet, further investigation of the valve and its functioning was

not pursued by specialty consultation or with a complete echocardiogram performed by the department of cardiology. Anchoring bias played a role in the decision to treat the patient for fluid overload—a diagnosis that should have been questioned given the findings of clear lungs, no peripheral edema, and a clear chest radiograph.

Verbal or cursory reports of the interpretation of a cardiac POCUS examination from one provider to another should be discouraged. "Phantom scanning" or a quick-look examination, in which a provider does not save (archive) images, performs the minimal criteria for a focused examination, and simply documents a procedure note in the medical record should also be discouraged. In general, all providers should ensure that a POCUS note is placed in the record, that the images are archived, and that images are viewable if patient care decision-making is based upon this examination.

In this case, the ultrasound report would state the indication for the examination, the technique, the findings, and the interpretation. Not only should the hospitalist have reviewed the findings and the interpretation; if qualified, he or she should have reviewed the images in an analogous way that an echocardiogram and a chest radiograph would be reviewed. If the hospitalist were not qualified to interpret the images, a reasonable option would be to have a cardiology consultant review them.(19)

Prosthetic valve thrombosis is a rare complication of a mechanical heart value. it is more common for patients to have embolic events, with a nonobstructive thrombosis. The physical examination presentation can be variable; however, a disappearance of heart sounds or a new murmur should raise suspicion of prosthetic valve thrombosis. The diagnostic workup requires a transthoracic echocardiogram.(20)

Institutions can take specific concrete steps to ensure the use of POCUS is evidence-based, safe, and high-yield. One solution, which standardizes and raises awareness of the scope of POCUS, is the formation of a hospital or systemwide POCUS committee. Such a committee can write and implement guidelines to ensure effective POCUS utilization. Such a committee would support quality POCUS utilization across the range of clinical settings. System guidelines for POCUS would address all aspects of a program (e.g., leadership, training, competency, credentialing, quality assurance and improvement, documentation, archiving, workflow, equipment, and infrastructure issues relating to communication and information technology). Such a committee would work with departments to ensure proper documentation and image archiving. The committee could also ensure all clinical documentation complies with institutional, local, regional, and national standards.(5,21) Literature on the development of such guidelines is scarce, but one recent communication has described a systemwide clinical ultrasound program and its impact.(22)

Regarding education and training, the current national guidelines for competency are specialty specific. These guidelines describe specific goals and expectations for didactic learning (e.g., lectures) and experiential learning (e.g., practice with the ultrasound). The guidelines also set forth expectations regarding assessment of competency in POCUS. Currently, residency programs and clinical departments can determine which combination of assessment methods best fits the program, learners, faculty, and curriculum. These methods may include but are not limited to a question bank, a quality assurance process, direct observation, observed structured clinical examinations, and simulation cases.(5,23)

While many issues led to the adverse event in this case, an overreliance on the reported POCUS findings clearly played a role. As with other diagnostic tests (e.g., radiographs, electrocardiograms, etc.), providers need to recognize when the findings of the test do not fit the clinical signs and symptoms, and when the clinical situation requires a different examination. Providers should correlate POCUS interpretations with other elements of the clinical evaluation to exclude common etiologies and accurately identify the diagnosis. Substantial evidence supports the accuracy of POCUS, and institutions should take steps to ensure its safe and evidence-based use.

Perils in Diagnosing a Stroke

The Case

A 75-year-old man with a history of hypertension, diabetes, chronic back pain, and opioid use disorder was brought to the emergency department after being found unresponsive. The patient's wife had been driving him back from the store when she noticed he was very lethargic. After he became unresponsive, she called 911. In the emergency department, the physician suspected a stroke given the patient's risk factors and the relatively acute onset of symptoms. A CT scan revealed no bleeding into the brain. After consulting with a neurologist, the decision was made to give systemic thrombolytics (drugs to dissolve a blood clot).

After the thrombolytic was administered, the patient's nurse noticed multiple patches on the patient's back. She realized that they were fentanyl patches—a potent opioid medication. She spoke with the patient's wife, who said that the patient was prescribed the patches for his chronic back pain and that she had placed two fentanyl patches on the patient earlier that morning. The patient's wife stated his physician had recently increase the dose due to his pain level. The nurse asked a pharmacy technician to perform medication reconciliation, which revealed that the patient's fentanyl patch had recently been increased from 100 micrograms per hour to 150 micrograms per hour. However, his wife had accidentally applied two 150 microgram patches that morning—instead of one—as she assumed the two patches would be his new regimen. Therefore, the patient had inadvertently received three times his previous dose of fentanyl.

The nurse alerted the physician, who realized that the opioid overdose probably explained the patient's symptoms. He quickly ordered administration of naloxone (an opioid reversal agent). Although the patient initially became more responsive, shortly thereafter he had a generalized seizure. A repeat CT scan showed intracranial hemorrhage—an adverse consequence of the thrombolytics. His neurologic status deteriorated, and he required urgent surgery to drain the bleeding. The patient had a long, complex hospital course, but eventually he was discharged to a rehabilitation facility with substantial (though not complete) recovery of his functional status.

Febrile Neutropenia and an Almost Fatal Medication Error

The Case

A 33-year-old woman with recently diagnosed acute myelogenous leukemia was admitted to the oncology service for treatment with chemotherapy. She reported feeling relatively well, apart from mild fatigue secondary to anemia. For chronic constipation, she took sennosides daily and polyethylene glycol as needed.

On admission to the hospital, her vital signs were stable, and physical examination was notable only for conjunctival pallor. Chemotherapy was administered as scheduled over 5 days. As expected, her blood counts dropped in response to the chemotherapy, and on hospital day 6 she was noted to be neutropenic with an absolute neutrophil count of 320. That night, she noted some abdominal discomfort. The bedside nurse noted that the patient had not had a bowel movement for the last 2 days despite taking both sennosides and polyethylene glycol daily. The nurse paged the overnight physician, who ordered a suppository without realizing that the patient was neutropenic and immunosuppressed after recent chemotherapy. The nurse administered the suppository as ordered, unaware that suppositories are contraindicated in neutropenic patients.

Several hours later, the patient felt warm and developed shaking chills. Repeat vital signs revealed a fever to 39.7°C and a heart rate of 121 beats per minute, concerning for sepsis. The nurse paged the overnight

physician once again. Blood cultures were drawn and broad-spectrum antibiotics were started for febrile neutropenia. The patient worsened clinically and required transfer to the intensive care unit for hypotension and management of septic shock. Her blood cultures ultimately grew *Escherichia coli*, which may have spread from her bowel to her bloodstream as a result of receiving the suppository. Ultimately, she recovered and was discharged home a week later.

Chest Pain in a Rural Hospital

A 62-year-old man with a history of diabetes presented to a rural emergency department (ED) complaining of chest pain, hiccups, and generalized weakness. His vital signs were within normal limits, and physical examination was unremarkable. His initial electrocardiogram revealed an incomplete left bundle branch block. Laboratory results were notable for a blood sugar of 615 mg/dL, an anion gap acidosis, and a troponin of 1.8 μg/L (normal < 0.05 μg/L). The ED provider felt this presentation was consistent with a hyperosmolar hyperglycemic state from poor adherence and that the patient should be admitted to the hospital.

As this was a rural hospital with 35 inpatient beds, there was no on-site provider to admit the patient overnight. The ED physician called the internist who was covering this hospital (and another rural hospital) and discussed the admission. The internist was concerned about the elevated troponin and possible myocardial ischemia, and he ordered aspirin and a heparin drip from home. These orders were not communicated to the nurse or the physician in the ED. Due to the configuration of the electronic health record, the ED nurse did not see the orders and neither medication was given. The internist's plan was to contact the local cardiologist who would be available the next day.

The patient was transferred to an acute care bed 2 hours later. When he arrived, he was diaphoretic, somnolent, tachycardic, and borderline hypotensive. The nurse called the covering internist at home about the situation, and the internist ordered more laboratory tests (including a troponin I) and inquired about the heparin drip. The nurse realized that the drip had never been started and called the pharmacy to clarify the dosing. When she went to administer the heparin, she found the patient to be unresponsive, hypotensive, and bradycardic. She called a code blue, and resuscitation was initiated.

During the resuscitation, the repeat troponin I level returned at 42 μg/L, consistent with an acute myocardial infarction. The patient's initial presentation with chest pain and weakness was likely because of an acute myocardial infarction. Despite maximal efforts, the patient could not be resuscitated and died. An autopsy revealed an acute myocardial infarction and a rupture of the left ventricular free wall.

Suicide Risk in the Hospital
The Case

A 37-year-old woman with a past medical history of depression, anxiety, and posttraumatic stress disorder presented to the emergency department (ED) after a suicide attempt. She overdosed on 3–4 tablets each of alprazolam (a sedative) and gabapentin (a pain medication) and then cut both of her forearms with a kitchen knife. Upon presentation to the ED, the patient endorsed active suicidality. She had no previous suicide attempts. Her physical examination was significant for a tearful, depressed affect and superficial lacerations to the bilateral forearms, including a 3 cm laceration on the left forearm.

The patient's left forearm laceration was sutured and bandaged with gauze padding. The patient was observed for a period of several hours postingestion, and she was evaluated by a psychiatrist who placed an involuntary legal hold due to high risk of self-harm. She was then transferred to the inpatient

psychiatric unit. On arriving to the unit, the patient asked to use the bathroom. She then unwrapped the gauze bandage from her wrist, wrapped it around her neck and over the shower bar in the bathroom, and attempted to hang herself.

Fortunately, a staff member heard a noise from the bathroom, immediately entered, and cut the gauze before the patient was seriously injured. The patient was transferred back to the ED, where she was found to have superficial abrasions to her neck but an otherwise normal physical exam. A CT scan of the head and cervical spine was obtained, which was normal. She was ultimately readmitted to the inpatient psychiatric unit for further treatment of her depression and suicidality.

Root Cause Analysis Gone Wrong
The Case

A 42-year-old man with history of end-stage renal disease on hemodialysis was awaiting a kidney transplant. A suitable donor was identified, and the patient was taken to the operating room for the procedure. The surgery was uneventful, and the transplanted kidney was connected successfully. As the procedure was drawing to a close, the surgeon instructed the anesthesiologist to give 3000 units of intravenous heparin (an anticoagulant) as part of the standard protocol to prevent graft thrombosis.

The surgical team was preparing to close the incision when the clinicians noticed blood in the surgical field. They performed a careful search for bleeding, but did not find a clear source, and the bleeding continued to worsen. The patient's blood pressure began to drop, and transfusions were administered while the team tried to stop the bleeding. At that point, the anesthesiologist reviewed the medications and realized that he had accidentally administered 30,000 units of heparin—not 3000 units. He immediately administered protamine to reverse the anticoagulant effect. However, the persistent bleeding and hypotension had irreversibly damaged the transplanted kidney. The kidney was explanted, and the patient was transferred to the intensive care unit in critical condition. The error was disclosed to the patient and his family, and he eventually recovered and was discharged home. He continued to receive hemodialysis while awaiting another transplant.

The hospital planned to perform a root cause analysis (RCA) to investigate the adverse event. The transplant surgeon was furious about the error and complained angrily to the operating room staff, chief of anesthesiology, and chief medical officer (CMO) about the "incompetence" that had resulted in the error. Although the hospital's patient safety officer attempted to conduct the RCA in a nonjudgmental fashion, she found it very difficult to focus the investigation on possible systems issues, as it seemed that all the personnel involved had already decided the anesthesiologist was to blame. The transplant surgeon was influential at the hospital, and under pressure from the CMO, the chief of anesthesiology decided to dismiss the anesthesiologist. The RCA was completed, but the conclusions focused only on the individual anesthesiologist, and no interventions to prevent similar errors or address systems issues were ever implemented.

Out of Sight, Out of Mind: Out-of-Office Test Result Management
Case & Commentary—Part 1

A 76-year-old man had previously presented with a right-sided headache, jaw claudication, and one episode of transient visual loss. He was diagnosed with giant cell arteritis (GCA) and was seen in rheumatology clinic for follow-up. Steroids were initiated for treatment and discontinued a year later, as his symptoms had resolved. Laboratory testing was ordered for follow-up and monitoring.

A month after stopping steroids, the headaches recurred. A blood test revealed that his C-reactive protein (CRP) was now elevated, suggesting that cessation of steroids had led to increased inflammation and a flare of GCA. His rheumatologist was out of town at a conference and did not receive the test result. Her colleague was covering the electronic inbox (the portal within the electronic health record in which test results needing follow-up were sent) and noticed the elevated CRP.

Management of test results in the ambulatory setting presents unique challenges.(1,2) Because ambulatory encounters are episodic and test results often arrive days to weeks after they are ordered, decisions regarding test results are stretched out across time and space. As this case illustrates, results may arrive when the ordering provider is unavailable or distracted, creating opportunities for critical pieces of information to fall through the cracks. These opportunities are not rare, as each full-time primary care physician reviews 930 chemistry/hematology results and 60 pathology/radiology reports per week.(3) As a result of this deluge, clinicians spend significant time addressing test results—about 75 minutes per day reviewing, communicating, and following up on both normal and abnormal results.(4) Studies suggest that delays in reviewing test results are common despite the use of electronic health records (EHRs).(4-7) In a retrospective review of closed malpractice cases involving missed or delayed diagnoses, failure to receive diagnostic test results or to transmit them to patients played a significant role in 12% of cases.(8)

With the widespread adoption of modern EHRs (9), certain aspects of test result management have become easier. For example, the chaotic streams of paper test results from different testing facilities can now be collated automatically in electronic *inbaskets* (sometimes called *inboxes*), linked to clinical documentation and other details associated with the encounter during which the test was originally ordered, and the severity of abnormality can be flagged, creating a valuable visible cue for the responsible provider. Furthermore, follow-up actions associated with test result management (such as ordering additional studies, referring patients to additional specialists, changing therapies, setting reminders for future actions, or generating correspondence with patients) can be executed within the EHR and recorded for future reference by members of the clinical team.(6)

However, implementation of technology has also created additional work for providers. The patient health record (PHR) tethered to the EHR has made it easier for patients to reach out to the provider directly with questions and requests (related to test result follow-up or otherwise), increasing the workload of providers in practices that do not have the resources to triage these incoming messages.(J.M. Perkins, D.E. Attarian, written communication, November 2017) In addition, administrative notifications abound in the inbasket, creating a new stream of tasks. Some studies suggest that management of the inbasket may be seen as a Sisyphean chore, and the clerical burden associated with the volume of messages, test results, and requisite follow-up is contributing to the epidemic of provider burnout.(10,11)

In light of the challenges associated with test result management in the ambulatory setting, how can clinicians maximize the reliability and conveniences offered by the inbasket while maintaining a reasonable work–life balance? Teamwork plays a key role in ambulatory test result management. When thoughtfully organized and executed, teamwork allows each member of the team to practice "at the top of their license" so that each team member does work he or she is uniquely suited to perform. For example, thoughtful implementation of workflow protocols could allow nurses to safely and effectively manage specific types of abnormal test results, e.g., abnormal pap smears. In addition, certain aspects of test result follow-up, such as making referrals or notifying patients of normal test results, could be performed by medical assistants, freeing up physicians' time to focus on tasks that require their specialized expertise. Importantly, teamwork also allows abnormal test results to be handled safely during periods when the responsible provider may be away from the office. To the credit of the rheumatology practice in this case, its providers have developed a coverage system in which they can designate a colleague to be responsible

for new inbasket items during periods of absence. Such efforts at simultaneously promoting safety for patients and work–life balance for providers should be lauded.

A safe, reliable, and efficient test result management system requires thoughtful design. Such design requires collaboration among clinicians, administrators, and technology experts who can come together to understand the current state, build a vision, develop new workflows, and anticipate unintended consequences.(12) These efforts must typically be iterative, and staff buy-in is crucial to success. Quality improvement tools and frameworks can be leveraged to define roles and responsibilities, help team members hold each other accountable, and sustain the initiative.(13)

Case & Commentary—Part 2

When the patient's rheumatologist returned from her conference the following week, the covering physician gave her the patient's last name but did not provide his medical record number or date of birth as a second form of patient identification. The rheumatologist happened to have two patients with the same last name, and both had GCA. She logged into the medical record of one of these patients—the wrong one—and saw a normal CRP value, so she took no action.

A few months later, the correct patient underwent repeat lab testing, and his CRP was elevated once again. The rheumatologist quickly called the patient for a follow-up appointment and realized that the elevated CRP from 2 months earlier had been missed. In the setting of the ongoing headache and joint pain with a persistently elevated CRP, the rheumatologist diagnosed the patient with a flare of his GCA and restarted him on steroids. It was not clear if the 2-month delay would have long-term consequences beyond the untreated symptoms.

One could reasonably argue that this mishap following the return of the rheumatologist to clinic was merely a case of mistaken patient identity. If the covering rheumatologist had used a second patient identifier during the handoff (as required by The Joint Commission) (14), the returning rheumatologist would have looked up the medical record for the correct patient and made the decision to restart steroids (or not) based on the initially elevated CRP that returned while she was away. However, this mishap gives us a window into three potential opportunities for improving the test result management system used by this practice.

First, why was it necessary for the returning rheumatologist to look up the patient electronically in the first place? If the covering rheumatologist had decided that resuming steroids was a nonurgent decision best left to the treating rheumatologist most familiar with the patient's symptom trajectory (15), the CRP result should have been left in the returning rheumatologist's inbasket (6,16) (perhaps with an annotation as to why steroids had not immediately been restarted). Did the covering rheumatologist mistakenly mark the elevated CRP result as "reviewed," thus hiding the result in the inbasket of the returning rheumatologist? If so, that mistake could have been avoided if the practice had laid out the procedure for what to do with test results reviewed by a covering colleague. Ambiguities in the logistics of test result management and handoffs are areas of vulnerability. Although a variety of approaches might be effective depending on local practice culture and EHR capabilities, the chosen approach should be formalized and rehearsed by the relevant care team members. Publicly available toolkits (17,18) may be helpful in developing and hardwiring these local approaches.

Second, if we assume that the covering rheumatologist *did* leave the elevated CRP result in the inbasket for the returning rheumatologist to follow up upon her return, that raises another concern. It is possible that the returning rheumatologist had fallen so far behind on reviewing test results in her inbasket that the elevated CRP was buried among many other test results. The case presentation does not state whether this

factor was at play, but in general, test result folders in the inbasket need to be aggressively managed by all providers, lest they create unmanageable backlogs of unfinished tasks.(19,20) In addition, clinical leaders (e.g., medical directors) need to hold all providers accountable for reviewing test results within a reasonable timeframe and for clearing the inbaskets before they are handed over to a covering provider. Electronic health records have made it possible to measure providers' adherence to these best inbasket practices (21-23), although it is unclear if organizations have fully taken advantage of this capability.

Third, this case highlights the potential role the patient could have played as part of the care team. Many PHRs automatically release test results (both normal and abnormal) to patients after a reasonable time lag. For years, patient safety organizations have educated the public that "no news [on test results] is not good news," and organizations that have chosen to release test results automatically to patients are reinforcing that message. However, patients desire more than just access to test results—they also want to know their clinicians' interpretation, particularly when test results and the follow-up actions might be unclear, as in this case. Most EHRs give clinicians the ability to summarize their interpretation of test results through electronic annotations in the PHR or through result letters delivered electronically or through traditional mail. If the practice in this case had set the expectation for the patient that he should receive timely *interpretation* of test results, then he might have inquired about the absence of an interpretation on an elevated CRP earlier, potentially shortening the 2-month delay in clinical decision-making by the responsible physician.

Take-Home Points

- Never assume electronic health record deployments have addressed all the problems associated with outpatient test result management and test workflows.
- Inbasket management is time-consuming. If this burden is not proactively mitigated, it could contribute to provider burnout and adverse patient outcomes.
- Clinical practices should leverage available technology to facilitate a team approach to test result management. If protocols are properly outlined and followed, nurses and medical assistants have the potential to assist physicians with test result management.
- Clinical practices should create formal processes for inbasket handoffs between providers.
- In organizations that have adopted patient health records, patients' test results should be released automatically to them electronically within reasonable timeframes.
- Providers should communicate their interpretation of test results to patients in a timely and consistent fashion.

Walking Patient, Missing Drain

The Case

A 43-year-old woman with a history of metastatic breast cancer was admitted to the hospital for an elective lumbar drain placement to treat hydrocephalus and elevated intracranial pressures. Because of the pressure on her brain, the patient had symptoms including mood changes, headaches, and appetite changes. Following the procedure, she was admitted to the intensive care unit (ICU) for monitoring under the care of the ICU team and neurosurgery team. She made progress with recovery as expected and participated in physical therapy. On day 5 of her hospitalization, the physical therapist administered vigorous therapy (as prescribed) with the patient out of bed. The therapist returned the patient to bed at the end of the therapy session. While resting in bed after the session, the patient complained of headaches, decreased appetite, and worsening visual problems. Since the complaints were similar to the patient's symptoms on admission, which should have been addressed by the lumbar drain, the nurse attributed the patient's complaints to depression and took no action, allowing the patient to sleep and keeping unchanged the prescribed frequency of neuro checks every 6 hours while awake.

Early in the morning, the patient was found to be barely arousable. The nurse and the team then discovered that lumbar drain had dislodged and was now on the floor. A stat CT scan was ordered, which revealed extensive hydrocephalus. An external ventricular drain was placed emergently at the bedside after securing the patient's airway. Eventually the patient had a new lumbar drain placement, with improvement of her mental status and other complaints. She was ultimately extubated and discharged to home.

Air on the Side of Caution

The Case

A young woman with morbid obesity was scheduled for cardiac catheterization to evaluate shortness of breath and chest pain. A decision was made to use a radial artery approach. Positioning the patient appropriately was challenging because she could not move easily. After multiple attempts, the team was able to access her radial artery. After the catheter was inserted, the patient began to experience increasing pain and pressure in both her arm and her chest. The team proceeded quickly with the procedure, but they hesitated to administer additional pain medication given the patient's body habitus and concern for respiratory suppression. Anesthesia was not consulted.

Review of the angiogram demonstrated the presence of an air embolism in the left coronary artery, caused by air being introduced into the patient's radial artery during the catheter insertion. It became clear that, because of the procedure's difficulty, the cardiac technician controlling the syringe for injecting dye failed to hold the syringe at the proper angle to prevent an air bubble from being introduced into the patient's vessel. When the air embolism was recognized, appropriate treatment protocols were implemented. The patient was ultimately transferred to a higher level of care, treated appropriately, and discharged from the hospital several days later.

Further review revealed that the team was under significant time pressure to perform the procedure, and many members were fatigued, as it had been a long day without breaks. Music playing in the background may also have created a distraction. In addition, during the procedure a Code Blue had been called in the room next door, which meant that several key personnel were not present for this patient's catheterization.

When Patients and Providers Speak Different Languages

The Case

A 56-year-old Spanish-speaking woman with a complicated medical history presented to the preoperative clinic for evaluation in advance of a scheduled elective total abdominal hysterectomy and bilateral oophorectomy. The electronic health record indicated that the patient required a Spanish interpreter to communicate with health care providers. A non–Spanish-speaking physician met the patient and discovered that no in-person interpreter had been booked in advance of the visit.

The provider attempted to use the clinic's phone interpreter services, but the phone reception in the exam room was poor and the interpreter and patient could not hear each other. The patient tried calling her husband to interpret, but he was unavailable. Eventually, a Spanish-speaking medical assistant was able to interpret for the visit. The provider learned that the patient was having symptoms concerning for unstable angina and determined that the patient would require additional cardiac testing before proceeding with the elective surgery. The visit had been booked for a 30-minute slot but took more than 75 minutes. The patient obtained the necessary cardiac follow-up and her surgery was rescheduled.

After the visit, the physician investigated the situation further and discovered that the interpreter phone line receiver was located at the opposite end of clinic, which likely explained the poor reception in the exam rooms. Additionally, the interpreter phone shared a line with the fax machine. Although the physician had previously been able to use her personal cellphone to access the interpreter services company, the practice had recently switched vendors and she did not have their access number. Furthermore, the clinic did not have a formal process in place designed to identify non–English-speaking patients in advance of their visits and to ensure that in-person interpreters were booked for those visits.

Missing ECG and Missed Diagnosis Lead to Dangerous Delay
The Case

A 35-year-old woman with no prior cardiac history called 911 after developing severe chest pressure at home. Based on the availability of local resources, a Basic Life Support Unit was dispatched. When emergency medical services (EMS) arrived at the patient's home, EMS providers obtained a 12-lead electrocardiogram (ECG) and administered aspirin. The ECG tracing showed ST elevations consistent with a large anterior wall myocardial infarction, or ST-elevation myocardial infarction (STEMI). According to protocol, EMS providers were required to transmit the ECG to the emergency department (ED) to activate "Code STEMI" while en route so that the cardiac catheterization laboratory, as well as necessary cardiology providers and staff, would be ready to treat the patient upon arrival to the hospital. Unfortunately, the ECG was not successfully transmitted to the ED (for technical reasons), which meant that the STEMI team was not activated in advance of the patient's arrival.

When the patient arrived in the ED, the clinicians (unaware of the original ECG) obtained a new ECG, which did not demonstrate the previously noted ST segment elevations. The patient's chest pain also seemed to be improving. She was treated with opioids for mild ongoing pain, and no additional ECGs or laboratory tests were ordered. She was subsequently admitted to the inpatient telemetry floor for overnight monitoring. The next morning, the patient's laboratory test results were notable for an elevated troponin level, suggesting that significant myocardial damage had occurred. Repeat ECG showed findings consistent with a large heart attack the prior day. She was rushed to the cardiac catheterization laboratory for emergency percutaneous coronary intervention (PCI). Because PCI had been delayed for many hours from the time of the original STEMI, the patient experienced significant loss of cardiac muscle function. She ultimately required placement of a device to assist her heart function and a prolonged stay in the cardiac intensive care unit.

Shortcuts to Acetaminophen-induced Liver Failure
The Case

An 18-year-old woman, 27 weeks pregnant, presented to the emergency department (ED) after a week of respiratory congestion, nausea, and fever. She was diagnosed with a viral upper respiratory infection, given IV fluids and acetaminophen, and discharged home with advice to continue taking acetaminophen as needed to control the fever. Thirty hours later, the patient returned to the ED with continued symptoms and new abdominal cramps. She was diagnosed with gastroenteritis and discharged with ondansetron and bismuth subsalicylate. Two days later, she presented again to the ED, this time with shortness of breath and abdominal pain. She was admitted to the ward and physical examination revealed lethargy, tachycardia, tachypnea, and generalized abdominal tenderness. Influenza B polymerase chain reaction was positive and Oseltamivir was started. Laboratory tests revealed leukocytosis, transaminitis in the thousands, and lactic acidosis. The patient was admitted to the hospital and given broad-spectrum antibiotics and a diagnosis of "influenza/possible sepsis." Further questioning revealed the patient had taken 1 g of acetaminophen every 4 hours since her initial ED visit. However, despite evidence of acute fulminant hepatitis due to chronic acetaminophen overdose, the antidote, N-acetylcysteine, was held for

10 hours because acetaminophen levels were less than 10 mcg/mL, deemed to be below the toxic level. The patient recovered over the next 24 hours with conservative management and N-acetylcysteine.

