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Original Study

Outpatient Wound Clinics During COVID-19 Maintained Quality but Served Fewer Patients

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A B S T R A C T

Objective: To evaluate the impact of COVID-19–related disruptions on care continuity and outcomes of chronic wounds.

Design: Retrospective cohort study.

Setting and Participants: Electronic medical records for 152,225 chronic wounds from a network of 488 wound care clinics in 45 US states and the District of Columbia.

Methods: Wound and patient characteristics, the number of chronic wounds newly seen at the clinics, and 12-week healing rates were compared between the first 2 quarters of 2019 and 2020. Multivariable regression models were constructed to evaluate whether the pandemic was associated with a statistically significant change in the probability of 12-week wound healing after risk adjustment.

Results: During the pandemic, wound and patient characteristics did not change compared to the previous year. Case volume dropped as much as 40% in April 2020 but returned to the previous year’s level by June. No systematic changes in measures of care continuity were observed. Unadjusted 12-week healing rates remained stable at 0.502 in 2019 and 0.503 in 2020. Likewise, risk-adjusted 12-week healing rates were 0.504 and 0.505 in 2019 and 2020, respectively, but the difference was not statistically significant. States with stricter lockdowns saw a greater decline in case volume. However, the pandemic was not associated with a statistically significant change in the probability of 12-week wound healing in most states. The percentage of wounds with 1 or more telehealth visits increased from 0.14% in 2019 to 1.04% in 2020.

Conclusions and Implications: Despite COVID-19–related disruptions, our results suggest that wound care clinics maintained standards of care and outcomes for patients who sought care. This positive result should not detract from the problem that the number of new wounds seen at the clinics dropped sharply. Further research should evaluate outcomes in patients with unattended chronic wounds.
and increased psychological distress are common in patients, with up to one-third of patients living with chronic wounds suffering from depression. Over time, more than 50% of diabetic foot ulcers become infected, and 1 in 3 patients eventually have a lower extremity amputation. Moreover, the shared causal path with other chronic diseases means that the incidence of chronic wounds will increase with the growing burden of diabetes, dyslipidemia, and other chronic conditions in the aging US population.

The management of chronic wounds requires continuous treatment of the wound and underlying diseases, typically lasting 3 to 6 months depending on size and etiology. However, the COVID-19 pandemic has created a unique challenge because, similar to dental care, the ability to substitute in-person encounters with telecare visits is limited for the management of chronic wounds. Routine in-person visits are required to change dressings, mechanically clean and inspect the wound, and swab for potential infections. A recent study analyzing electronic medical records from 480 US wound care clinics showed that disruptions in continuity of care (eg, less frequent provider visits and mechanical removal of devitalized tissue) were associated with worse wound outcomes after adjusting for the differences in case-mix across the clinics.

During the pandemic, staff had to accommodate new cleaning and sanitation requirements and change personal protective equipment after each patient encounter while maintaining established care practices. Additional tasks included informing patients about the need for regular visits, screening patients and staff for COVID-19 at the clinics, monitoring adherence to safety protocols, and sending letters to referring physicians that the clinics remained fully operational. Moreover, the duration of the face-to-face phase of the in-person visit had to be reduced to a minimum. Only patients, not family members and caregivers, were allowed to enter the treatment rooms. Transportation services and home visits had to be reduced or eliminated. Clinic staff tried to counteract these headwinds by offering greater scheduling flexibility, as the drop in the number of new patients opened up additional slots.

Against this background, it was hypothesized that the COVID-19 pandemic had disrupted continuity of care and adversely affected outcomes of chronic wounds. Using electronic medical records from a network of 488 wound care clinics in 45 US states and the District of Columbia, this study compared care continuity and outcomes for chronic wounds newly seen at the clinics between the first 6 months of 2019 and 2020. The decision to focus on the first half of the year was made because this was the period when processes and workflows had to be adapted in response to the ongoing pandemic. As states responded differently to the pandemic, outcomes were compared across the states.

**Methods**

**Data Source**

The study analyzed electronic medical records from a national wound care management company, which manages a network of outpatient wound care clinics in 45 US states and the District of Columbia. These clinics are staffed by a combination of employed and contracted physicians, supported by specialized nurses and case managers. With more than 4000 physicians and advanced practitioners, the company is the largest provider of wound care services in the United States and treats around 300,000 patients each year. All participating clinicians are required to attend a 1-week specialty wound care training course and follow evidence-based algorithmic clinical practice guidelines. These clinics are hospital-based, and most have access to specialty consultants (eg, vascular surgeons), advanced treatment modalities, and hyperbaric oxygen therapy. Medicare patients account for almost half of the patients, but all major insurance carriers are accepted. Although the company has treatment privileges at more than 300 skilled nursing facilities, it does not provide care in-house for long-term care facilities. The vast majority of patients are treated at outpatient clinics.

