

Standardized care protocol and modifications to electronic medical records to facilitate venous ulcer healing



Julie Bitner, PA-C,^a Ulka Sachdev, MD,^a Eric S. Hager, MD,^a and Ellen D. Dillavou, MD,^b Pittsburgh, Pa; and Durham, NC

ABSTRACT

Background: Venous ulcers are painful, recurrent, and difficult to heal. Electronic medical records (EMRs) are often not optimized to track wounds. Specialized wound care programs may not interface with office-based records, creating a need to standardize the process of venous ulcer measurement and dressing documentation within existing systems. This work describes the creation of an EMR protocol to track venous ulcer size, to standardize dressings, to address related health issues, and to improve education of the patient. We hypothesized that the institution of an EMR protocol to track clinical features of venous ulcer patients, including wound size and health status, would facilitate wound healing.

Methods: We performed a retrospective review of a prospective database from September 2014 to May 2017. Modifications to the EMR included the formation of a venous ulcer patient list, a dressing tracker, calculation of total ulcer area, graphing of ulcer size over time, and images of the wound area. Patient education materials were created through the EMR and loaded into an automatic end-visit printout that emphasized smoking cessation, weight loss, and consultation with specialty services as necessary. Quarterly meetings with the supervising physician were established to review each patient's wound progress and to target areas of improvement.

Results: During the study period, 204 patients with chronic C5 and C6 disease were observed. Before the start of the project, the healing rate was 53.3%. Wound healing rates improved from 59.5% (quarter 1) to 77.94% (quarter 8). In the quarter before the project started, there were no patients who had quit or cut down on smoking or smokeless tobacco, no patients who were referred for weight loss consultation, and nine who were already patients of bariatric surgery. During the study period, 29% of patients quit smoking, 19% decreased smoking, and 20% cut down smokeless tobacco use. There were 54 patients who underwent advanced arterial evaluation; 175 patients underwent sclerotherapy and 137 patients had endovenous thermal ablation to treat axial reflux in the affected limb. The EMR modification project took 13 months to craft and to implement, with approximately 8 hours of meeting time from the surgical team.

Conclusions: A comprehensive care model for venous ulcer patients through EMR modification improved overall patient care, increased communication between providers, and facilitated ulcer healing. EMR modification can be introduced with an acceptable time investment on the part of both the provider and the institutional information technology team. (*J Vasc Surg: Venous and Lym Dis* 2019;7:570-6.)

Keywords: Venous ulcer; Electronic medical record

Venous ulcers are often painful and unsightly and require frequent dressing changes.¹ On average, a venous ulcer takes at least 6 months to close and has a 70% recurrence rate within 5 years.¹ Venous ulcers occur in approximately 1% of people in the United States.² Deep

venous thrombosis, obesity, family history, female sex, advanced age, trauma, multiple pregnancies, and persistent standing are risk factors that contribute to venous ulceration.^{2,3} In 2010, the Pacific Vascular Symposium 6 made a goal to decrease prevalent chronic venous ulcers by 50% during the next 10 years.⁴ Patients frequently present to specialty practices without either a compression regimen or evaluation of venous insufficiency, despite multiple visits to other health care providers.¹ A lack of coordinated and comprehensive care deterred venous ulcer healing in many patients within our practice.

Before September 2014, our institution had no formal system in place to assess wound healing progress. Wound photographs and measurements were taken sporadically, and there was no continuity across our medical system to assess wounds. Our venous ulcer tracking project was established >2½ years ago to capture both the healed and open venous ulcer patients, to track their progress,

From the Department of Surgery, Division of Vascular Surgery, University of Pittsburgh Medical Center, Pittsburgh^a; and the Department of Surgery, Division of Vascular Surgery, Duke University Health System, Durham.^b

Author conflict of interest: none.

Presented at the Thirtieth Annual Meeting of the American Venous Forum, Tucson, Ariz, February 20-23, 2018.

