

## Lack of Sepsis Recognition Leads to Delay in Care Following Cesarean Delivery.

November 25, 2020

Leiserowitz GS, Hedriana H. Lack of Sepsis Recognition Leads to Delay in Care Following Cesarean Delivery. PSNet [internet]. 2020.

<https://psnet.ahrq.gov/web-mm/lack-sepsis-recognition-leads-delay-care-following-cesarean-delivery>

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### The Case

A 26-year-old woman with a history of systemic lupus erythematosus and gestational hypertension was admitted to the hospital for induction of labor at 36 weeks due to intrahepatic cholestasis of pregnancy. The induction failed and the resulting cesarean delivery was complicated by significant postpartum hemorrhage. The infant was taken to the neonatal ICU (NICU) for sepsis evaluation. Approximately 8 hours after birth, the infant was found to have extended spectrum beta-lactamase (ESBL) producing *Escherichia coli* bacteremia and sepsis.

On the morning of the first post-operative day, the patient was noted to be dizzy and hypotensive and complained of severe perineal and abdominal pain. The obstetric team attributed the perineal pain to prolonged efforts to push during labor and offered symptomatic relief with cold packs and Benzocaine spray. They were more concerned about the hypotension, which was thought to be due to hypovolemia from peri-operative blood loss.

A SIRS (systemic inflammatory response syndrome) alert occurred later in the afternoon due to hypotension. Laboratory tests showed markedly elevated lactic acid (6.3), leukopenia and thrombocytopenia. The patient was given antibiotics, intravenous fluids, and blood. The unit nurses had significant concerns about the patient's status in the morning of the first postoperative day but were unable to get the physicians to intervene until the SIRS alert, and even then, the physicians were skeptical of the both the alert and the laboratory results. The physicians felt that they were adequately addressing the patient's problems, whereas the nurses did not feel that their concerns were being taken seriously. An Endocrinology consultation was obtained due to a suspicion for adrenal crisis associated with chronic steroid use. The patient was booked for an urgent exploratory laparotomy due to persisting concerns about postoperative blood loss. However, she stabilized after fluid resuscitation and a computed tomography (CT) scan was obtained instead. The CT scan showed no evidence of intra-abdominal bleeding, and therefore the laparotomy was cancelled.

After the CT scan, the patient went to the postpartum unit instead of the medical intensive care unit (MICU) due to miscommunication. Several hours later with persistent hypotension, she was transferred to the MICU where she was treated for putative adrenal crisis, hypotension, and septic shock. She was noted by the ICU physicians to have severe abdominal and perineal pain and was visibly ill. She had developed new ecchymoses of both flanks extending to the vulvar labia that were exquisitely tender in association with neutropenia and hypotension. The possibility of necrotizing soft tissue infection was considered.

Urgent consultations were obtained from Maternal-Fetal Medicine and Acute Care Surgery. They took her to the operating room (OR) together for suspected necrotizing fasciitis. The Pfannenstiel incision was opened and counter-incisions of the bilateral flanks and labia were performed. The tissues were found to be dusky, but necrosis was not found. She returned to the surgical ICU for fluid resuscitation. Later that day, the patient deteriorated and failed to respond to resuscitation. She was urgently taken back to the OR, where she was found to have necrotizing soft tissue infection, including in the flanks, labia, and uterus. She underwent a hysterectomy, bilateral salpingo-oophorectomy, and extensive resection of soft tissue including fascia and muscle. Her subsequent, lengthy hospitalization was notable for multiple wound debridements, rehabilitation, and skin grafts. Her son required antibiotic treatment for neonatal sepsis in the NICU.