Isolated Clot, Real Error
The Case

A 65-year-old woman underwent an elective hysterectomy and had a complicated postoperative course, including excessive bleeding during the procedure. She was given multiple blood products and developed acute respiratory distress syndrome (ARDS) and respiratory failure requiring mechanical ventilation. She spiked a fever, and her temperature remained elevated through her sixth day in the intensive care unit (ICU). An extensive evaluation for infection failed to reveal a source.

On rounds, the team decided to order whole-leg Doppler ultrasounds of both lower extremities looking for a deep venous thrombosis (DVT) as a cause of the fevers. That afternoon, the intern checked the results and noted the first line of the final result stated "Positive. Thrombosis of right lower extremity." Because she was trying to sign out at the end of the day, she did not read the entire report. No other provider reviewed the official results.

The next day on rounds, the intern reported to the rest of the ICU team that the ultrasound was positive for a DVT. Because of the patient's life-threatening postoperative bleeding, the team agreed the patient was not a candidate for anticoagulation (the usual treatment for DVT). Instead, they ordered an inferior vena cava (IVC) filter in the hopes that it would prevent a pulmonary embolism (PE). She tolerated the placement of the filter without complication.

The next week, a new team started in the ICU. They were reviewing the plan of care and discussed the reason for the IVC filter (an unusual intervention given recent studies questioning its overall benefit). The senior resident reviewed all of the radiology records and read the original ultrasound report, which did state there was a thrombosis in the right lower extremity, but went on to describe it as being localized to the great saphenous vein. This particular vein is considered a superficial vein, meaning that a clot in it carries very low risk for PE and should not have been treated with placement of an IVC filter. The team determined that the next step in management should have been active surveillance with repeat ultrasound.

The team recognized the error and disclosed it to the patient and family. The family was upset but understood the confusion. A repeat ultrasound of the right leg showed resolution of the thrombosis. The IVC filter was removed the following day without complication. The patient experienced no direct consequences from the placement of the IVC filter and slowly recovered over the next few weeks.

Right Place, Right Drug, Wrong Strength
The Case

A 2-year-old girl was admitted to a hospital burn unit for a 10% total body surface area burn on her face, upper chest, and back. She was being treated with oral acetaminophen around the clock and nonsteroidal anti-inflammatory drugs as needed for pain and discomfort. The patient underwent dressing changes and burn inspection every third day. On these days, she was also given oxycodone, which was highly effective and allowed her to rest the whole day.

One week into the hospital stay, the mother noticed the patient's breathing was very shallow after a dressing change. On examination, the patient was difficult to arouse and lethargic, and an arterial blood gas revealed CO_2 retention and hypoxemia. While preparing to intubate, the physician reviewed that

day's medications to identify possible causes of this sudden change in respiratory status. He discovered the patient had received oxycodone 3 times in less than 8 hours (1 dose prior to the dressing change and 2 doses after). The nurse checked the automated dispensing machine in which the oxycodone was stored and was surprised to find a higher concentration of oxycodone solution stored in place of the typical, lower concentration pediatric solution. Consequently, the dose administered to the patient was almost 5 times what was ordered.

After the physician and nurse recognized the error, the patient immediately received multiple doses of naloxone. Her breathing improved quickly, and intubation was avoided. The patient was monitored in the hospital for 1 week after the incident, did well, and was safely discharged home.

Root cause analysis (RCA) by the safety committee determined the higher concentration of oxycodone solution was incorrectly placed in the automated dispensing machine by a pharmacist who was working per diem. The RCA also found that the nurse did not check the concentration of the medication to be administered against the order written by the physician.

After the incident, multiple checkpoints were established in the pharmacy and a new protocol was established, with a special focus on pediatric medication doses. In-service training was provided to all the pharmacists, including those who work irregular shifts (e.g., overnight).

Returning Home Safely

The Case

A 72-year-old man was admitted to the hospital after a fall at home resulting in a right humerus fracture and shoulder dislocation, as well as other injuries including a right knee contusion. During his admission, the patient underwent right shoulder reduction surgery with plan to keep his arm in a sling until reassessment in 1 month. Given the extent of his injuries and the need for ongoing physical therapy, the plan was made to admit the patient to a skilled nursing facility (SNF) for continued rehabilitation.

The patient lived alone and had little social support. His primary care physician (PCP) suspected that the patient might have dementia, and the results of a Montreal Cognitive Assessment and Kohlman Evaluation of Living Skills assessment performed during the hospitalization raised concerns about the patient's ability to continue to live independently in the community. The hospital's social worker started the process of applying for In-Home Supportive Services and Meals on Wheels, and referred the patient to a home care agency to provide home physical therapy and home nursing visits. However, the final arrangements for these services could not be completed before the patient was discharged, so the trauma team communicated these recommendations to the patient's PCP and the SNF in their discharge summary.

The patient was discharged home from the SNF after a 4-week stay. Three days later, his neighbor brought him to the clinic for an urgent appointment with his PCP. The patient appeared distressed and was complaining of right shoulder pain. His arm remained in a sling, and he was unclear about his medication regimen. His neighbor reported that the patient had not left his apartment since being discharged from the SNF because he was having difficulty climbing the stairs, and he appeared to lack access to food, medications, or transportation to his appointments. The PCP had not received any communication from the SNF about the patient's discharge.

Fortunately, the clinic's social worker followed up on the prior referrals and arranged a home nursing visit and transportation to future appointments. The neighbor also agreed to help with obtaining the patient's medications. The patient did not need to be readmitted to the hospital and was able to stay at home, but the PCP felt frustrated that the patient had not had a better discharge plan.

Signout Fallout

The Case

A 43-year-old woman with a history of atrial fibrillation was brought to the hospital with altered mental status and found to have an intracranial mass with a surrounding hemorrhage. She was intubated for airway protection and managed in the intensive care unit (ICU). She was monitored clinically and with daily CT scans of the brain. Fortunately, for the first 3 days, her exam remained unchanged, and the bleeding was stable on repeated CT scans.

On hospital day 4, the ICU team and the neurosurgeon decided it would be safe to start deep venous thrombosis (DVT) prophylaxis. They collectively decided that, if the CT scan that day remained unchanged, the benefits of low-dose DVT prophylaxis would outweigh the risk of serious bleeding. The senior resident on the neurosurgical service told the intern during the day that "heparin should be started if the CT scan is unchanged," but didn't specify the dose or route of the heparin. The intern did not ask any follow-up questions about the plan. At the end of the day, the intern signed out to the overnight on-call resident to "start heparin if the CT scan is unchanged."

The on-call resident reviewed the CT scan with the radiology resident overnight and they agreed it was stable. He then briefly reviewed the records and saw the history of atrial fibrillation and decided the day team must have wanted to treat the patient with full-dose anticoagulation (rather than lower dose anticoagulation, appropriate for venous thromboembolism prophylaxis). He ordered full-dose anticoagulation with a heparin infusion.

About 2 hours after starting the infusion, the patient became more obtunded. A repeat head CT scan showed a significant increase in the intracranial hemorrhage and worsening brain compression. The heparin infusion was stopped, but the patient continued to worsen over the next few hours. Based on the extent of the bleeding and her neurologic examination, she had no chance for a meaningful recovery. After discussions with her family, care was withdrawn, and she died with her family at her bedside.

The neurosurgical attending and the ICU attending met with both of their teams to discuss what happened. They identified many errors but were particularly concerned about the miscommunication regarding what was signed out to the overnight provider. With their local graduate medical education office, they initiated a literature review and began quality improvement efforts to embrace best practices in signout.

A Costly Colonoscopy Leads to a Delay in Diagnosis

The Case

A 50-year-old man presented to a primary care clinic to establish care, as he had recently switched health insurance. As part of age-appropriate cancer screening, the primary care provider ordered a fecal immunochemical test (FIT) to screen for colon cancer. When FIT returned positive, the physician called the patient to inform him of the results and explained that a colonoscopy was the appropriate next step in the diagnostic process. The medical assistant contacted the patient with instructions for scheduling the colonoscopy.

Two months later, the clinic's nurse called the patient to see if he had obtained the colonoscopy. The patient reported that he was unable to schedule the colonoscopy due to cost. His health insurance required a 30% copayment for the test, which amounted to $2000 out-of-pocket. The clinic instructed the patient to contact his insurance company again. The clinic nurse followed up with the patient a few months later.

Although the patient had contacted the insurance company multiple times, he was repeatedly informed that he would be responsible for 30% of the cost. The primary care provider spoke with the clinic's social worker who assessed options for financial assistance but could not find any for which the patient was eligible.

Ultimately, the primary care provider called the insurance company directly and was informed that if the indication for the colonoscopy was changed from *diagnostic* to *preventive* (for screening purposes), the test would be 100% covered (the full cost of preventive colonoscopies is covered under the Affordable Care Act). Because the colonoscopy represented the second step in the colon cancer screening process after a positive FIT, the primary care provider changed the indication for the test and the patient was eventually able to obtain the colonoscopy without any out-of-pocket cost. Because the initial communication about the out-of-pocket cost was between the patient and insurance company, the patient did not know to inform the insurance company that the colonoscopy was for screening purposes (rather than diagnostic purposes, as initially coded by the primary care physician) and that the copayment should have been waived. The colonoscopy demonstrated colon cancer; the diagnosis was made more than 6 months after the positive FIT. Luckily, the delay had no impact on his clinical outcome.

Slow Down: Right Drug, Wrong Formulation

The Case

A 65-year-old man presented to his primary care clinic for follow-up after a recent hospitalization for exacerbation of heart failure. His past medical history was significant for heart failure with reduced ejection fraction and atrial fibrillation. The physician noted the patient, once again, showed several other signs of decompensated heart failure and sent him back to the hospital for intravenous (IV) diuretic therapy and control of his atrial fibrillation. The admitting internal medicine resident, in concert with the cardiology consult team, initiated IV diuresis and restarted the patient's home beta-blocker and antihypertensive medications. The patient reportedly had not taken his beta-blocker in the 36 hours prior to admission. As the evening progressed, the patient developed increasing oxygen requirements, decreasing blood pressure, and worsening mental status. That night, he developed atrioventricular block, experienced a pulseless electrical activity cardiac arrest, and died.

As part of the clinical review process, the case was discussed in a morbidity and mortality conference. The review revealed the patient's home medication was metoprolol succinate 300 mg. Instead, metoprolol tartrate 300 mg was ordered on hospital admission and administered as a single dose. In the institution's computerized provider order entry (CPOE) system, the first formulation of metoprolol to populate into the ordering field was "Metoprolol Tab," which the system defined as metoprolol tartrate. Metoprolol succinate populated as "Metoprolol *Do Not Crush* SA" with "SA" standing for "sustained action," not "short acting."

The ordering physician was clear in chart documentation that the intent was to start extended-release metoprolol. Thus, the ordering of metoprolol tartrate at that dose was a prescribing error believed to have contributed to the patient's death. The review also determined that insufficient attention to human factors in the electronic health record played a significant role in the error and highlighted an opportunity for future enhancement of the CPOE system to include human factors thinking in the design.

A Painful Medication Reconciliation Mishap

The Case

A 56-year-old woman with a history of alcohol dependence was admitted to the hospital after falling while intoxicated. Prior to this episode, she had been taking naltrexone to treat her alcohol use disorder and had been sober for 3 months. After the fall, a CT scan revealed a fracture of the cervical spine, which required spinal fusion surgery.

Postoperatively, the patient's pain was severe and opioids were initiated for pain control. She was discharged to a skilled nursing facility (SNF) on a long-acting opioid twice a day with a short-acting opioid for breakthrough pain every 6 hours. On admission to the hospital, her naltrexone had been held in anticipation of the fact that she would require opioid therapy for pain control. However, the provider performing medication reconciliation at the SNF restarted her on her home dose of naltrexone (a powerful opioid antagonist), along with the newly prescribed opioid medications. The provider overrode the drug–drug interaction alert regarding the risk of simultaneously prescribing naltrexone and opioids.

While at the SNF, the patient continued to receive naltrexone daily in addition to high-dose opioids. Her pain worsened and remained uncontrolled for most of her time there. The providers at the SNF did not realize that, as a μ-opioid receptor antagonist, the naltrexone was blocking the effect of the opioids, thus explaining why her pain was uncontrolled. The patient was seen in the general medicine clinic for follow-up 3 weeks after being discharged from the SNF, and the medication error was quickly recognized. Her primary care physician instructed her to stop the naltrexone, to halve the total opioid dose to prevent an overdose, and to return to clinic for close follow-up in 2 days.

Over-the-Counter Oversight

The Case

A 56-year-old man was evaluated in the burn clinic for a second-degree burn on his chest. Although portions of his skin were healing well, the patient was told that he would require skin grafting to ensure a complete recovery. He was scheduled for a preoperative evaluation prior to the date of surgery. During the preoperative visit, the patient's prescription medications were reviewed and updated in his medical record. During the surgery, the patient experienced profuse bleeding and required transfusion of multiple units of blood products. His blood counts and vital signs were closely monitored after surgery and he eventually stabilized. Postoperatively, the attending surgeon reviewed the patient's medications with him in detail and specifically asked about medications purchased over the counter. The patient reported that he purchased aspirin over the counter and had been taking one pill every day, including on the day of surgery. Although the patient had been asked about blood thinning medications at his preoperative visit, he didn't realize that he should have mentioned taking aspirin because he obtained it without a prescription, and he was not specifically asked about over-the-counter medications.

Miscommunication in the OR Leads to Anticoagulation Mishap

The Case

A 63-year-old man with a history of coronary artery disease and diabetes was scheduled to undergo bilateral femoral artery embolectomy. Eight months previously, he had experienced a myocardial infarction and was started on dual antiplatelet therapy with aspirin and clopidogrel. Six days prior to surgery, as instructed by the surgeon, he stopped taking his aspirin and clopidogrel in order to decrease the risk of bleeding during and after the operation.

On the day of surgery, just prior to anesthesia induction, the team conducted a preoperative briefing, using the World Health Organization Surgical Safety Checklist. The patient's identity, the operation, the surgical site, and the anesthesia plan were verified. The surgeon told the anesthesiologist that the patient would benefit from epidural analgesia continued into the perioperative period. However, he failed to mention that postoperatively the patient would be therapeutically anticoagulated with enoxaparin for several days. The anesthesiologist was new to the hospital and unfamiliar with the postoperative management of patients undergoing femoral artery embolectomy. After surgery, no formal postoperative debrief was conducted. Unaware that the patient was going to be placed on enoxaparin, a blood thinning medication, the anesthesiologist continued orders for epidural analgesia and the epidural catheter remained in place.

The patient was started on enoxaparin per the surgeon's order. Five days later, the epidural catheter was removed. Fortunately, the patient did not experience bleeding, a potential and sometimes devastating complication of therapeutic anticoagulation in patients with epidural catheters.

Dying in the Hospital With Advanced Dementia
Case & Commentary—Part 1

A 74-year-old woman with history of advanced dementia and end-stage renal disease on hemodialysis was found unconscious at home by her family. Paramedics were immediately called, and they found her without a pulse, in a rhythm of asystole. She was intubated and received cardiopulmonary resuscitation (CPR) with return of spontaneous circulation. Upon arrival in the emergency department, still unresponsive, she was registered under a temporary medical record number. Her examination was notable for hypothermia, hypotension requiring vasopressor infusion, fixed and dilated pupils, and an absence of voluntary extremity movement or brainstem reflexes. Laboratory studies were notable for an anion gap metabolic acidosis, with pH 6.97 and lactic acid 9.2 mg/dL.

Dementia is common in the United States, and Alzheimer disease is the most common form of dementia. It is now the fifth leading cause of death for Americans age 65 and older, and 1 in 3 seniors die with dementia.(1) The median survival from diagnosis ranges from approximately 3 to 7 years.(2,3) Median survival for those with advanced dementia, like this patient, is 1.3 years.(4) Most individuals with dementia will die in a nursing home (67%), but a large minority, such as the woman in this case, will die in the hospital (16%).(5)

Evidence suggests that those with dementia prefer to die at home or in hospice. In one study comparing end-of-life experiences of patients with dementia who were enrolled or not enrolled in hospice, those in hospice were almost 10 times more likely to die in their "location of choice."(6) In that analysis, 76% of those in hospice died at home, and only 7% died in a hospital; in contrast, 45% of patients not enrolled in hospice died in a hospital.(6) Other evidence suggests that caregivers and clinical providers have similar preferences for patients with dementia.(7) Avoiding hospitalization for patients with advanced dementia is not only consistent with the preferences of most, it is also good care. Patients hospitalized with dementia have increased risks of functional decline (8), as well as greater risks of receiving unnecessary care, such as feeding tubes.(9)

For patients with advanced dementia who do end up dying in hospitals, caregivers might not have a clear understanding of a loved one's poor prognosis. Research suggests that if surrogates have a better understanding of their family members' prognosis, there is a lower likelihood of hospital admission. Similarly, those with documented advance directives are less likely to have burdensome treatments at the end of life, including feeding tubes, hospitalizations, and intensive care unit stays in their last months of life.(4,10)

The Physician Orders for Life-Sustaining Treatment (POLST) paradigm is one method to improve the documentation of care wishes at or near the end of life. POLST forms include preferences about code status, as well as general level of medical interventions (comfort care vs. full treatment), antibiotics, and artificial nutrition. A physician signature is commonly required to activate the form, which serves as an order to care providers, regardless of setting.(11) The form is often pink, included in statewide registries for easy access by providers (from physicians to emergency medical technicians [EMTs]), and can be placed in locations in the home, such as on the refrigerator, that are easy to locate. In a study of 572 EMTs in Oregon, 73% had treated patients with a POLST form, and 45% stated the orders changed treatment decisions.(12) Another study in Oregon suggested that 91% of those dying with POLST forms had CPR use consistent with their documented preferences.(13) Studies in other settings such as nursing and hospice facilities suggest that the care patients receive is more likely to be consistent with their preferences when those preferences are clearly documented in a POLST form.(13)

Case & Commentary—Part 2

The patient's permanent medical record was later identified, noting a recently completed POLST form, with DNR/DNI code status recorded. After communication with the family, the patient's care was transitioned to a focus on comfort and the patient died peacefully a few hours later.

Despite the ultimate transition to comfort care, many would agree that this patient's death was less peaceful than she, her family, or her providers would have liked. Her last hours of life included intubation and CPR in the field, transfer to an emergency department (ED), and placement of a central line with vasopressor infusion, none of which were consistent with her goals of care at the end of life. How did this happen?

Most likely, the family member who found her and the EMTs who responded were not aware of this patient's wishes regarding end-of-life care. Despite the encouraging studies about the impact of POLST forms in Oregon, a more recent study of 230 EMTs in New York suggested less than a third had ever seen a POLST form in the field (14), and another study of 178 EMTs noted that POLST forms were often hard to locate when needed.(15) Just as important, many patients near the end of life do not have such forms completed. In another study in Oregon, out of more than 1500 out-of-hospital cardiac arrests, only 5% had a POLST form.(16) Importantly, for those with POLST forms, the vast majority included orders for no resuscitation.(17)

The 2015 National Academy of Medicine (NAM, formerly the IOM) report *Dying in America* provides a path forward.(18) The report offers five recommendations to help prevent scenarios like the one illustrated by this case. First, the NAM recommends the development of standards to foster advance care planning, such that all patients, particularly those at high risk of mortality, are able to share their medical preferences to ensure their medical care is consistent with their goals. Such standards could include the completion and filing of POLST forms for patients at high risk of mortality. In our own institution, we are currently auditing the proportion of patients with malignancies who have care preferences documented in the Advance Care Planning tab of our electronic health record (EHR), and providing that feedback to our oncology providers to foster improvement.

Second, the NAM recommends professional development and education focused on advance care planning. Professional societies may provide such education, which may be required for state licensure or by the ACGME for residency training programs. At our institution, we are utilizing Ariadne Labs' Serious Illness Care Program to train our palliative care physicians to train our oncology providers.(19) Third, the NAM recommends public education to encourage patients and their families to have advance care planning discussions and to engage their physicians in these conversations. Fourth, the NAM

recommends that government and commercial payers cover comprehensive care programs for patients with serious illness. Medicare's 2016 decision to reimburse providers for their time when having advance care planning discussions with their patients was a positive step.(20) Covering palliative care and hospice services are other important approaches.

Palliative care services are initiated when patients are diagnosed with serious illness. As illness progresses, the ratio of palliative care to life-prolonging care may gradually increase (Figure). When provided in the context of serious illness, palliative care services include pain management, symptom management, therapies with palliative rather than curative intent (e.g., radiation, milrinone), assistance with complicated medical decision-making, coordination of care with other providers, and emotional and social support. While palliative care may be beneficial for patients at various stages of serious illness, to be eligible for Medicare's hospice care benefit, patients must have an expected survival of 6 months or less.(21) Given the unpredictability of death for patients with advanced dementia, these hospice criteria are often difficult to satisfy, resulting in low rates of hospice enrollment: in 2007, only one third of Americans dying with dementia received hospice care.(3) Regardless of hospice eligibility, palliative care should be offered to patients such as the woman in this case. Evidence suggests that patients with dementia in palliative or hospice care are much more likely to have care consistent with their goals, have greater family satisfaction with their care, and die outside of the hospital setting.(3,22)

Lastly, the NAM recommends the development of health policy strategies to foster advance care planning. This could include support and further development of state registries for cataloguing POLST forms, public reporting of advance care metrics, and pay for performance based on these metrics. Currently, POLST registries are being developed or are available in many states.(18) Improving the documentation of advance care planning information in EHRs (23) and sharing this information through state registries or health information exchanges may also help.(24) If the EMTs in the case above had unfettered access to the patient's POLST form in a state registry prior to arrival at the patient's home, her resuscitation, intubation, and transfer to the hospital in the last hours of her life may have been avoided.

Case & Commentary—Part 3

Two months later, the primary care clinic staff called the patient's home with an appointment reminder, and the family replied that the patient had died. This information was relayed to the primary care provider (PCP) who then called the family, assuming that the patient must have passed away recently. The family informed the PCP that the patient had died 2 months earlier. The family had thought their doctor had been informed of their mother's death and assumed that the PCP was "just too busy" and unable to make it to the hospital to support them. In reality, the PCP had not been contacted, and the electronic health record system had not listed the patient as deceased.

Communication between hospital-based providers and PCPs is challenging, even in the era of the EHR. One study found that only 3 in 4 PCPs were aware that their patient had been hospitalized.(25) A more recent systematic review found similar rates of awareness among PCPs, but the frequency of direct communication between hospital providers and PCPs was much lower (about 1 in 4).(26) While one could argue that communication about a patient's death is among the most important in this context, most discussions of hospital–PCP transitions omit this crucial topic, perhaps owing to an underlying assumption that death is "the end of the story," and thus there is no need for clear communication with the outpatient provider. This case illustrates the fallacy of this thinking.

One might assume that the EHR will notify PCPs of hospitalizations and of significant events, such as death, during a hospital stay. Unfortunately, system limitations often prevent this from happening. To address such challenges, many health systems are designing and implementing standardized discharge

summary formats that ensure complete and uniform inclusion of essential information.(27) At our institution, the "summary of care" document required by Meaningful Use is automatically transmitted electronically to identified primary care physicians within our health system 24 hours after hospital discharge.(28) This document includes the hospital course and, as such, allows inpatient clinicians to communicate the circumstances of a patient death to outpatient providers.

In this case, there was yet another important glitch: The patient was registered with a temporary medical record number (MRN) when she arrived at the hospital. Although the care team was subsequently able to access her existing MRN to identify the preexisting POLST form, the temporary MRN associated with her admission was never reconciled with the permanent MRN, thus preventing automated communication with the PCP and others involved in her care. The duplicate records problem is surprisingly daunting.(29) Because clinical emergencies can necessitate the creation of duplicate records (e.g., a patient presenting with possible stroke who needs immediate attention on arrival to the ED), institutions should build systems to ensure the merging of medical records in a timely manner.(27)

Conclusion

This case illustrates opportunities to build and sustain systems to honor individual preferences and goals of care at the end of life, both by aligning policy with practice (in the case of POLST forms) and by aligning systems with practice (in the case of EHRs).(20) As stated by the NAM: "For patients and their loved ones, no care decisions are more profound than those made near the end of life… A person-centered, family-oriented approach that honors individual preferences and promotes quality of life through the end of life should be a national priority."(30) This case vividly illustrates why.

Take-Home Points

- Most with dementia prefer to die somewhere other than a hospital.
- Those with advanced dementia who have advance directives are less likely to have inappropriate care and more likely to have care consistent with their preferences at the end of life.
- The 2015 National Academy of Medicine report, *Dying in America,* offers a roadmap to improving the quality of life for those at the end of life, and their families.
- Communication between hospital-based providers and primary care providers is essential, especially when a hospitalization ends in the death of the patient.

Specimen Almost Lost

The Case

A 29-year-old woman presented to the hospital with a rash that had spread across her legs and abdomen. She was admitted to the medicine service for further evaluation and treatment of the painful, itchy rash.

To determine the etiology of the rash, she underwent a punch biopsy of her skin. The resident entered orders into the patient's electronic health record (EHR) indicating that the biopsy specimen should be sent to pathology for further evaluation. The resident also discussed the orders with the patient's nurse. The bedside nurse took the biopsy specimen to the pathology laboratory but neglected to print a copy of the resident's orders to accompany the specimen. The pathology laboratory did not have access to the same EHR as the inpatient medicine service, and the pathologist could not view the resident's orders. Without a printed copy of the orders, the biopsy specimen could not be directed to the appropriate area in the pathology laboratory for processing and analysis.

The following day, the resident attempted to look up the results of the biopsy but found none. The resident called pathology and, luckily, the laboratory had placed the specimen on hold instead of

discarding it. The resident was able to print a paper order form and bring it to the laboratory so that the specimen could be processed and read by a pathologist. The patient was ultimately diagnosed with Henoch-Schönlein purpura and managed appropriately.

Delayed Diagnosis of Endocrinologic Emergencies
The Cases

Case #1:

A 47-year-old man with a history of hyperthyroidism and hypertension presented to the emergency department (ED) with subjective symptoms of "not feeling himself." He told the ED clinician that he had been unable to take his medications for several months due to financial difficulties. Initial evaluation revealed low-grade fever, a heart rate of 170 beats per minute, and trace lower extremity edema bilaterally. There were possible infiltrates on his chest radiograph. An electrocardiogram revealed new-onset atrial fibrillation.