Correspondence: Ellen D. Dillavou, MD, Duke Vascular Surgery Clinic, 407 Crutchfield St, Durham, NC 27704 (e-mail: ellen.dillavou@Duke.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2213-333X

Copyright © 2019 by the Society for Vascular Surgery. Published by Elsevier Inc. <https://doi.org/10.1016/j.jvsv.2018.11.009>

and to establish systematic wound care. The goals of this pilot project were to create a protocol for treating venous ulcer patients, to standardize venous ulcer measurements and documentation, and to create a patient list to track venous ulcer patients. Additional goals were to establish periodic meetings with the supervising physician to assess healing and to prevent attrition, to collaborate with other services to improve venous ulcer treatment, and to improve education of venous ulcer patients. The aim to place patients on a healing trajectory⁵ was activated and included modifications of the electronic medical record (EMR) to standardize documentation. An example of how EMR technology may improve patient care is through the wound EMR (WEMR), which similarly has the wound documentation in one location, is updated at each visit, and can assist providers in noticing changes to a wound that can be treated on an outpatient basis.⁶ We hypothesized that wound healing rates would improve within a single practice with the institution of a standardized, comprehensive program of patient tracking and intervention that incorporated modifications to the EMR. As this was a pilot program, it was initiated in the largest of the University of Pittsburgh Vein Centers with plans to roll out to other sites if it was successful.

METHODS

A retrospective review was performed of patients prospectively enrolled in a venous ulcer quality improvement program at the Magee-Womens Hospital Vein Center of the University of Pittsburgh Medical Center. As this was a quality improvement project, informed consent was not obtained. When the project was completed and the decision was made to publish results, Institutional Review Board approval was obtained.

Patients attending specialized wound clinics at different locations were excluded from the study. The number of procedures was calculated for each quarter. If a patient had more than one of the same procedure in the same quarter, it was counted as one per limb. The procedures evaluated included ultrasound-guided foam sclerotherapy, thermal ablation, débridement, split-thickness skin graft, substitute skin graft, and phlebectomy. Foam sclerotherapy consisted of 0.5% or 1% polidocanol (Asclera; Merz Pharma, Raleigh, NC) and was performed with an ultrasound technologist. Radiofrequency ablation and endovenous laser therapy were totaled together as thermal ablation. Compression was evaluated for every patient on the first visit. The ulcer's morphologic features and drainage and the patient's preferences and dressing changing ability were used to derive an acceptable method to provide at least 30 to 40 mm Hg of compression to be worn at all times when the patient was out of bed. The type of dressing would change on the basis of changes in the ulcer or the patient's ability to perform dressing care.

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective review of prospectively collected data
- **Key Findings:** In 204 patients with C5 and C6 disease, venous ulcer healing rates improved from 59.5% (quarter 1) to 77.94% (quarter 8) under a comprehensive care model administered through electronic medical records changes.
- **Take Home Message:** Electronic medical records can be used as a tool to facilitate comprehensive care and improved venous ulcer outcomes.

The patients' demographics, including sex and age, history of deep venous thrombosis, tobacco status, and body mass index, were recorded. The time investment required by both the vascular surgery division and the EMR provider to modify the outpatient record to target venous ulcer patients was recorded. The EMR (Epic; Epic Systems Corporation, Verona, Wisc) was modified to include a Wound Status section to capture the details of the dressing and wound. Recorded information included the laterality, wound chronicity, and status (healed vs active). It also included the current dressing, dressing change frequency, and whether any substitute skin grafts or split-thickness skin grafts were used. The Wound Status standardized the documentation of the dressing regimen with dropdown menus. A Wound Tracker program was created within the EMR to standardize venous ulcer measurements and documentation that could be accessed with a wound tracker button in the Epic Visit Navigator. In the Wound Tracker, wounds were numbered and localized. Wound measurements were entered into preset boxes, and the surface area was automatically calculated. A Synopsis feature presented line graphs of the ulcer's surface area to visualize ulcer area over time. The Synopsis contains the Wound Status and the Wound Tracker. The Wound Tracker measurements and the Wound Status dressing details were automatically populated in the Synopsis for each visit. The Synopsis allowed the dressing regimen in the Wound Status to be compared with the ulcer area in the Wound Tracker for every office visit to assess for ulcer progress, stagnation, or closure. An example of the Synopsis is shown in Fig 1.