This study included all patients with chronic wounds who had an initial intake assessment between January 1 and June 30 of 2019 or 2020. The electronic medical records contained detailed patient information such as age, sex, smoking status, body mass index, comorbid conditions, and wound measurements such as length, width, and depth, in addition to categorical descriptors for wound etiology, location, and appearance. At the clinic level, the measures of care continuity included the rates of weekly provider visits, weekly debridement, and quit/transfer. The weekly provider visit rate was the proportion of patients at a clinic with at least 1 in-person visit with a clinician each week. The calculation of weekly visits did not require each visit to include the same clinician, as many clinics have multiple providers on staff, but each visit had to be at the same clinic to be included. Weekly debridement rate was defined as the proportion of clinic visits during which wounds were mechanically cleaned. Quit/transfer rate was defined as the proportion of patients that were transferred to another facility or lost to follow-up.

The original data included 156,831 chronic wounds from the 488 wound care clinics after excluding wounds that were caused by radiation and other acute wounding events (eg, trauma and surgery) and the wounds in patients who were seen only for an initial consultation. Then 4606 (3%) wounds with missing or implausible values (ie, wound surface areas >100 cm² for arterial ulcers and 150 cm² for other wound types) were excluded. The final data for analysis included 152,225 (97%) chronic wounds from 90,629 patients. In 2019, there were 84,094 wounds and 50,053 patients, and in 2020, 68,131 wounds and 40,576 patients. For ease of presentation, hereafter, new wounds refer to chronic wounds newly seen and treated at the clinic regardless of whether they are in new or existing patients.

**Primary Outcome**

Following previous clinical trials of wound treatment, the primary outcome was the status of the wound within the first 12 weeks of an initial clinic visit, dichotomously coded as healed or nonhealed. Although patients could remain in the treatment for longer than 12 weeks, wound healing beyond this time point was considered nonhealed. Using a modified intent-to-treat framework, wounds in patients lost to follow-up before the end of the 12 weeks were classified as nonhealed.

Each wound was assessed at intake and each subsequent visit. The wound status was documented by the treating clinician based on the following criteria: (1) wound has zero wound measurements, is covered with a full layer of epithelium, and has no exudate; (2) wound has received a flap procedure and presents postprocedure with complete take; (3) wound has received a graft procedure and presents postprocedure with complete success; and (4) wound margins have been approximated and sutured to facilitate closure and wound has zero measurements.

**Statistical Analysis**

Characteristics of wounds and patients, the number of in-person and telehealth visits, and clinic-level measures of care continuity were compared between the first 6 months of 2019 and 2020. Linear probability models were constructed to evaluate the impact of the pandemic on the probability of 12-week wound healing. Linear probability models were appropriate for 3 reasons. First, the proportion of chronic wounds that heal within 12 weeks is about 50%. Second, the estimated probability of 12-week wound healing fell between 0 and 1 for all wounds in this analysis. Third, linear probability models
are easier to interpret than logistic regression models because the impact of an estimated coefficient is independent of the level of the other coefficients in the model.

All multivariable models were constructed at the wound level. The first model evaluated the association of the pandemic-related disruptions with the probability of 12-week wound healing, using a fixed effect for the year 2020. The model included the wound and patient characteristics described previously for risk adjustment and fixed effects for clinics and states to adjust for unobserved time-invariant confounders. In this model, the estimated coefficient on the 2020 year fixed effect captured the change in the probability of 12-week wound healing due to pandemic-related disruptions. In the second model, interaction terms between the year and state fixed effects were added to the first model to evaluate whether the impact of the pandemic-related disruptions varied across the states. The analysis of simple main effect differences tested for a statistically significant change in the risk-adjusted probability of 12-week wound healing in each state between 2019 and 2020.

Hereafter, the term, the 12-week wound healing rate, was used when describing the probability of 12-week wound healing in a specific time period (ie, month and year). Two-sided t test and chi-square test were used for statistical hypothesis testing of continuous and categorical variables, respectively. Statistical significance was assessed at a P value <.05. All statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC). The SLICE command was used for the analysis of simple main effect differences.16 The study was reviewed and approved by the Institutional Review Board of our institution under its Innovation/Flexibility Policy (UP-18-00477).

