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Original Study

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

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ABSTRACT

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.

Chronic wounds, defined as wounds that fail to progress through normal healing process and remain open for more than 4 weeks, are an important but frequently overlooked public health challenge.[1] In 2014, more than 8 million Medicare beneficiaries suffered from chronic wounds, and associated Medicare spending was estimated to be as high as $96.8 billion annually.[2] Primarily caused by diabetes, peripheral vascular disease, immobilization, and elevated venous pressure, chronic wounds are a visible manifestation of poorly controlled chronic diseases.[3,4] Different etiologies of chronic wounds share a common pathway of compromised microcirculation, which leads to skin breakdown, bacterial colonization, and impaired tissue repair processes.[5]

In itself, a chronic wound causes substantial distress to patients, as many types are painful, and patients may be embarrassed by the associated smell and secretions, leading to withdrawal from social and professional interactions. Reduction of health-related quality of life

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and increased psychological distress are common in patients, with up to one-third of patients living with chronic wounds suffering from depression.[6−8] Over time, more than 50% of diabetic foot ulcers become infected, and 1 in 3 patients eventually have a lower extremity amputation.[9,10] 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.[11]

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.[12]

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 be with 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 cm^2 for arterial ulcers and 150 cm^2 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.[13,14] 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.[15]

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).

Table 1
Comparison of Wound Characteristics by Year

	2019 (n = 84,094 Wounds)	2020 (n = 68,131 Wounds)	*P* Value
Wound status at the end of 12 wk			
Healed	42,235 (50)	34,267 (50)	
Wound characteristics			
Depth, mm, mean (SD)	3.16 (6.21)	3.17 (7.21)	<.001
Area, cm^2, 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 (%)

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 cm^2; $P < .001$) 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 2
Comparison of Patient Characteristics by Year

Patient Characteristics	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 obstructive disease	6274 (13)	5016 (12)	.434
Diabetes	28,589 (57)	23,073 (57)	.443
Hypertension	27,724 (55)	21,097 (52)	<.001
Peripheral vascular diseases	15,139 (30)	12,114 (30)	.202
Plegia	1783 (4)	1188 (3)	<.001

Unless otherwise noted, values are n (%).

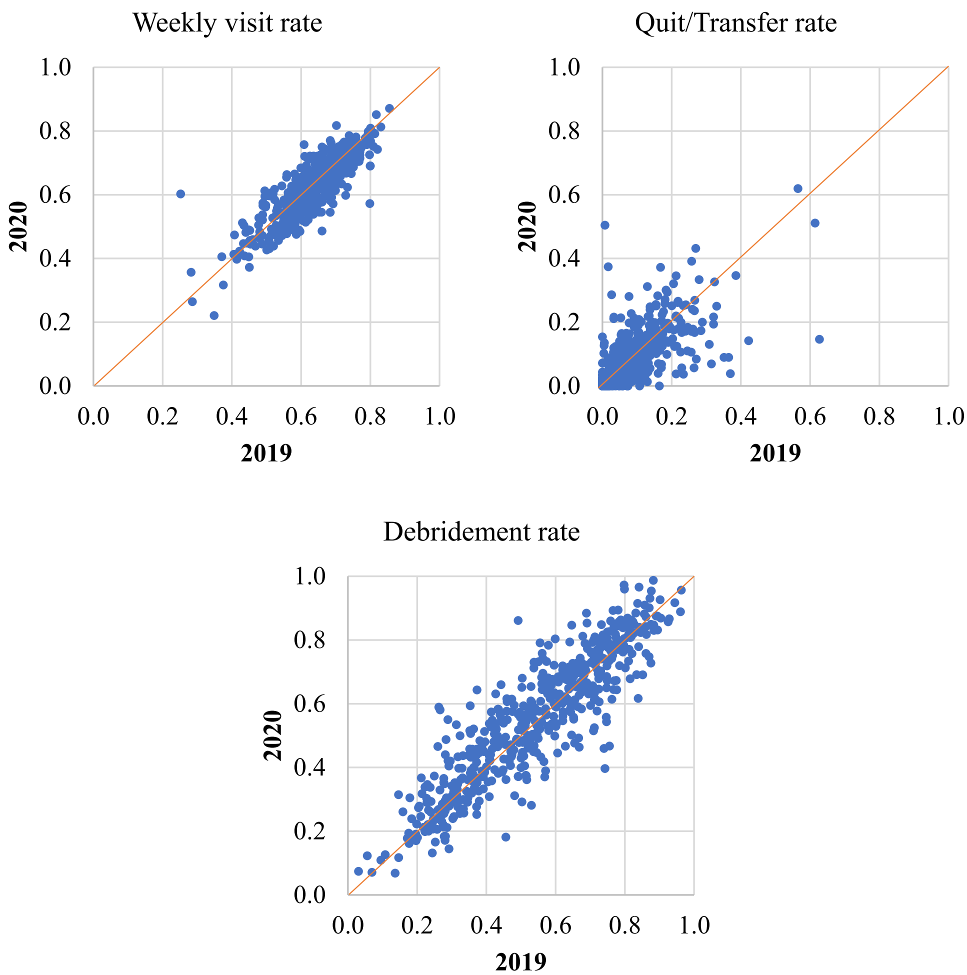

Figure 1. Clinic-level measures of care continuity.

