

Wound Emergencies: The Importance of Assessment, Documentation, and Early Treatment Using a Wound Electronic Medical Record

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Abstract

Chronic wounds such as diabetic foot ulcers, venous ulcers, and pressure ulcers are a major source of morbidity and mortality. To describe wound characteristics associated with a wound emergency, the Wound Electronic Medical Records (WEMR) of 200 consecutive admissions (139 patients, average number of admissions 1.4) to a dedicated inpatient wound healing unit over a period of 5 months were retrospectively reviewed. Patient mean age was 62 ± 16 years, 59% were men, 27% had a foot ulcer and diabetes mellitus, and 29% had venous ulcers. Presenting signs and symptoms included wound pain, cellulitis, nonpurulent drainage, and undermining, but few presented with classic local clinical signs of infection. Treatment consisted of sharp debridement with deep tissue culture and pathology from the wound base and/or systemic antibiotics. Twenty-percent (20%) of patients had pathology-confirmed and 38% had pathology- or radiology-confirmed osteomyelitis on admission, supporting that new or increasing wound pain, cellulitis, and/or nonpurulent drainage or presence of significant undermining may be indicative of an invasive infection and that patients presenting with these signs and symptoms require an immediate treatment plan and consideration of hospital admission. Use of an objective documentation system such as the WEMR may help alert clinicians to subtle wound changes that require aggressive treatment; thereby, avoiding emergency room visits and hospital admissions. Future research is needed utilizing the WEMR across multiple medical centers to further define criteria for a chronic wound emergency.

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Chronic wounds are defined by their multiple physiologic impairments to healing,¹ including inadequate angiogenesis,² impaired innervation,³ and impaired cellular migration.⁴ In 2005, the annual cost of caring for patients with these wounds exceeded \$20 billion.⁵

It is estimated that four million patients with diseases of the skin and subcutaneous tissue (ICD-9s 680 through 709.0) visit

emergency departments across the country each year.⁶ Based on data from the Healthcare Utilization Project (HCUP) website (www.hcupnet.ahrq.gov),⁷ a minimum estimated 938,000 patients per year are admitted to the hospital with a diagnosis of a chronic wound (ICD-9 codes 707.0 and 707.1).

The three most common types of chronic wounds are diabetic foot ulcers, venous ulcers, and pressure ulcers.^{8–10}

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According to several population-based studies in Europe¹¹ and the US,¹² individuals with type 1 diabetes have a 25% lifetime risk of developing a foot ulcer¹³; presence of an ulcer may increase the risk of lower extremity amputation almost six-fold.¹⁴ The 5-year survival rate of patients with diabetes is approximately 31% after major amputation.¹⁵ Venous stasis ulcers and their infectious complications have not been well quantified but often have been found to result in decreased quality of life,¹⁰ decreased mobility, and increased pain.⁹

According to the most recent HCUP data, in 2006 more than 500,000 patients admitted to hospitals had a pressure ulcer, representing an 80% increase since 1993. The most common associated diagnosis was septicemia.¹⁰ Depending on the setting, pressure ulcer prevalence ranges from approximately 18%¹⁶ to 27%.¹⁷ The mortality rate is estimated at 0.4%; pressure ulcers were identified as an underlying cause in 18.1% of these deaths.¹⁸

For this reason, the authors hypothesize that any patient presenting with systemic inflammation, multi-organ system failure, or sepsis should be examined for the presence of a chronic wound, which is often an under-diagnosed source of invasive infection. Systemic inflammatory response syndrome (SIRS), which can occur in the presence or absence of infection, is characterized by at least two of the following symptoms: temperature $>100.9^{\circ}\text{F}$ or $<96.8^{\circ}\text{F}$, elevated heart rate (>90 bpm), respiratory rate 20, $\text{PCO}_2 <32$ mm Hg, or white blood cell count $>12,000$ or $<4,000$ cells/ μl . A "septic" patient also may have altered mental status, ileus, hyperglycemia in the absence of diabetes, elevated C-reactive protein, renal dysfunction (oliguria or increase >0.5 mg/dL in creatinine), coagulopathy (international normalized ratio [INR] >1.5) or partial thromboplastin time [PTT] >60 seconds, thrombocytopenia, hyperbilirubinemia, and hemodynamic dysfunction.¹⁹ A full skin exam should be part of any evaluation for a patient with SIRS or signs of sepsis.