## The Commentary

By Gary S. Leiserowitz, MD, MS and Herman Hedriana, MD

Necrotizing fasciitis (NF) encompasses a spectrum of necrotic soft tissue infections with potential involvement of skin, muscle, and fascia due to a variety of bacteria.<sup>1</sup> In many cases, the destructive infection is fulminant with a high mortality rate. The precipitating causes include breaches of skin or mucosa, non-penetrating soft tissue injuries, and even routine obstetric or gynecologic surgeries.<sup>1,2</sup> Risk factors include diabetes mellitus, arteriosclerosis, chronic renal disease, obesity, malnutrition, and immunosuppression (present in this case).<sup>2</sup>

Necrotizing soft tissue infections are commonly divided into several categories.<sup>1,2</sup> Type I is a polymicrobial infection including mixed aerobic and anaerobic organisms. Type II is a monomicrobial infection, classically due to either Group A streptococcus (most common) or *Staphylococcus aureus*. Type II cases may develop in young, healthy patients with no predisposing factors.<sup>2</sup> Type III includes monomicrobial infections with gram negative organisms, including *Escherichia coli*<sup>1,3</sup> (as in this case) or *bacteroides* species, and can be associated with gas infiltrating into the tissues. Also, these infections are typically seen in patients who are immunocompromised, diabetic, obese, or in the postoperative setting.<sup>1</sup> Mortality in Type III cases can be as high as 30-40%.<sup>2</sup>

Typical presentations for NF include soft tissue edema, erythema, severe pain, tenderness, fever, and necrosis.<sup>1</sup> Frequently, the pain is out of proportion to the clinical findings.<sup>1,2,4</sup> Stevens et al. provide a list of pitfalls in the diagnosis of necrotizing soft tissue infections: absence of fever, absence of cutaneous manifestations, attributing severe pain to a recent injury or procedure, nonspecific imaging findings, and attributing systemic manifestations to other causes (Table 2, page 2,258).<sup>1</sup> In this case, three of these factors played a role in the delay of diagnosis. Although this patient did have cutaneous manifestations on

the morning after her cesarean section, the finding was attributed to having pushed during the second stage of labor and her incision, which is commonly seen.<sup>1</sup>

A delay in diagnosis of necrotizing fasciitis is both common and associated with increased morbidity and mortality.<sup>1,2,4</sup> One study by Wong et al. showed that the mortality rate increased if the definitive surgery was delayed beyond 24 hours (i.e., survival was 93.2% at 24 hours, but decreased to 75.2% at 48 hours). This patient had her first surgical intervention within 24 hours of presenting symptoms and underwent a second procedure within 10 hours of the first. A reasonable interpretation of this patient's course is that she had a "near miss", rather than a failure to diagnose NF. Her clinical picture evolved from the first postpartum morning as she manifested perineal pain, then signs of sepsis and hypotension. She was evaluated by multiple obstetric, medical, and surgical teams, and ultimately the correct diagnosis was recognized as her symptoms became more severe and localized.

### **Contributing Factors**

There are likely three processes that contributed to this "[near miss](#)": cognitive errors marked by (1) knowledge deficit (the primary team physicians were unaware that necrotizing fasciitis was a diagnostic possibility); (2) [cognitive bias](#) (failure to attribute symptoms and signs to the correct diagnosis due to other possible etiologies); and (3) systems-related problems manifesting as a breakdown of communications between the physicians and nurses. The combination of these elements probably contributed to a delay in diagnosis.

Graber et al. analyzed 100 cases from an Internal Medicine service to classify and quantify the types of diagnostic errors that were identified.<sup>5</sup> These included no-fault errors (e.g., atypical presentation of disease), systems-related errors (e.g., organizational flaws, team miscommunication), and cognitive errors (e.g., faulty knowledge, faulty data gathering, faulty synthesis). System-related factors were contributors in 65% of cases, and cognitive factors in 74%; both were present in 46%. No-fault errors seemed to play a role, although as noted in this review of NF, delays in recognition are common since the symptoms are easily attributed to other disease processes. This patient had several other reasonable explanations for hypotension, such as extensive intra-operative blood loss, adrenal insufficiency, and evolving bacteremia/sepsis from *E. coli* (which was also seen in the neonate).

Cognitive factors may have been particularly important in this case. Graber listed [four categories](#) of cognitive errors<sup>5</sup> including: faulty knowledge, faulty data gathering, faulty information processing, and faulty synthesis and verification. To some degree, all four played a role in the delay in this case. The junior obstetric residents involved likely had a knowledge deficit with respect to NF, as this diagnosis is much more common in the setting of trauma. Later, problems with data gathering and information processing led to a brief delay in recognizing emerging sepsis. Faulty verification as seen by premature closure (prematurely attributing the constellation of symptoms to another etiology), failure to periodically review the situation, and confirmation bias also influenced the course of events during the first postoperative day. Cognitive biases are commonly identified in patients who experience post-operative complications. Antonacci found that cognitive biases were involved in nearly 33% of [surgical cases](#) with complications.<sup>6</sup> As described by [Graber](#) and colleagues, anchoring on the diagnosis of postpartum hemorrhage, confirmation, and premature closure biases were seen in this case.