Results

Wound and Patient Characteristics

Tables 1 and 2 compare the wound and patient characteristics between the first 6 months of 2019 and 2020. New wounds in 2020 were slightly larger (ie, 9.60 vs 9.16 cm²; P < .001) and deeper in terms of both physical depth (ie, 3.17 vs 3.16 mm; P < .001) and tissue penetration (ie, 55% vs 53% full thickness; P < .001). Other wound characteristics showed statistically significant differences, but the differences were small in magnitude. Likewise, the differences in patient characteristics showed statistically significant differences, albeit with small magnitudes.

In-Person and Telehealth Visits

The mean number of in-person visits per wound decreased by 12%, from 12.31 in 2019 to 10.79 in 2020 (P < .001). On the other hand, the mean number of telehealth visits increased from 0.02 in 2019 to 0.11 in 2020 (P < .001). Throughout 2020, the mean number of telehealth visits and the percentage of wounds with 1 or more telehealth visits were consistently higher than the previous year (Supplementary Figures 1 and 2). They peaked in February 2020 and gradually decreased thereafter.

Clinic-Level Measures of Care Continuity

For each of the 488 clinics in the analysis, the year-to-year changes in the 3 measures of care continuity are visualized in Figure 1. The X-coordinate is for 2019 and the Y-coordinate for 2020. The mean weekly visit rates were 0.64 in 2019 and 0.63 in 2020 (P = .08). The mean debridement rates were 0.55 in 2019 and 0.56 in 2020 (P = .36). The mean quit/transfer rates were 0.09 in both 2019 and 2020 (P = .90).

### Table 1

| Wound Status at the End of 12 wk | 2019 (n = 84,094 Wounds) | 2020 (n = 68,131 Wounds) | P Value |
|---------------------------------|--------------------------|--------------------------|---------|
| Healed                          | 42,235 (50)              | 34,267 (50)              |         |
| Wound Characteristics           |                          |                          |         |
| Depth, mm, mean (SD)            | 3.16 (6.21)              | 3.17 (7.21)              | <.001   |
| Area, cm², mean (SD)            | 9.16 (19.22)             | 9.60 (19.78)             | .001    |
| Infected                        | 5541 (7)                 | 4726 (7)                 | .007    |
| Necrotic                        | 3768 (4)                 | 3601 (5)                 | <.001   |
| Heavily exuding                 | 4355 (5)                 | 3928 (6)                 | <.001   |
| Eschar formation                | 1494 (2)                 | 1456 (2)                 | <.001   |
| Wound Location                  |                          |                          |         |
| Amputation site                 | 1349 (2)                 | 1467 (2)                 | <.001   |
| Foot                            | 24,413 (29)              | 19,879 (29)              |         |
| Lower leg                       | 27,115 (32)              | 22,412 (33)              |         |
| Pelvic                          | 8467 (10)                | 6298 (9)                 |         |
| Toe                             | 8718 (10)                | 7140 (10)                |         |
| Upper leg                       | 2052 (2)                 | 1584 (2)                 |         |
| Others                          | 1859 (2)                 | 1370 (2)                 |         |
| Missing                         | 10,121 (12)              | 7981 (12)                |         |
| Wound Type                      |                          |                          |         |
| Arterial ulcer                  | 3882 (5)                 | 3047 (4)                 | <.001   |
| Diabetic ulcer                  | 33,226 (40)              | 27,120 (40)              |         |
| Pressure ulcer                  | 18,785 (22)              | 13,905 (20)              |         |
| Venous ulcer                    | 19,776 (24)              | 16,981 (25)              |         |
| Others                          | 8425 (10)                | 7078 (10)                |         |
| Wound Stage                     |                          |                          |         |
| Full thickness                  | 44,920 (53)              | 37,180 (55)              | <.001   |
| Partial thickness               | 18,456 (22)              | 14,980 (22)              |         |
| Superficial                     | 5411 (6)                 | 3760 (6)                 |         |
| Unknown                         | 15,307 (18)              | 12,211 (18)              |         |

Unless otherwise noted, values are n (%).