A protocol was created for treatment of venous ulcer patients by performing a venous assessment that addressed compression, obesity and nutrition, and tobacco use (Fig 2). The ulcer was treated as a venous ulcer if it had characteristic morphologic features of a venous ulcer, was located on the lower leg, and existed in the absence of other demonstrable disease, such as arterial insufficiency or other biopsy-proven causes. Biopsy of the ulcer was performed if there was no demonstrable venous disease, no wound response to

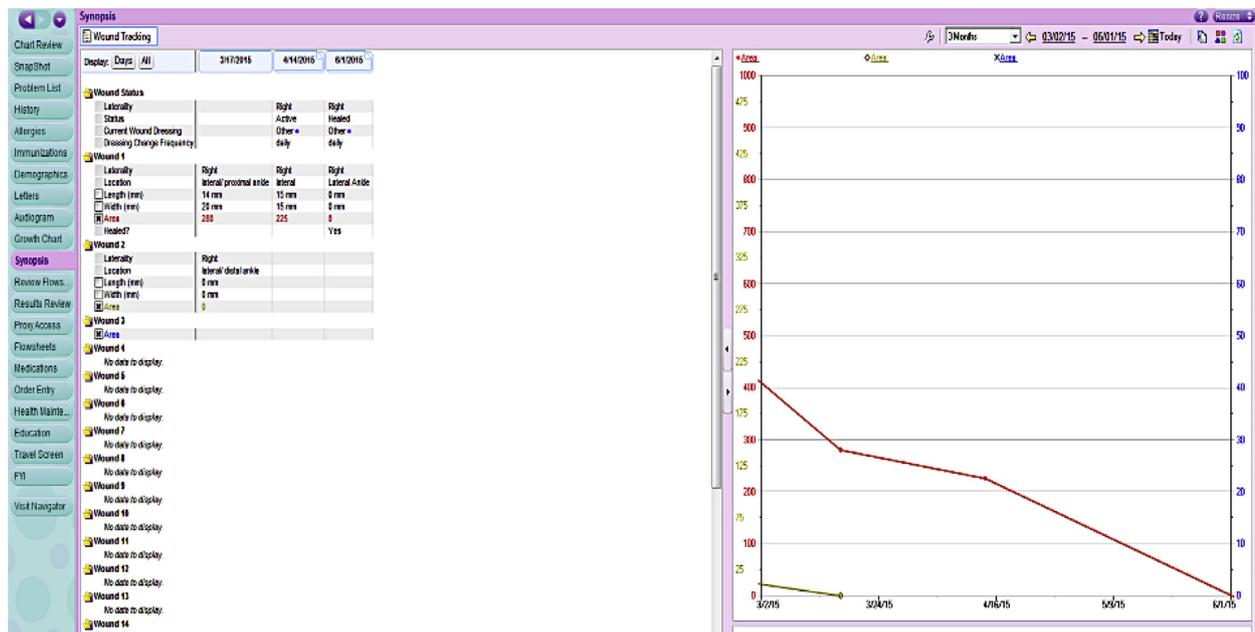


Fig 1. Example of healed ulcer with Wound Status, Wound Tracker, and Synopsis.

venous intervention, or no decrease in wound size after 6 weeks of compressive therapy. A venous reflux study of both legs was obtained at the first office visit for new patients, after interventions, and for return patients with new or recurrent venous ulcers or stagnation in wound healing. Stagnation of healing was defined as <5% decrease in wound area per week for >4 weeks. Proximal venous obstruction was evaluated by assessing ultrasound flow dynamics in the common femoral vein and iliac veins, moving to venography with intravascular ultrasound and stenting as appropriate with evidence of obstruction at the common femoral vein or with wound healing stagnation. Great, small, and anterior accessory saphenous veins with reflux of ≥ 1 second and dilation ≥ 5 mm were treated with ablation.⁷ Perforating veins with reflux of ≥ 0.5 second and dilation ≥ 3.5 mm in the vicinity of the active or healed ulcer were treated with thermal ablation or ultrasound-guided foam sclerotherapy after saphenous reflux was addressed.⁷ Large, bulging branch varicosities with reflux of ≥ 1 second and dilation ≥ 5 mm were treated with phlebectomy or ultrasound-guided foam sclerotherapy. Arterial-brachial index was obtained if pedal pulses could not palpated. If the arterial-brachial index was <0.5, an angiogram was obtained, and arterial revascularization was performed as anatomically appropriate.