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

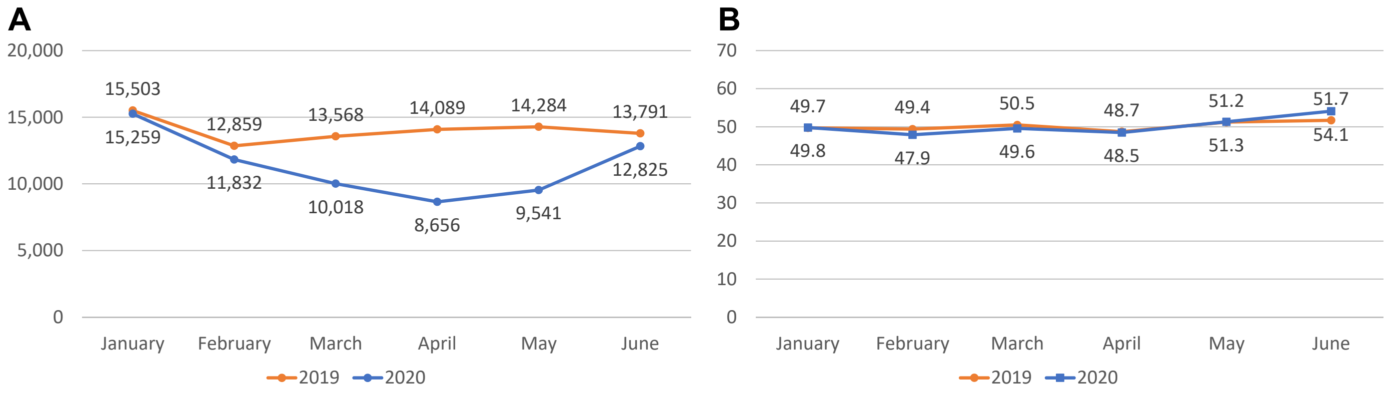

Figure 2. (**A**) Number of new chronic wounds by the month and year of initial intake assessment. (**B**) Percentage of chronic wounds healed within 12 weeks by the month and year of initial intake assessment.

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 showed worse wound outcomes during their first and stricter lockdown in March 2020 and slightly improved outcomes during a second and less restrictive lockdown in October 2020.[19] Moreover, the positive results from this analysis should not detract from the problem that the number of wounds newly seen in the clinics dropped sharply, indicating that many patients did not seek care and were exposed to an increased risk of unattended wound complications. Indeed, another study in Italy compared patients with new diabetic wounds from March 2020 to a cohort of similar age, glucose control, and comorbidities from the first half of 2019.[20] The 2020 cohort was more likely to be admitted on an emergency basis and had higher rates of gangrene and amputation. The study mentioned above similarly reported higher amputation rates during the first lockdown.

These findings are in line with several studies showing substantial declines in health care utilization, even for high-acuity conditions. Across the globe, the number of patients with acute myocardial infarction declined during the pandemic whereas the number of out-of-hospital cardiac arrests increased.[21–24] During the initial COVID-19 wave in Boston, cardiac-related emergency medical services calls decreased by 27%, calls with hospital transportation refusal increased by 33%, and out-of-hospital cardiac arrest cases increased by 36% compared to historical baselines.[25]

As with other studies analyzing observational data, this analysis has important limitations. First, this study analyzed electronic medical records from a single network of wound care clinics, thereby limiting the generalizability of the findings. The state-level estimates on the impact of the pandemic on the 12-week healing rate should be carefully interpreted in states like North Dakota, New Mexico, and Vermont. These states had only had a few clinics and a small number of wounds contributing data for the analysis. Therefore, related estimates are prone to sampling bias. Moreover, some of our design decisions, such as the exclusion of wounds with implausible dimensions and the use of a unified grading scheme to quantify wound severity, may have introduced errors or even bias. Lastly, despite standardized guidelines for treatments and coding of outcomes at the clinics, there may be spurious variations in the quality of data entry and documentation across the clinics. Our data have been collected under real-world conditions and are subject to measurement errors (eg, wound size and depth).