The management of patients with chronic wounds requires longitudinal, coordinated outpatient care. However, as occurs in many chronic conditions, patients with nonhealing wounds may present with acute complications or exacerbations. When patients present with acute complaints, the treating physician must evaluate whether the presentation merits an urgent treatment plan or routine outpatient follow-up. Even in the absence of systemic inflammation, a chronic wound may be associated with pain, cellulitis, drainage, or significant undermining that indicates invasive soft tissue infection, often involving bone.

A retrospective study was conducted to elucidate the local signs and symptoms as recorded in the Wound Electronic Medical Record (WEMR) of wounds from patients who required urgent treatment to help determine what constitutes a wound emergency.

Methods

Over 5 months (July to November 2006), the records of 200 consecutive admissions to a dedicated inpatient wound

Key Points

- The classic local signs and symptoms of infection are frequently absent in patients with infected chronic wounds.
- Careful monitoring of chronic wound changes is imperative to ascertain progress or deterioration.
- A review of 200 patient records led the authors to conclude that new or increasing wound pain, cellulitis, and/or nonpurulent drainage or presence of significant undermining may be indicative of an invasive infection warranting immediate treatment.
- Studies to help clinicians diagnose infections, including osteomyelitis, are needed to optimize care and prevent significant morbidity and mortality.

healing service of a large tertiary care hospital were reviewed (outpatient visits were not included in this analysis). All patients had pain, cellulitis, nonpurulent drainage, and/or undermining associated with their wound, requiring immediate inpatient medical attention.

Standard of care. Once a patient is admitted to the wound healing inpatient unit, an interdisciplinary team of nurses, a surgeon, a primary care physician, a social worker, and physician assistants implements published protocols and guidelines.²⁰⁻²⁶ All admitted patients typically receive intravenous antibiotics and/or operative debridement of the wound.

The wounds are examined, photographed, measured, and documented in the WEMR database. The WEMR displays on a single printed sheet or computer screen the wound measurements (ie, length, width, depth, and area graphed over time), as well as digital photographs of the wound, vascular testing results (ie, noninvasive flow studies [NIFS]), bacterial cultures, laboratory values, and radiology and pathology reports, in addition to notations regarding amount of drainage, undermining, and presence or absence of cellulitis and pain. Providers can view these data in a single comprehensive Wound Report Form that displays a graph of healing rate, providing an objective framework for each treatment decision (see Figure 1).

Data collection. Medical records, wound data, and wound photographs of patients with a lower extremity ulcer and diabetes, venous ulcer, or pressure ulcer were selected for review.

Descriptive data were collected from the WEMR, the hospital medical record, and vascular laboratory reports. Patients were classified as having peripheral arterial disease if it was recorded that their ankle-brachial index (ABI) was <0.9 . Osteomyelitis data were recorded as the presence of a positive radiology report (either bone scan or magnetic resonance imaging [MRI]) or a positive pathology report. After the patients were identified, the data were reviewed by all of the authors for completeness. Data were entered into Microsoft Excel (Redmond, WA); means and proportions were calculated using this software.

All patient data were reviewed under IRB-approved protocol.

NYU Langone Medical Center

Medical Record Number: _____

Name: _____ DOB: _____

Chief Complaint: Wound Left Third Toe Anterior

History of Present Illness: *[Faint text]*

Medication: *[Faint text]*

Wound Length: 2.33 cm.
 Wound Width: 1.33 cm.
 Wound Depth: 0.05 cm.
 Wound Area: 3.86 square cm.