The collaboration group consisted of an internal medicine physician, bariatric surgeon, plastic surgeon, home health nurses and aids, primary care physicians, and wound centers. By working with home health nurses and telemedicine, immobile and elderly patients could avoid excess traveling and reduce frequency of appointments. Telemedicine services at the University of

Pittsburgh Medical Center were linked to home health care. This service was provided to patients who had difficulty in complying with the follow-up visit schedule. Wound care visits were scheduled variably, between weekly and every 6 weeks, on the basis of dressing choices, appearance of the wound, and schedule of procedures. A new venous ulcer patient education handout was created to describe symptoms, risk factors, prevention, ultrasound testing, compression, bathing, dry skin, weight management, bariatric surgery, and tobacco cessation.

A multilayer compression dressing was typically started at the first office visit for new patients and return patients with new venous ulcers. Healthy eating habits with fruit, vegetables, and lean protein were encouraged for all venous ulcer patients. Morbidly obese patients were referred to an internal medicine physician who specialized in nonsurgical weight loss, namely, diet and exercise. Patients saw a dietitian at the same appointment as the weight loss consultation. Patients who failed to achieve nonsurgical weight loss were referred for possible bariatric surgery. Tobacco use and cessation were discussed at every office visit with emphasis on the role in wound healing as well as in overall health. Smoking cessation and compliance with dietary recommendations were self-reported by patients as part of the review of systems.

Active and healed venous ulcer patients were tracked using a patient list in the computer EMR. The patient list contained the name, date of birth, age, tobacco status, last office visit, next office visit, and surgical procedures such as bariatric surgery. The patient list was accessible to all health care providers. Open and closed venous ulcer patients were reviewed quarterly with the