### Table 2

| Comparison of Patient Characteristics by Year | 2019 (n = 50,053 Patients) | 2020 (n = 40,576 Patients) | P Value |
|---------------------------------------------|-----------------------------|-----------------------------|---------|
| Female                                      | 21,904 (44)                 | 17,460 (43)                 | .027    |
| Palliative care                             | 1029 (2)                    | 669 (2)                     | <.001   |
| Number of concurrent wounds, mean (SD)      | 1.67 (1.24)                 | 1.69 (1.27)                 | <.001   |
| Age, y                                      |                            |                             |         |
| <54                                         | 9596 (19)                   | 7836 (19)                   | <.001   |
| 55-64                                       | 10,743 (21)                 | 9048 (22)                   |         |
| 65-74                                       | 12,355 (25)                 | 10,290 (25)                 |         |
| ≥75                                         | 17,359 (35)                 | 13,402 (33)                 |         |
| Body Mass Index                             |                            |                             |         |
| <18.5                                       | 1086 (2)                    | 833 (2)                     | <.001   |
| 18.5-24                                     | 7102 (14)                   | 5756 (14)                   |         |
| 25-29                                       | 8330 (17)                   | 6872 (17)                   |         |
| ≥30                                         | 17,506 (35)                 | 14,703 (36)                 |         |
| Missing/unknown                             | 16,029 (32)                 | 12,412 (31)                 |         |
| Smoking status                              |                            |                             |         |
| Current smoker                              | 6085 (12)                   | 4878 (12)                   | <.001   |
| Former smoker                               | 13,549 (27)                 | 10,153 (25)                 |         |
| Never smoker                                | 17,614 (35)                 | 13,465 (33)                 |         |
| Missing/unknown                             | 12,805 (26)                 | 12,080 (30)                 |         |
| Comorbidity                                 |                            |                             |         |
| Alzheimer disease                           | 2405 (5)                    | 1546 (4)                    | <.001   |
| Coronary artery disease                     | 9676 (19)                   | 7706 (19)                   | .196    |
| Congestive heart failure                    | 7715 (15)                   | 5991 (15)                   | .007    |
| Chronic pulmonary disease                   | 6274 (13)                   | 5016 (12)                   | .434    |
| Obstructive disease                         | 28,589 (57)                 | 23,073 (57)                 | .443    |
| Diabetes                                    | 27,724 (55)                 | 21,095 (52)                 | <.001   |
| Hyperension                                 | 15,139 (30)                 | 12,114 (30)                 | .202    |
| Peripheral vascular diseases                | 1783 (4)                    | 1188 (3)                    | <.001   |

Unless otherwise noted, values are n (%).
National-Level Outcomes

The total number of new wounds decreased by 19% between 2019 and 2020. Following a nearly 40% drop in monthly volume in April 2020, the case volume returned to the previous year’s level by June (Figure 2A). At the national level, unadjusted 12-week healing rates remained stable at 0.502 and 0.503 in 2019 and 2020. In other words, about 50% of all chronic wounds healed within 12 weeks from the initial intake assessment in both years (Figure 2B). Likewise, in the multivariable regression model, the 12-week healing rates were 0.504 and 0.505 in 2019 and 2020, respectively (Supplementary Table 1 for the full regression results). With 0.002 in the estimated coefficient of the 2020 year fixed effect and a P value of 0.385, there was no difference in the probability of 12-week wound healing between 2019 and 2020.

State-Level Outcomes

Supplementary Figure 3 shows relative declines in case volume between 2019 and 2020 at the state level. Case volume declined in all states, with larger declines of >20% primarily observed in the Northeastern, Mid-Atlantic, and West Coast states (eg, California, Washington, New York, New Jersey, and Vermont). Declines of <10% were observed in Georgia, Louisiana, Montana, and Texas. The number of clinics and wounds and the 12-week healing rates in each state are listed in Supplementary Table 2.

Based on the results of the second multivariable regression model, the state-level changes in the probability of 12-week wound healing are visualized in Supplementary Figure 4. Actual estimates are presented in Supplementary Table 3. Oklahoma, Vermont, and Maryland had statistically significant increases in the risk-adjusted probability of 12-week healing between 2019 and 2020, whereas Washington, Pennsylvania, and Connecticut had statistically significant decreases. However, these statistically significant differences were small in absolute terms, with <5% in most states. Moreover, larger changes in the probability of 12-week wound healing were observed in Vermont and North Dakota, which had only 1 clinic in the state treating fewer than 100 chronic wounds a year.