Undermining of 0 cm at stock


Treatment: Silvadene

The wound is currently associated with no fever, no pain, and with drainage:

Appearance: Normal Cellulitic

WOUND ASSESSMENT AND PROGRESS NOTE

Primary Care MD: _____
 Phone: _____
 Extension: _____



Wound Culture

Media: *[Faint text]*

Wound Pathology

Wound: *[Faint text]*

PFK:

Right ABI: 1.2 Left ABI: 1.2

The ABI and Tegmental Puff Values are WNL UL

HT: 183 Wt: 115PTT: 20 HgbA1C: 5.8

137 104 15 67 28.8 28.8 426 (The A/GDS)

4.2 24 1.4 38.3 38.3

Radiology

Wt: No Osseous soft tissue masses, small fluid collection dorsal to 1st toe

Signature: _____ Name (Please Print): _____ Title: _____

Figure 1. Screen capture of the Wound Electronic Medical Record Datasheet. The WEMR aggregates all the relevant clinical information in a single, easy-to-read sheet that includes photographs of the wound at the initial and most recent visit (right). The graph (left) depicts the trend in wound area since the initial visit, allowing the clinician to determine if the current treatment regimen is effective. In addition, ample space is provided on the data sheet for wound pathology and cultures. Noninvasive flow study results are displayed as well as laboratory values, color-coded red if higher than the reference range and blue if below. Taken together, the WEMR sheet is a useful way to present all the relevant clinical variables and because of the trend in wound area, allows the clinician to make an objective decision about the treatment course.

Results

The 200 admissions reviewed comprised 139 patients, most commonly with venous ulcers and foot ulcers in the presence of diabetes mellitus and managed with surgical debridement and/or treatment with systemic antibiotics (see Table 1). Approximately one third of all patients had peripheral arterial disease and evidence of osteomyelitis. Of the 139 patients, 109 (78%) had at least one admission originating in the emergency department; for 80 (74%), this was the first presentation. Each patient had an average of 1.4 ± 0.8 admissions during the study period. Of the 200 consecutive admissions, 134 (67%) originated in the emergency department. Based on a review of all the records, three patients with the most commonly encountered types of chronic wounds — one each with a lower extremity ulcer and diabetes, a venous ulcer, and a pressure ulcer — are described.

Case Reports

All case study patients had at least one of the following—increasing wound drainage, increasing pain, persistent or non-resolving cellulitis, and/or significant undermining — and were managed based on presenting characteristics as summarized in Table 2.

Case 1: Recurrent pain from a lower extremity ulcer in a patient with diabetes. Mr. U, an 89-year-old man with a medical history that included diabetes, hypertension, myocardial infarction, congestive heart failure, chronic renal insufficiency, cerebrovascular accident, and asthma, presented in the clinic with a tender, painful ulcer over the area of the Achilles tendon. This was Mr. U's only symptom; he had stopped walking approximately 6 months before this presentation. The initial appearance of his wound before emergent presentation is shown in Figure 2a.

Mr. U's wound subsequently was debrided but he returned to the clinic 4 weeks later complaining of increasing pain. No drainage or cellulitis was noted. Because of the severity of his pain, he was admitted the same day (see Figure 2b). At the time of admission, Mr. U's vital signs were temperature 100° F, respiratory rate 20, pulse 73 bpm, and blood pressure 176/80 mm Hg. His serum glucose was 98 mg/dL, blood urea nitrogen 19 mg/dL, serum creatinine 1.2 mg/dL, and white blood cell count $5,400/\mu\text{L}$. A bone scan revealed osteomyelitis of his right heel. His ABIs were within normal limits. Although the wound initially appeared to be 3 cm in diameter over the Achilles tendon, operative debridement revealed 12 cm of undermining superiorly (see Figure 2c). The pathology report noted tendon and skeletal muscle with chronic inflammation and degenerative changes. Sterile wound cultures of the tendon grew *Escherichia coli* resistant to fluoroquinolones and tobramycin. After extensive debridement, resection of a portion of the Achilles tendon, bilayered cellular therapy^{27,28} with human living keratinocytes and fibroblasts, and 6 weeks of IV antibiotics for treatment of osteomyelitis, Mr. U's pain resolved and the wound healed (see Figure 2d). Most importantly, Mr. U's