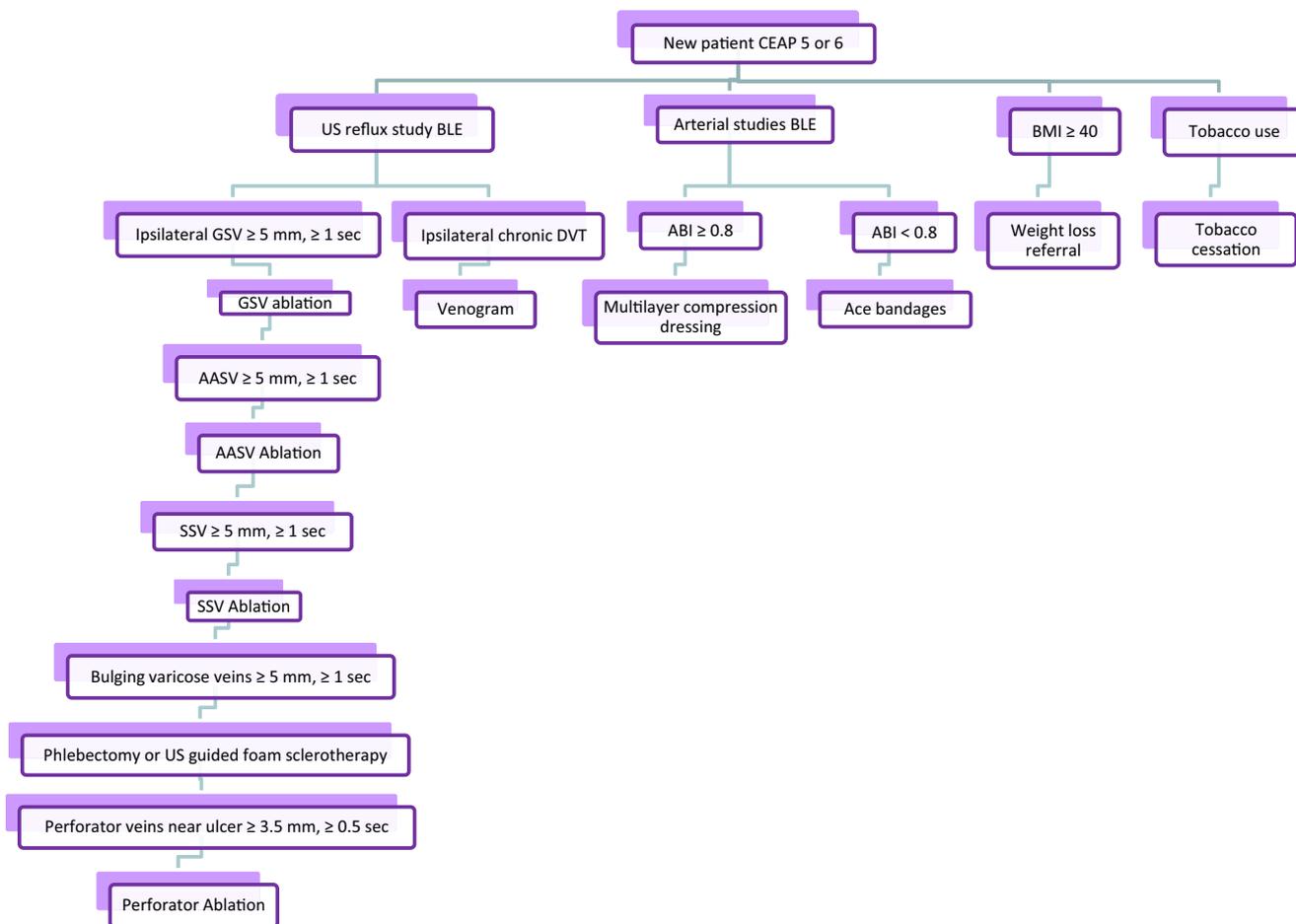


Fig 2. Treatment algorithm. AASV, Anterior accessory saphenous vein; ABI, ankle-brachial index; BLE, bilateral lower extremities; BMI, body mass index; CEAP, Clinical, Etiology, Anatomy, and Pathophysiology classification; DVT, deep venous thrombosis; GSV, great saphenous vein; SSV, small saphenous vein; US, ultrasound.

physician and physician assistant to facilitate follow-up and to improve wound care by establishing a proactive plan. The line graph in the Synopsis was used to follow wound area over time. Wounds were tracked individually to guide interventions. Before and during EMR changes, patients were counted as open if they had any open ulcer and closed when all skin was intact on both limbs. The ulcer closure rate of our population was the progression of patients from having open to closed ulcers over time. If an ulcer reopened or a new ulcer formed, the patient was moved from the closed to the open group.

Statistics were performed with χ^2 for nominal variables and Student *t*-test for continuous variables. No attempt was made to perform a multivariable analysis because of inconsistencies in visit frequency and medication tracking for patients receiving home care. $P \leq .05$ was considered significant.

RESULTS

The total number of Clinical, Etiology, Anatomy, and Pathophysiology (CEAP) clinical class C5 and C6 patients at the Vein Center at Magee-Womens Hospital of the

University of Pittsburgh Medical Center increased from 126 to 204 during the course of the study (quarter 1 to quarter 8). The population of patients consisted of an equal number of women and men. The demographics of these patients are shown in the Table. Enhancements and modifications in the EMR were generated through 8 hours of vascular surgery and 50 hours of Epic support time.

During the course of the study, 175 patients had ultrasound-guided foam sclerotherapy, 137 patients had radiofrequency ablation or endovenous laser therapy, and 3 patients had a phlebectomy. Thirty-six patients had débridement, 6 patients had split-thickness skin grafts, and 13 patients had substitute skin grafts. In comparison, in the quarter before the project, 18 patients had ultrasound-guided foam sclerotherapy, 13 patients had radiofrequency ablation or endovenous laser therapy, 4 patients had débridement, 1 patient had a split-thickness skin graft, 9 patients had substitute skin grafts, and no patients had a phlebectomy. The largest number of patients had ultrasound-guided foam sclerotherapy in quarter 3 at 39 and the lowest number in quarter 7 at 12.

Table. Patients' demographics

Factor	Patients (N = 204), No. (%)
Female	102 (50)
History of DVT	57 (27.9)
Age, years	
29-59	78 (38.2)
60-79	96 (47.1)
≥80	30 (14.7)
Body mass index, kg/m ²	
35-40	26 (12.7)
>40	58 (28.4)

DVT, Deep venous thrombosis.

The most patients had radiofrequency ablation or endovenous laser therapy in the last quarter at 23 compared with 11 in quarter 7. Fig 3 illustrates the breakdown of procedures over time. Although there were more procedures performed in the early (quarters 1-4) part of the analysis, this difference was not statistically significant.

Since project initiation, eight patients quit smoking, four patients cut down smoking, and one patient reduced smokeless tobacco use. In an effort to improve patients' nutritional status, 25 patients were referred for nonsurgical weight loss, where they also met with a dietitian. Ten other patients were already patients of the bariatric service. Of the two patients referred for bariatric surgery, one had bariatric surgery and the other did not follow through to schedule the surgery that was recommended. There were 84 patients with a body mass index of >35 kg/m².