The patient was started on a diltiazem drip and admitted to the telemetry unit for management of his heart rhythm and possible pneumonia. He continued to have fevers and tachycardia during the first 2 hospital days despite antibiotics and fluids. On top of that, he developed lethargy and delirium.

A new hospitalist assumed care of the patient on the third hospital day. She reviewed the laboratory results and found that the patient had an undetectable thyroid-stimulating hormone (TSH) level and a high level of circulating thyroid hormone—indicating a diagnosis of thyroid storm (a severely overactive thyroid gland). These laboratory tests had been ordered in the ED. Although results were available the following day, they had not been noted or acted upon. The hospitalist realized that this life-threatening syndrome almost certainly explained the patient's clinical condition. She immediately discontinued intravenous fluids, started treatment with propranolol to control the heart rate and methimazole to suppress thyroid hormone production, and consulted an endocrinologist.

However, the patient remained lethargic and developed hypoxemia over the course of the day. An echocardiogram showed a diminished ejection fraction and dilated left ventricle, consistent with a tachycardia-induced cardiomyopathy (weakness of the heart muscle due to longstanding rapid heart rate). The patient was transferred to the intensive care unit (ICU) due to worsening respiratory status. Shortly after arrival in the ICU, he went into cardiac arrest and could not be resuscitated.

Case #2:

A 53-year-old woman with a history of chronic obstructive pulmonary disease (COPD) on home oxygen, congestive heart failure, atrial fibrillation, status post coronary artery bypass grafting and mechanical aortic valve replacement was admitted with shortness of breath and lower leg swelling for several days attributed to an acute exacerbation of congestive heart failure. On the second hospital day, she developed atrial fibrillation with rapid ventricular response, requiring transfer to the ICU for management. She was started on an amiodarone drip and reverted to normal sinus rhythm within 12 hours. She stabilized and was discharged home on oral amiodarone therapy.

Over the next 3 months, the patient had multiple hospital admissions for presumed COPD exacerbations requiring treatment with bronchodilators, antibiotics, and oral steroids. She also developed abnormal liver function tests and was diagnosed with fatty liver disease. Eventually, she was readmitted to the hospital with hypothermia, hypotension, delirium, and continued hypoxemia. She had bilateral infiltrates on her

chest radiograph and was assessed as having septic shock due to pneumonia. She was admitted to the ICU and required noninvasive positive pressure ventilation. Her liver function worsened, and she developed pseudo-obstruction of her colon (Ogilvie syndrome) requiring decompression.

On a Saturday afternoon, well into her prolonged hospital stay, her condition worsened. The covering physician reviewed her old labs and found a very high TSH level and undetectable levels of thyroid hormone. This test had been ordered during a hospitalization one month previously, but the result was not documented in any progress notes, and there was no evidence that anyone had acted on the result. The physician realized that the result likely indicated myxedema coma—systemic illness due to lack of thyroid hormone. Her worsening respiratory status, liver abnormalities, and colonic pseudo-obstruction were all consistent with severe hypothyroidism. This thyroid dysfunction is a known complication of amiodarone therapy, but despite the patient's multiple hospitalizations and overall worsening clinical status, none of her prior physicians had recognized this diagnosis.

The patient was immediately started on levothyroxine and endocrinology was consulted. However, within 24 hours, she went into multi-organ failure and respiratory failure with hypoxia and hypercapnia. She required intubation and mechanical ventilation as well as institution of vasopressors due to shock. Although her condition improved slightly, she could not be weaned from the ventilator and developed a ventilator-associated pneumonia. She had previously stated her wishes to avoid resuscitative measures or a prolonged ICU course. After extensive discussions with her family, the goals of care were changed to comfort measures only. She died peacefully in the ICU after a 3-week hospitalization.

Palliative Care: Comfort vs. Harm

The Case

An 83-year-old man with chronic kidney disease and end-stage congestive heart failure (CHF) with a severely reduced ejection fraction was admitted for an exacerbation of his CHF. It was his third admission in the previous 4 weeks. During this admission, he improved slightly with treatment, but his overall prognosis remained poor. In discussions with the patient and his son, the patient expressed that he would like to focus on comfort and pursue hospice care. His life expectancy was believed to be weeks to months, based on his comorbidities and frailty.

While he was still hospitalized, comfort measures were initiated. His diuretics, statins, beta-blockers, and other treatments for his heart failure were stopped. He seemed more at peace after making the decision and was able to spend time with his family. Wanting to ensure the patient's comfort, the inpatient team wrote for a standing dose of intravenous hydromorphone every 4 hours.

On the night shift, the bedside nurse went to see the patient at 3:00 AM to administer the next scheduled dose of hydromorphone. The patient appeared to be sleeping but woke up when the nurse came in the room. She asked him, "Are you having any trouble breathing?" He responded, "A little bit," but he remained drowsy. The nurse administered the scheduled dose of intravenous hydromorphone.

The following morning, the palliative care attending saw the patient at 7:00 AM and found him obtunded, with shallow respirations and a low respiratory rate. She believed he was close to death and contacted his family, who came to see him. The patient continued to be obtunded and unarousable, but his respiratory rate and effort improved. He survived for another 5 days in the hospital, requiring a few doses of intravenous hydromorphone for comfort. He died peacefully with his family at the bedside.

In reviewing the case, the palliative care team felt that the overnight dose of hydromorphone may not have been indicated and may have been excessively large. Although the patient did not suffer and died

peacefully, they believed that his life may have been shortened. At the same time, the review team remained sensitive to the bedside nurse's desire to relieve suffering in a patient who wanted to focus on comfort. They wondered how best to educate providers about the balance between providing adequate pain control at or near the end of life and minimizing harm.

Hyperbilirubinemia Refractory to Phototherapy

The Case

A 1-day-old full-term infant was noted to have elevated total serum bilirubin (TSB) of 14.7 mg/dL (251 μmol/L) due to hemolytic disease of the newborn (ABO incompatibility). The patient was placed on a mattress with embedded phototherapy lights in the mother's postpartum room. Despite the treatment, the TSB level continued to climb, reaching 18 mg/dL (308 μmol/L).

The patient was transferred to the neonatal intensive care unit and staff began preparations for an exchange transfusion. In the meantime, a neonatologist asked that the irradiance level of the phototherapy lights be tested, and it was found to be well below the recommended level. The lights were replaced. The infant's TSB level began to drop and the exchange transfusion was aborted.

Further investigation revealed that there had been no regular testing of phototherapy light irradiance and that some of the unit's equipment had aging lights with insufficient irradiance levels. A protocol was put in place to ensure: (i) testing of irradiance levels prior to each use of the phototherapy mattresses or other device; (ii) routine monthly irradiance level testing of all phototherapy devices; and that a label is placed on each device with the date and time of the last test.

High-Risk Medications, High-Risk Transfers

The Case

A 47-year-old woman with history of primary pulmonary arterial hypertension (PAH) was admitted to the hospital for sepsis secondary to an infected intravenous (IV) line through which she was receiving IV treprostinil, a potent pulmonary vasodilator used for. Given its potential toxicity, it is categorized as a "high alert" medication. The patient's home pump was switched to another line that had been inserted in the intensive care unit (ICU). The bedside nurse received education about treprostinil, with special instructions not to flush the line as this would lead to a very large and dangerous dose. The ICU nurses were very familiar with using treprostinil in patients with pulmonary hypertension.

After the patient's infection improved and blood cultures cleared, the decision was made to have the interventional radiologistsplace a new permanent catheter. She was transferred to interventional radiology (IR) with a full treprostinil supply, and the sign-off between the ICU charge nurse and the IR department included instructions to not flush the treprostinil line.

During preparation in the IR suite for the new line placement, one of the infusion pumps started alarming. However, the charge nurse was outside the suite at that time. A radiology technician in the room attempted to identify the alarm, and in the process accidentally flushed the treprostinil line. Consequently, the patient received an excessive amount of the medication, which resulted in a near code situation. The patient experienced flash pulmonary edema and respiratory distress, which required emergent intubation.

The charge nurse entered the room while the patient was being resuscitated, recognized the error, and stopped the medication. Once the patient was stabilized, a pharmacist was consulted, and the patient was

restarted on a lower dose of treprostinil to allow for elimination of the excess medication. She was extubated and eventually discharged home after a prolonged ICU stay.

After this incident, inservice training was given to all individuals involved in the use of this high-alert medication, including medical, pharmacy, and nursing staff. In addition, a new protocol was established that requires the charge nurse to escort patients during all transfers from the ICU.

Translating From Normal to Abnormal

The Case

A 54-year-old Spanish-speaking woman with depression and anxiety disorder presented to an urgent care clinic complaining of headache and worsening dizziness. She had seen her primary care physician a few weeks earlier for the same symptoms and, after a normal physical examination, she was prescribed meclizine for symptomatic treatment of the dizziness. She now presented with a worsening headache and dizziness. During the interview with the urgent care provider, she was anxious about the nature and degree of her symptoms. The history was obtained using a telephone Spanish medical interpreter from a medical interpreter/translator company contracted by the hospital.

The patient had a normal physical examination, including a normal neurologic exam, during the urgent care visit. However, given the worsening symptoms and persistent headache, the provider ordered an urgent magnetic resonance image (MRI) of the brain. The MRI was completed later that day and officially interpreted as normal, with no concerning findings and no explanation for her symptoms. Given the patient's anxiety, the urgent care provider wanted to inform her of the results that day. He called the phone number in the record but there was no answer and no opportunity to leave a voicemail. He decided to send a letter to ensure receipt of the results.

However, he was worried that the patient would not be able to read the letter or have anyone to translate it and decided to use Google Translate to do so himself. He typed the following into Google's translator: "The results of your recent MRI were normal, making an infection, mass, or stroke unlikely causes of your symptoms. Please make sure to follow up with your primary care provider and call the clinic with any questions." Unfortunately, the Google-translated output was such that, when the patient received the letter she could not understand the statement. She interpreted the wording to mean that the MRI *showed* a mass, infection, or stroke. She became very anxious and immediately returned to urgent care, bringing the letter with her.

Another urgent care provider (also English-speaking) saw her and had difficulty obtaining a clear history from the anxious and tearful patient. Even though the provider read the normal findings of the MRI included in the patient's electronic chart and described this to the patient using a phone interpreter, she remained distressed and upset, complaining of a severe headache and worsening dizziness. He referred the patient to the emergency department (ED) for further evaluation. In the ED, neurology was consulted and concluded that the patient's symptoms were likely benign positional vertigo (a common condition that leads to intermittent dizziness) with amplification of her symptoms by her anxiety. She was treated with an Epley maneuver, taught to perform this maneuver at home, and discharged.

The second urgent care provider was troubled by the case. He took the letter to an in-person medical interpreter who read the letter and noted that the language and syntax used by Google Translate was confusing and could indeed have been understood to relay serious findings. The miscommunication led to patient distress, frustration, and unnecessary visits to the urgent care clinic and ED. Both urgent care providers were left wondering whether software programs that translate from one language to another are accurate enough to be used in health care.

Failed Interpretation of Screening Tool: Delayed Treatment

The Case

An 88-year-old man presented to the emergency department (ED) with a 2-day history of upper back pain. His medical history was significant for hypertension and longstanding mitral valve prolapse with mitral regurgitation. His initial vital signs showed a blood pressure of 130/75 mm hg, heart rate of 65 beats per minute, respiratory rate of 16 breaths per minute, temperature of 36.3°C, and an oxygen saturation of 90% on room air. Physical examination revealed a frail elderly man in no distress. He had normal heart sounds and a soft systolic murmur heard best at the apex; his lungs showed faint bilateral crackles. He had no spinal tenderness and a normal neurological examination, including mental status. The rest of his physical examination was unremarkable. Initial laboratory investigation demonstrated a normal white blood cell count, serum lactate, electrolytes, liver enzymes, and kidney function. A chest radiograph showed hilar fullness and mild bilateral infiltrates, consistent with pulmonary edema or early pneumonia.

The emergency physician assessed the patient as having either new onset congestive heart failure or an atypical pneumonia. She considered starting antibiotics but held off as the patient looked well and did not "screen positive" for sepsis. (The hospital had recently implemented a formal sepsis screening system for all ED patients.) The patient was admitted for workup of his hypoxemia. The admitting internist also deferred starting antibiotics, in part guided by the negative sepsis screening. He ordered an echocardiogram for the next morning and prescribed diuretic medications. At the time of ward admission (4 hours after presentation), the patient remained hemodynamically stable and afebrile.

Early the next morning, the patient acutely decompensated with worsened hypoxemia, hypotension, and delirium. He remained afebrile, but repeat labs now showed a markedly elevated serum lactate level and white blood cell count. A repeat chest radiograph demonstrated worsened bilateral infiltrates. He was started on broad-spectrum antibiotics and transferred to the intensive care unit. However, he rapidly experienced further respiratory decompensation requiring intubation and mechanical ventilation, as well as hemodynamic compromise requiring vasopressor support. Later that day, his blood and sputum cultures grew Escherichia coli. Over the next 4 days, he developed progressive organ dysfunction and died.

The Forgotten Radiographic Read

The Case

A 60-year-old woman with peripheral artery disease and chronic mesenteric ischemia was admitted for management of inferior mesenteric artery (IMA) stenosis. She underwent IMA and right renal artery stenting by vascular surgery and was transferred to an internal medicine teaching service for ongoing management of hyponatremia and hypertension during the second week of hospitalization.

On hospital day 18, the patient had sudden nausea and abdominal distension. The overnight cross-cover intern evaluated the patient and ordered an abdominal radiograph. Although the patient was uncomfortable, her vital signs were stable, and the intern did not observe an acute abdomen on examination. The intern read the radiograph as an ileus and attributed patient's symptoms to this; tube feeds were held. While the intern intended to contact radiology to confirm her interpretation, another patient acutely deteriorated (requiring a Code Blue activation), and she forgot to follow up on the radiograph. Early the next morning, the vascular surgery patient developed delirium, hypotension, and hypoxemia, and she was emergently transferred to the intensive care unit.

The radiograph was formally read by a radiology attending at approximately 8:00 AM. She immediately recognized portal venous gas—a sign of acute mesenteric ischemia. She contacted the primary team, who ordered a CT angiogram, which revealed internal mesenteric artery dissection, diffuse bowel ischemia, and infarction of the liver and spleen. After discussion between surgery, the primary team, and the family, the decision was made not to pursue further surgery as the expected mortality was extremely high. The patient was transitioned to comfort care and died that evening.

The case was formally reviewed by the medical service and by radiology. The reviews concluded that the delay in diagnosis of internal mesenteric artery dissection and bowel infarction represented a preventable adverse event. The major contributing factors were considered to be the workload of the overnight cross-cover intern and the lack of a formal system for obtaining radiology interpretations of radiographs performed overnight. At this hospital, the overnight staffing on the medicine service consisted of two hospitalists, two senior residents, and one intern, but the intern was "first call" for all acute issues overnight. The radiology department had two residents in house overnight, but provided interpretation only for emergency department studies, CT scans, and MRIs performed overnight. Regular radiographs were not formally read until the morning, unless specifically requested.

Transfusion Thresholds in Gastrointestinal Bleeding
Case & Commentary—Part 1

A 70-year-old man with severe, refractory Crohn disease was admitted for management of abdominal pain and high stool output from his ileostomy. He was admitted to the medicine service and initially treated with steroids. On the third day of hospitalization, the patient developed bloody ostomy output. Over the course of the night, his blood pressure began to drop. He was given 2 liters of normal saline with some improvement in his blood pressure. He continued to pass blood and clots from his ostomy, and his hemoglobin fell.

Gastrointestinal hemorrhage is a common cause of morbidity and mortality in the United States, accounting for more than 500,000 hospital admissions and 10,000 inpatient deaths annually. In 2012, there were close to 100,000 hospitalizations for inflammatory bowel disease (IBD), more than 60,000 of which were for Crohn disease. In-hospital deaths were rare, occurring in only 0.3% of admissions.(1) However, brisk gastrointestinal bleeding (GIB) in patients with IBD is associated with a mortality rate of up to 3%.(2,3)

Gastrointestinal bleeding can be divided into upper GIB, middle GIB (bleeding between the ligament of Treitz and the colon), and lower GIB or bleeding from the colon. Common causes of upper GIB include erosive disease, ulcers, varices, and angioectasias.(4) Common causes of lower GIB include diverticulosis, ischemic colitis, hemorrhoids, polyps or neoplasms, and angioectasias.(5)

Mild, chronic bleeding is more common than severe, acute bleeding in patients with IBD. The incidence of severe bleeding in patients with Crohn disease is thought to range from 0.6% to 4%.(6) However, data regarding severe bleeding in IBD is limited to case reports and case series. Bleeding typically arises from the ileum or colon. It can be difficult to identify a single source of bleeding, and blood loss is often attributed to diffuse disease.(7) IBD patients with severe bleeding often require surgery and are at high risk for rebleeding.(2)

The history and physical examination can help to elucidate the site of bleeding as well as to risk stratify the patient. The history should include color, volume, and frequency of bleeding, a review of comorbid conditions, and an inventory of medications, particularly antiplatelet and anticoagulant medications.

Physical examination should begin with a review of vital signs, as the presence of positive orthostatics, tachycardia, and hypotension generally reflect a more brisk bleed.

Laboratory evaluation should include a complete blood count, comprehensive metabolic panel, coagulation studies, and blood typing and screening.(8) While monitoring hemoglobin is essential in GIB, it should be noted that in a brisk bleed, hemodynamic instability can be a more sensitive marker of blood loss than hemoglobin level. This is because there can be a delay in hemoglobin drop due to a loss of whole blood with delayed intravascular expansion.

Clinical factors that point to the upper track being the source of a GIB include melena, nasogastric lavage with blood or coffee grounds, and a blood urea nitrogen (BUN) to creatinine ratio of more than 30. The presence of blood clots in the stool decreases the likelihood of upper GIB.(9) However, in some cases, particularly those with brisk hematochezia, it can be difficult to determine the source; 15% of patients felt initially to have lower GIB are ultimately diagnosed with an upper GI source.(10) Therefore, a nasogastric lavage or urgent upper endoscopy is recommended in these patients to exclude an upper GI source.(11)

In patients with GIB, it is important to identify high-risk patients who benefit from closer monitoring, more aggressive resuscitation, and early interventions. Risk scores used in upper GIB include the AIMS65, Glasgow-Blatchford, and Rockall scores.(12-14) Factors associated with higher mortality include advanced age, comorbidities, presentation with melena, onset of bleeding while hospitalized, tachycardia, hypotension, altered mental status, and laboratory abnormalities such as elevated BUN, low albumin, and anemia. There also have been a number of risk factor models for poor outcomes in patients with presumed lower GIB. The largest study identified multiple comorbidities, syncope, the absence of abdominal tenderness and diarrhea, nonsteroidal anti-inflammatory drug or antiplatelet use, hypotension, and hypoalbuminemia as risk factors for severe lower GIB.(15) Ongoing hematochezia has also been identified as a risk factor for severity.(16,17)

In this case, the presence of multiple high-risk factors—including onset of bleeding while hospitalized, older age, comorbid disease, hypotension, ongoing bleeding, and failure to adequately respond to IV fluids—should have alerted the clinician to the potentially seriousness of the bleeding. The assumption that most bleeding in IBD is mild may have led the clinician to downplay these signs of serious bleeding. In addition, the presence of altered anatomy, in this case an ileostomy, may make it difficult to predict the location of bleeding because of more rapid transit of blood.

At this point, it would have been appropriate for the clinician to consider transferring the patient to an intensive care setting and to contact the gastroenterologist on call. The input of interventional radiology and surgery also may have been helpful in the event that endoscopy failed to identify and treat the source of bleeding. Indeed, small bowel sources of bleeding are generally more difficult to localize and treat than upper or lower GI sources. A nasogastric lavage might have been used to help determine if this was a brisk upper GIB versus a small bowel bleed, although the presence of clots suggests a more distal source.

Case & Commentary—Part 2

The overnight hospitalist evaluated the patient but decided not to administer a blood transfusion because the patient's hemoglobin was still above the restrictive hemoglobin transfusion threshold of 7.0 g/dL (which has been supported by the literature and promoted as a quality standard). However, the hospitalist failed to recognize the briskness of the patient's blood loss. Several hours later, the patient passed even more blood through his ostomy. Repeat vital signs revealed profound hypotension and

tachycardia. Eventually, he lost his pulse and, despite aggressive attempts at resuscitation, the patient died.

The first step in the management of a GIB is administration of IV fluids to maintain or achieve hemodynamic stability.(18) In the setting of upper GIB, initiation of proton pump inhibitors (PPIs) is generally recommended. Although early initiation of PPI therapy has not been shown to reduce mortality, rebleeding, or surgery, its use has been associated with a decrease in high-risk endoscopic findings and need for endoscopic therapy at index endoscopy.(19) While specific medications are typically not indicated at the time of onset of mid-bowel or lower GIB, initiation of PPI therapy may be prudent in patients with brisk hematochezia until the source of bleeding has been determined.

While historically hemoglobin transfusion thresholds were in the 9–10 g/dL range, studies conducted over the past decade have shown a decreased risk of mortality, rebleeding, and adverse events with a transfusion threshold of 7 g/dL in most patients with upper GIB.(20) However, it is important to note that the results of these studies do not apply to all patients. The largest single center trial excluded patients with massive exsanguinating bleeding, lower GIB, acute coronary syndrome, symptomatic peripheral vasculopathy, stroke, transient ischemic attack, recent transfusion, and recent trauma or surgery.(20) In addition, all patients underwent upper endoscopy within 6 hours of presentation, with treatment of bleeding sources as indicated. A multicenter, open label, cluster-randomized feasibility trial included patients with preexisting comorbidities. In a subanalysis of patients with ischemic heart disease, 28-day mortality was higher in those transfused using a restrictive versus liberal strategy (12% vs. 3%).(21) Therefore, although restrictive transfusion has been applied broadly to GIB, available data supports the use of restrictive transfusion only in patients without massive hemorrhage or certain comorbidities.

The case above illustrates the need to modify standard protocols according to the needs of the individual patient. While restricted transfusion is supported by the literature and has been incorporated into guidelines, it is important to recognize when clinical circumstances necessitate deviation from a standard approach. In this case, the patient showed signs of massive bleeding, therefore he was not an appropriate candidate for the restrictive strategy. In such cases, the hemoglobin tends to fall precipitously and waiting can result in delayed and insufficient resuscitation. In addition, most of the patients included in studies of restrictive transfusion thresholds had upper GIB due to ulcers, varices, or erosive disease—sources that are amenable to endoscopic treatment and/or responsive to PPIs. Furthermore, these patients underwent urgent upper endoscopy with endoscopic treatment of stigmata of hemorrhage. This patient, on the other hand, was likely to have small bowel bleeding from a deep, inflammatory bowel disease—related ulcer. This location and source are challenging to treat endoscopically, meaning that angiography and/or surgery may be necessary to address ongoing bleeding.

Implementation of protocols can help physicians meet quality standards. However, this case demonstrates that strict adherence to such protocols may not be appropriate for all patients. Educating physicians about the limitations of these templates is an important part of their utilization. Electronic health records provide templates for care and play a significant role in patient safety. Flags could be created to alert physicians to clinical situations to which these templates may not apply, including cases in which clinical judgment may prompt us to deviate from guidelines and protocols. Well-constructed and nuanced algorithms can be helpful in guiding physician decision making. For example, a transfusion algorithm might alert physicians of circumstances in which a higher transfusion threshold is recommended. Such algorithms could also indicate the need for intensive monitoring and specialist consultation.

Take-Home Points

- Although bleeding in inflammatory bowel disease is typically mild, severe bleeding can occur and is associated with a higher mortality, rebleeding, and need for surgery.
- Risk stratification and the use of risk scores may help to identify patients at risk for severe bleeding and the need for higher levels of care and early involvement of consultants.
- Restrictive transfusion protocols have been shown to decrease mortality, rebleeding, and adverse events in certain patients with upper gastrointestinal bleeding.
- However, strict adherence to restrictive transfusion protocols may not be appropriate for all patients, particularly those with brisk bleeding and major comorbidities.
- Early involvement of consulting services can be particularly helpful in patients with atypical presentations.

Point-of-care Mixup: 1 Shot Turns Into 3

The Case

A 2-month-old boy was brought in for a routine 2-month well-child visit. The exam was completed and the appropriate vaccinations were ordered, including Pentacel (which contains vaccines against DTaP [diphtheria, tetanus, pertussis], Hib [Haemophilis influenza], IPV [inactivated polio vaccine]), Hep B (hepatitis B), PCV (pneumococcal conjugate vaccine), and RV (rotavirus). The nurse gave the vaccinations to the infant, and then, when documenting them in the electronic health record, noticed she had given the DTaP vaccination, not the Pentacel combination. The patient and his mother were still in the exam room; the mother was breastfeeding the infant.

The physician spoke with the mother about the error. The mother was distressed to learn that her son would need two additional injections but agreed for them to be given because she knew her child needed the additional vaccinations (Hib and IPV). The patient cried and was difficult to settle after the additional injections. In the postincident review, the nurse described being rushed and because of that, she did not properly verify the vaccinations against the orders before administering them.

Add-on Case and the Missing Checklist

The Case

A 65-year-old woman was admitted for evaluation of abdominal pain and weight loss. Based on diagnostic data and imaging, she was found to have a large gastric mass concerning for malignancy. The patient had recently been diagnosed with a deep venous thrombosis, which was being treated with enoxaparin (an anticoagulant). A gastroenterologist was consulted for possible biopsy of the gastric mass. The gastroenterologist planned to perform an esophagogastroduodenoscopy (EGD) with biopsy the following day. This recommendation was not conveyed directly to the hospitalist caring for the patient, although the consultant did document it in his note.

The next day, the patient was scheduled for an EGD as an add-on case. Because the hospitalist was unaware of the plan, the patient was not made NPO (nothing by mouth), nor was the enoxaparin stopped. When the endoscopy suite called for the patient, the bedside nurse said that the patient had just had breakfast, but she forgot to mention that morning dose of the anticoagulant had already been given. Three hours later, the patient was taken to the EGD suite. While performing the preanesthesia checklist, the certified nurse anesthetist documented that enoxaparin had been given that morning, but did not notify the gastroenterologist. EGD was performed and a biopsy was taken from the mass. The patient was observed briefly in the recovery room and sent back to her room on the ward.

Two hours later, the patient developed delirium and looked pale. She was found to be hypotensive and stat labs were sent. Resuscitation with intravenous fluids was started, but within 15 minutes, the patient

went into cardiac arrest. The laboratory results showed a sharp drop in her blood count, consistent with postprocedural bleeding. The patient was resuscitated, transferred to the intensive care unit, and received massive transfusions. An angiogram revealed that the bleeding was from the gastric mass. Embolization was attempted but was unsuccessful, and the patient subsequently arrested again. After extensive discussions with the family, the decision was made to focus on comfort measures only. The patient died shortly thereafter.