Table 1. Characteristics of patients admitted to an inpatient wound service

	Wound Service Admissions (n = 139 patients)
Age (years), mean \pm SD	62 \pm 16
Male (%)	59
Wound type (category)*	
Foot ulcer in patient with diabetes (%)	27
Ischemic ulcer (%)	16
Pressure ulcer (%)	15
Venous ulcer (%)	29
Other (%)	13
Peripheral arterial disease (%)	32
Osteomyelitis—radiology (%)	37
Osteomyelitis—pathology (%)	20
Radiographic or pathologic evidence of osteomyelitis (%)	38

* Proportions are rounded to nearest whole number.

mental status dramatically improved; after 6 months of being bed-bound and not able to walk, he was ambulatory.

Case 2: Drainage and cellulitis in a venous stasis ulcer. Ms. W, a 53-year-old woman with a history of hepatitis C cirrhosis, presented to the emergency room with increased drainage and chronic cellulitis from multiple nonhealing venous ulcers. Oral antibiotics had been administered in her nursing home without improvement. One of these ulcers on her left calf is shown at time of presentation (see Figure 3). On admission, her vital signs included temperature 96.8° F, respiratory rate 20, pulse 64 bpm, and blood pressure 150/90 mm Hg. Her serum glucose was 95 mg/dL, blood urea nitrogen 8.0 mg/dL, and serum creatinine 0.5mg/dL. Her white blood cell count was 6,300 cells/ μL . Clear, nonpurulent drainage and mild cellulitis were noted on physical exam. Pathology from operative debridement showed granulation tissue with focal areas of acute inflammation and necrosis. Atrophic skeletal muscle and fibrosis also were reported. Deep sterile cultures of the muscle and tendon grew *Acinetobacter baumannii* resistant to multiple antibiotics including imipenem, amikacin, ampicillin/sulbactam, third generation cephalosporins, and fluoroquinolones. Previous cultures of this area had grown vancomycin-resistant enterococci, and methicillin-resistant *Staphylococcus aureus* (MRSA). Over the next 6 months, Ms. W required multiple debridements with application of human living keratinocytes and fibroblasts and antibiotics to control her recurrent local infections. In that time, her wound area decreased from 22.2 cm² to 9.1 cm².

Case 3: Undermining and drainage in a pressure ulcer. Mr. V, a 63-year-old bed-bound man with a history of multiple sclerosis and ulcerative colitis, presented to the emergency room with increased nonpurulent drainage from a Stage IV sacral pressure ulcer (see Figure 4). He denied having pain or

Table 2. Clinical characteristics of wound emergency

Wound Characteristic*	Clinical Point	Treatment Rationale	Treatment Point
New or increasing pain	Palpate for tenderness in areas adjacent to the wound	May indicate that the infection has spread beyond visible boundaries of wound	<ul style="list-style-type: none"> • Explore wound and surrounding structures for nonviable and infected tissue • Treat with antibiotics tailored to the organisms. Perform sharp debridement
New or increasing cellulitis	Skin may appear taut and shiny as well as warm and erythematous	May indicate a new soft tissue infection or infection with resistant or multiple pathogens	<ul style="list-style-type: none"> • Culture the wound bed before starting new antibiotics • Deep culture/pathology of the viable wound base after sharp debridement should guide antibiotic therapy
New or increasing nonpurulent drainage	Ask patient about frequency of dressing changes and examine dressing for nature of fluid — ie, discoloration, odor	May indicate a new soft tissue infection or infection with resistant or multiple pathogens	<ul style="list-style-type: none"> • Culture wound fluid before starting new antibiotics • Culture/pathology analysis of tissue left behind after sharp debridement should guide subsequent therapy
Significant undermining	Use a soft cotton swab to explore wound below the level of skin. Note: skin over undermined areas may appear normal	Indicates compromised subcutaneous tissue usually secondary to deeper infection; removing areas of undermining provides access to entire wound bed for debridement, topical therapy, and dressings	<ul style="list-style-type: none"> • Excise undermined skin in triangular fashion to expose entire wound bed and minimize loss of normal tissue • Send a portion of noninfected, viable-appearing tissue at the base of the wound for culture and pathology