The study group was CEAP C5 and C6 patients. The percentage of CEAP C5 of the entire group was 59.5% in the first quarter of project initiation, and it increased to 77.94% at the end of the study period ($P = .03$; Fig 4). Before the project, 41.3% had open venous ulcers (CEAP C6), and 53.3% of these closed within the study period.

Through the standardization of wound measurements, location, and laterality in the Wound Tracker, each ulcer was observed individually. Twenty-two patients died during follow-up. These and other patients who were lost to follow-up or who chose to pursue care from another center ($n = 12$ at conclusion of the study) were eliminated from the analysis at each time point, with the status of the wound at the last visit being used as the state of the ulcer for final statistics.

DISCUSSION

This report demonstrates improvement in venous ulcer healing through the institution of a standard venous ulcer care protocol built into the EMR. The healing rate before the EMR changes was 53.3% compared with 77.94% at the conclusion of the project. Interestingly, EMR changes were not needed to institute evidence-based care. On the contrary, our team thought that we provided excellent care at all time points, and our treatment algorithms did not change. What did change and improved care was a systematic way to ensure consistent multidisciplinary attention for every patient without additional documentation. Through tracking of open and closed venous ulcer patients with the patient list, we decreased the number of patients lost to follow-up, standardized care, and enabled more comprehensive evaluation and referral. In the Wound Tracker, each ulcer was numbered, the location and laterality were specified, and the ulcer area was calculated. By using the Wound Tracker, we were able to follow each venous ulcer. With the creation of a venous ulcer treatment protocol, patients with new, stagnated, or recurrent venous ulcers received a venous reflux study to identify new disease that may contribute to the ulcer. The results of the venous reflux study were used to guide future venous treatments. Although these same treatment algorithms had been employed before the EMR changes, there was no method to graph results, so stagnation was

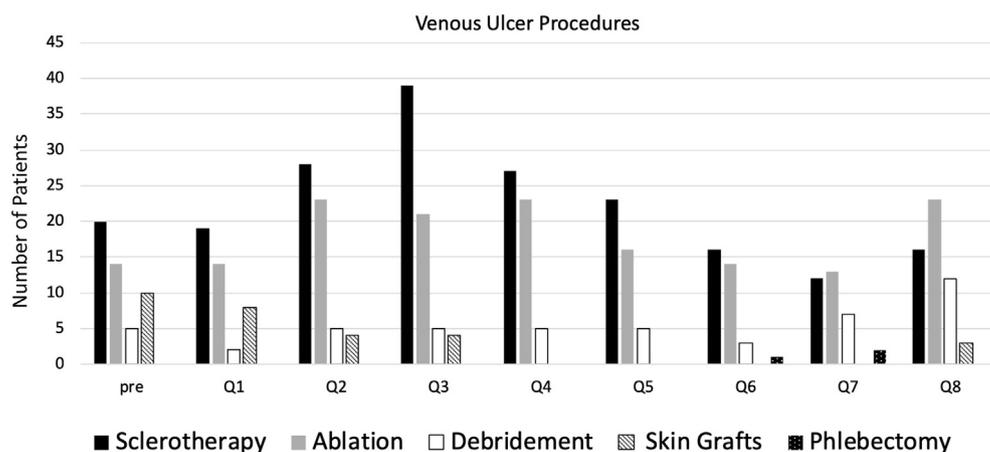


Fig 3. Venous insufficiency procedures during the implementation of electronic medical record (EMR) standardization, stratified by quarter (Q).