Diagnostic errors can cause significant preventable harm;<sup>9</sup> vascular events, infections, and cancers were the most important missed diagnoses in a review of closed malpractice cases from 2006 to 2015.<sup>9</sup> Of 1660 infection cases, the total payouts were \$458 million, with a mean payout of \$275,000 per case. Sepsis was the leading cause among the infectious cases. Analysis of these cases identified clinical judgment problems as a contributing factor (85% of cases): (1) failure or delay in ordering a diagnostic test; (2) narrow diagnostic focus with failure to establish a differential diagnosis; (3) failure to appreciate and reconcile relevant symptoms, signs, or test results; (4) failure or delay in obtaining consultation or referral; and (5) misinterpretation of diagnostic studies (imaging, pathology, etc.). Communication and clinical systems factors were also identified in 35% and 22% of these malpractice suits, respectively. It is not clear to what degree malpractice cases reflect severe diagnostic errors in clinical practice, since they represent only a small fraction of medically negligent events,<sup>9</sup> but they may show the spectrum of contributing factors.

Diagnostic errors are common, since medical diagnosis is extremely difficult.<sup>10</sup> Diagnostic errors can be caused by cognitive biases or knowledge deficits, or both. Norman et al. describe a [framework](#) to understand the genesis for medical errors, related to a dual process of thinking.<sup>11</sup> The faster system (Type 1) is automatic, unconscious, intuitive, and heuristic. Type 2 processing is controlled, conscious, reflective, and analytic. Type 1 (intuitive) thinking involves making a direct association between new information and a similar example in one's memory (pattern recognition). These associations are generally effortless and do not overload working memory. In contrast, Type 2 thinking is more deliberate and requires identifying features from a diagnostic category present in the case and estimating the likelihood of such features in a particular disease. It places a heavy burden on working memory, and thus increases the risk of computational errors.<sup>11</sup>

Among the systems-related contributors to this delayed diagnosis were ineffective communications between the unit nurses and physicians, and lack of coordination of care. Ineffective nurse-physician communication may compromise patient safety.<sup>7</sup> Dysfunctional communication accounts for 91% of medical errors reported by resident physicians.<sup>8</sup> A significant proportion of errors in the ICU are due to poor communications between nurses and physicians.<sup>8</sup> Structured communication techniques can potentially improve high-stakes communications (discussed below). Dysfunctional communication accounts for 91% of medical errors reported by resident physicians.<sup>8</sup> A significant proportion of errors in the ICU are due to poor communications between nurses and physicians.<sup>8</sup> Structured communication techniques can potentially improve high-stakes communications (discussed below).

## **Systems Change Needed/Quality Improvement Approach**

It is not clear whether knowledge deficits or cognitive biases contribute the most to diagnostic errors, since there is evidence for both, mostly based on retrospective reviews.<sup>11</sup> A common intervention to prevent cognitive biases is to educate physicians about them. However, there is, at best, weak evidence that raising awareness of cognitive biases influences future performance. There is stronger evidence that strategies that encourage clinicians to mobilize and reorganize their knowledge are beneficial.<sup>11</sup> Dhaliwal notes that although a study of biases and heuristics is important, the primary benefit of understanding the cognitive pitfalls is keeping people humble.<sup>12</sup> Retrospective "morbidity and mortality" review of cases such as this one may be affected by hindsight bias. For example, if a clinician is able to make a challenging

diagnosis based on just a few data points, they are hailed as a brilliant diagnostician.<sup>12</sup> On the other hand, if the diagnosis is wrong, then it is called “premature closure” (cognitive error). The focus on cognitive errors ignores the reality that heuristics are a powerful and useful component of clinical decision-making that can be quite accurate. Norman et al. emphasized that focusing on enhancing a clinician’s fund of knowledge is a better strategy to avoiding diagnostic errors than attempting to the traps of cognitive biases, since most of them are unconscious in any case.<sup>11</sup>