* Proportions are rounded to nearest whole number.

fever. On admission, his vital signs were temperature 99.3° F, respiratory rate 20, pulse 78 bpm, and blood pressure 110/70 mm Hg. His admission serum laboratory values were glucose 101 mg/dL, blood urea nitrogen 13.0 mg/dL, serum creatinine of 1.0 mg/dL, and white blood cell count of 9,100 cells/ μ L. On examination, extensive undermining was present between 3 and 6 o'clock, and operative debridement of necrotic tissue extended into the bone. Pathology revealed necrotic soft tissue and focal acute osteomyelitis. After the necrotic tissue was removed, deep sterile tissue cultures of sacral bone were taken and grew *Enterococcus faecalis*. After 2 months of treatment including local wound care and operative debridement, the wound area decreased from 30.1 cm² to 21.2 cm².

Discussion

Although the literature describing acute wound emergencies (eg, necrotizing fasciitis or gangrene) is extensive and the number of patients with chronic wounds visiting emergency rooms is high, few reports or data define a chronic wound emergency — ie, the clinical characteristics that merit urgent inpatient treatment. In this report, the authors reviewed the records of 200 admissions, the majority of which (74%) presented to their service for the first time not through the clinic but through the emergency

room. The 139 unique patients admitted in the study period were for the most part older (mean age 62 years), male, and presented with a diabetic foot ulcer or venous ulcer. At initial admission work-up, a 32% prevalence of peripheral arterial disease was noted and one-in-five patients presented from the community with pathology-confirmed osteomyelitis.

The purpose of this initial report was to draw attention to the clinical characteristics that may constitute a chronic wound emergency. The fact that the majority of first-time patients present through the emergency room merits further quantitative study with an objective tool such as the WEMR to rigorously define the characteristics of chronic wounds requiring urgent treatment. Moreover, a dedicated electronic record supports comprehensive and consistent care to all patients presenting with wounds in the emergency room and thereby may help eliminate disparities in care. In the authors' experience working in the inner city, patients have access to interdisciplinary services and care regardless of insurance or socioeconomic status because the WEMR objectifies care based on why the wound is not healing — eg, cellulitis, drainage, or pain. Once alerted from the WEMR, the wound clinician then can alter the treatment course accordingly.

From the case reports selected, the authors observed that although these wounds did not have gangrene or purulence on admission exams, wound cultures grew antibiotic-resistant organisms and were associated with histological signs of necrosis, ulceration, or osteomyelitis. Because diabetes impairs the local inflammatory response secondary to neuropathy,³ all classic signs of infection may not be present. Moreover, the authors hypothesize that if these warning signs of impending sepsis or SIRS are missed, patients may be undertreated for conditions such as invasive soft tissue infection or osteomyelitis and may subsequently present with a larger wound and a resistant organism if partially treated and inadequately debrided. In these cases, the wound may turn gangrenous or lead to necrotizing fasciitis, sepsis, or amputation; therefore, deep debridement is indicated when the patient presents.

Infection. A nonhealing wound, as measured by change in area, is often a sign of occult infection. Use of an informatics system such as the WEMR in the emergency room or clinic setting would allow clinicians to determine if the wound is not healing as compared to previous visits.

Patients with chronic wounds may not present with classic signs of soft tissue infection, such as redness, warmth, swelling, and pain, particularly if they have impaired immune response from aging³⁰ or impaired local vasodilation linked to neuropathy.³¹ Hence, absence of these classic signs does not rule out a wound infection; the clinician should be aware of the atypical signs of a chronic wound infection and devise a treatment plan (see Table 2). In any

person with diabetes and wound pain, even a small ulcer may harbor an infection. Increased drainage in a chronic wound is often a sign of persistent infection.²¹ Although the drainage may not be purulent, discoloration or an increase in drainage may be a sign of persistent infection that requires treatment.