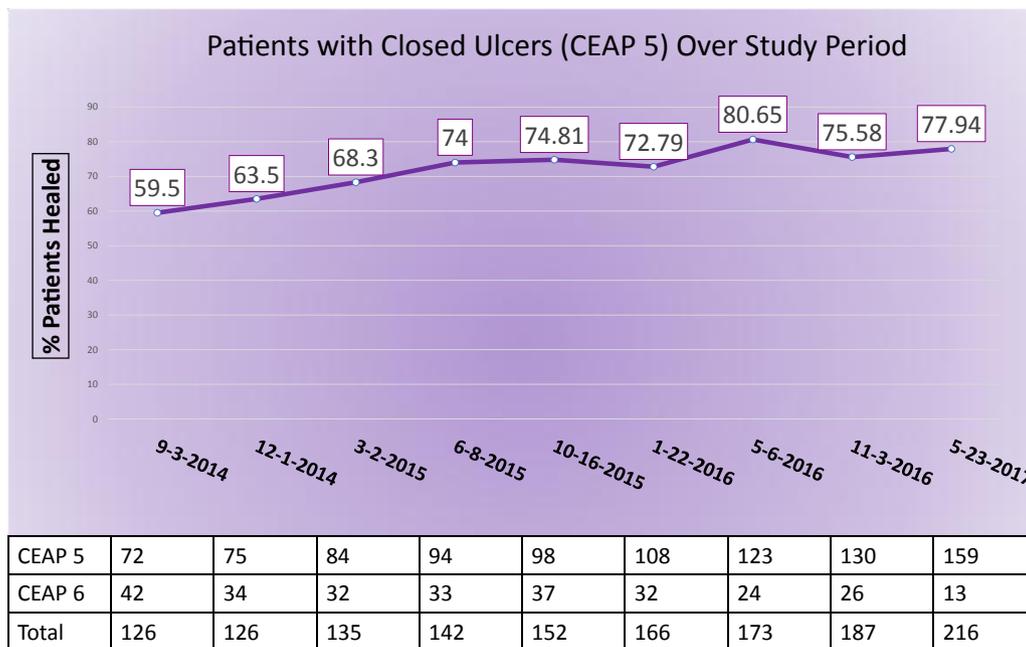


Fig 4. Percentage of all patients with healed ulcers at each time point. CEAP, Clinical, Etiology, Anatomy, and Pathophysiology classification.

more difficult to appreciate. The new tools allowed the team to keep patients on track. This feature and more attention and support for overall health are the likely reasons we saw improvement in wound healing.

Treatment of incompetent superficial axial and perforator veins improves venous ulcer healing and reduces the risk of recurrence.⁷⁻¹⁰ Since the start of the project, ultrasound-guided foam sclerotherapy and endovenous thermal ablation represented the most venous insufficiency procedures. Refluxing and dilated axial veins, branch varicosities, and incompetent perforator veins were treated with the goals of healing open venous ulcers and prolonging the ulcer-free period.^{11,12}

The Synopsis, consisting of a line graph of each of the first four ulcers as well as the total ulcer area and coinciding with the Wound Status dressing regimen at each office visit, allowed a visual representation of the ulcer's progress. During quarterly meetings with the supervising physician, the Synopsis was referenced to demonstrate ulcer progress and to guide changes in patients' care. Other specialties and patients' primary care physicians could also view pictures of the ulcers from each office visit, advancing continuity of care.

There has been very little written about EMR modification and resultant venous ulcer healing. This paper contributed to the small discrete literature that highlighted use of the EMR to improve wound care. An example of improvement in documentation for other types of ulcers is the WEMR.¹³ In the WEMR, wound description, digital photograph, treatment, and comorbidities were all listed in one location.¹³ Having an easier

access to patient information was useful for taking care of chronic wounds.¹³ The WEMR study contrasted to our study in that it focused on the digital photograph for measuring wounds.¹³ The WEMR was similar to the advancements in the EMR through protocols and wound tracking.¹³ In addition, the studies were comparable because they both improved communication between specialties.¹³

The study on wound emergencies was similar to our study in that both focused on development of the WEMR and EMR, respectively, to improve documentation.⁶ Advances in the WEMR and EMR allow clinicians to more clearly delineate the wound's progress.⁶ In the WEMR study, the focus was to reduce admissions and emergency department visits through addressing wound complications promptly.⁶ The studies were different in that the WEMR was used to decrease wound emergencies overall, whereas our study concentrated on venous ulcers.⁶

The time to use and to improve the EMR can seem overwhelming to a busy clinician. However, the EMR is the way medicine is practiced, and this project illustrates that modifications to the EMR benefit not only patients but clinicians as well. By enrolling patients in this program and logging the details of their care, we were able to quickly and accurately assess the history of the wounds and the progress being made. After the initial time investment by the wound care representative and the Epic team, daily use of the program seemed to be no more time intensive than standard visit documentation and yielded better longitudinal results.

Operationalizing care aspects, such as dressing take-down and wound measurement, and recording of these by medical assistants greatly enhanced efficiency and use of the program.