Despite Clues, Failed to Rescue

The Case

A 72-year-old woman with a history of systolic heart failure, hypertension, and chronic kidney disease who was healthy and active at baseline was admitted for an elective dilatation and curettage for postmenopausal bleeding. Because she had relatively low blood pressures during the operation and slightly more bleeding than expected, she was admitted to the inpatient gynecology service for monitoring. A postoperative hemoglobin check showed a drop from 9.5 g/dL before the procedure to 6.8 g/dL. She was given a transfusion of two units of packed red blood cells but not evaluated by a provider.

The following morning, she complained of severe abdominal pain with nausea, which the gynecology team attributed to postoperative pain. When she had persistent severe pain later that day, her heart rate was 145 beats per minute (bpm), and she had new-onset atrial fibrillation. She was moved to a telemetry unit and cardiology was consulted. The consulting cardiology service ordered medications to control her heart rate and initiated rivaroxaban, a systemic anticoagulant, for her atrial fibrillation.

The next morning, her hemoglobin level was 7.5 g/dL and her creatinine had increased from a baseline of 2.1 mg/dL to 3.1 mg/dL. Throughout the day, her severe abdominal pain and nausea continued. At 7:00 PM, she had an episode of hematemesis (bloody vomit). Her vital signs were normal, and she was given intravenous fluids. No laboratory values were checked, and there were no urgent interventions. Despite the hematemesis, the rivaroxaban was continued.

Later that night at 2:00 AM, she had another episode of hematemesis. The gynecology resident evaluated the patient and found her to be confused and complaining of abdominal pain. Stat labs were ordered but not reviewed until the following morning. She was given intravenous fluids overnight but received no specific treatments. Laboratory results were reviewed at 6:00 AM and showed her hemoglobin had dropped to 5.8 g/dL, and her creatinine had risen to 4.5 mg/dL. Bedside evaluation revealed she was hypotensive (blood pressure 75/45 mm Hg), tachycardic (heart rate 130 bpm), and confused.

The intensive care unit (ICU) team consulted at the bedside and made plans to transfer her to the ICU. While being transferred, she had a pulseless electrical activity arrest in the setting of massive hematemesis, and she died despite maximal efforts. In the end, providers believed she likely developed mesenteric ischemia in the setting of atrial fibrillation and died from bowel ischemia and gastrointestinal bleeding.

The institution performed a multidisciplinary root cause analysis and found many specific errors that contributed to her death. The group acknowledged this case was a clear example of failure to rescue a healthy woman who underwent a simple procedure. They discussed steps to prevent such an event in the future.

The Hidden Harms of Hand Sanitizer

The Case

A 57-year-old woman with a history of alcohol abuse and severe depression was admitted to the hospital for community-acquired pneumonia. After 2 days on the medical ward, she was found unconscious. Oxygen was administered, and the patient was intubated and placed on a ventilator. As part of the workup for her altered mental status, a toxicology panel was drawn, and her blood alcohol level returned elevated at 530 mg/dL. A search of the ward revealed several empty containers of alcoholic foam hand sanitizer. The patient required mechanical ventilatory support for over 12 hours, after which she was successfully extubated. Upon interview, the patient confessed to ingesting the alcoholic foam hand sanitizer on the ward to satisfy her strong alcohol craving.

Delayed Recognition of a Positive Blood Culture

The Case

A 58-year-old woman with metastatic breast cancer recently treated with immunosuppressive therapy presented to the hospital for evaluation of diarrhea. As part of the infectious workup performed in the emergency department (ED), blood cultures and stool studies were sent to the laboratory. The following morning, her stool test returned positive for *Clostridium difficile* (*C. difficile*), a potent bacteria that can cause serious infections, especially in immunocompromised hosts. At that time, one out of the two blood cultures drawn in the ED was positive for gram-positive rods, but the speciation (type of bacteria) and sensitivity profile (which suggests which antibiotics are best to use) were not yet available. The medical team ordered appropriate antibiotic treatment for *C. difficile* but did not initiate treatment for the preliminarily positive blood culture.

After improvement in her symptoms, the patient was discharged 2 days after admission with instructions to complete the course of antibiotics for *C. difficile* and to follow up with her outpatient providers. On the day of discharge, the blood culture that was positive for gram-positive rods had now speciated and was growing *Listeria monocytogenes*, a bacterium that can cause life-threatening infection if not treated appropriately. Moreover, a diagnosis of *Listeria monocytogenes* must be reported to the local department of public health because of its risk of contagion. Unaware that the patient required treatment for listeriosis, the team discharged her.

A later review revealed that the hospital microbiology laboratory was aware of the microbiology result and, per its protocol, had notified the patient's bedside nurse of the positive blood culture. However, this result was not communicated to the primary medical team prior to the patient's discharge. Some team members who saw the positive result in the medical record erroneously thought that *Listeria monocytogenes* might be a contaminant (a bacteria that can be viewed as a false positive not requiring treatment). Although the positive blood culture was sent to the medical attending's inbox in the electronic health record, he did not see the result until well after the patient was discharged. When the mistake was recognized, the team called the patient and she was immediately readmitted to the medical service. The positive blood culture was reported to the city's department of public health. She received further workup including additional blood cultures and a lumbar puncture, which remained negative. Intravenous antibiotics were initiated for treatment of listeriosis. She was eventually discharged and did well.

Pseudo-obstruction But a Real Perforation
Case & Commentary—Part 1

A 77-year-old healthy man with a history of long-standing gastroesophageal reflux disease, refractory to medical management, was admitted to the hospital for surgical treatment (a laparoscopic Nissen fundoplication). The surgery was uncomplicated, and he was slowly recovering in the hospital.

Postoperatively, he developed an ileus. Despite conservative treatment, his symptoms progressed and computed tomography (CT) of the abdomen revealed acute colonic pseudo-obstruction (sometimes referred to as Ogilvie syndrome). He was treated conservatively with placement of a nasogastric tube, discontinuation of all oral intake, administration of intravenous fluids, and cessation of all medications that can impair colonic motility.

Acute colonic pseudo-obstruction (ACPO) is severe dilation of the colon without the presence of a mechanical obstruction. ACPO typically occurs in hospitalized or institutionalized patients after surgery or in association with severe illness. Timely recognition and management of ACPO is important to minimize morbidity and mortality of this serious condition. Risk factors for ACPO are shown in Table 1. Patients at highest risk for developing ACPO typically have one or more of the following risk factors: advanced age, immobility, postsurgical, electrolyte abnormalities, and use of constipating medications.(1)

ACPO should be suspected in patients with abdominal distention and altered bowel habits. ACPO should be suspected in patients who have acute illness or have just had surgery who develop abdominal distention in association with abdominal pain, nausea/vomiting, or altered bowel habits (e.g., constipation or diarrhea). Diagnosis of ACPO is secured with imaging showing a dilated colon in the absence of a mechanical obstruction (Figure). Once mechanical obstruction is excluded (typically requires a CT scan or a water-soluble contrast enema study), management of ACPO is focused on reversal and treatment of precipitating factors and decompression of the colon. Prompt treatment is important to reduce the risk of complications, including colonic ischemia and/or perforation. The risk of perforation depends on the acuity, severity, and duration of colonic distention. Cecal diameter greater than 10–12 cm and duration of distention longer than 6 days are associated with increased risk of perforation.(2,3)

Principles of ACPO management are shown in Table 2. Empiric therapy starts with treating reversible causes, including correction of electrolyte abnormalities, NPO with IV fluids, minimizing the use of narcotic pain and other constipating medications, placement of nasogastric and rectal decompression tubes, and optimizing patient mobility with frequent turns, sitting, standing, and walking.(3) In the case above, providers followed guidelines for conservative management.

Case & Commentary—Part 2

This conservative management did not work, as the patient developed worsening distention and severe abdominal pain. He was not a candidate for pharmacologic treatment with neostigmine (an acetylcholinesterase inhibitor that can stimulate motility). The next step in treatment was colonoscopy with the goal of decompressing the dilated colon.

A gastroenterologist who had just finished her fellowship training performed a decompression colonoscopy. At the beginning of the procedure, the gastroenterologist inserted the colonoscope and began insufflation (pumping air into the colon—a routine part of the colonoscopy and allows for better visualization). Almost immediately, the patient's abdomen became diffusely distended and he became more tachycardic. An abdominal radiograph revealed free air, consistent with a colonic perforation. He

was taken emergently to the operating room, where he underwent resection of the perforated colon. Unfortunately, he developed progressive septic shock requiring mechanical ventilation and vasopressors. Despite maximal efforts, he died later that day.

If patients fail to respond to 24 hours of conservative management or have already been optimized, prioritization shifts to active colonic decompression. Decompression of the colon can be performed medically or endoscopically. For patients without contraindications, neostigmine 2 mg intravenously over 3–5 minutes is generally effective at stimulating colonic contraction and decompression.(4) Stool production is generally swift, within 15 minutes, and high volume. It is important to have the bedpan ready before administering the neostigmine. While neostigmine is effective, the risk of cardiovascular collapse limits its use. Neostigmine is absolutely contraindicated in patients with known hypersensitivity or mechanical obstruction of the intestinal or urinary tract. Relative contraindications include a history of asthma, cardiac arrhythmia, congestive heart failure, recent myocardial infarction, bradycardia, or use of beta-blockers. All patients who receive neostigmine should be on a cardiac monitor. Resuscitation equipment, including atropine as a reversal agent, should be immediately accessible. Use of methylnaltrexone in patients on narcotics has been reported.(5) If treatment of ACPO is successful with the above measures, maintaining normal electrolytes, a regular bowel regimen, avoidance of constipating medications, and patient mobilization are key to reduce the risk of recurrence.

Colonoscopy is indicated as a treatment when conservative measures fail and the colon remains dilated. However, colonoscopy is contraindicated in the setting of overt peritonitis or perforation. Guidelines for the role of colonoscopy in the management of ACPO were published by the American Society of Gastrointestinal Endoscopy.(1) Colonoscopic decompression in the setting of ACPO is associated with rates of perforation and mortality in approximately 2% and 1% of cases, respectively.(1,6) In ACPO, the already dilated and possibly ischemic bowel is at particularly high risk for overdistention and perforation. To reduce such risk, it is important to minimally insufflate the colon (if at all). Risk factors for perforation in general include prolonged distention, ischemia, excessive insufflation of the colon, technical factors that result in looping of the colonoscope, or tension at a point of endoscope fixation from prior adhesions. Therefore, the goal of colonoscopy is to decompress the colon as safely as possible and to try to prevent recurrence of distention.

In this case, it is unclear if radiographs were obtained immediately prior to initiation of colonoscopy. Because the abdomen became distended immediately upon colonoscope insertion, it is possible that a perforation was already present before the colonoscopy was started, and then the air insufflation made clear that a perforation was present. Abdominal radiographs should generally be obtained at least daily, and more frequently if there is a change in clinical status. These images should be reviewed prior to colonoscopy to exclude evidence of perforation.

The appropriate timing of interventions for ACPO is clinically challenging because conservative therapy is reported to be effective in 20% to 92% of cases and the risk of complications with endoscopic therapy is high, especially when ischemia is present.(1) Even when pharmacologic or endoscopic therapy for ACPO is successful, relapse occurs in approximately 40% of patients.(1) Therefore, it is important to address the underlying etiology (e.g., electrolyte abnormalities). Placement of a decompression tube during colonoscopy appears to reduce the rate of recurrence in retrospective series, and daily administration of polyethylene glycol electrolyte-balanced solution has been shown to reduce the rate of relapse in a small randomized controlled trial.(7)

This case also highlights the dramatically higher risk of perforation from colonoscopic decompression in the setting of ACPO compared to elective colonoscopy. Population-based studies demonstrate that while elective colonoscopy is quite safe, the risk of postcolonoscopy bleeding, perforation, and mortality is

reported to be 2.6/1000, 0.5/1000, and 2.9/100,000, respectively.(8) The risk of complications is lower for screening and surveillance colonoscopy than for diagnostic or exams, with a clearly higher risk when polypectomy is performed (e.g., perforation rate of 0.8/1000). Overall, the risk of serious complications from colonoscopy (which includes cardiovascular events, severe abdominal pain and diverticulitis, in addition to those listed above) is estimated to be 2.8 per 1000.(9) Risk factors associated with colonoscopic perforation in elective colonoscopy include colonic dilation (as in this case), colonic ischemia, severe colitis (e.g., in the setting of infection), corticosteroid use, colonic stricture, severe diverticular disease, abdominal/pelvic radiation, or abdominal/pelvic surgery.(10)

Due to the risk of complications resulting in significant morbidity and mortality, it is important to have a strong indication to perform the colonoscopy in the first place and to ensure that there are no absolute contraindications. The anticipated benefit of performing the procedure should outweigh the risks, which must be clearly explained to the patient during the informed consent process. Colonoscopic technique is always important, but is critically important in the setting of preexisting risk factors for complications. Physicians must be especially careful to avoid barotrauma (i.e., overdistention of the colon), minimize looping of the colonoscope during advancement through the colon, and recognize when further advancement of the colonoscope may cause perforation. Ultimately, the physician must use their experience and judgment to determine when the risks of proceeding with the procedure outweigh the risk of complications from an incomplete procedure.

Operator inexperience may have contributed to the morbidity and mortality in this case. It is unclear if the gastroenterologist, who had just recently completed her training, was experienced in the management of ACPO. Current competency-based gastroenterology fellowship training programs are designed to graduate gastroenterologists who have demonstrated clinical competence in a wide variety of clinical scenarios. However, there are invariably situations that arise that are beyond the experience of an individual physician. It is in these situations where it is important to recognize one's limitations and seek expert counsel. As a group, fellowship-trained gastroenterologists are prepared to perform routine colonoscopies with low complication rates that are not affected by provider volume.(11) Elective colonoscopy, however, carries a significantly lower risk compared to high-risk colonic decompression for ACPO, which is uncommonly performed since the introduction of neostigmine.

An institutional culture that encourages communication among all members of the health care team can help to reduce the risk for complications. For example, an experienced endoscopy nurse may have recognized abdominal distention prior to insertion of the colonoscope or recommended use of CO_2 instead of air insufflation. The new gastroenterologist may not have felt comfortable calling a more experienced colleague to ask for advice in managing this case. Institutions can also encourage development of protocols to aid clinicians in managing complicated conditions. Individuals must recognize their limitations and know when to seek help. Institutions face significant challenges in ensuring that their providers are competent to perform the procedures that they are called upon to perform. Guidelines for the granting of endoscopic privileges recommend the use of objective criteria and direct observation to assess competence, often relying upon the use of proctors.(12)

In this case, the patient may have already had a perforation before the colonoscopy was performed, which ideally would have been identified before the procedure worsened his clinical condition. If a perforation is immediately recognized during colonoscopy, there may be an opportunity to correct the defect using clips.(13) Immediate closure of the defect decreases the risk of spillage of the colonic contents into the peritoneum and thereby reduces the risk of peritonitis. The chance of successful immediate closure is highest in patients with small perforations and absence of peritonitis.(14,15) However, some patients may require surgical intervention. That was the appropriate next step for this patient; endoscopic attempts at closure would not be recommended since the site of perforation was not endoscopically visualized (as it

was probably ischemic). It is likely that peritonitis, sepsis, and multi-organ failure progressed postoperatively, ultimately leading to the death of this patient.

Take-Home Points

- Acute colonic pseudo-obstruction is a gastrointestinal urgency that requires prompt recognition and management.
- The tenets of treatment include:
    - Exclude mechanical obstruction.
    - Initiate conservative management, including treatment of any reversible causes and increased ambulation or frequent position changes, as able.
    - If conservative therapy fails, neostigmine is recommended for patients who do not have contraindications to its use.
    - Colonoscopy with placement of a decompression tube should be performed if medical management fails.
- Colonoscopic decompression is associated with a high risk for perforation and mortality and should be performed by an experienced endoscopist using techniques to minimize the risk for perforation.
- Institutions should, whenever possible, use objective criteria and direct observation to assess competence in the performance of invasive procedures, such as colonoscopy.

Diagnostic Overshadowing Dangers

The Case

A 72-year-old woman with history of opioid abuse was sent to the emergency department (ED) from a methadone clinic because she appeared confused when she came to get her daily dose of methadone. In the ED, the patient complained of pain in her epigastric region and back. She was given IV fluids for tachycardia (heart rate 140 beats per minute [bpm]) and hypotension, with prompt improvement in her blood pressure but not in tachycardia. The initial electrocardiogram revealed sinus tachycardia at 156 bpm and initial laboratory test results revealed a white blood cell count of 19,000/μL, troponins at 0.38 μg/L, and creatine kinase of 270 U/L. A CT scan of her abdomen revealed multiple fractures at thoracic and lumbar spinal region with possible cord compression.

Neurosurgery was consulted and the attending requested an MRI to further evaluate the spinal cord. The patient was given pain medication but remained tachycardic. The MRI, performed about 13 hours after admission, revealed an acute L2 fracture with cord compression. Neurosurgery recommended conservative management until morning. The patient was admitted to the ward, still tachycardic and complaining of pain in the epigastric region. The medical team attributed her pain to the fracture.

The next morning, the patient's troponin levels were in the 20s μg/L and creatine kinase was approximately 900 U/L. However, because of a delay in reporting, by the time the medical team saw the laboratory test results, it was 28 hours into the admission. A stat electrocardiogram revealed ST elevation in the inferior leads, diagnostic of a myocardial infarction. A "Code STEMI" (ST-elevation myocardial infarction) was called, but the clinicians chose to delay taking the patient to the cardiac catheterization laboratory, since they wanted the use of any antiplatelet agents to be cleared by neurosurgery in light of her spinal fracture. A bedside echocardiogram revealed severely reduced left ventricular function with an akinetic inferior wall and an ejection fraction of about 10%.

The patient was eventually stabilized on cardiac medications. At the time of discharge, it was unclear how much of her cardiac function might recover. As the team reflected on the case, they believed that they had

not responded aggressively enough to the patient's epigastric pain because of her history of drug use and chronic pain.

Chest Tube Complications
The Case

A 30-year-old woman with a history of cystic fibrosis was admitted to the hospital for management of a spontaneous left pneumothorax (collapse of her lung). She required urgent thoracostomy (chest tube) placement in the emergency department. The chest tube was connected to wall suction in order to promote reexpansion of her lung.

Over the next 2 days, the patient improved, and repeat imaging showed reexpansion of her lung. The consulting pulmonary team felt that the chest tube might be able to be removed, so they requested that the tube be disconnected from suction and clamped. The plan was to obtain a chest radiograph 1 hour after clamping the tube, and if the pneumothorax had not recurred, the tube would be removed.

About 45 minutes after the tube was clamped, the patient complained of acute, sharp pain radiating to her left arm. The nurse gave the patient pain medication. She noted that the radiograph had not yet been done but assumed that it would be done soon. Unfortunately, the radiograph was not done, and the nurse became busy with another acutely deteriorating patient.

Approximately 2 hours later (3 hours after the tube was clamped), the nurse found the patient unresponsive, in cardiac arrest with a rhythm of pulseless electrical activity. A code blue was called. The code team recognized that the arrest could have been due to a tension pneumothorax, reconnected the chest tube to suction, and eventually performed needle decompression. Despite these measures, the patient did not recover spontaneous circulation for more than 30 minutes and sustained severe anoxic brain injury as a result. The patient required tracheostomy and feeding tube placement, and she was eventually transferred to a long-term care facility with a poor neurologic prognosis.

The hospital conducted a root cause analysis (RCA). The RCA committee found that there was considerable variation around chest tube removal practices between services. For example, the trauma surgery service did not routinely perform a clamping trial before chest tube removal. Although other services did perform such a trial, there was variation in when the radiograph was performed after clamping the tube. The committee noted that this variation led to confusion among bedside nurses about how to monitor patients and communicate with physicians immediately after chest tube removal. As a result, the committee felt the complication might still have occurred even if the radiograph had been performed.

The Perils of Contrast Media
Case & Commentary—Part 1

A 66-year-old man with a past medical history of atrial fibrillation (not on anticoagulation) presented with abdominal pain and hematochezia (bloody stool). He was found to be febrile with abdominal pain on examination. Laboratory test results were notable for leukocytosis (29,100 µL), lactic acidosis (9.9 mmol/L), and new acute kidney injury (creatinine 1.8 mg/dL, up from a baseline of 0.6 mg/dL).

Given the clinical presentation, there was concern for mesenteric ischemia (impaired blood flow to the intestines), possibly secondary to emboli from his atrial fibrillation. The emergency department provider believed a computed tomography (CT) study with contrast was the best diagnostic test to evaluate for

possible mesenteric ischemia or other cause for the symptoms. However, out of concern for worsening the renal failure with contrast (i.e., contrast-induced nephropathy) in the setting of acute kidney injury, the physician instead ordered a noncontrast abdominal CT scan. This scan showed thickening of the jejunal loop but was not diagnostic for mesenteric ischemia, nor other cause for the symptoms. The patient was evaluated by vascular surgery who recommended conservative management with intravenous fluids and supportive care.

Even though the provider in this case believed that a CT scan with contrast was indicated, he ordered a noncontrast CT out of concern for the patient's kidney function. Contrast-induced acute kidney injury (CIAKI) is one of the most widely discussed and debated topics in cardiovascular medicine. Iodinated contrast media can cause kidney injury through direct cytotoxic effects on renal tissue.(1) An increasing number of individuals are exposed to iodinated contrast media during imaging-based investigations for either diagnostic or interventional purposes. Moreover, increasing life expectancy has resulted in a growing elderly population with comorbidities such as hypertension, diabetes mellitus, renal disease, and cardiovascular disease, all of which predispose to renal impairment. Thus, providers should understand the etiology of and risk factors for CIAKI and harness evidence-based prophylactic and therapeutic regimens to reduce its incidence.

Many different organizations, including the American College of Radiology have proposed definitions for CIAKI.(2) Some examples include the RIFLE criteria (Risk, Injury, Failure, Loss, End-stage renal disease) and the Kidney Disease Improving Global Outcomes classification.(1) A systematic review found that these definitions do not differ significantly in their ability to diagnose and stage AKI or to predict future adverse outcomes.(1) With regard to CIAKI, the most common and accepted definition is a rise in serum creatinine of at least 0.5 mg/dL or a 25% increase from the baseline value, assessed 48 hours following contrast media administration.(3) Evidence suggests that CIAKI is associated with multiple adverse events including progressive loss of kidney function, major cardiac complications, and prolonged length of hospitalization.(3)

Using the common definition of CIAKI, the general incidence of CIAKI in hospitalized patients exposed to contrast is approximately 7%.(4) However, the incidence reported varies depending on the definition used, ranging in one study from 7% to more than 18%.(5) The most common risk factors for the development of CIAKI are hypotension, congestive heart failure, chronic kidney disease, diabetes, age older than 75 years, anemia, and volume/type of contrast media.(6) The risk in the setting of chronic kidney disease depends on the degree of baseline renal dysfunction. In one set of patients, the incidence of CIAKI following contrast-enhanced CT was 0.0%, 2.9%, and 12.1% in patients with an estimated glomerular filtration rate (eGFR) of 45–59, 30–44, and less than 30 mL/min/1.73 m^2, respectively.(7) In that study, only 1 patient out of the 520 studied (0.2%) had severe CIAKI that required urgent hemodialysis. This finding is consistent with other studies (8,9) that have shown that while AKI in the setting of contrast is relatively common, CIAKI requiring urgent hemodialysis is rare.

Recent information suggests that the literature has overestimated the risk of developing CIAKI after contrast-enhanced imaging, and that the risk may be comparable for CT studies with and without contrast enhancement.(10) According to the most recent consensus guidelines published by the Contrast Media Safety Committee of the European Society of Urogenital Radiology (11), patients referred for contrast-enhanced CT are genuinely at risk of CIAKI if they have an eGFR less than 45 mL/min/1.73 m2 (i.e., chronic kidney disease stage 3b, 4, or 5 or new acute kidney injury). It follows that the decision to offer contrast-enhanced CT imaging in patients with reduced eGFR (i.e., < 60 mL/min/1.73 m^2) should be based on the clinical need for the contrast-enhanced diagnostic imaging and whether its benefits outweigh the risk of CIAKI. Case-by-case assessment is therefore recommended.

In the case under discussion, in the presence of a past medical history of atrial fibrillation (without anticoagulation), the clinical presentation of the patient and laboratory investigations strongly favor the diagnosis of acute mesenteric ischemia. Despite the presence of new onset AKI and some increased risk for CIAKI, a contrast-enhanced CT was essential to confirm the clinical diagnosis. The study likely would have shown a thrombus/embolus within the mesenteric arteries and/or lack of enhancement of bowel wall (due to ischemia). Without urgent intervention, mesenteric ischemia carries 100% mortality. Unless there is significant patient frailty and/or comorbidities that precluded surgical intervention, conservative management for mesenteric ischemia would not be advisable.

Case & Commentary—Part 2

Later that evening, the patient developed acute paralysis and loss of sensation of the bilateral lower extremities. An urgent CT scan with contrast was performed, which revealed complete occlusion of the abdominal aorta with blood clot from the superior mesenteric artery to the bilateral common iliac arteries. The patient was taken emergently to the operating room and underwent aortic thrombectomy (removal of the blood clot). Unfortunately, the extent of ischemia to multiple organs was so profound that he developed progressive multi-organ failure and died a few days later.

In a root cause analysis (RCA), providers who reviewed the case believed a contrast CT scan should have been ordered in the emergency department, and that diagnosing the blood clot earlier might have prevented the adverse event. During the RCA, the emergency medicine physician reflected that she had contacted the on-call radiologist about the CT scan and the radiologist had strongly recommended that a noncontrast study be ordered. The RCA also revealed that there were no standard protocols in place at this hospital for deciding when contrast studies should be ordered or describing the evidence-based best practices for prevention of contrast nephropathy when contrast studies were used.

Comprehensive specialty-specific protocols have been proposed to prevent CIAKI for eGFR-based, risk-stratified patient groups.(12) These guidelines more or less form the basis of various institution-built nephroprotective protocols. Such measures should include halting nephrotoxic medications (such as metformin, etc.), minimizing contrast media volumes, and using low- or iso-osmolality contrast media.(3,12) High osmolality contrast media have been completely replaced by low osmolality contrast media and increasing use of iso-osmolality contrast media in western countries due to lower incidence of adverse effects (including CIAKI) from the latter two with no difference in image quality. High osmolality agents are no longer used in routine clinical practice.

Hydration has been shown to decrease the rates of CIAKI as it reduces the contrast media concentration in the kidneys, limiting the cytotoxic effects. All three of the specialty-specific protocols recommend hydration through intravenous volume expansion using an isotonic electrolyte solution before and after contrast media administration.(12) The recommendations vary as to the type of hydration recommended. Evidence has shown that isotonic solutions, such as isotonic sodium chloride (0.9 %), are more protective than hypotonic solutions (e.g., hypotonic saline [0.45%]).(13,14) Many different regimens have been investigated, and there is conflicting evidence regarding the optimal isotonic fluid and optimal rate. This has led to variability in the specialty-specific guidelines. Providers should explore the guidelines relevant to the test being ordered (e.g., CT scanning, interventional cardiology) and develop local protocols, all of which should involve pre- and postcontrast intravenous infusions with isotonic fluids.