Discussion

Using electronic medical records for 152,225 chronic wounds from 488 wound care clinics in 45 US states and the District of Columbia, this study evaluated the impact of the pandemic-related disruptions on 3 measures of care continuity and outcomes of chronic wounds newly seen at the clinics. Although the wound volume declined nationally, the 12-week wound healing rates and continuity care were maintained during the pandemic. The symmetrical distribution around the 45-degree line suggests that year-to-year changes in the 3 measures of care continuity were rather random than systematic. Several wound and patient characteristics were statistically significantly different between the 2 periods. However, the magnitudes of
the differences were small, and the unadjusted 12-week healing rates remained unchanged. These results suggest that such differences did not reflect clinically meaningful changes in wound acuity and patient health status.

Our results show that states with earlier and stricter lockdowns, such as California and New York, had greater declines in wound volume than other states, such as Georgia and Texas (Supplementary Figures 3 and 4). In this analysis, 87% of the 68,131 chronic wounds treated in 2020 came from 37 states and the District of Columbia that did not have statistically significant changes in the 12-week wound healing rates between 2019 and 2020. Still, our results warrant careful interpretation as we do not account for differences in COVID-19 incidence and their effect on behavioral responses to lockdown rules.

Like in other areas of medical care, the utilization of telehealth visits increased in patients with chronic wounds during the pandemic, albeit from a low base.[17,18] Telehealth visits accounted for 1.53% of all encounters for wounds starting treatment in February 2020, up from 0.09% in 2019 (Supplementary Figures 1 and 2). This may not be surprising because the management of chronic wounds requires routine in-person visits for visual examination, accurate wound measurement, mechanical removal of devitalized tissue, and application of new dressings.

The finding of stable outcomes in patients who entered treatment despite the COVID-related disruptions is somewhat unexpected. However, it is also no means guaranteed. A recent study in Italy compared patients with new dressings.

Figure 2. (A) Number of new chronic wounds by the month and year of initial intake assessment. (B) Percentage of chronic wounds healed within 12 weeks by the month and year of initial intake assessment.

Conclusions and Implications

Our findings suggest that wound care clinics maintained the continuity of care and outcomes for patients who entered treatment during the COVID-19 pandemic. However, the drop in case volume remains a concern. It indicates that many patients with chronic wounds were unwilling or unable to seek treatment. Although our results do not provide proof that the drop in volume leads to higher rates of adverse outcomes in patients with unattended chronic wounds, further research should evaluate the “side effects” of lockdowns and find a data-driven balance between infection containment and provision of regular medical care.

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Supplementary Fig 1. Mean number of telehealth visits per wound by the month and year of initial intake assessment.

Supplementary Fig 2. Percent of chronic wounds with 1 or more telehealth visits by the month and year of initial intake assessment.
**Supplementary Fig 3.** Changes in the number of new chronic wounds between 2019 and 2020.