Communications between physicians and nurses represent an important opportunity for improvement in this case. Structured communications, such as use of the SBAR ([Situation, Background, Assessment, and Recommendations](#)) technique, can be effective in high-stress or fraught circumstances.<sup>13</sup> The value of this technique comes from framing the conversation so that critical information intended to spur decision-making is brought “front and center.” This technique, adapted from the military and then modified for use at Kaiser Permanente,<sup>14</sup> has been widely adapted in many institutions and promoted by the Institute for Healthcare Improvement.<sup>15</sup> It bridges the differing communication styles used by nurses and physicians, especially in critical situations as commonly encountered by Rapid Response teams. It helps focus attention on the problem with very specific information and limits the unfortunate aspects of hierarchy.

Use of the SBAR communication technique is readily taught and can be adapted in other healthcare interactions, such as within a surgical residency.<sup>16</sup> Telem noted that surgical residents found the standardized communication technique to be clinically beneficial, although it was difficult to demonstrate improved outcomes.<sup>16</sup> SBAR is the best known of many handoff mnemonics utilized to improved communication effectiveness for nurse-physician and physician-physician interactions.<sup>17</sup> A systematic review of SBAR handoffs demonstrated that the technique could be reproducibly taught, although methodological limitations made it difficult to show efficacy.<sup>17</sup> Nonetheless, content and clarity can be increased by continual practice with the technique.<sup>18</sup> There is evidence that use of the SBAR technique improves both the perception of communication between professionals and the safety climate.<sup>19</sup> The key to structured communication between nurses and physicians is that the message is sequenced effectively to deliver a cogent imperative to intervention. It makes expectations for recommended action explicit and requires a direct response.

In the case above, using the SBAR format, the obstetric unit nurse could have framed the presentation as such:

- Situation: “Dr. X, I need you to re-evaluate this patient because she is doing worse than expected on postoperative day #1. It seems that her clinical situation is deteriorating.”
- Background: “This morning, I noted that the patient has perineal pain that is worse than expected. She is making limited urine and is hypotensive. Although she does not have a fever, she has triggered a SIRS alert.
- Assessment: “I am worried that the patient is developing a serious infection and appears to be septic”.
- Recommendation: “I would like to trigger a SIRS alert and have the Rapid Response Team come evaluate the patient for possible sepsis. Also, I think the patient would be better managed in the ICU, because the acuity of her care is beyond what we can manage in the obstetrics unit.”

This structured presentation would have made the nurses concerns about impending sepsis quite clear. Even if the physician disagreed at that moment, he/she would feel compelled to accelerate the interventions and be ready to elevate to a higher level of care rapidly if the patient deteriorated further. It also avoids the loss of direct communication due to concerns about hierarchy and asymmetry of power between the nurse and physician.

## Take Home Points

- Necrotizing soft tissue infections are often subject to delayed diagnosis, since the signs and symptoms are commonly attributed to more common etiologies, and the initial findings are not specific. Unfortunately, a delay in diagnosis beyond 24 hours is associated with markedly increased mortality.
- Knowledge deficits and cognitive biases are both associated with diagnostic errors. Dual process theory describes a fast, intuitive system for processing information and a slower, methodical, and analytic system. These systems appear to be inextricably linked in diagnostic reasoning, although the former may be more subject to cognitive biases. Nonetheless, knowledge deficit may be a greater factor in misdiagnosis than cognitive biases in cases such as this episode of NF.
- Communications between professionals (e.g., nurses and physicians) are one of the most critical elements of systems-related problems. Use of structured communications, such as the SBAR technique, can be an effective methodology for simplifying the critical information to be communicated and limiting hierarchical barriers in the health care team.

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*This project was funded under contract number 75Q80119C00004 from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The authors are solely responsible for this report's contents, findings, and conclusions, which do not necessarily represent the views of AHRQ. Readers should not interpret any statement in this report as an official position of AHRQ or of the U.S. Department of Health and Human Services. None of the authors has any affiliation or financial involvement that conflicts with the material presented in this report. [View AHRQ Disclaimers](#)*