Various pharmacological agents such as N-acetylcysteine, statins, ascorbic acid, and theophylline have also been investigated as nephroprotective agents. Based on its ability to ameliorate contrast media–induced vasoconstriction and limit free radical injury, N-acetylcysteine has been the most widely studied agent. A recent meta-analysis suggested that N-acetylcysteine plus normal saline may be associated with

greater reduction in CIAKI.(15) However, the use of the above agents lacks level 1 evidence to date, and it is difficult to make firm recommendations.(3)

Given the uncertainty in the literature, institutions should consider developing standardized protocols for the prevention of CIAKI. A large prospective multicenter study explored the impact of a quality improvement intervention on rates of CIAKI in the setting of cardiac catheterization.(16) The intervention included (i) development of a multidisciplinary team; (ii) participation in conference calls; (iii) review of the literature; (iv) participation in focus groups to discuss barriers and successes; and (v) biannual review of CIAKI rates. Adjusted rates of CIAKI were reduced by 21% in intervention hospitals. In reviewing the program, the key factors associated with improvement were building multidisciplinary teams, limiting contrast media volume, standardizing fluid orders, using an intravenous fluid bolus, and educating patients about oral hydration.(16)

In this case, the delay in diagnosis of a potentially life-threatening condition led to profound worsening of the patient's condition and, ultimately, his death. It remains widely accepted among surgical specialists that making a prompt diagnosis of a potential life-threatening condition (in this case, ischemic bowel) should trump a comparatively small risk of likely reversible CIAKI. In emergency situations, prolonged debates are inappropriate; prompt action and definitive treatment must be foremost. The recognized nephroprotective measures can all be administered after the appropriate diagnostic and therapeutic actions.

Take-Home Points

- Contrast-induced acute kidney injury is defined as a rise in serum creatinine of 0.5 mg/dL or a 25% increase from the baseline value, assessed 48 hours following contrast media administration, and has been associated with multiple adverse events.
- Although CIAKI is common, permanent kidney damage is fairly rare.
- Providers should screen patients for key risk factors for CIAKI including hypotension, congestive heart failure, chronic kidney disease, diabetes, age older than 75 years, anemia, and volume/type of contrast media.
- Introducing qualitative system factors such as building multidisciplinary teams, standardizing fluid orders, using an intravenous fluid bolus, and educating patients about oral hydration can reduce the risk of developing CIAKI.
- In case of a potentially life-threatening condition, contrast-enhanced imaging should be used without concern for the development of CIAKI.

Communication Error in a Closed ICU

The Case

A 70-year-old man with a complex medical history including end-stage renal disease (status post kidney transplant), coronary artery disease, and peripheral vascular disease requiring lower extremity bypass surgery in the past, was admitted to the intensive care unit (ICU) with septic shock secondary to an infected lower extremity wound. Soon after admission, he developed hypotension refractory to intravenous fluid resuscitation. The ICU team decided that the patient required central venous catheter placement in order to administer vasopressors to improve his blood pressure.

The ICU at this hospital was a closed system, where the ICU team had primary responsibility for daily management and acute issues, including performing procedures. The surgical team rounded on patients daily and discussed the plan of care with the ICU team regularly, but the team was not first call and did not write routine orders. The ICU team thus decided to place the central line after confirming the plan with the surgical team. Establishing central venous access in this patient was challenging. He had been on

hemodialysis in the past through a right upper extremity arteriovenous fistula, which had failed. Due to worsening function of his transplanted kidney and anticipated need for restarting hemodialysis, he had a catheter in his left internal jugular vein already. The combination of this catheter and his prior fistula meant that upper extremity catheter placement was not possible. The ICU team therefore chose to place the central line in the right femoral vein and was able to do so after much effort. However, the team failed to recognize that the patient's transplanted kidney was also on the right side. This was a serious mistake, as femoral catheter placement is contraindicated on the same side as a transplanted kidney due to the risk of damaging the vein to which the transplanted kidney is anastomosed (surgically attached).

As the ICU team was finishing the procedure, the transplant surgeon arrived and recognized the mistake. The surgeon was furious at the ICU team for making such an error. Attempts were made to cannulate the left femoral vein, but they were unsuccessful due to the presence of blood clots. The patient required vasopressor administration through the right femoral line for several hours despite the risks, as he remained hemodynamically unstable. Eventually, the left internal jugular hemodialysis catheter was removed and replaced with a different catheter that could be used for vasopressor administration.

Over the next few days, the patient's kidney function continued to worsen and hemodialysis was initiated. The relationship between the ICU team and the surgical team remained tense and mistrustful, and the intensivists eventually ceded primary responsibility for the patient to the surgeons. The patient's overall condition did not respond to aggressive therapy for septic shock, and he eventually developed multiple organ system failure. After extensive discussion, his family eventually decided to pursue comfort measures only, and he died on hospital day 12.

Hemolysis Holdup

The Case

A 72-year-old man with congestive heart failure due to nonischemic cardiomyopathy, stage 3 chronic kidney disease, atrial fibrillation, and type 2 diabetes mellitus presented to the emergency department (ED) with new onset generalized weakness. The ED physician ordered a chemistry panel, which came back as showing evidence of acute kidney injury, as well as a serum potassium level of 7.4 mEq/L (normal range 3.5 to 5.0 mEq/L). However, the laboratory noted that the patient's blood sample was hemolyzed, which can spuriously increase the measured serum potassium.

The ED physician assumed that the first result must have been incorrect due to hemolysis, but felt that the patient should be admitted to the hospital for further workup and treatment of his acute kidney injury. She ordered a repeat potassium level and called the hospitalist for admission. The hospitalist noted mild electrocardiographic abnormalities that could have been consistent with hyperkalemia (high potassium levels), but she did not institute immediate treatment for hyperkalemia as the repeat level was still pending. The patient was admitted to the medical ward.

When the patient arrived at the floor, he started to feel more confused and lethargic and he became progressively more hypotensive and bradycardic. The laboratory then called the hospitalist with a panic result—the repeat potassium level had come back at 8.4 mEq/L, a level associated with a high risk of cardiac complications. Almost immediately thereafter, the patient went into cardiac arrest. The patient was resuscitated and emergently administered calcium gluconate, sodium bicarbonate, and insulin to treat the hyperkalemia. He was able to be resuscitated and was emergently transferred to the intensive care unit for initiation of hemodialysis. The patient had a lengthy hospital course, but he ultimately survived and was discharged home off dialysis and with improved renal function.

Diagnostic Delay in the Emergency Department
Case & Commentary—Part 1

A 43-year-old man with a history of morbid obesity and hypertension presented to the emergency department (ED) with right upper quadrant pain. The patient lived a sedentary lifestyle and received disability benefits. On examination, he was afebrile but tachycardic (heart rate 110–120 beats per minute [bpm]) and hypertensive (blood pressure 155/85 mm Hg). He had mild right upper quadrant tenderness on examination, but the exam was limited because of his obesity.

The ED provider ordered basic laboratory tests and a right upper quadrant ultrasound to look for cholecystitis. While waiting for the diagnostic tests, the patient had progressively severe pain, requiring relatively high doses of intravenous morphine.

Blood test results (including liver function tests) were normal except for an elevated creatinine level of 1.8 mg/dL (up from a baseline of 1.1 mg/dL), indicating acute kidney injury. The ultrasound showed gallbladder sludge with no gallstones and no evidence of acute cholecystitis. This initial evaluation took nearly 7 hours, and there was still no clearly identified cause for his pain.

Over this period, his heart rate increased to greater than 120 bpm and his blood pressure was 175/95 mm Hg. An electrocardiogram showed sinus tachycardia and low voltage throughout. The low voltage was attributed to the patient's obesity, and he was given a small bolus of intravenous fluids.

Although the ED provider pursued further imaging, she avoided a contrast study because of the patient's acute kidney injury. She ordered a noncontrast CT scan of the abdomen and pelvis. For various logistical reasons, the CT scan was delayed 4 hours and a preliminary read was not available for another hour.

Abdominal pain is the most common chief complaint and diagnosis in United States emergency departments (EDs), accounting for more than 10 million visits annually.(1,2) Accurately determining the diagnosis poses special challenges and is known to be error-prone.(3) Although many patients have a benign or self-limited etiology, some have serious and acute pathology. This means that identifying patients that require emergent or urgent intervention is key.

The foundation for an appropriate evaluation of abdominal pain starts with a thorough history and physical examination. However, symptoms may be misleading, difficult for patients to convey, unusual, or even change over time (3), and communication breakdowns related to language or cultural differences can occur.(2) Evaluation of patients with obesity may be more difficult due to several factors, such as provider perceptions (4) and weight restrictions of diagnostic imaging tests (e.g., CT scanning).(5) Furthermore, abdominal processes requiring surgery may be more prevalent in overweight populations and associated with increased morbidity and mortality.(6) Considering a broad differential diagnosis is essential in the initial evaluation of all patients with abdominal pain; this is particularly true in patients with obesity.

The provider in this case was most concerned for cholecystitis, or inflammation of the gallbladder, which can present with right upper quadrant abdominal pain, nausea, vomiting, decreased appetite, and fever. Additional physical examination findings can include tachycardia, guarding, or rebound pain in the right upper quadrant. Initial laboratory and imaging tests ordered for this patient seemed appropriate. While laboratory results such as leukocytosis, elevated serum aminotransferase, elevated bilirubin, or elevated alkaline phosphatase have a low sensitivity and are nonspecific, right upper quadrant ultrasound imaging is the most useful test in the ED. Visualization of the gallbladder without identification of stones has an extremely high negative predictive value for cholecystitis.(2)

The other diagnoses the provider was considering are not described in the case. However, there was a 7-hour delay in obtaining an ultrasound while the patient's pain increased. Worsening tachycardia, severe pain unrelieved with intravenous morphine, and elevated creatinine would lead one to consider a broader differential, including myocardial infarction, aortic dissection, sepsis from a variety of sources, pyelonephritis, or ureteral stones. Thus, an urgent CT scan would have been an appropriate next step, along with additional laboratory tests based on the differential diagnosis. In this case, however, the CT scan report was only available 5 hours later. It is also unclear how many shift changes occurred between initial presentation until the CT report was available and if the treating team recognized the patient's worsening status.

Case & Commentary—Part 2

The preliminary CT read was concerning for an acute aortic dissection, but it was not definitive without intravenous contrast. Cardiothoracic surgery, cardiology, and the intensive care unit team were consulted for further management. The decision was made to order a CT scan of the abdomen and pelvis with contrast to evaluate for the possibility of dissection.

The CT scan of the abdomen showed a dissection of the descending aorta with involvement of the renal arteries and the mesenteric vessels. A CT scan of the chest was then performed 90 minutes later; it showed the dissection started at the proximal aorta with involvement of the carotids and extended into the descending aorta (type A dissection).

At this point, the patient was given aggressive intravenous antihypertensives (his blood pressure had risen to 180/100 mm Hg). He was taken to the operating room for repair of his dissection. Unfortunately, the surgery was complicated and he had massive intraoperative bleeding. He developed hemorrhagic shock and multi-organ failure and died 2 days later despite maximal efforts.

The ED case review committee analyzed the case in detail and wondered how common diagnostic errors are in patients presenting with abdominal pain, and specifically, whether this issue is impacted by patient obesity. They also wondered what steps could be taken to prevent such an error in the future.

Diagnostic error, as defined by the Academy of Medicine (formerly the Institute of Medicine), is the failure to establish an accurate and timely explanation of a patient's health problems or communicate that explanation to the patient.(7) Annually, diagnostic errors are estimated to affect 12 million US adults in the outpatient setting alone.(8) They involve a large variety of common diseases and have significant potential for harm.(9)

In the ED, the frequency of diagnostic errors is not fully known (10); however, malpractice studies have found that 47% of ED claims are due to diagnostic errors.(3,11) Other methods of identifying or estimating diagnostic errors include autopsies, surveys, standardized patients, diagnostic testing audits, second or peer reviews, case reviews, and voluntary reports.(9,12,13) However, none of these methodologies have been applied in a structured way to document the frequency of diagnostic errors in the ED.

The diagnosis of aortic dissection in the ED is missed in 16% to 38% of cases.(14,15) A previous WebM&M commentary identified three key factors that appeared to predispose to errors in the diagnosis of aortic dissection: (i) perceived mildness of presenting symptoms; (ii) diagnostic testing that suggested another disease process; and (iii) absence of typical radiographic findings, such as a widened mediastinum.(14)

So how does one further understand the diagnostic error in this case and learn from it? One operational definition of diagnostic error is missed opportunities to make a correct or timely diagnosis based on the available evidence, regardless of patient harm.(16) This definition helps identify, on a retrospective review, how diagnostic evaluation could have been done differently. The knowledge gained from such an analysis can be used to improve patient safety.

Diagnostic errors can be contextualized within five interactive, process-based dimensions: patient–provider encounter (history, examination, test ordering); performance and interpretation of diagnostic tests; follow-up or tracking of diagnostic information, such as test results; processes related to referrals; and patient dimensions.(9) A previous ED study of abdominal pain related to diagnostic errors showed multiple process breakdowns within the dimensions above, most commonly involving the patient–provider encounter and follow-up or tracking.(3) Within the patient–provider encounter, examples of diagnostic errors included problems with the history or physical examination, failure to review previous documentation, and problems ordering the appropriate diagnostic tests for further workup.

In this case, at least two of the five dimensions involved missed opportunities: the patient–provider encounter and performance and interpretation of diagnostic tests. There were problems with the physical examination owing to the patient's obesity, and the mildness of symptoms likely affected the timeliness of workup. This issue was also described in a previous WebM&M case, where obesity was found to affect physical examination, diagnostic imaging, airway management, and venous access. The present case also illustrates problems ordering the appropriate diagnostic tests for further workup and problems performing diagnostic tests in a timely manner.

When would we have expected the ED care team to get alarmed about the possibility of a much more serious condition in this case? Perhaps when acute kidney injury was identified, along with worsening pain and tachycardia. However, we know very little about clinicians' thought processes in such cases. Making a diagnosis often involves shades of gray, rather than black and white data points. In general, diagnostic errors can be caused by many factors, including bias, premature closure, system factors, and overreliance on type 1, or automatic, heuristic reasoning (3,17), some of which have been discussed in other WebM&M commentaries (here and here). We often underestimate how system factors can affect the way clinicians think. For example, ED crowding and frequent interruptions are associated with delays in diagnosis, inappropriate care, increased mortality, longer length of stay, and higher likelihood of error.(18-20) Other factors that cause EDs to be stressed or chaotic, including problems with staffing, supplies, or equipment, can lead to increased errors.(21) As a strategy to reduce error potential, ED providers often need to balance overzealous diagnostic testing (which increases costs and false-positive results) with more conservative approaches, which could include shared decision-making and watchful waiting.(22) Some emergency medicine physicians argue that pressures to do more with fewer resources, while maintaining timeliness and decreasing costs, increases the opportunity for diagnostic errors.(23) Under-resourced EDs are a significant risk. Our health system needs appropriate resources and personnel to evaluate complex patients with acute presentations like this in a timely fashion.(22,23)

So how can ED providers handle this area of vulnerability? Tools, workflows, and methods to encourage deliberate (type 2) reasoning prior to making critical decisions might help. Such interventions can include checklists (17), deliberate consideration of a broader differential diagnosis (3,24), and learning from missed opportunities.(16) Receiving feedback on unexpected return visits to the ED that led to a hospitalization could be a useful way to look for these missed opportunities. Similarly, the use of treatment protocols or algorithms may reduce the risk of error.(12) Ensuring that providers develop deliberate and thorough differential diagnoses also can help.(3) In one study, 81% of records with diagnostic errors had no differential diagnosis documented.(9) In this case, it is unclear if the care team pursued a broader differential in the face of worsening abdominal pain. Not asking for help during

diagnostic difficulty or uncertainty is also a vulnerability.(25) Seeking help could be through either a formal consultation or curbside consult of another team member for a second opinion. Even simpler strategies like calling the radiologist when a test has been delayed or to communicate the urgency of a study can go a long way; unfortunately it seems this practice has waned over time. This case highlights how a focus on basic clinical skills, cognitive processes, and team-based care is essential in this day and age.(9,26)

While we are not there yet, future health IT tools to support busy ED providers and improve their cognitive processes may be beneficial, such as those reviewed by El Kareh and colleagues (Table).(27) Health IT tools such as electronic tracking systems may help reduce wait times and delays in evaluation, like those present in this case. Additional techniques such as process and workflow mapping and discrete-event simulation modeling can improve flow, shorten wait times, reduce ambulance diversions, and enhance patient satisfaction.(28,29) Furthermore, EDs should use cases like this one to assess current workflows and identify opportunities to reduce waits and delays.

Ultimately, providers and their health care organizations must own the responsibility for addressing diagnostic errors and work together to develop multifaceted approaches for prevention.(30) EDs should put mechanisms in place to identify and learn from diagnostic missed opportunities and work toward a collaborative, nonpunitive environment to foster their reduction.

Take-Home Points

- Evaluation of acute abdominal pain requires a thorough and time-sensitive approach, which should account for high-risk situations such as obesity and a busy emergency department setting.
- Diagnostic errors can be quite common in emergency departments and involve five interactive process dimensions: patient–provider encounter; performance and interpretation of diagnostic tests; follow-up or tracking of diagnostic information; processes related to referrals; and patient dimensions.
- Approaches to reduce diagnostic error could include methods to encourage deliberate reasoning and differential diagnoses as well as system-based improvements, including health information technology solutions.
- Individual providers and emergency departments should put mechanisms in place to identify and learn from missed opportunities in a nonpunitive fashion.

Wrong-side Bedside Paravertebral Block: Preventing the Preventable

The Case

An 84-year-old woman presented to the emergency department following a mechanical fall at home. The fall occurred as she attempted to sit down in the bathroom and missed the toilet, falling backwards and striking her right back and flank against the bathtub. Imaging demonstrated multiple right-sided rib fractures.

The patient was admitted to the medical-surgical ward. On the first hospital day, the patient continued to have difficulty with maximal inspiration because of pain associated with the rib fractures. The clinical team decided to obtain an anesthesia consultation to place a paravertebral block. The anesthesiologist performed the block on the patient while she was in her bed. At the completion of the block, postprocedure imaging was performed to rule out complications. It was then that the performing physician realized that the fractures were on the opposite side—which meant that the block had been placed on the wrong side. This was then confirmed by reviewing the chart.

On review of the case, it was noted that the personnel carrying out the procedure at the bedside had not performed the usual safety checks or a "time out" to identify the correct side.

The patient required an additional paravertebral block on the correct (right) side to control the pain, increasing her chances of postprocedure complications, including bleeding and pneumothorax. Because of the error, the patient was exposed to unnecessary additional medication, and the institution bore unnecessary additional costs for the additional local anesthesia, regional block instrument tray, and personnel (the patient was not charged for the repeat procedure).

Patient Allergies and Electronic Health Records

The Case

A 40-year-old woman presented with recurring intense right upper quadrant pain, which worsened with large meals. Her past medical history was significant for cholecystectomy 3 years earlier and gastroesophageal reflux disease controlled by proton-pump inhibitors. After she was found to have an elevated white blood cell count, an abdominal CT scan with contrast was ordered.

Upon the patient's arrival at the CT scan, a technician reviewed the electronic health record (EHR) for allergies and found none documented. The technician asked the patient whether she had ever responded poorly to contrast media or dyes. In response, the patient stated she had experienced hives upon receiving contrast in the past. Consequently, the patient was premedicated prior to receipt of the contrast agent, and diagnostic imaging was completed without further incident.

During a follow-up clinic visit, the patient discussed this contrast intolerance with a medical assistant, assuming the allergy had been documented in her medical record. Surprisingly, the intolerance was not listed. A follow-up investigation revealed that the previously stated intolerance had been removed from the patient's allergy profile and never updated at the clinic appointment. The investigation found that the medical assistant had removed contrast from the patient's allergy list because it was not a "true" allergy. She intended to ask where to document an intolerance in the EHR but forgot to ask. Consequently, the EHR had no evidence of either allergy or intolerance to contrast. This case led to a system-wide analysis of practices regarding allergy documentation in the EHR and development of a mechanism to prevent a similar event in the future.

Engaging Seriously Ill Older Patients in Advance Care Planning

The Case

A 94-year-old woman with history of congestive heart failure (CHF), hypertension, and gout presented for a routine primary care visit to a new physician, an intern in the local training program. She had been seen in the housestaff clinic for more than 10 years by a series of residents, each handing over her care to a new intern at the end of their residency. Her previous resident had recently graduated.

The intern reviewed the patient's chart and discovered that the patient lived alone, walked mainly with a cane, and was able to manage all of her activities of daily living independently. She did have severe hearing impairment and could not read or write (she never learned literacy skills). Notably, in the last year the patient had been hospitalized 5 times for CHF exacerbations or pneumonia. She had experienced a clear functional decline in the previous 3 months.

In reviewing the medical record, the intern discovered the patient's code status in the hospital and in the clinic had always been documented as "full code." The intern was surprised to see that there was no

documentation of any in-depth discussions of the patient's wishes. Given the patient's comorbidities and recent decline, the intern was quite concerned that she was at very high risk for becoming seriously ill and requiring aggressive life-sustaining measures.

During their first visit, the intern asked, "Has anyone ever talked with you about what you would want if you got so sick that you needed artificial life support to survive?" The patient answered, "You know, no one has ever asked me about that. I guess I always figured the doctors would just do what is right."

The intern performed a more detailed chart review and spoke with the patient's daughter. He discovered no evidence that any health care provider had ever engaged in advance care planning with the patient.

Concerned about the possible harm the patient could experience, the intern and his supervisor engaged the patient in a thoughtful discussion of her wishes. Ultimately she stated clearly she would not want full resuscitation, mechanical ventilation, or any other aggressive artificial life-prolonging measures. She told them with a smile and a wink, "Hey, when it's my time, I'm fired up and ready to go!"

Correct Treatment Plan for Incorrect Diagnosis: A Pharmacist Intervention

The Case

A 48-year-old woman with a history of human immunodeficiency virus infection, migraines, polysubstance abuse, and a penicillin allergy presented to the emergency department with complaints of headache and blurry vision. Meningitis was ruled out by a negative lumbar puncture; neurosyphilis was ruled out by a negative cerebrospinal spinal fluid (CSF) fluorescent treponemal antibody absorption (FTA-ABS) test. Additional blood tests were sent out to test for other infectious causes of her symptoms, and the patient was discharged home. Following her discharge, the results of a full infectious disease panel returned showing a nonreactive rapid plasma reagin but positive FTA-ABS, a potential indication of latent syphilis. The patient was asked to return to the infectious disease clinic for follow-up.

At the follow-up appointment, the infectious disease attending recommended standard treatment: penicillin G benzathine 2.4 million units IM weekly for 3 doses. Because of her allergy history, the patient was first sent to the hospital for penicillin sensitivity testing. The plan was to initiate the penicillin desensitization protocol if she had an allergic reaction to initial testing, or to give her the first dose of penicillin and have her report to the Department of Public Health for the remaining doses if she did not.

The penicillin sensitivity test result was negative, so the allergist placed orders to initiate penicillin therapy. Recalling the patient's previous symptoms of headache and blurry vision, the allergist placed orders for neurosyphilis treatment (a far higher penicillin dose, and an inappropriate one since neurosyphilis had been ruled out). These orders included hospital admission, peripherally inserted central catheter (PICC) line placement, and penicillin G 4 million units every 4 hours via the PICC line.

On seeing the admission diagnosis of neurosyphilis, the pharmacist verifying the patient's admission orders performed a thorough chart review. The pharmacist realized that neurosyphilis had been ruled out and contacted the allergist to clarify the treatment plan. The allergist recognized the error, and the orders were corrected to reflect treatment for latent syphilis. The patient received her first IM dose of penicillin G benzathine and was referred to receive her two additional doses of penicillin. The pharmacist's catch prevented an unnecessary hospital admission, a PICC line, and multiple doses of IV penicillin.

Diagnosing a Missed Diagnosis

The Case

A 57-year old woman was admitted to the hospital with cough, slurred speech, confusion, and disorientation. She was taking modified-release lithium for bipolar disorder. Her medical history was also significant for primary hyperparathyroidism and coronary artery disease. A brain CT on admission showed no evidence of a stroke or intracranial bleed. Her initial serum sodium level was normal at 140 mmol/L, but her serum calcium level was mildly elevated. Her initial serum lithium level was also mildly elevated at 1.5 mmol/L.

The patient's delirium was attributed to hypercalcemia, so she was admitted to the ward and hydrated with intravenous (IV) normal saline. Her lithium was continued. The following day, she remained confused and disoriented. Her hypercalcemia had slightly improved, but her serum sodium had risen to 149 mmol/L. The bedside nurse told the physician that the patient seemed to be going to the bathroom frequently; urine output had not been formally recorded. The physician attributed the rising sodium to the IV fluids and decided to continue aggressive hydration given the lack of improvement in her symptoms. A repeat lithium level was not ordered.

That evening, the nurse found the patient to be comatose and minimally responsive. The patient was urgently transferred to the intensive care unit (ICU), where repeat labs showed a sodium level of 163 mmol/L (normal < 145 mmol/L). She required intubation for airway protection, and a repeat lithium level was markedly elevated at 2.1 mmol/L. After admission to the ICU, her urine output was noted to be 500 cc/hour of extremely dilute urine, consistent with a diagnosis of nephrogenic diabetes insipidus due to lithium toxicity.

The patient was successfully managed in the ICU with 5% dextrose infusion to gradually correct her hypernatremia. Her lithium was held, and she was treated with ibuprofen and diuretics. Her mental status gradually improved and she was able to be extubated on hospital day 3. Fortunately, she did not experience any neurologic sequelae, and she was discharged home on hospital day 7. Her lithium was discontinued and she was started on valproic acid for treatment of her bipolar disorder.

Consequences of Medical Overuse

The Case

A 76-year-old woman with history of hypertension, diabetes, and advanced dementia was brought to the emergency department (ED) from a nursing facility with confusion and generalized weakness. Based on her initial evaluation, she was diagnosed with a urinary tract infection and started on antibiotics in the ED. As part of this evaluation, she was found to have a mildly elevated troponin I level (0.10 μg/mL; normal is < 0.07 μg/mL). Her electrocardiogram (ECG) was unchanged from her baseline and showed no evidence of ischemia. She did not complain of chest pain or shortness of breath.