**Supplementary Fig 4.** State-level changes in the risk-adjusted 12-week wound healing rates between 2019 and 2020.
| Variable                        | Estimate | SE  | 95% CI    | P Value |
|--------------------------------|----------|-----|-----------|---------|
| Intercept                      | 0.651    | 0.035 | 0.582 0.720 | <.001  |
| Year                           |          |     |           |         |
| 2019 Reference                 |          |     |           |         |
| 2020                           | -0.002   | 0.002 | -0.007 0.003 | .385    |
| Depth                          | -0.009   | 0.000 | -0.009 0.008 | <.001  |
| Wound area                     | -0.003   | 0.000 | -0.003 0.003 | <.001  |
| Age category <55               |          |     |           |         |
| 55-64                          | 0.008    | 0.004 | 0.000 0.015 | .047    |
| 65-74                          | 0.017    | 0.004 | 0.009 0.024 | <.001  |
| ≥75                            | 0.027    | 0.004 | 0.020 0.035 | <.001  |
| BMI category 18.5-24           |          |     |           |         |
| 25-29                          | 0.023    | 0.004 | 0.017 0.034 | <.001  |
| <18.5                          | -0.035   | 0.009 | -0.052 0.017 | <.001  |
| Missing                        | 0.006    | 0.005 | -0.004 0.016 | .249    |
| Palliative                     |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.182   | 0.008 | -0.198 -0.165 | <.001  |
| Gender                         |          |     |           |         |
| Female                         |          |     |           |         |
| Male                           | 0.021    | 0.003 | 0.016 0.026 | <.001  |
| Smoking status                 |          |     |           |         |
| Never smoker                   |          |     |           |         |
| Current smoker                 | -0.036   | 0.004 | -0.044 -0.027 | <.001  |
| Former smoker                  | -0.005   | 0.003 | -0.011 0.001 | .130    |
| Unknown                        | -0.026   | 0.006 | -0.037 -0.016 | <.001  |
| Alzheimer disease              |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.038   | 0.006 | -0.050 -0.026 | <.001  |
| Coronary artery disease        |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.018   | 0.003 | -0.024 -0.011 | <.001  |
| Congestive heart failure       |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.026   | 0.004 | -0.033 -0.019 | <.001  |
| COPD                           |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | 0.007    | 0.004 | -0.000 0.015 | .059    |
| Diabetes                       |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | 0.021    | 0.004 | 0.014 0.028 | <.001  |
| Peripheral vascular diseases   |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.086   | 0.003 | -0.092 -0.080 | <.001  |
| Plegia                         |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | -0.092   | 0.007 | -0.106 -0.079 | <.001  |
| Hypertension                   |          |     |           |         |
| No                             |          |     |           |         |
| Yes                            | 0.012    | 0.003 | 0.005 0.018 | <.001  |
| Number of concurrent chronic wounds |  |       |           |       |
| 1                              | 0.007    | 0.003 | 0.002 0.014 | .010    |
| ≤2                             | -0.040   | 0.003 | -0.046 -0.034 | <.001  |
| Wound location                 |          |     |           |         |
| Foot                           |          |     |           |         |
| Amputation site                | 0.031    | 0.009 | 0.013 0.049 | <.001  |
| Lower leg                      | 0.135    | 0.004 | 0.128 0.143 | <.001  |
| Missing                        | 0.074    | 0.004 | 0.066 0.083 | <.001  |
| Other                          | 0.102    | 0.009 | 0.084 0.119 | <.001  |
| Pelvic                         | 0.098    | 0.006 | 0.088 0.109 | <.001  |
| Toe                            | 0.056    | 0.004 | 0.048 0.065 | <.001  |
| Upper leg                      | 0.158    | 0.008 | 0.142 0.174 | <.001  |
| Wound stage                    |          |     |           |         |
| Superficial                    |          |     |           |         |
| Full thickness                 | -0.193   | 0.006 | -0.205 -0.181 | <.001  |
| Partial thickness              | -0.057   | 0.007 | -0.071 -0.044 | <.001  |
| Unknown                        | -0.238   | 0.006 | -0.250 -0.225 | <.001  |
| Wound type                     |          |     |           |         |
| Diabetic ulcer                 |          |     |           |         |
| (continued on next column)
### Supplementary Table 2
Changes in Volume and Unadjusted 12-Week Healing Rate by State