Limitations of the study were that there was no prospective tracking of the time that practitioners needed to invest, both initially and in maintenance, to have patients in the Wound Tracker system. In addition, the Synopsis did not have line graphs for more than four ulcers, and the exact time that patients' ulcers opened and closed (within 1-2 weeks) was occasionally difficult to ascertain.

CONCLUSIONS

Although the number of CEAP C5 and C6 patients increased from 118 to 204, the percentage of active ulcer patients was the lowest at the conclusion of the project at 4.9%, with 17% of the total original cohort being deceased or lost to follow-up. The number of closed venous ulcer patients increased from 59.5% at the beginning of the project to 77.94% at the end. The EMR was improved by the addition of the Wound Tracker, Wound Status, and Synopsis. Through collaboration with other specialists and primary care physicians, continuity of care was instituted, communication was facilitated, and overall health of the patients was improved.

AUTHOR CONTRIBUTIONS

Conception and design: JB, ED

Analysis and interpretation: US, EH, ED

Data collection: JB, US, EH, ED

Writing the article: JB, US, EH, ED

Critical revision of the article: JB, US, EH, ED

Final approval of the article: JB, US, EH, ED

Statistical analysis: Not applicable

Obtained funding: Not applicable

Overall responsibility: ED

REFERENCES

1. Gillespie DL. Venous ulcer diagnosis, treatment, and prevention of recurrences. *J Vasc Surg* 2010;52:8S-14S.
2. Kolluri R. Management of venous ulcers. *Tech Vasc Interv Radiol* 2014;17:132-8.
3. Hager ES, Washington C, Steinmetz A, Wu T, Singh M, Dillavou E. Factors that influence perforator vein closure rates using radiofrequency ablation, laser ablation, or foam sclerotherapy. *J Vasc Surg Venous Lymphat Disord* 2016;4:51-6.
4. Henke P; Pacific Vascular Symposium Faculty. The Pacific Vascular Symposium 6: the Venous Ulcer Summit in perspective. *J Vasc Surg* 2010;52:1S-2S.
5. Cardinal M, Eisenbud DE, Phillips T, Harding K. Early healing rates and wound area measurements are reliable predictors of later complete wound closure. *Wound Repair Regen* 2008;16:19-22.
6. Golinko MS, Clark S, Rennert R, Flattau A, Boulton AJ, Brem H. Wound emergencies: the importance of assessment, documentation, and early treatment using a wound electronic medical record. *Ostomy Wound Manage* 2009;55:54-61.
7. O'Donnell TF Jr, Passman MA, Marston WA, Ennis WJ, Dalsing M, Kistner RL, et al. Management of venous leg ulcers: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. *J Vasc Surg* 2014;60(Suppl):3S-59S.
8. Dillavou ED, Harlander-Locke M, Labropoulos N, Elias S, Ozsvath KJ. Current state of the treatment of perforating veins. *J Vasc Surg Venous Lymphat Disord* 2016;4:131-5.
9. Van Gent WB, Hop WC, Van Praag MC, Mackaay AJ, De Boer EM, Wittens CH. Conservative versus surgical treatment of venous leg ulcers: a prospective, randomized, multicenter trial. *J Vasc Surg* 2006;44:563-71.
10. Harlander-Locke M, Lawrence P, Jimenez JC, Rigberg D, DeRubertis B, Gelabert H. Combined treatment with compression therapy and ablation of incompetent superficial and perforating veins reduces ulcer recurrence in patients with CEAP 5 venous disease. *J Vasc Surg* 2012;55:446-50.
11. Barwell JR, Davies CE, Deacon J, Harvey K, Minor J, Sassano A, et al. Comparison of surgery and compression with compression alone in chronic venous ulceration (ESCHAR study): randomized controlled trial. *Lancet* 2004;363:1854-9.
12. Lawrence PF, Alktaifi A, Rigberg D, DeReubertis B, Gelabert H, Jimenez JC. Endovenous ablation of incompetent perforating veins is effective treatment for recalcitrant venous ulcers. *J Vasc Surg* 2011;54:737-42.
13. Kiguchi MM, Hager ES, Winger DG, Hirsch SA, Chaer RA, Dillavou ED. Factors that influence perforator thrombosis and predict healing: perforator sclerotherapy for venous ulceration without axial reflux. *J Vasc Surg* 2014;59:1368-76.

Submitted Jun 23, 2018; accepted Nov 12, 2018.