The hospitalist admitting the patient consulted a cardiologist for evaluation of the elevated troponin levels. The cardiologist recommended starting aspirin, clopidogrel, and heparin for treatment of possible non–ST-elevation myocardial infarction (NSTEMI). The hospitalist wondered if this was overly aggressive treatment for the elevated troponin but followed the specialist's recommendations.

The following day, the patient remained confused. Her troponin level rose to 0.13 μg/mL and was 0.12 μg/mL on repeat. Her ECG continued to show no evidence of myocardial ischemia. At the recommendation of the cardiologist, the aspirin, clopidogrel, and heparin were all continued.

That evening, the patient became acutely confused. A computed tomography scan of the head revealed a large intraparenchymal hemorrhage with midline shift. She was placed on a mechanical ventilator and transferred to the intensive care unit. Given the bleeding, the heparin, aspirin, and clopidogrel were discontinued. Unfortunately, despite aggressive treatment, she developed evidence of cerebral herniation and became comatose. After discussions with the family, the patient was transitioned to comfort measures and she died a few hours later.

The root cause analysis of this adverse event determined that treatment with three anticoagulants was not clinically indicated as the patient did not have objective evidence of an NSTEMI. The committee believed the overly aggressive treatment had led to the patient's death.

Refused Medication Error

The Case

A 59-year-old man was admitted to the hospital with acute renal failure and mental status changes. He was alert to self and place only. The patient had end-stage liver disease and was not following his home treatment regimen. Specifically, he was noted to have doubled his daily dose of furosemide for more than 5 days in an attempt to remove edema. He was also noted to be poorly adherent with his lactulose.

Initial therapy was to carefully correct his acute renal injury while using lactulose to improve his hepatic encephalopathy. With treatment, both his mental status and his creatinine improved. Throughout his admission, he was assessed as a very high fall risk on a standard risk scale. As his platelet level was less than 40,000 ?l, the staff's level of concern was heightened, in that a fall could be associated with dangerous bleeding.

As his hospitalization progressed, the patient refused to take his lactulose because of frustration with frequent, loose stools. The nursing staff noted the patient refusal in his medication record, but did not inform his primary care team. On the fourth day after his initial refusal, the patient became more confused, now only oriented to self, and began acting impulsively, including getting out of bed without assistance. The nurse alerted the primary care team of the patient's declining mental status and their concern about increased fall risk, but did not describe the missed doses of lactulose. The patient was placed on close observation for safety purposes but continued to decline and was transferred to the intensive care unit (ICU).

After being transferred to the ICU, the patient's mental status further deteriorated, and he became comatose and required intubation. The following morning, his next-of-kin and health care surrogate provided documentation of the patient's wish to forego mechanical ventilation. Less than 24 hours after admission to the ICU, the patient was extubated and died shortly thereafter.

Safeguarding Diagnostic Testing at the Point of Care

The Case

A 23-year-old woman presented to the family medicine clinic for contraception. She was sexually active with one partner and expressed interest in long-term contraception. After talking with her provider, she selected intrauterine device (IUD) placement.

The protocol in the clinic was to check a urine pregnancy test prior to placing an IUD. The patient provided a urine sample to the nurse. Point-of-care testing in the office revealed a negative result. The physician informed the patient and then placed the IUD during the same visit without complication.

At the end of her shift, the nurse manually entered the results of all point-of-care tests performed in the office that day into the appropriate patient's electronic medical record. By mistake, she entered the result of the urine pregnancy test for this patient as positive instead of negative. When the patient's provider received the positive result via electronic notification, she recognized the error and immediately corrected the medical record.

Although the mistake was recognized quickly and no incorrect information was relayed to the patient, the provider decided to review the results of all point-of-care tests that had been manually entered into the electronic health record system for her patients that day to make sure there were no other errors.

The Hazards of Distraction: Ticking All the EHR Boxes
The Case

A 55-year-old woman with a history of metastatic cancer of unknown origin was sent to the emergency department (ED) after a magnetic resonance imaging (MRI) scan of her brain (done for cancer staging) showed a right subdural hematoma with a very small (5 mm) midline shift. The patient was alert and oriented when she arrived in the ED, but she did report falling and hitting her head a few weeks before. Her vital signs were normal and she had a normal neurologic examination. A noncontrast head computed tomography (CT) scan showed the subdural hematoma was unchanged when compared to the MRI. She was examined by a neurosurgeon in the ED who recommended no acute intervention and repeat imaging in one week. She was admitted to a hospitalist service for observation.

She did well with no new complaints or complications and was discharged from the hospital the following afternoon (about 36 hours after admission). She left the hospital and went directly to a previously scheduled positron emission tomography CT scan, also being done for her cancer workup. On that study, the radiologist noted that the subdural hematoma had enlarged and the midline shift had increased to 11 mm. The patient was readmitted to the same hospital medicine team that had cared for her before. She was stable on admission with no neurologic complaints and a normal neurologic exam.

Unfortunately, the next day, her mental status deteriorated and a repeat CT scan showed an enlarging subdural hematoma. She was taken to the operating room for evacuation of the blood. The surgery was uncomplicated, but postoperatively she developed sepsis secondary to a hospital-acquired pneumonia. Despite maximal efforts, the sepsis progressed to multi-organ system failure. Care was ultimately withdrawn and she died peacefully 10 days after admission.

The hospital medicine service routinely reviewed all deaths on their service. In reviewing the death, the case review committee discovered the patient had been given low-molecular-weight heparin (LMWH) for venous thromboembolism (VTE) prophylaxis during the first admission. They spoke with the admitting provider for that admission. She did not realize she had prescribed the LMWH and stated she certainly didn't intend to prescribe it in light of the subdural hematoma. She stated that she was just "clicking boxes" on the admission order set in the electronic health record (EHR), and that she was used to ordering it as nearly all patients she admitted met criteria for VTE prophylaxis. She did recall being distracted by another complex patient at the time of entering the admission orders.

The case review determined that ordering the LMWH was a medical error that may have contributed to the patient's death. They realized there clearly were many benefits to using order sets in the EHR, but wondered about the risks associated with order sets and how best to balance the risks and benefits.

A Potent Medication Administered in a Not So Viable Route

The Case

A 55-year-old man with history of nonischemic cardiomyopathy and severe systolic dysfunction, as well as diffuse atherosclerotic vascular disease, was brought to the emergency department for septic shock of possible intra-abdominal origin. Owing to his cardiac condition, he was given a minimal fluid challenge and vasopressor support was ordered.

The plan was to start norepinephrine bitartrate after the placement of a central intravenous line. However, for reasons that are unclear, the norepinephrine was infused through a peripheral line. It was started at a low dose but then titrated up to 20 μg/hr to address the patient's continued hypotension. Approximately 7 hours later, when the intensive care unit team arrived to transfer the patient to the critical care unit, they were surprised to not find any central line. Instead, they found the norepinephrine was infusing in the peripheral line placed near the patient's right wrist.

The patient now complained of severe pain. However, given his altered mental status in the setting of sepsis, he could not point out where he felt the pain. His right arm, and particularly the fingers, had a bluish discoloration. The team recognized that the vasopressor had extravasated into the subcutaneous tissue of the arm. A right internal jugular line was immediately placed, and the norepinephrine switched to infuse through this central line. Attempts were made to treat the extravasation and salvage the right wrist and fingers, but eventually three of the patient's fingertips had to be amputated. The patient eventually recovered from his sepsis and was discharged home.

The case was discussed in the multi-departmental morbidity and mortality review, and a new protocol was issued that potent medications may be started only after the pharmacy, primary medical team, and nurses identify the medication, route of administration, and plan for titration. The protocol also stated that vasopressors may only be infused through central lines.

Hazards of Loading Doses

The Case

A 40-year-old woman was recently discharged after a prolonged hospitalization for seizures and a cardiac arrest. Two days after discharge, she presented to the emergency department (ED) complaining of headache, abdominal pain, and diarrhea. Her stool tested positive for *Clostridium difficile* colitis, which led to admission to the medicine service. As part of the initial ED patient evaluation, the neurology fellow (seeing the patient because of her history of seizures) noted a subtherapeutic phenytoin serum level and subsequently recommended that she be re-loaded with phenytoin. The ED physician ordered the correct loading dose of intravenous (IV) phenytoin, to be administered every 8 hours for 3 doses. Unfortunately, the physician failed to order that the dose be switched back to the appropriate maintenance dose of once daily after the loading was completed, so the patient continued to receive IV phenytoin every 8 hours.

Three days after admission, the patient developed somnolence, severe ataxia, and dysarthria. These new symptoms prompted the medicine provider to evaluate the patient's hospital course and medication history. After noticing the phenytoin dosing at every 8 hours, he checked a serum phenytoin level, which returned at 3 times greater than the maximum therapeutic level. The patient's neurologic symptoms persisted for 3 days after discontinuation of phenytoin. However, no long-term harm occurred.

Investigation of the event revealed that the admitting medicine physician did notice the unusually high phenytoin dose; however, he did not question it because he assumed it was recommended by the

neurology service. Apparently, the neurology consultant told the ED physician about his recommendations, but no formal consult note had been placed in the patient's chart to provide clear instructions for phenytoin dosing or monitoring.

The Missing Abscess: Radiology Reads in the Digital Era

The Case

A 45-year-old woman with type 2 diabetes and hypertension who had three previous cesarean deliveries presented with menorrhagia and anemia from large fibroids. She underwent a hysterectomy to remove the fibroids. To preserve hormonal function, the ovaries were not removed. The surgery was uncomplicated.

Postoperatively, she developed a fever and pelvic pain, and a computed tomography (CT) scan showed a large pelvic abscess. She was given antibiotics, and a percutaneous drain was placed. Over the next few days, her fever resolved and her pain improved. The infection was felt to be adequately treated, the drain was removed, and she was discharged.

The patient re-presented to the hospital 3 days later with recurrent abdominal pain. A repeat CT scan was performed and the radiologist reported a persistent large pelvic abscess. The gynecologist examined the patient and read the radiologist's report but did not personally review the CT scan images herself. Based on the report, she took the patient to the operating room for treatment of a presumed recurrent pelvic abscess.

In the operating room, the gynecologist had difficulty finding the abscess. She stopped the surgery and looked at the CT scan images on a computer in the operating room. She realized that what the radiologist had read as an abscess was actually one of the patient's ovaries, and that there was no evidence of a recurrent abscess or other infection. The surgery was aborted and the patient was taken to the recovery room. The initial complaint of abdominal pain on this admission was felt to be related to the incision and not to any infection.

Unfortunately, the patient developed a wound infection related to this second surgery. The infection led to delayed wound healing and a prolonged hospital stay. She went on to develop chronic abdominal pain, some of which was thought to stem from the unnecessary exploratory surgery.

The Empty Bag

The Case

A 90-year-old woman with end-stage dementia was admitted to an acute care hospital for treatment of a hip fracture after a fall at a nursing home. During the hospitalization, her kidney function worsened, as did her mental status. Because of this, the patient's family chose not to put her through surgery, and she was placed on the hospice service for comfort care.

The care team identified that the patient had increasing restlessness and that the current order for intravenous (IV) push morphine PRN [when necessary] was not effective for pain control. The physician ordered a morphine drip for better pain control. The nurse set up the morphine drip along with a carrier solution of normal saline. He placed the normal saline on a pump but failed to place the morphine drip on a pump as well. He mistakenly set the rate intended for the morphine on the pump that the normal saline

was on, and opened the clamps for both solutions. He turned the pump on and left the room to answer an alarm for another patient. The nurse had five other patients assigned to him that day.

The nurse checked on the patient approximately every 30 minutes, but only observed from the doorway and asked the family members present how things were going. Approximately 4 hours after the nurse started the morphine drip, he noticed that the patient was breathing very slowly and went to the bedside to examine her. He noted that the patient appeared near death and explained this to the family. Realizing that the morphine bag was empty, he immediately called the physician, obtained an order for naloxone, and administered it to the patient. However, the patient died shortly thereafter.

Later, the bedside nurse and the charge nurse went back into the room to examine the IV set-up and pump. They discovered that the morphine was connected into the tubing below the pump for the saline (instead of in its own pump), which meant it had flowed into the patient at an uncontrolled rate.

One Dose, Two Errors
he Case

A 65-year-old woman was admitted to the intensive care unit (ICU) with severe sepsis and respiratory failure secondary to community-acquired pneumonia. The patient was intubated and treated with broad-spectrum antibiotics while waiting for blood culture results. A few hours into the admission, the microbiology lab called the ICU to report that the blood cultures were growing yeast. The report was received by the nurse and relayed to the covering resident. The patient was immediately started on treatment with intravenous (IV) amphotericin (an antifungal drug), and broad-spectrum antibiotics were continued.

Two days later, the patient's respiratory status was improving and she was extubated. However, she was noted to have worsening renal function and decreased urine output, and she needed to be placed on hemodialysis on hospital day 3. The consulting nephrologist felt that amphotericin toxicity was the most likely cause of the acute kidney injury. A new resident took over the patient's care that day, after the previous resident rotated off service. She reviewed the laboratory data and was surprised to find that the patient had no positive blood cultures reported in the electronic medical record. She called the microbiology lab, who confirmed that the patient had not had any positive blood cultures. In the course of the discussion, she came to a troubling realization: the positive yeast cultures were actually for the patient in the *adjacent* ICU bed.

Further review revealed that the information about the positive yeast culture had been correctly called in to the bedside nurse, who then relayed to the correct resident. However, the resident had been caring for both patients, and he mistakenly entered the amphotericin order for the wrong patient.

At this hospital, prescribing IV amphotericin required approval from an infectious disease specialist due to its potential for toxicity. The resident who placed the order had, in fact, called the infectious disease fellow, described the correct patient, and obtained approval for the medication. However, once the verbal approval was secured, no further verification was required—the resident merely had to enter "infectious disease approval obtained" into the free-text section of the electronic order for amphotericin.

Once the error was detected, the amphotericin was immediately stopped. The patient who had received the drug continued to require hemodialysis for several more days. Although she was not dialysis-dependent when discharged from the hospital, her kidney function never returned to her previous baseline. The other patient—who should have been started on amphotericin—did not experience any adverse consequences as a result of the delay in initiating appropriate therapy.

Suicidal Ideation in the Family Medicine Clinic

The Case

A 20-year-old woman with bipolar disorder, borderline personality disorder, and a history of multiple inpatient psychiatric hospitalizations for prior suicide attempts called her primary care doctor's office at 10:30 AM stating that she had been "cutting her wrists" and had taken "extra doses of medication."

A front office staff member who did not have any clinical training answered the patient's phone call. He informed the patient that the next available appointment was at 3:00 PM that afternoon. The primary care doctor was not notified of the patient's behavior at the time of the phone call.

During the patient's office visit that afternoon, she was noted to have multiple cuts on both her wrists and stated that she "did not care" if she harmed herself. She stated that in addition to cutting herself, she had ingested several lithium pills. Recognizing that the patient was at high risk for suicide based on her behavior and medical history, the evaluating physician called security to escort the patient to the emergency department for a formal psychiatric assessment and inpatient admission. However, the patient was unintentionally left unattended for a brief period and eloped before providers could evaluate her.

The emergency department physician notified the local police who found the patient at her apartment later that evening. Luckily, she had not engaged in additional self-destructive behavior. She was brought back to the emergency department and ultimately admitted to an inpatient psychiatry unit for further treatment.

Continuity Errors in Resident Clinic

The Case

A 32-year-old woman presented to internal medicine clinic for evaluation of headaches and difficulty concentrating. The symptoms began after a motor vehicle collision a week earlier. She tried to schedule the visit with her primary care doctor—a resident—but his available slots were already full. This was not unusual—his availability was often limited to one clinic session per week due to his inpatient clinical obligations. Therefore, the appointment was booked with another resident provider.

During the clinic visit, the patient relayed the events of the collision to the resident. She reported that she had been sitting in the backseat, wearing her seatbelt, and that the impact caused her to strike her head on the window. Immediately after, she had been taken to a local emergency department for evaluation. Physical examination and head imaging were unremarkable, and the patient was discharged home. She subsequently developed headaches and difficulty concentrating as well as sensitivity to sound and light. The resident diagnosed probable postconcussive syndrome and started the patient on amitriptyline.

Given a lack of improvement in her symptoms, the patient returned to the same clinic 4 days later. Again, her primary provider was not available to see her. The resident who had seen her initially was no longer on his outpatient rotation, and the appointment was booked with a different resident provider. This resident ordered a brain MRI and placed a referral for the patient to be seen in neurology clinic. The resident had never placed a subspecialty referral before and did not realize that there were multiple neurology clinics. When the patient arrived at the neurology appointment several days later, she was informed that the referral had been made to the neuromuscular clinic though it should have been made to the headache clinic.

The patient returned to the internal medicine clinic for a third time because she was still experiencing severe headaches. This time she was able to see her assigned primary care provider. Although she was frustrated by the lack of continuity and incorrect neurology referral, the patient repeated in detail the same history she had relayed to the first and second resident providers. Her primary provider increased the dose of her amitriptyline and placed a new neurology referral to the headache clinic. The patient's headaches improved, and she was feeling much better by the time she saw the neurologist.

Unexpected Drawbacks of Electronic Order Sets

The Case

A 70-year-old man with stage 4 prostate cancer presented to the emergency department with severe muscle weakness. His lab results revealed severe hypokalemia and hypomagnesemia (2.2 mmol/L and 1.2 mEq/L, respectively). His electrocardiogram was significant for QTc prolongation and U-waves. The admitting team noted the patient had recently been started on abiraterone, an antiandrogen drug known to cause hypokalemia.

Because the patient had symptomatic hypokalemia, the medical resident was instructed to order potassium replacement using the hospital order set. Using the patient's potassium value to select the appropriate hypokalemia order set, the resident signed the order in the new electronic health record. However, while receiving his IV potassium repletion, the patient developed ventricular tachycardia and became nonresponsive. No resuscitation efforts were made due to the patient's DNR status.

Hypomagnesemia often accompanies hypokalemia. Despite the patient's low serum magnesium levels, neither the resident nor medical team recognized that the patient required magnesium replacement along with the potassium. Before the hospital transitioned to computerized provider order entry (CPOE), orders for common electrolytes were available on a single paper order set with check-boxes to indicate the appropriate replacement dose and route for specific lab values, including potassium and magnesium.

When the hospital recently switched from paper orders to CPOE, all order sets were imported into the electronic health record. However, to minimize the amount of information presented on each screen, a separate order set was created for each electrolyte replacement order (e.g., hypokalemia, hypomagnesemia). The team responsible for transitioning the paper orders to CPOE did not realize that the old paper electrolyte order set provided a reminder to order magnesium replacement to accompany potassium replacement, and that, by separating out the order sets electronically, an important safety reminder was lost. An internal investigation concluded that the transition to electronic order sets contributed to mismanagement of the patient's low magnesium and potassium levels, which resulted in a fatal arrhythmia.

Don't Dismiss the Dangerous: Obstetric Hemorrhage

The Case

A 19-year-old woman, pregnant at 35 weeks gestation, was admitted to the labor and delivery unit in the setting of new hypertension. Blood tests revealed a hemoglobin level of 11.1 g/dL and mildly elevated liver enzymes (aspartate aminotransferase [AST] 205 mg/dL and alanine aminotransferase [ALT] 189 mg/dL).

Given concerns for preeclampsia and for viability of the fetus, she was taken to the operating room for an emergency cesarean delivery. The delivery was uncomplicated with an expected degree of bleeding; the

infant was delivered in good condition. The mother was taken to the recovery room in stable condition. A postoperative hemoglobin level was 9.6 g/dL.

Over the next few hours, the patient had progressive tachycardia and persistent hypertension. Out of concern for pulmonary embolism, a computed tomography scan was ordered, which showed no evidence of pulmonary embolism. She continued to have worsening tachycardia (heart rate in the 140s) and some new abdominal discomfort.

Repeat blood tests were done 8 hours after the previous ones and showed a hemoglobin level of 3.6 g/dL. Her AST was 1185 mg/dL and her ALT 1344 mg/dL. She was given blood transfusions and taken back to the operating room out of concern for postpartum hemorrhage. In the operating room, approximately 3 liters of blood were evacuated from the uterus. A source of bleeding could not be found so the uterus was packed with gauze, and she was transferred to the intensive care unit in critical condition.

Over the next few hours, the patient had progressive shock, respiratory failure from acute respiratory distress syndrome, and disseminated intravascular coagulation. She required vasopressors, mechanical ventilation, and more than 10 units of packed red blood cells. She had a long and complicated hospital course but was ultimately discharged to a rehabilitation facility with no major permanent injuries.

Near Miss With Neonate
The Case

A 37-year-old pregnant woman was admitted to the hospital for scheduled induction of labor for postterm dates. Early the next morning, intravenous oxytocin was administered to induce labor.

When the obstetrics team rounded on the patient several hours later, AROM (artificial rupture of membranes) was recommended to accelerate labor. The intern reviewed the patient's chart and noted that a culture done from a vaginal and rectal swab at 36 weeks was negative for group B streptococcus (GBS)—a bacteria that sometimes colonizes the gastrointestinal and genital tracts of pregnant women. If documented at any time during pregnancy, the infant is at increased risk of infection at the time of delivery. The intern failed to note that faxed records from a clinic outside the hospital system included another culture—a urine culture positive for GBS. This test had been ordered at an office visit earlier in the patient's pregnancy. Given this positive culture, to prevent transmission of GBS infection to the infant, the patient should have been started on intravenous antibiotic prophylaxis before the membranes were ruptured.

The senior resident on the team happened to review the faxed records and noted the positive urine culture. She immediately ordered antibiotics and delayed AROM for several hours to allow time for the medication to infuse. Luckily, the senior resident's "catch" made this case a near miss, and the patient ultimately delivered a healthy infant and experienced no adverse consequences.

Lapse in Antibiotics Leads to Sepsis
The Case

A 34-year-old near-term pregnant woman presented to the emergency department (ED) with abdominal pain, fevers, and shortness of breath. Upon further evaluation, she was noted to have a rapid heart rate and low blood pressure. Laboratory studies, including blood cultures, were drawn. Given that the fetus was in distress, intravenous (IV) antibiotics were administered and the patient was rushed to the operating room for an emergent cesarean delivery. The amniotic fluid was foul smelling and chorioamnionitis—an

infection of the amniotic sac that can cause severe infection in both the mother and the baby—was diagnosed.

After delivery, the patient was transferred to the hospital floor and admitted to the postpartum service. Antibiotics should have been continued to treat the infection, but the initial order was placed as a one-time dose by the ED providers, and the inpatient team did not realize that it had been discontinued. Several hours later, the patient was noted to be lethargic with a low blood pressure. IV fluids were administered. While the inpatient care team discussed possible causes for her low blood pressure, the microbiology lab called to notify the team that the patient's blood cultures had grown gram-negative rod bacteria. At that point, the team realized that the patient was in septic shock. A review of the inpatient orders revealed that IV antibiotics had not been continued since the initial dose administered almost 24 hours earlier in the ED.

Although antibiotics were administered immediately, the patient's clinical status deteriorated further, and she was transferred to the intensive care unit for management of septic shock. She required intubation and hemodynamic support but eventually made a full recovery. The delay in appropriate treatment of sepsis with continued antibiotic therapy on admission resulted in a longer and more complex hospital stay for the patient.

Unintended Consequences of CPOE
The Case

A 60-year-old woman with a history of metastatic colon cancer and known malignant ascites was admitted to the hospital with abdominal pain, nausea, and vomiting. She presented with sepsis and acute kidney injury with a creatinine of 2.0 mg/dL (up from a baseline of 0.8 mg/dL). She underwent paracentesis and was found to have evidence of acute bacterial peritonitis. She was started on broad-spectrum antibiotics.

The cultures from her peritoneal fluid grew multiple bacterial species, raising concerns for bowel perforation. Her creatinine improved but remained elevated at 1.6 mg/dL and the team felt the persistent acute kidney injury was probably from her sepsis. The team decided to order a CT scan of the abdomen and pelvis with oral contrast. After a discussion, they decided to order the scan without intravenous contrast, out of concern for causing worsening renal function (i.e., contrast nephropathy).

The intern caring for the patient was rotating at this hospital for the first time and was new to the computer system; in fact, she had not ordered a CT scan through the system yet. She only vaguely remembered the necessary steps from the online computer module she had completed 5 weeks earlier as part of her orientation to the training program.

When entering the order for the CT scan, there was a long list of options that were labeled in many different ways. She scanned the list and chose the one named "CT Abdomen and Pelvis with contrast," assuming that she'd need to order the oral contrast separately. She placed the CT scan order, along with a separate order for the oral contrast.

Unfortunately, the CT scan that she ordered had, bundled with it, the use of oral contrast and intravenous contrast. The patient therefore received both kinds of contrast during the scan. The next day when they reviewed the images and saw evidence of both kinds of contrast, the team recognized the error. The patient's creatinine worsened over the next few days, rising to a peak of 3.1 mg/dL. The team caring for the patient felt this was consistent with contrast nephropathy.

The patient remained in a hospital for 6 more days for monitoring and adjustment of her other medications. She ultimately was discharged to an inpatient hospice facility.

Wrong-Time Error With High-Alert Medication

The Case

A 60-year-old man was admitted to the hospital for a total knee arthroplasty. During the admission process in the early evening, the surgical resident restarted his maintenance home medications, including oral dofetilide (an antiarrhythmic agent) taken every 12 hours. In the electronic health record, drugs ordered for "q12 hour" dosing are scheduled for 6 AM and 6 PM by default. The overnight nurse saw that the morning dose was scheduled to be given at 6 AM, but the patient was scheduled to leave for the operating room before 6 AM, so she gave the dose early, at 4 AM. During his preoperative assessment at around 6 AM, the patient was noted to have severe QTc prolongation on his electrocardiogram, putting him at high risk for torsades de pointes, a sometimes fatal arrhythmia. Considering the acute ECG changes (prior QTc intervals were normal), surgery was canceled and the electrophysiology service was consulted.

The electrophysiology fellow felt that the 4 AM dofetilide administration likely contributed to the arrhythmia. Dofetilide is known to be associated with QTc prolongation if administered too early or at excessive doses. Further investigation revealed the patient also took his previous night's dose later than usual, at 10 PM. Consequently, rather than having received his dofetilide doses 12 hours apart, the 2 doses had been given only 6 hours apart. Neither the surgical resident nor the nurse responsible for administering the drug was aware of the risks associated with deviation from the strict 12-hour dosing interval, and neither had asked the patient about the timing of his last dofetilide dose.

The patient was monitored on telemetry for a few days, and surgery was delayed until the return of his QTc to baseline. After this case, the hospital added dofetilide to a list of drugs that could only be ordered by a specialty service.

Complaints as Safety Surveillance

The Case

A 42-year-old woman presented to the emergency department with abdominal pain. She said the pain came on suddenly that morning after binge-drinking vodka. The pain was in the epigastrium, radiated around to her back, and was accompanied by nausea and vomiting. Her laboratory studies showed elevated amylase and lipase, and a CT scan confirmed the diagnosis of acute pancreatitis. She was admitted to the hospital and given intravenous fluids and intravenous hydromorphone (Dilaudid) for pain control.