Pain. The presence of pain is an abnormal finding that merits observation and usually intervention. Mr. U (Case 1) complained only of pain, but this was an indication of a severe soft tissue infection and osteomyelitis (see Figure 2c). Pain should be evaluated not only in the wound itself, but also in normal-appearing adjacent areas.

Undermining. Undermining is defined as loss of subcutaneous tissue beyond the visible epidermal boundaries of the wound; it often is missed on initial exam. Undermining reflects significant infection and requires sharp debridement. A sterile swab can be used to gently probe the wound for exposed bone and to evaluate for undermining of the wound. In the study population, more than one third of the patients presented with some evidence of osteomyelitis and one out of five was confirmed by surgical pathology. The Center for Medicaid and Medicare Services (CMS) guidelines (Federal Tag F314) mandate assessment of undermining.³² A similar evaluation is useful in the clinic or emergency department setting. Even when skin surrounding the wound appears healthy, it may conceal infected or necrotic tissue underneath. Any Stage IV pressure ulcer or wound that probes to bone should raise suspicion for osteomyelitis. Biopsy of the tissue left behind after debridement can verify

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presence or absence of osteomyelitis and guide subsequent treatment.

In summary, the authors recommend that clinicians:

1. Evaluate the skin in all patients with signs of sepsis¹⁹;
2. Obtain deep cultures upon presentation and initiate systemic antibiotics when patients present with signs or symptoms suggestive of acute or worsening infection;
3. Debride all nonischemic wound infections, best performed by sharp excision of the superficial infected fibrinous and nonviable tissue. Noninfected tissue from the wound base, judged after debridement to be viable, should be sent to microbiology and pathology for analysis;
4. When persons with chronic wounds present with signs and symptoms such as new or increasing pain, cellulitis, nonpurulent drainage, or significant undermining, they should be evaluated for hospital admission and a treatment plan should be initiated. Table 2 summarizes the clinical characteristics of a chronic wound emergency.

Conclusion

After evaluating the results of this study analyzing the descriptions of wounds in patients presenting emergently for treatment, the authors hypothesize that the implementation of an objective electronic wound-specific database such as the WEMR will be helpful in decreasing chronic wound emergencies because even a subtle change in wound area can be documented at every outpatient visit. Moreover, the clinician would have all available clinical information in one location — ie, laboratory values, pathology, and culture results — to readily ascertain why the wound is not healing and subsequently intervene. Additional research will aim to utilize the WEMR to conduct a multicenter study to further define a wound emergency. ■

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Figure 2. Patient with diabetes and a lower extremity ulcer.
 2a. Initial appearance of a wound — Achilles tendon area — in an 89-year-old man with diabetes. He had stopped walking 6 months before presentation because of this ulcer.
 2b. The area underneath the scab containing nonviable tissue. A bone scan revealed osteomyelitis of the heel.
 2c. Significant undermining was found intraoperatively. Tendon and muscle pathology revealed chronic inflammation and degenerative changes. Deep sterile cultures grew *E. coli* resistant to fluoroquinolones and tobramycin.
 2d. The patient healed after implementation of wound healing protocols including sharp debridement, bilayered cellular therapy (eg, human living keratinocytes and fibroblasts), IV antibiotics, and negative pressure wound therapy.



Figure 3. A patient with a long-standing recurrent venous stasis ulcer on the left calf presented to the Emergency Department with progressive cellulitis and moderate drainage. Note: culture results indicated presence of a highly resistant strain of *Acinetobacter baumannii* in this wound sensitive to polymyxin only.



Figure 4. Patient with a pressure ulcer. A Stage IV pressure ulcer cannot be assessed by visual inspection alone. As comfortably and safely as possible, all pressure ulcers should be explored with a swab or gloved finger. This patient had a significant area of undermining and underwent operative debridement to excise the undermined skin and expose the wound bed.

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