| State                  | 2019 | 2020 | Relative Changes Between the 2 Years | Number of Clinics |
|------------------------|------|------|-------------------------------------|-------------------|
|                        | Number of Wounds Admitted | 12-wk Healing Rate, % | Number of Wounds Admitted | 12-wk Healing Rate, % | Number of Wounds Admitted, % | 12-wk Healing Rate, % |                        |
| Alabama                | 1056 | 51   | 945 | 51   | −11 | 0 | 8 |
| Arizona                | 1436 | 48   | 1265 | 48   | −12 | −1 | 7 |
| Arkansas               | 1891 | 50   | 1516 | 50   | −20 | 1 | 9 |
| California             | 2697 | 50   | 2111 | 53   | −22 | 5 | 16 |
| Colorado               | 1062 | 48   | 861  | 49   | −19 | 2 | 7 |
| Connecticut            | 1424 | 50   | 1006 | 43   | −29 | −14 | 9 |
| Delaware               | 415  | 47   | 320  | 44   | −23 | −8 | 2 |
| District of Columbia   | 75   | 40   | 32   | 50   | −57 | 25 | 1 |
| Florida                | 7382 | 51   | 6060 | 51   | −18 | 2 | 46 |
| Georgia                | 1672 | 49   | 1450 | 50   | −10 | 2 | 9 |
| Idaho                  | 278  | 55   | 226  | 61   | −19 | 12 | 2 |
| Illinois               | 3352 | 54   | 2621 | 51   | −22 | −5 | 21 |
| Indiana                | 3374 | 54   | 2772 | 54   | −18 | −1 | 16 |
| Iowa                   | 1657 | 58   | 1230 | 54   | −26 | −6 | 11 |
| Kansas                 | 974  | 56   | 804  | 56   | −17 | 1 | 6 |
| Kentucky               | 3630 | 51   | 2926 | 49   | −19 | −5 | 15 |
| Louisiana              | 622  | 51   | 560  | 52   | −10 | 2 | 4 |
| Maine                  | 116  | 63   | 86   | 56   | −26 | −11 | 1 |
| Maryland               | 1942 | 46   | 1550 | 50   | −20 | 7 | 11 |
| Massachusetts          | 1928 | 47   | 1547 | 47   | −20 | 1 | 12 |
| Michigan               | 1504 | 53   | 1312 | 53   | −13 | 0 | 10 |
| Minnesota              | 545  | 56   | 460  | 54   | −16 | −3 | 4 |
| Mississippi            | 1376 | 45   | 1083 | 42   | −21 | −6 | 8 |
| Missouri               | 2856 | 48   | 2511 | 49   | −12 | 1 | 17 |
| Montana                | 253  | 56   | 235  | 49   | −7  | −12 | 2 |
| Nebraska               | 947  | 48   | 724  | 47   | −24 | −1 | 2 |
| Nevada                 | 281  | 62   | 204  | 51   | −27 | −17 | 1 |
| New Hampshire          | 437  | 52   | 424  | 53   | −3  | 0 | 5 |
| New Jersey             | 1628 | 49   | 1190 | 51   | −27 | 3 | 13 |
| New Mexico             | 89   | 57   | 79   | 58   | −11 | 2 | 1 |
| New York               | 3144 | 48   | 2068 | 48   | −34 | 0 | 19 |
| North Carolina         | 6956 | 47   | 5767 | 49   | −17 | 5 | 34 |
| North Dakota           | 92   | 66   | 56   | 41   | −39 | −38 | 1 |
| Ohio                   | 5360 | 53   | 4332 | 54   | −19 | 3 | 30 |
| Oklahoma               | 1169 | 43   | 985  | 51   | −16 | 17 | 8 |
| Oregon                 | 905  | 54   | 792  | 54   | −12 | 0 | 7 |
| Pennsylvania           | 2107 | 48   | 1483 | 45   | −30 | −7 | 13 |
| Rhode Island           | 188  | 54   | 117  | 62   | −38 | 15 | 1 |
| South Carolina         | 2537 | 49   | 2112 | 47   | −17 | −5 | 13 |
| Tennessee              | 3503 | 50   | 2759 | 51   | −21 | 3 | 14 |
| Texas                  | 6263 | 49   | 5720 | 50   | −9  | 2 | 38 |
| Vermont                | 83   | 37   | 66   | 58   | −20 | 54 | 1 |
| Virginia               | 1864 | 50   | 1530 | 52   | −18 | 3 | 10 |
| Washington             | 2017 | 53   | 1497 | 47   | −26 | −12 | 10 |
| West Virginia          | 195  | 46   | 159  | 48   | −18 | 5 | 1 |
| Wisconsin              | 872  | 55   | 578  | 54   | −34 | −3 | 7 |
### Supplementary Table 3
Changes in the Risk-Adjusted Probability of 12-Week Wound Healing Between 2019 and 2020 by State