The next morning, the patient was still experiencing moderately severe abdominal pain. She requested "more of the medicine that starts with a 'D.'" The hospitalist—not being entirely familiar with the pain medication she was on—said that he would increase it. He decided to increase her 1 mg dose of Dilaudid to 4 mg and asked the nurse to administer another dose immediately. The nurse thought it unusual to increase the pain medication so much, but she remembered that this hospitalist had a reputation for being brusque and defensive when his orders were questioned. She administered the medication without challenging the order.

About 10 minutes later, the nurse returned to check on the patient and found her to be unresponsive and apneic. She immediately called the hospital's rapid response team, who administered naloxone (a

medication that reverses the effects of opioid medications). Despite this treatment, the patient remained unresponsive and had to be transferred to the intensive care unit. She was intubated for airway protection and treated with a naloxone infusion overnight until her mental status and respiratory status improved. She was successfully extubated the next day. Her hydromorphone was discontinued and the patient was treated with oral pain medications for the remainder of her hospital stay. Following improvement in her pancreatitis, she was discharged home in stable condition.

Due to the severity of the event, the hospital's patient safety committee investigated the incident with a formal root cause analysis. The hospitalist was interviewed and admitted that he was unfamiliar with prescribing hydromorphone. He had assumed it was similar in potency to morphine, but in fact, 1 mg of intravenous hydromorphone is equivalent to 4 mg of morphine. The hospital's patient relations committee reviewed its records and found that in the past 2 years, 3 other patients had filed complaints about the care provided by the hospitalist. None of those patients had clearly experienced an adverse event, but the hospital faced a decision about how best to address the concerns about the quality of the physician's care.

A Pill Organizing Plight

The Case

As part of an outpatient geriatrics rotation, an internal medicine resident visited one of his patients—an 80-year-old, Spanish-speaking woman with multiple medical problems including hypertension, hypothyroidism, hyperlipidemia, gastroesophageal reflux, coronary artery disease, and depression—in her home for recent onset of lightheadedness and dizziness. At a recent outpatient visit, she had been diagnosed with Alzheimer dementia for which she was prescribed a new medication, donepezil. Her family was advised that she would require ongoing assistance to manage complex tasks including organizing her medications.

During the home visit, the resident reviewed the patient's medications in detail. The patient's medical record revealed that she was supposed to be taking eight medications daily, including losartan and hydrochlorothiazide for hypertension, levothyroxine for hypothyroidism, pantoprazole for gastroesophageal reflux, aspirin for coronary artery disease, simvastatin for hyperlipidemia, escitalopram for depression, and the newly prescribed donepezil.

The patient reported using a pillbox, which her daughter sometimes filled for her when she visited. The resident identified several errors in the pill organization system, including empty slots for upcoming days as well as slots that contained a higher number of blood pressure medications than the patient was supposed to take. The resident also discovered that an old blood pressure medication (a beta-blocker), which had been stopped by the patient's cardiologist months ago, was still in the pillbox. As a result of these problems, on some days the patient was taking up to five blood pressure pills when she was only supposed to be taking two. The resident suspected that her symptoms of lightheadedness and dizziness were the result of intermittently overdosing on blood pressure medications. Additionally, the resident discovered that the new medication—donepezil—was not in any of the pill slots because the patient's daughter was unaware that it had been prescribed to the patient and therefore never picked it up from the pharmacy.

Fortunately, the resident was able to spend time explaining the clinical significance of each medication to the patient's daughter and helped her develop a standard approach to filling her mother's pillbox each month. A follow-up home visit revealed that once the pillbox had been properly organized, the patient's lightheadedness and dizziness had resolved.

Falling Between the Cracks in the Software

The Case

A 61-year-old man with a history of osteoarthritis was scheduled for a total knee replacement. Prior to surgery, he saw his orthopedic surgeon in clinic because of increased pain. The surgeon prescribed oxycodone. The new prescription was reflected in the outpatient medical record, which was on a different information technology platform than the hospital system and did not communicate with it. At the time of hospital admission, the patient did not remember to mention the oxycodone as a new medication when asked for his list of outpatient medications.

Unaware that the patient had started taking oxycodone, the anesthesiologist, hoping to achieve adequate postoperative pain control, placed an epidural catheter through which morphine was administered. While in the postanesthesia care unit, the patient became somnolent from receiving morphine on top of the oxycodone he had already taken earlier that day. Despite the administration of naloxone, the patient required intubation and a brief intensive care unit stay. He was quickly extubated and experienced no long lasting adverse effects from the medications.

If the inpatient medical record had been automatically updated to include the patient's oxycodone, the anesthesiologist would have taken this into account when administering morphine. The lack of interoperability between the office-based medical record platform and the inpatient system contributed to the error.

Getting the (Right) Doctor, Right Away

The Case

A 57-year-old woman with a history of chronic obstructive pulmonary disease underwent hip surgery. Postoperatively, the patient was short of breath and remained in the postanesthesia care unit (PACU) for close monitoring of her respiratory and cardiac status while awaiting an intensive care unit (ICU) bed. When the patient suddenly lost a pulse, providers initiated cardiopulmonary resuscitation, which led to a return of spontaneous circulation.

As part of the evaluation for the patient's shortness of breath, providers ordered a chest radiograph, which showed a pneumothorax. But the radiologist, who knew that such a finding might require emergent treatment (usually a chest tube), found herself unable to find the correct ("first call") physician to page regarding this critical information. She was forced to call the PACU, find a nurse, and then have the nurse access the online physician scheduling system to determine who was currently the first call physician.

When the results were eventually communicated to the first call provider, needle thoracostomy was performed immediately and a chest tube was placed. The patient's shortness of breath resolved, and she was moved to the ICU after being stabilized. A follow-up chest radiograph showed resolution of the pneumothorax. Thus, while the delay in reaching the first call provider did not lead to long-term harm to the patient, it easily could have.

Cognitive Overload in the ICU

Case & Commentary—Part 1:

A 72-year-old woman was admitted to the intensive care unit (ICU) with acute respiratory distress syndrome secondary to severe acute pancreatitis. A central line was placed into the left subclavian vein to

administer intravenous fluids and vasopressors. A chest radiograph showed the central line in the proper position, with no evidence of pneumothorax.

Over the next 8 hours, despite maximal treatment, the patient's condition worsened, with progressive hypotension, acidosis, and hypoxia. The intensivist in charge was actively managing her complex care while intermittently updating the family about her worsening condition. At the same time, the intensivist was also managing nine other sick and complicated ICU patients, with nurses and respiratory therapists intermittently approaching her with questions about their ongoing management.

The patient with acute pancreatitis continued to worsen and had progressive bradycardia from acidosis resulting in a pulseless electrical activity (PEA) cardiac arrest. The intensivist led the resuscitation, which lasted for approximately 25 minutes. The patient ultimately regained a pulse but required two vasopressors to maintain her blood pressure and near maximal ventilator support because of severe hypoxia. A new set of laboratory tests, an arterial blood gas, and a chest radiograph were performed.

The intensivist responded to the full set of labs (e.g., repleting electrolytes, etc.), ordered additional fluid boluses, and changed the antibiotics. The patient remained acidotic and hypoxic over the next few hours. The intensivist was not sure why the patient was getting worse and sat down to think more about the clinical course—wondering what she might be missing. At that moment, another nurse in the ICU approached her about a different patient who had new hypotension and altered mental status.

Severe acute pancreatitis threatens life by several mechanisms: respiratory failure, renal failure, and circulatory shock. Standard evaluation includes an estimate of lung water by chest radiograph and of intravascular volume by measurement of central venous pressure.(1) Standard treatment routinely includes intubation and mechanical ventilation, infusion of intravenous fluids, and administration of potent vasopressors if necessary. Bedside cannulation of the central circulation for measurement of central venous pressure and for vasopressor infusion is often indicated.(2) The intensivist in this case took all the appropriate steps: inserting a central line, obtaining follow-up chest radiograph, intubating the patient and placing her on mechanical ventilation, and carefully monitoring fluids, electrolytes, and acid–base status.

Although the intensivist appears to have provided standard care for this patient, she was pulled in several directions by concerns about nine other sick patients in the ICU and had limited time to explore the reasons for the patient's deterioration. This phenomenon is known as cognitive overload, which is a familiar and frequent challenge in fast-paced environments such as ICUs and emergency departments.(3,4) In this case, a major source of *cognitive overload* was the frequent interruptions that prevented quiet contemplation and interpretation of the existing problems affecting the sickest of her ICU patients.(5)

Interruptions can increase the cognitive load on memory and attention, and they can subsequently lead to errors, compromising patient safety.(6,7) Yet, interruptions are an inescapable component of clinical work. Because they cannot be completely eliminated, it is necessary to understand the circumstances in which interruptions are likely to occur and to consider ways that their effect on cognitive load and patient safety can be mitigated.(8-10)

Studies suggest that interruptions can compromise memory and attention by requiring individuals to switch focus from one task to another.(11) As in this case, returning to a disrupted task requires completion of the interrupting task and then regaining the context of the original task. Multiple variables, including the characteristics of the primary task, the nature and length of interruptions themselves, and the environment itself, may influence the impact of interruptions on clinical tasks and errors.(12) For

example, interruption disrupts complex cognitive tasks, which then require almost three times longer to resume effectively than simple tasks.(13) Interestingly, surveys and retrospective accounts of adverse incidents have often implicated interruptions, yet real-world evidence of the relationship between interruptions and clinical errors is scarce.

Providers and institutions can take measures that allow a more facile return to a complex task or reduce the likelihood of interruptions. For example, staff can be educated about the need to allow attending clinicians to have uninterrupted time for contemplation. However, in a complex, fast-paced, life-and-death environment, this practice may be challenging. As a result, careful assessment of staffing requirements, as well as individual roles and responsibilities, is crucial. In this case, the attending physician appeared to be the lone intensivist managing nine patients. While not an excessive volume of patients, the workload can quickly become unmanageable if multiple patients become unstable simultaneously. Monitoring and alerting technology may also be helpful. The notion is to use other people and technology to distribute the cognitive tasks (sharing mental efforts) so that one person is not overwhelmed as the sole recipient of the cognitive load in such environments.(14)

There are also lessons related to our growing use of electronic health records (EHRs), within and outside of the ICU setting. The traditional paper chart offered a shared information space; it allowed each member of the team (including nurses and other health professionals) to share their interpretation of patient data, thus leading to negotiation of meaning and consensus building.(15) In contrast, most current EHR systems provide clinicians with an individual narrow view of a patient case, not allowing multiple clinicians to create and share common views of the available patient data. New tools for collaborative annotation and access to decision histories can enrich traditional EHR systems and help the entire team engage in collective sensemaking over patients' care.(16) Some have proposed something akin to a "Facebook wall" for patients where all providers engaged in a patient's care can access the wall and add information as deemed necessary.(17)

Case & Commentary—Part 2:

Over the next few hours, the intensivist responded to new clinical data for the patient with pancreatitis, but she never found time to reflect on the clinical presentation. At 4:00 AM (3 hours after the chest radiograph had been performed following the PEA arrest), the radiologist called to inform the intensivist that there was a large pneumothorax. A thoracic surgeon was called to place a chest tube. The patient immediately responded, with improved oxygenation and blood pressure. The intensivist felt the pneumothorax likely explained most of the worsening clinical course overnight. It was not clear when or why the pneumothorax had occurred. Despite the temporary improvement, the patient experienced recurrent hypotension and progressive acidosis. Ultimately, after discussions with the family, care was withdrawn and the patient died peacefully. In thinking about the case, the intensivist recognized that she simply didn't have the time to think more broadly about why the patient was worsening despite treatment, and that she had felt overwhelmed by numerous required tasks and multiple interruptions.

In retrospect, the patient's initial deterioration and subsequent cardiac arrest were due to a pneumothorax not yet evident on the initial film obtained when the central line was placed. Two common risks to insertion of central lines include (i) misdirection of the catheter (cranially up a jugular vein or laterally into the axillary vein) and (ii) pneumothorax resulting from puncture of the lung.(18) The rate of pneumothorax following central venous insertion has declined from its initially reported rate of 2% to below 1%. Technical improvements to cannulation procedures (including cannula-over-wire ["Seldinger"] techniques and ultrasound guidance) have reduced, but not eliminated, pneumothorax as a complication.(19) It therefore remains common practice to obtain and interpret a chest radiograph after central line placement. In this case, the initial radiograph provided reassurance that the central line was in

the correct position without evidence of lung injury. The latter is especially important because the combination of a punctured lung ventilated with positive pressure can lead to hemodynamic compromise due to a tension pneumothorax.

That the initial film did not demonstrate a pneumothorax is reassuring but not definitive. Several reports spanning decades suggest that a small fraction of pneumothoraces—fewer than one in five—that arise following central line insertion are not visible on initial chest radiograph.(20) This means that an occult pneumothorax occurs quite rarely—fewer than once in every 500 attempted insertions. Most clinicians will never encounter an occult pneumothorax following central line placement—or its potentially deadly consequences—during their professional lifetimes.

We cannot know for certain whether the pneumothorax was the result of the central line insertion. Mechanical ventilation of stiff acute respiratory distress syndrome–affected tissue can also lead to pneumothorax. Moreover, the clinician followed standard care when, following successful resuscitation, laboratory studies and a repeat chest radiograph were ordered. What is of interest in this case—and the narrative is silent on these matters—is (i) whether the clinician had a bedside ultrasound device immediately available to evaluate for pneumothorax, and (ii) whether a protocol was in place that a critical chest radiograph (such as one obtained after a cardiac arrest) would be interpreted by a radiologist as a priority.

The intensivist failed to verify the absence of a pneumothorax or other chest radiograph problem immediately after the code. The error was cognitive in nature and resulted from external factors common in critical care medicine. In general, common cognitive errors include failure to (i) receive or perceive data; (ii) comprehend data; (iii) communicate or transfer data; and (iv) accurately anticipate the consequences of decisions based on the data. Any of these failures can result from a loss of *situational awareness*, i.e., lack of intuitive understanding of key elements in the environment, including insights into the actions of team members at any given time and the projection of their likely status in the near future.(21,22) Such loss of situational awareness predisposes to a poor decision or sequence of actions that can lead to adverse events. In this case, stress and interruptions seemed to result in diminished situational awareness regarding the patient's deterioration and consequently a failure to review (i.e., receive) the data necessary to make the appropriate decision.

We may be tempted to blame the physician for the errors that occurred in this case. However, one can argue that in a setting like the ICU, all team members had a role in preventing the error: the clinician who was too busy to check on the postcode film, the nursing staff who interrupted the intensivist and pulled her in multiple directions, and the radiologists who evidently failed to note the problem immediately on the patient's postcode film and to notify the clinician urgently about the pneumothorax. And one may argue that the complexity of the ICU environment makes such occasional errors inevitable.

Yet, in complex settings, teamwork can help to reduce errors. We know that characteristics of teamwork are intimately tied to the occurrence of errors and to their prevention or mitigation.(23) Although much lip-service is paid to the role of teamwork in clinical care, health care systems have tended to assume that providers will learn and become proficient in such teamwork skills through experience alone. But opportunities exist to enhance training so that team-based care is better understood as a cognitive collaboration, one that requires joint discussion and communication to ensure errors are recognized early while there is still time to intervene. Simulation has long been used to train teams to work more effectively together, and those methods are becoming more sophisticated. Complex tasks in complex environments (e.g., active full resuscitation efforts) can be replicated using simulation to train individuals and teams. Evidence suggests that realistic and high-fidelity simulation programs can improve knowledge and confidence among critical care providers.(24) Simulation methods should accordingly be used to train

members of ICU teams to work together more effectively and to learn how to enhance their joint ability to recover from the inevitable errors that will occur in such environments.(24) Recovery from error is arguably more important and realistic than trying to prevent all errors at the outset.(25)

In this case, multiple interruptions, stress, and patient complexity led a critical care physician to experience cognitive overload and an inability to maintain situational awareness to recover from interruptions. Technology could have been harnessed to help alert the physician to results in a more timely manner. Better staffing and protocols might have lessened the impact of workload and interruptions. Lastly, enhanced teamwork, facilitated through specific training and the use of simulation, may have created an environment where the team could have collaborated to ensure safe and effective care.

Take-Home Points

- In the complex ICU environment, teams must recognize that their work is cognitively distributed across all members and the support systems used.
- With effective approaches to balancing and sharing tasks, well-functioning teams can help to reduce the cognitive load and interruptions that are often a source of errors in such settings.
- Technology can support busy clinicians?monitoring for problems, alerting clinicians when appropriate, and providing intuitive and accurate displays of the information.
- In critical care environments, emphasis should be on team communication, prompt recognition of errors when they occur, and steps to recover from such errors or to mitigate their adverse effects.
- Effective teams are built through effective training, including the use of simulation methods.
- Teams should learn how to distribute cognitive loads so as to complement each other, offload tasks when appropriate, and contribute to increased patient safety.

Communication With Consultants

The Case

A 30-year-old pregnant woman presented to the emergency department (ED) with nausea, headaches, and fevers. Her laboratory studies were notable for a markedly elevated white blood cell count of 121,000 (normal is 5,000–10,000, and routine infections virtually never raise the count above 25,000, making this level highly suspicious for a hematologic malignancy). The ED physician contacted the hematologist on call regarding the abnormal complete blood count (CBC). The hematologist informed him that she would follow up the labs and see the patient the following day.

Later that afternoon, the patient was admitted to the hospital by the primary medical team and continued to worsen through the night. She became progressively tachypneic with an increasing oxygen requirement, ultimately requiring intubation and transfer to the intensive care unit. The primary team did not attempt to contact the hematologist again overnight, assuming that the information about the patient's tenuous clinical status and markedly elevated white blood cell count had been adequately conveyed by the ED provider and that no acute intervention was required overnight, which is why the hematologist had decided to see the patient the following day. In fact, the hematologist had been told only that the patient had an "abnormal CBC with a pending differential" and that her input might be helpful. She was unaware of the urgent nature of the consult.

The following day, the hematologist confirmed the diagnosis of leukostasis as the result of acute myeloid leukemia—an oncologic emergency for which treatment should have been initiated immediately. Although leukapheresis and induction chemotherapy were ordered, the patient had already developed multi-organ system failure as a result of the delay. She was transitioned to comfort measures and died shortly thereafter.

July Syndrome

The Case

A 64-year-old man was seen in the thoracic surgery clinic in June after being diagnosed with a right lower lobe lung cancer. The attending surgeon saw the patient along with his fellow, who was completing his 1-year fellowship. By that point in the year, the attending had supervised the fellow's operative and postoperative care of nearly 100 patients, and he trusted him completely. The patient was a good candidate for surgery, so the surgeon discussed the operative plan (a right lower lobe lobectomy) briefly with the fellow and had the procedure scheduled for a few weeks later.

The procedure was scheduled for the first week of July. However, by this time, the fellow who had seen the patient in clinic had graduated and left the institution. The procedure itself was uneventful and the patient was transferred to the intensive care unit (ICU) postoperatively. The initial postoperative orders were written by the new thoracic surgery fellow, who had just started his fellowship and was new to the organization. He wrote brief orders for postoperative care, assuming (as had been the case at the hospital where he did his residency) that the ICU team would write more comprehensive orders.

The patient was received in the ICU by a surgical intern, who was in her first rotation and had also graduated from medical school elsewhere. The patient's nurse noticed that there were no orders for venous thromboembolism (VTE) prophylaxis, despite the patient being at high risk for VTE. She brought this to the intern's attention. The intern assumed that VTE prophylaxis was contraindicated, since the fellow had not ordered VTE prophylaxis; she also recalled an incident during medical school where a surgery intern had been chastised for starting VTE prophylaxis inappropriately. Although the standard postoperative order set in the electronic medical record included a prompt for a VTE prophylaxis order, the intern found that she could easily skip this order and complete the rest of the order set without difficulty. Therefore, the patient was not prescribed VTE prophylaxis.

Two days later, the pharmacist on the ICU team was reviewing orders for the patient and realized that the patient was not receiving VTE prophylaxis. She brought this to the attention of the intern, who replied that she thought it was contraindicated so she had not ordered it. The pharmacist conferred with the ICU attending, who agreed that VTE prophylaxis should have been started postoperatively and made sure it was started that day. Fortunately, the patient experienced no adverse consequences as a result, but the pharmacist and ICU attending wondered what could have been done to limit the risk of such an event in the future.

The Case of Mistaken Intubation

The Case

A 65-year-old man with a history of end stage renal disease, injection drug use, and multiple prior infections was living at a skilled nursing facility (SNF). He had recently been discharged from the hospital after a prolonged and complicated hospitalization for severe sepsis secondary to osteomyelitis.

During a routine morning vital signs check at the SNF, he was found confused and tachypneic, complaining of severe shortness of breath. Paramedics were immediately called, and they found him hypoxic, hypotensive, and tachycardic. He was taken to the hospital. A packet with the appropriate documentation from the nursing facility was transported with the patient. The physician at the SNF who knew him well called the emergency department (ED) to provide clinical details.

When the patient arrived in the ED, he had persistent hypoxia despite maximal oxygenation. The ED providers attempted to determine the patient's wishes for intubation and life-sustaining care, but no family members were present and they could not find clear documentation in the records from the SNF.

The patient was intubated and placed on a mechanical ventilator, and a central line was inserted. He was treated for severe pneumonia with antibiotics and intravenous fluids. The ED providers contacted the inpatient internal medicine team for admission.

The inpatient team happened to be the same team that had recently discharged him. When hearing about the case, the resident asked why the patient had been intubated as the patient had made it clear during the last admission that "he did not want to be intubated or resuscitated under any circumstances." The resident stated the patient had completed a POLST form (Physician Orders for Life-Sustaining Therapy), and the team had clearly documented his wishes in the discharge summary. They had also spoken directly with the provider at the SNF.

The admitting team evaluated the patient in the ED. When the patient's family arrived, the team explained to them that the patient had been intubated because his wishes were not clear when he arrived to the ED in acute respiratory distress. In discussions with the family, all agreed the patient would not want ongoing aggressive therapy. The endotracheal tube was removed and he was taken off life support. He died peacefully later that day with his family at the bedside.

Given the serious nature of the adverse event, the case was referred for a formal root cause analysis (RCA). At the RCA, a number of errors were identified, including:

- During the first admission the patient had completed the POLST form, but it had not been loaded into the computer system because the house staff did not know the standard process. They simply put the form in the paper chart.
- The POLST form that had been completed was not included with the paperwork sent with the patient to the SNF when he left the hospital.
- When the patient became ill, the physician at the nursing facility called the ED at the nearest hospital and told them about the patient (including his code status as DNR/DNI). However, the patient was taken to a different hospital (the one he had been discharged from) by the ambulance, and the physicians there had not spoken with the SNF physician.
- In the paperwork that came with the patient from the SNF, there was conflicting information about his wishes. While an old advance directive documented "full code," a more recent physician progress note documented "DNR/DNI."

The Fluidity of Diagnostic "Wet Reads"

The Case

A 64-year-old man with heavy tobacco use presented to the emergency department (ED) with chest pain. His electrocardiogram showed no evidence of myocardial ischemia, but his blood pressure was markedly elevated. The treating physician, concerned about a possible aortic dissection, ordered a CT angiogram of the chest. The preliminary ("wet") read from the radiologist was communicated to the ED physician—it reported "no evidence of aortic dissection," so the patient was discharged home once his symptoms resolved. He was advised to establish care with a primary care physician (PCP). A final read of the CT scan would be performed the following morning, but by then the patient was already home and no clinician reviewed it that day.

The patient saw his new PCP about 1 month later and reported fatigue, a chronic nonproductive cough, and a 17-pound weight loss over the past year. He brought his printed after-visit summary (AVS) from

the ED visit, which noted that a chest CT had been performed, which showed no aortic dissection. After reviewing the AVS, the PCP assumed there were no other concerning findings on the CT scan. As it was a very busy clinic day, he did not review the final radiology report for the CT scan. The PCP counseled the patient on tobacco cessation and obtained basic lab tests to work up his fatigue and weight loss. He scheduled the patient for a follow-up visit in 1 month.

The patient missed this follow-up appointment and ultimately returned to the clinic several months later. At that point, he told the PCP that his cough had worsened and was now producing blood-tinged sputum. Concerned, the PCP immediately obtained a chest radiograph, which showed a large right upper lobe nodule. Only then did the PCP review the formal report from the earlier CT—which had documented "a suspicious noncalcified, spiculated nodule in the right upper lobe of the lung measuring approximately 1.2 cm in diameter, concerning for malignancy given the patient's history of tobacco use"—and realize that the nodule had been seen previously. It was not clear if any physician had been informed about the lung nodule after the final reading of the earlier CT was issued. The patient was ultimately diagnosed with primary lung adenocarcinoma involving the right upper lung.

The error was disclosed to the patient with the help of clinic leadership and risk management. The patient was understandably upset that he was not made aware of the initial findings, but he continued working with providers to expedite his care.

Mismanagement of Delirium

The Case

An 85-year-old man with early stage vascular dementia fell on the sidewalk and fractured his leg. Although fitted with a cast at a regional hospital, the patient was not able to walk independently. He was given crutches and instructions for no weight-bearing on the injured leg. He was admitted to a skilled nursing facility for physical therapy to establish mobility and for assistance with bathing and dressing. His wife stayed with him most of the day during first 2 days.

Prior to this event, the patient lived at home and was independent in activities of daily living. He used distance and reading glasses, eye drops 3 times daily, and had hearing aids. Over the previous year, he experienced nondisturbing visual hallucinations (e.g., bird in the tree, squirrel on the lawn, bug on the floor). He had disturbed nighttime sleep and occasionally got up at night, showered, and dressed, before asking his wife the time. He experienced frequent daytime sleepiness with varying levels of concentration. He had a shuffling and sometimes propulsive gait, and he fell easily.

On day 3 in the skilled nursing facility, prior to arrival of his wife, the patient became delirious and agitated. He waved his crutch to keep staff at a distance, threatened to kill them if they approached, and knocked over furniture. The sheriff was called. The patient was taken to the hospital emergency department (ED). The patient spent his first night in the ED hallway with his wife and daughter alternately by his side. On day 2 of hospitalization, he was transferred to a hospital room and was visited by a psychiatrist. That night, the patient became delirious and threw a cup of water at a sitter. On day 3, the patient was lucid and explained he thought he been captured and was trying to escape. He expressed remorse. The psychiatrist recommended transfer to the geriatric-psychiatry ward for better patient management, and the patient's wife accepted the recommendation without understanding the implications. At the time of the transfer, the patient had been immobile for 3 days, and he had constipation, mild dehydration, and pain.

Over the next 2 days, the wife and daughter became concerned about their loved one's care and requested alternate ward placement that allowed a 24-hour family caregiver at the bedside. They further requested that the staff address the patient's mobility needs and work to eliminate some of the delirium triggers. The psychiatric intern was called and explained to the patient's family that the patient has been involuntarily committed, and no change in placement or treatment would be considered. The intern further explained that the primary medical concern was the patient's behavior, not his mobility. The family requested to see the intern's supervisor, who spoke to the family by telephone and confirmed the intern's statement. The family then called the patient's primary care physician, who deferred to the specialists on the overall plan, but requested that the patient's daughter be allowed to stay with the patient overnight. The ward nurse refused the request and the wife and daughter were escorted from the locked ward at 9:30 PM.

The patient continued to experience nighttime agitation and was aggressive toward staff during nights 3–5, which led to the use of restraints. Ward staff extended the daytime visiting hours for the family, 8 AM–10 PM, but continued to refuse the family's requests to stay at night to provide comfort and reassurance. Medical students rounded on days 5 and 6 and administered mini-mental status exams, but no in-depth medical history or dementia evaluation was administered. The patient continued to have constipation, mild dehydration, increased leg pain, and ingrown toenail pain. Risperidone was administered to control agitation and hallucinations on day 5. On day 6, the patient became aphasic, exhibited slurred speech, moaned with discomfort, occasionally cried "spinning," and exhibited breakdown on the skin of his heels and buttocks. On day 8, the patient's wife called the hospital legal department to file a complaint. At that point, the hospital allowed the patient's daughter to spend the night. The patient continued to act out dreams, but having a family caregiver at the bedside prevented escalation to aggression.

The patient was released back to the skilled nursing facility on day 9, with a diagnosis of Lewy body dementia. The risperidone was discontinued several months later by a new geriatrician in the skilled nursing facility. Since the precipitating incident, the patient has lost 40 lbs. He now has limited speech, limited mobility, and tardive dyskinesia, and he is dependent for all activities of daily living.

Falling Through the Crack (in the Bedrails)
The Case

A 65-year-old woman with cirrhosis presented to the hospital with septic shock and respiratory failure. She was placed on a mechanical ventilator and admitted to the intensive care unit. In order to administer medications, a nasogastric tube was also inserted. Although given medications for sedation, the patient was disoriented, and restraints were placed on her wrists to prevent her from pulling out key lines or tubes. She was found to have ascites on examination, and the team decided to perform paracentesis to rule out infection. The intern and resident on the team worked together to prepare the patient for the procedure. The bedrail on one side was lowered, and the wrist restraint on that side was removed to facilitate the procedure.

The procedure went smoothly without any complications. The intern and resident cleaned up the materials from the procedure and left the room. Moments later, multiple alarms went off in the patient's room. As nurses ran into the room, they found the patient confused and trying to get out of bed. She had pulled out the nasogastric tube and the endotracheal (breathing) tube, and her leg was stuck between the bedrail and the bed. She had a large laceration on her foot. Her oxygen saturation fell rapidly, and she required urgent re-intubation. Fortunately, she was safely placed back on the mechanical ventilator. The nasogastric tube was also replaced, and the laceration of her foot was sutured. She slowly improved with antibiotics and supportive care and was ultimately discharged to a nursing facility 10 days later.

In a review of the incident, it became evident that, after the procedure, the wrist restraint was not replaced and the bedrail had been left down. In addition, the team had not communicated with the bedside nurse about when they would be performing the procedure or when they had finished. The institution wondered what steps could be taken to prevent a similar incident in the future, as well as what were best practices for preventing inpatient falls.

Dropping to New Lows
Case & Commentary—Part 1:

A 62-year-old man with type 1 diabetes was admitted to the hospital with osteomyelitis of the right foot and acute kidney injury. The patient had previously had a stroke. At baseline he had some cognitive deficits and received his nutrition through a percutaneous gastrostomy (feeding) tube. He also received small amounts of soft food by mouth. For his diabetes, at home he was on a complex regimen of twice daily insulin glargine (Lantus, a long-acting insulin), insulin NPH (another long-acting insulin) once in the morning, and regular (short-acting) insulin multiple times a day.

The patient's blood sugars were difficult to control during the first 3 days of his hospitalization. He had multiple episodes of critical hypoglycemia (blood sugars less than 50 mg/dL) as well as serious hyperglycemia (blood sugars > 300 mg/dL). The hospitalist caring for the patient consulted an endocrinologist to help with the glucose management.

Although previous WebM&M commentaries have addressed best practices in inpatient management of diabetes, new evidence and guidelines have emerged in the past decade. This case provides an opportunity for an update to describe optimal management of inpatient diabetes, especially in the era of the electronic health record.

Diabetes is prevalent in the inpatient setting and is an independent risk factor for poor clinical outcomes.(1-3) Hospital goals for the patient with diabetes are to (i) prevent hyperglycemia and hypoglycemia, both of which are associated with adverse outcomes (including death), (ii) minimize the length of the hospital stay, and (iii) ensure an effective and safe transition out of the hospital. Current guidelines for pharmacologic management of inpatient diabetes support the discontinuation of oral diabetes agents and other non-insulin therapies in most circumstances. Patients often have contraindications to their use while hospitalized, including NPO status (taking nothing by mouth), variable oral intake, acute renal failure, and receipt of IV contrast.(3)

In most instances, insulin is the preferred treatment during hospitalization as it allows easier titration to adjust to the ever-changing variables in the inpatient setting. The sole use of sliding scale insulin in the inpatient setting is strongly discouraged. The preferred route depends on the site of care: continuous intravenous insulin infusion has been shown to be the best method for achieving glycemic targets in the critical care setting, while scheduled subcutaneous insulin with a basal, nutritional, and correction regimen is recommended in the noncritical care setting.(3-5) Although this patient presented to the hospital with a complex home regimen of two long-acting insulins (glargine and NPH) and one short-acting insulin (regular), the preferred subcutaneous insulin regimen for inpatient glycemic management includes one long-acting and one short-acting insulin along with a correctional scale that uses the same short-acting insulin to cover for nutrition.(6) The choice of which short-acting insulin to use is made based on the frequency and form of nutrition ordered; a complete discussion of this is beyond the scope of this commentary.

Glycemic targets in the inpatient setting have evolved over the last 2 decades, moving from "tight" control to a more moderate target. The initial target of 80–110 mg/dL was based on a significant reduction

in intensive care unit mortality in critically ill surgical patients treated with IV insulin targeted at normalizing blood glucose.(7) However, subsequent trials had mixed results and a meta-analysis of more than 26 studies, including the largest, NICE-SUGAR, showed increased rates of severe hypoglycemia and mortality in tightly (versus moderately) controlled cohorts.(8) This evidence established new standards and the current American Association of Clinical Endocrinologists and American Diabetes Association inpatient glycemic control guidelines were revised to initiate insulin therapy for persistent hyperglycemia greater than 180 mg/dL and to keep target glucose in the controlled, rather than tight, range.(3) Specifically, once insulin therapy is initiated, a glucose target of 140–180 mg/dL is recommended for most critically ill patients. Greater benefit may be realized at the lower end of this range and lower targets may be appropriate in select patients, but targets less than 110 mg/dL are no longer recommended.

For noncritically ill patients, targets are based on clinical experience and judgment, but premeal glucose less than 140 mg/dL and random glucose less than 180 mg/dL are generally recommended. Higher glucose ranges may be appropriate for terminally ill patients and those with severe comorbidities, while lower ranges may be appropriate for patients who tolerate tight glycemic control as outpatients.(3,6) Clinical judgment combined with ongoing assessment of the patient's clinical status, including changes in glycemic trends, illness severity, nutritional status, or concomitant medications that might affect glucose, should be incorporated into the daily decisions regarding insulin doses.(3) In the above case, given the patient's comorbidities, including his cognitive deficit and acute kidney injury as well as his continuous nutrition, his glucose target should probably be 140–180 mg/dL. This target could likely be achieved using a long-acting insulin (such as glargine or levemir) for basal coverage, a short-acting insulin (such as regular insulin every 6 hours) to cover for continuous tube feeds and a correctional scale using the same short-acting insulin.

Case & Commentary—Part 2:

The endocrinologist believed there were multiple reasons for the hard-to-control blood sugars including an active infection, acute kidney injury, variable oral intake, and tube feeds that were intermittently held. She also recognized multiple problems with the system that were contributing. The nurses caring for the patient would often "hold" the morning or evening doses of insulin if his blood sugars were found to be less than 200 mg/dL. Because these "holds" were not clearly charted in the electronic health record (EHR), providers were unaware of how much insulin had actually been given.

In addition, the widely fluctuating sugars were often not immediately entered into the EHR but would only appear at the end of the shift—when the glucometer that was used to measure the blood sugars was "docked" to the EHR and the blood sugar results uploaded into the system. Because of this, the providers were often reacting to old or incomplete data.

To solve the problem in the short term, a paper tracking system of insulin dosing, blood sugars, and vital signs was developed for the patient. These logs were kept in the (now nearly empty) paper chart and then uploaded into the progress notes in the EHR. The hospital information technology team, aided by a multidisciplinary task force that was convened to improve on the overall process and workflow for inpatient diabetes management, began working on modifying the EHR to integrate these improvements.

Building a hospital program to optimally manage inpatient blood glucoses is a complex task, involving multiple levels of management, including physicians, nursing staff, diabetes educators, care coordinators, dieticians, and informatics teams. As evidenced by this case, when communication between the nursing staff and the provider is suboptimal, it becomes difficult to figure out if and when insulin was administered and when insulin doses should be held. One organizational strategy that has been critical for effective programs is establishment of an interdisciplinary steering committee that meets regularly to

implement best practices and address issues in a collaborative and timely manner.(9) This committee should include representatives from several disciplines that have stake in improving hospital-wide glycemic control. These groups typically involve participants from pharmacy, nursing, IT, physician groups (including hospitalists, intensivists, surgeons, endocrinologists, and other hospital physicians), as well as diabetes educators, quality and patient safety improvement staff, lab, dietary and nutrition services, and hospital administration. Order sets and hard-wired systems of care that support safe glycemic control are also essential in building a hospital program. Many hospital systems take it a step further and create a frontline glycemic management team to accelerate and reinforce practice guidelines as well as target individual patients or population of patients, and providers, in a more direct way.(10) One team structure that has been effective in our experience is having an inpatient diabetes team consisting of advanced practice nurses/clinical diabetes educators supervised by an endocrinology faculty member. The inpatient diabetes team can act as consultants, change agents, and educators. Consults are triggered by traditional calls or pages from the primary team as well as by proactive surveillance of glycemic outliers prompting pages to the primary team with recommended changes.(11)

Provider education is also an essential element in achieving glycemic control in the hospital. One mechanism to ensure education of all ordering providers is to require successful completion of a competency exam. The exam could be combined with a live lecture or built as an online module focusing on main inpatient glycemic concepts in a case-based format. Education in real time can be targeted toward specific providers. Outreach to an individual can be triggered by an event (e.g., a reported adverse event related to glucose management), by pharmacy during the order validation process (e.g., a pharmacist notices an unusual order), or even screening by a glucose management team using proactive surveillance of glycemic outliers (e.g., a glucose management team receives a daily report of all patients with a recorded blood sugar less than 70 mg/dL or > 180 mg/dL and can choose to reach out to specific providers).(11) Another form of provider education that has been trialed is a Hyperglycemia Grand Rounds (HGR). The HGR is a continuing education initiative comprised of a four-module seminar series focused on best practices in inpatient diabetes management. Between 2006 and 2013, these seminars have been presented as Grand Rounds to more than 12,000 health care providers at over 300 institutions nationally. More than 2000 participating health care professionals self-reported that the program had improved learner knowledge, performance, and outcomes, and had motivated specific changes in clinical practice. The survey was also able to help identify barriers to implementing best practices; the three most common barriers to implementation were insufficient of coordination among hospital team members, lack of institutional protocols, and time limitations.(12)

In addition to education, policies, algorithms, and protocols are crucial to building an inpatient diabetes management program. Protocol-driven and evidence-based order sets for specific clinical scenarios can help standardize insulin prescribing. Order sets can be designed for many scenarios, including transition from intravenous to subcutaneous administration, treatment of diabetic ketoacidosis, and treatment of hyperkalemia.(13) Order sets with built-in clinical decision support can help guide appropriate insulin ordering and glucose monitoring. An example of subcutaneous insulin orders in an electronic health record is seen in Figure 1. Here, insulin regimens are matched to various nutritional intake patterns; using order sets allows for incorporation of standardized administration instructions, indications, and holding parameters.(4,10-11) System-wide dissemination of these policies, algorithms, and protocols, as well as direct links throughout the electronic health record, can allow all providers and nursing staff to have immediate access to glucose management guidelines whenever questions should arise. Figures 2a and 2b show an example of a nurse-driven hypoglycemia protocol and a screenshot with direct links to the protocol from the electronic health record for easy access and reference. Once the protocols and order sets are disseminated, their use must be monitored and the process redesigned or protocols or order sets adjusted to ensure reliable use.(10)

In this case, the patient's tube feeds were intermittently held and nurses were often "holding" morning or evening doses of insulin if patient's blood glucose was less than 200 mg/dL. A previous WebM&M commentary specifically addressed how to optimally manage holding orders in the hospital, concluding that holding orders should be avoided unless absolutely necessary and that hold orders should provide specific instructions on when to resume the medication. In addition, the commentary described building a mechanism (presumably electronically) where the prescribing provider would be clearly notified when a medication has been held. In the present case, an ideal system would have automatically and clearly notified the provider when the insulin had not been given.

In addition to medications frequently being "held" in the hospital, food or nutritional intake is often temporarily stopped. If a patient is receiving insulin to match an expected caloric intake, stopping nutrition or tube feeding can lead to life-threatening hypoglycemia. Some institutions have standard algorithms to guide assessment and interventions when nutrition is unexpectedly held for a patient. Figure 3 shows one such guideline. Such algorithms are made even more useful when hyperlinks are added at appropriate places in the electronic medical record to allow for quick reference look up.(11)

Electronic health records are particularly helpful in achieving optimal glycemic control, but only if information is quickly and easily accessible to providers. For example, a glucose management page that displays all necessary variables that impact glycemic control enables providers to quickly review glycemic trends and look for contributing factors such as insulin doses given, renal function, steroid dosing, and nutrition intake (Figure 4).

In the case above, the widely fluctuating sugars coupled with unclear documentation over whether insulin doses were actually given resulted in a complicated clinical scenario that was difficult for providers to disentangle. To facilitate inpatient glycemic management, glucometer readings need to be transferred to the electronic health record in real time, and insulin administration times and doses need to be clearly charted in a timely manner. Having easily accessible and timely glucose and insulin data is the only way providers can make appropriate adjustments to inpatient insulin regimens to prevent recurrent hypoglycemia and severe hyperglycemia. A multidisciplinary team approach to safe glycemic management is needed to build an inpatient glycemic program that is functional and effective.

Take-Home Points

- Target blood glucose for a critically ill patient is 140–180 mg/dL and an insulin infusion should be started for glucose greater than or equal to 180 mg/dL. General targets for the non-critically ill patient are premeal glucose less than 140 mg/dL and random glucose less than 180 mg/dL.
- "Tight" or euglycemic glucose control has been shown to increase mortality among critically ill patients.
- An interdisciplinary glycemic control steering committee that meets regularly (i.e., monthly) has been an essential element for successful programs.
- Electronic health records need to make glucose management information quickly and easily accessible to providers in order to be useful.
- Having extensive clinical decision support built into the electronic health record order sets is a way to quickly guide providers in ordering appropriate insulin regimens.

Situational Awareness and Patient Safety

The Case

A 40-year-old woman with a history of cirrhosis and known esophageal varices was admitted to the hospital with one day of bloody stools. Blood transfusion and IV proton pump inhibitor therapy were initiated. Gastroenterology was consulted to assess and treat the source of her GI bleeding.

On the same evening, a 50-year-old man with a history of antiphospholipid antibody syndrome, complicated by recurrent blood clots and heparin-induced thrombocytopenia, was admitted to the next room with a new pulmonary embolus. Given his known adverse reaction to heparin, IV argatroban was ordered for anticoagulation.

The following morning, while pre-rounding on the woman with the GI bleed, an astute intern noticed that one of the medications hanging from her IV pole was labeled as argatroban—but the name on the label matched that of the patient with the pulmonary embolus. The intern immediately notified the nurse that argatroban had been administered to the wrong patient and disclosed this error to the patient. The argatroban infusion was stopped. Fortunately, the patient did not experience any adverse effects.

Lost in Sign Out and Documentation

The Case

A 71-year-old man presented to the emergency department with chest pain. While being evaluated by the emergency physician, he suddenly went into cardiac arrest. He was successfully resuscitated and underwent emergent cardiac catheterization, which revealed multivessel coronary artery disease requiring placement of three stents. The patient was subsequently transferred to the coronary care unit (CCU) with respiratory failure requiring mechanical ventilation and acute kidney injury requiring hemodialysis. He had a prolonged CCU course and eventually needed tracheostomy placement due to inability to wean from the ventilator.

On hospital day 18, he underwent placement of a percutaneous endoscopic gastrostomy (PEG) tube for nutrition. The following day, an abdominal radiograph was performed to check tube placement prior to initiating feedings. The radiograph showed "free air under the diaphragm." The patient had no abdominal symptoms, and the CCU team discussed the case with a gastroenterologist who said that this finding was normal after PEG placement. The primary resident got a "curbside consult" from the on-call surgery resident who also felt that, given the absence of symptoms, the patient could simply be monitored. No official surgery consult was placed in the chart. Tube feeds were started later that day.

The patient was transferred to the ward on hospital day 20. Late that evening, the patient complained of left-sided abdominal pain. Labs showed a marked increase in his white blood cell count. A stat abdominal radiograph revealed a significant amount of air under the diaphragm. Only at that point did the ward team realize that the radiograph done 2 days earlier had also showed the same finding; this issue was not signed out to them when the patient was transferred out of the CCU. The surgery team was urgently re-consulted, and the patient was taken to the operating room. Exploratory laparotomy revealed a large gastric perforation at the PEG tube site and spillage of tube feeds into the peritoneum, with signs of acute peritonitis. Repair of the perforation was performed along with washout of the abdomen. The patient was transferred to the intensive care unit from the operating room in septic shock. Fortunately, he eventually recovered and was transferred to a long-term acute care facility on hospital day 30.

The case was reviewed in a multidisciplinary morbidity and mortality conference. Multiple errors were noted, including poor communication between teams and a lack of a standardized signout process for patients being transferred from the CCU to the ward. As a result of this case, a structured signout was designed and implemented with the expectation that both residents and attending physicians on the critical care team would directly sign out patients to the ward team.

Good Night's Sleep Gone Wrong

The Case

A 64-year-old woman came to the emergency department complaining of cough and shortness of breath, along with an itchy throat and a runny nose. She had a past medical history of end-stage renal disease (on hemodialysis 3 times/week), hypertension, type 2 diabetes, and a left below-knee amputation. Her serum creatinine was 9.48 mg/dL. She was transferred to the hemodialysis unit where she underwent hemodialysis and was then admitted to the medical floor.

That night, the patient was given her home medications at the prescribed doses: zolpidem 10 mg at 22:03 and hydroxyzine 25 mg by mouth at 00:48. At 03:00, the nurse noted that the patient was agitated, crying out, "I will not cooperate until I get some rest." At 11:20, the nurse noted acute changes in mental and neurological status, including severe drowsiness, unresponsiveness to painful deep stimuli, and unequal pupil size. A "Code Stroke" was called. Laboratory results were suggestive of respiratory and metabolic acidosis. The patient was transferred to the medical intensive care unit for close observation and hemodialysis. All CNS depressants were discontinued. A CT scan showed no evidence of a new stroke. Two days later, the patient was alert, awake, fully oriented, and hemodynamically stable.

Case review revealed that prior to admission, the patient's nephrologist had added a prescription for hydroxyzine 25 mg by mouth at bedtime as needed, because the patient had been complaining of itchiness and continuously picked at her skin. The zolpidem dose had also been increased from 5 mg to 10 mg at bedtime as needed. Then, at the time of admission, she received additional doses of both medications. Although duplicate therapy alerts for zolpidem and hydroxyzine appeared on the order entry screen, it was a "soft stop" without management recommendations, and the ordering physician bypassed the alerts.

Picking Up the Cause of the Stroke

The Case

A 62-year-old man with poorly controlled diabetes was transferred to a tertiary care center from a community hospital for management of persistent abdominal pain and inability to tolerate oral feedings, possibly secondary to diabetic gastroparesis. The day before transfer, the patient had undergone placement of a peripherally inserted central catheter (PICC) to address his continued need for intravenous pain medications, intravenous fluids, and parenteral nutrition. An initial chest radiograph performed to evaluate the catheter reported the PICC was located in "a persistent left-sided superior vena cava." The physicians caring for the patient assumed the PICC was safe to use, and the patient began receiving nutrition and hydration through the line. He was not receiving any oral nutrition at this point.

The following day, the patient complained of headache, unilateral visual loss, and left-sided tingling and numbness. A stat noncontrast CT scan of the head revealed strokes distributed in an embolic fashion. The radiologist reviewed the chest radiograph and pointed out that the persistent left-sided superior vena cava is in fact a congenital remnant that can drain into the left atrium of the heart. A subsequent CT of the chest revealed the PICC tip was actually in the left atrium, and was therefore delivering fluid into the patient's systemic circulation. Fat emboli from the lipid emulsion infused through the PICC were the likely cause of the patient's strokes.

The patient was urgently transferred to the neurological intensive care unit. He ultimately developed increased intracranial pressure and required intubation, mechanical ventilation, and mannitol to prevent further neurologic damage. The patient was eventually stabilized and weaned off the ventilator, but his

neurological deficits persisted. He required a permanent feeding tube and tracheostomy tube, remained unable to perform any activities of daily living independently, and required 24-hour care.

Robotic Surgery: Risks vs. Rewards
The Case

A 66-year-old man was seen by a urologist for difficulty urinating and diagnosed by biopsy with localized prostate cancer. The urologist recommended a radical prostatectomy (removal of the prostate). The urologist stated that the best and safest way to remove the prostate was with a minimally invasive robotic surgery. The robotic surgery, he explained, would involve a few small incisions, performed by a surgeon seated at a computer console in the operating room. The procedure would be carried out using robotic arms and surgical instruments. The urologist went on to say that the robotic technology would allow for smaller incisions, better control of the instruments, lower risk of complications, and faster return of erectile function.

During the procedure, there were mechanical problems as the robotic arms were not responding as expected. The urologist persisted in using the robotic technology and ultimately was able to complete the procedure. The operation took twice as long as expected, but the urologist felt it had been successful.

Postoperatively, the patient developed serious bleeding requiring multiple blood transfusions. He was taken back to the operating room where it was noted the inferior epigastric artery (a key artery in the pelvis) had been damaged during the original procedure. The injury was repaired but this second operation was prolonged and complicated due to the degree of bleeding. The patient ultimately required several additional surgeries and a prolonged hospital stay.

Inadvertent Use of More Potent Acid Leads to Burn
The Case

A 31-year-old woman came to the clinic for a routine well-woman evaluation. She has a history of cervical dysplasia and vaginal warts, previously treated with trichloroacetic acid (TCA). She reported normal health and no health concerns. The physical exam revealed a raised lesion on the perineum, midline, just outside of the introitus. The patient described this as the area of her prior wart. The attending physician recommended placing some acetic acid on the area to evaluate the lesion and, if that showed signs concerning for vulval intra-epithelial neoplasia, they would then discuss performing a biopsy. The patient gave verbal consent for this.

The resident physician asked the medical assistant for acetic acid and unknowingly received TCA. Immediately after the application, the area turned densely white, which was abnormal for acetic acid, and that led to the discovery that TCA had been applied rather than acetic acid. The patient was immediately informed of the error and treated with sodium bicarbonate to neutralize and reverse the effects of the TCA. No TCA appeared to have come in contact with the vaginal mucosa or the labia, and after the sodium bicarbonate treatment the white area was smaller than 0.5 cm. Once the area was completely dry, petroleum jelly and lidocaine ointment were applied for comfort, and the patient was pain-free at discharge. However, one year after the event, the patient continued to complain of discoloration and discomfort.

New Patient Mistakenly Checked in as Another

The Case

A 55-year-old man, presented to a primary care physician's office for an initial visit to establish care and obtain routine health maintenance. He had not seen a physician in some time, but since his older brother had recently had a heart attack, he wanted to ask a physician if he should have his cholesterol checked and what else he could do to reduce his risk of heart disease.

Unknown to him, the physician he selected had another patient with the exact same first and last name, who was also 55 years of age but had a different birthday. The office receptionist was new to the practice, had not yet met most of the patients, and was struggling to become familiar with the practice's newly installed electronic medical record (EMR). She logged in and quickly found the chart of a patient with the same age and name of the patient who was registering. Assuming this must be the same patient, she checked the "new" patient in under the "old" patient's medical record number.

The physician examined the patient and advised that given his age and family history, he should have a fasting lipid panel checked. She placed an electronic order for the lab tests to be performed, and the patient had blood drawn the next day. The test results showed a slightly elevated low-density lipoprotein (LDL) cholesterol level, so the physician sent the results to the patient via the EMR's patient portal, along with a note advising him to modify his diet and engage in a weight loss program for the next 3 months.

Because of the mistake made when registering the patient, the test results and email from the physician actually went to the *other* patient—the one who was an established patient of the practice. When he logged into the patient portal, he was surprised, as he had not had any labs drawn recently. Moreover, he was already taking medication to reduce his cholesterol. He called the office and told them that there seemed to be a mix-up with his test results. Only then was the registration error noticed.

A Room Without Orders

The Case

A 56-year-old man with acute lymphoblastic leukemia and diabetes mellitus was admitted to the hospital for a scheduled cycle of chemotherapy. He had no acute complaints. The patient arrived directly to the medical unit on a busy afternoon and waited in a nearby area for his assigned room. At shift change, the patient's room was ready but the nurse who had initially greeted him on arrival had been replaced by a new nurse, who escorted the patient to his room. The nurse completed the usual check-in process later in the evening but did not contact the admitting provider, making the assumption this had occurred several hours earlier. Therefore, no admitting orders were written.

The patient spent the night in the hospital and took his own insulin, which he had brought from home. No evening meal was delivered; the patient thought that holding his food was part of his chemo regimen so he didn't question this. Since he wasn't complaining of any symptoms and takes few medications at home, he didn't prompt the need for any orders overnight.

The following morning, the new nurse (the third in his care so far) noted the patient was difficult to arouse. She went to review the existing orders and discovered they were completely absent. She paged the on-call team who immediately evaluated the patient and successfully treated him for symptomatic hypoglycemia, which had been caused by the patient's insulin taking effect in the absence of food intake.

The case prompted a formal review as, in addition to the preventable episode of hypoglycemia, the initiation of his scheduled chemotherapy was delayed.