| State          | Estimate | SE   | P Value |
|----------------|----------|------|---------|
| Alabama        | -0.026   | 0.021| .22     |
| Arizona        | -0.015   | 0.018| .41     |
| Arkansas       | -0.008   | 0.016| .63     |
| California     | 0.018    | 0.014| .19     |
| Colorado       | 0.007    | 0.022| .74     |
| Connecticut    | -0.056   | 0.019| .004    |
| Delaware       | -0.029   | 0.035| .41     |
| District of Columbia | 0.112  | 0.099| .26     |
| Florida        | 0.005    | 0.008| .56     |
| Georgia        | 0.019    | 0.017| .27     |
| Idaho          | 0.077    | 0.042| .07     |
| Illinois       | -0.018   | 0.012| .15     |
| Indiana        | 0.000    | 0.012| .98     |
| Iowa           | -0.033   | 0.018| .06     |
| Kansas         | -0.005   | 0.022| .84     |
| Kentucky       | -0.022   | 0.012| .06     |
| Louisiana      | 0.001    | 0.027| .98     |
| Maine          | -0.078   | 0.066| .24     |
| Maryland       | 0.041    | 0.016| .01     |
| Massachusetts  | 0.006    | 0.016| .73     |
| Michigan       | -0.024   | 0.018| .18     |
| Minnesota      | -0.021   | 0.03  | .48     |
| Mississippi    | -0.024   | 0.019| .22     |
| Missouri       | 0.001    | 0.013| .93     |
| Montana        | -0.050   | 0.043| .24     |
| Nebraska       | -0.072   | 0.043| .10     |
| Nevada         | 0.023    | 0.023| .33     |
| New Hampshire  | -0.037   | 0.032| .25     |
| New Jersey     | 0.021    | 0.018| .25     |
| New Mexico     | -0.013   | 0.073| .86     |
| New York       | -0.002   | 0.013| .85     |
| North Carolina | 0.016    | 0.008| .06     |
| North Dakota   | -0.191   | 0.084| .023    |
| Ohio           | 0.004    | 0.01  | .65     |
| Oklahoma       | 0.065    | 0.02  | .001    |
| Oregon         | -0.017   | 0.023| .46     |
| Pennsylvania   | -0.037   | 0.016| .019    |
| Rhode Island   | -0.007   | 0.055| .90     |
| South Carolina | -0.027   | 0.014| .048    |
| Tennessee      | 0.009    | 0.012| .47     |
| Texas          | 0.009    | 0.009| .28     |
| Vermont        | 0.170    | 0.077| .027    |
| Virginia       | 0.011    | 0.016| .49     |
| Washington     | -0.061   | 0.016| <.001   |
| West Virginia  | -0.024   | 0.05  | .63     |
| Wisconsin      | -0.029   | 0.025| .26     |

The size of coefficient is the difference in the risk-adjusted 12-week healing rate in a given state between 2019 and 2020.

### Supplementary Table 4
Changes in the Probability of 12-Week Wound Healing Between 2019 and 2020 by Patient Age Group

#### Unadjusted 12-week Healing Rates by Year

| Age Group | 2019, % | 2020, % | P Value |
|-----------|---------|---------|---------|
| <55 y     | 47.15   | 48.05   | .13     |
| 55-64 y   | 49.41   | 49.71   | .59     |
| 65-74 y   | 51.04   | 51.14   | .86     |
| ≥75 y     | 51.89   | 51.37   | .25     |

#### Adjusted Year-to-Year Change in 12-week Healing Rate

| Age Group | Estimate | SE   | P Value |
|-----------|----------|------|---------|
| <55 y     | 0.004    | 0.006| .51     |
| 55-64 y   | 0.002    | 0.005| .64     |
| 65-74 y   | -0.002   | 0.005| .69     |
| ≥75 y     | -0.009   | 0.004| .041    |

These adjusted estimates were from the first multivariable regression model described in the manuscript. Then the interaction terms between the year and the wound type variables were added for the analysis of simple main effect differences. For instance, after adjusting for the changes in case mix, age ≥75 years were associated with a 0.009–percentage point decrease in the probability of 12-week wound healing between 2019 and 2020.

*Chi-square test was used for statistical hypothesis testing for the unadjusted 12-week healing rates by year.

### Supplementary Table 5
Changes in the Probability of 12-Week Wound Healing Between 2019 and 2020 by Wound Type

#### Unadjusted 12-week Healing Rate by Year

| Wound Type | 2019, % | 2020, % | P Value |
|------------|---------|---------|---------|
| Arterial ulcer | 34.13   | 34.76   | .59     |
| Diabetic ulcer | 48.05   | 48.33   | .49     |
| Others       | 58.30   | 57.94   | .65     |
| Pressure ulcer | 42.25   | 40.43   | .001    |
| Venous ulcer | 61.17   | 61.11   | .91     |

#### Adjusted Year-to-Year Change in 12-week Healing Rate

| Wound Type | Estimate | SE   | P Value |
|------------|----------|------|---------|
| Arterial ulcer | 0.008   | 0.011| .46     |
| Diabetic ulcer | 0.001   | 0.004| .84     |
| Others       | -0.006   | 0.008| .44     |
| Pressure ulcer | -0.014  | 0.005| .008    |
| Venous ulcer | 0.003    | 0.005| .54     |

These adjusted estimates were from the first multivariable regression model described in the manuscript. Then the interaction terms between the year and the wound type variables were added for the analysis of simple main effect differences. For instance, after adjusting for the changes in case mix, pressure ulcer was associated with a 0.01–percentage point decrease in the probability of 12-week wound healing between 2019 and 2020.

*Chi-square test was used for statistical hypothesis testing for the unadjusted 12-week healing rates by year.