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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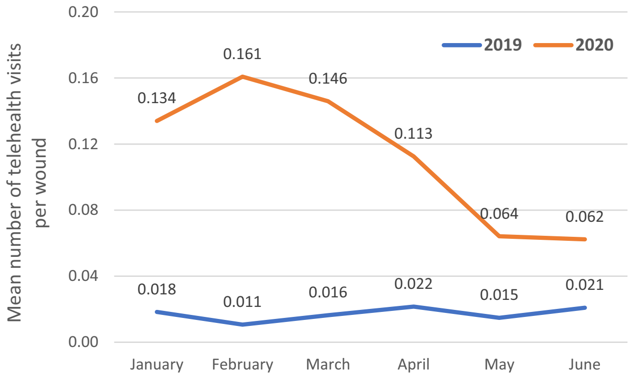
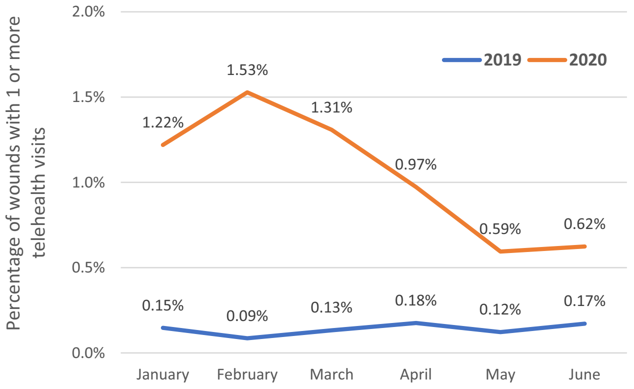
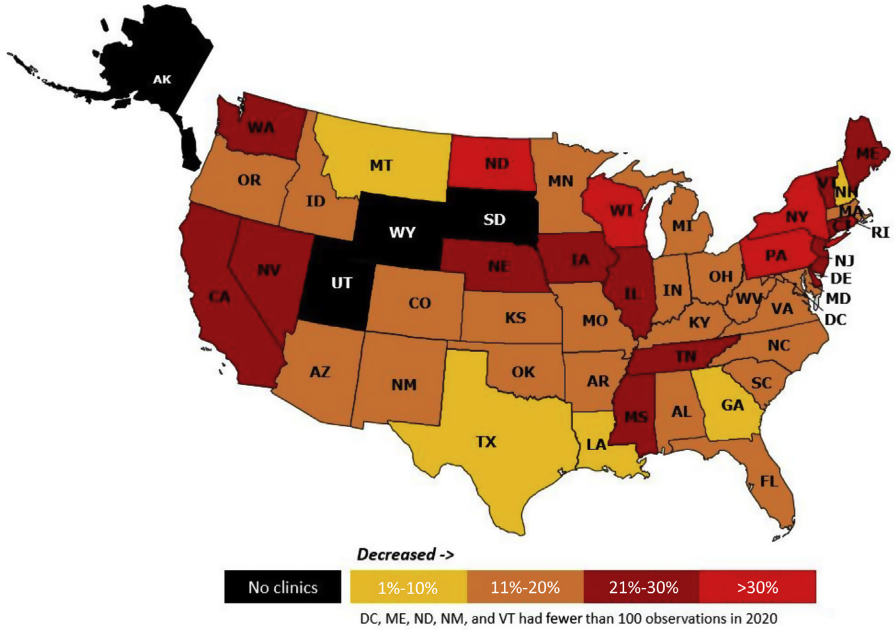


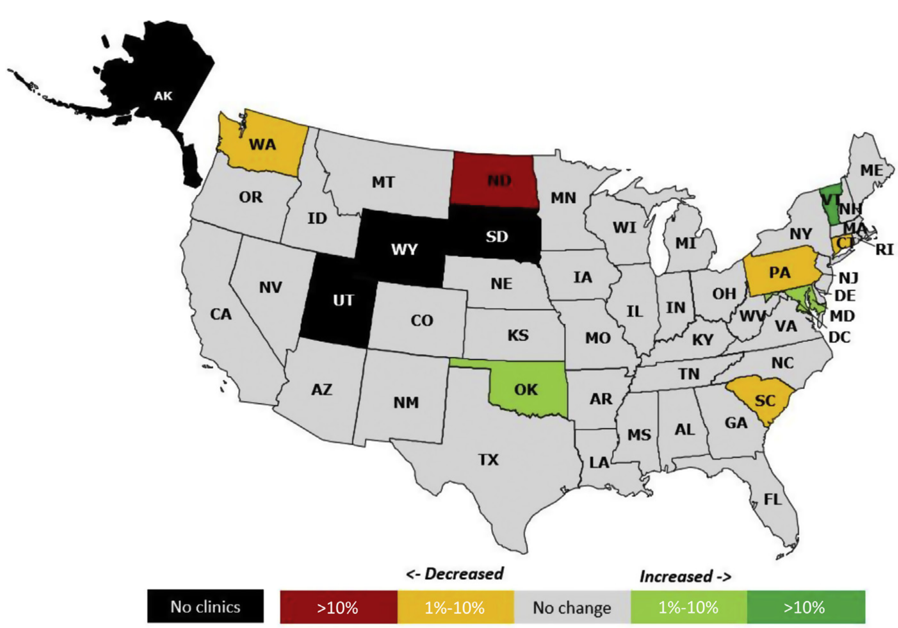
Supplementary Fig 1. Mean number of telehealth visits per wound by the month and year of initial intake assessment.



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.

Supplementary Table 1
Regression Model With the 2020 Year Fixed Effect

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	Reference				
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	Reference				
25-29	0.025	0.004	0.017	0.034	<.001
>30	0.056	0.004	0.048	0.064	<.001
<18.5	−0.035	0.009	−0.052	−0.017	<.001
Missing	0.006	0.005	−0.004	0.016	.249
Palliative					
No	Reference				
Yes	−0.182	0.008	−0.198	−0.165	<.001
Gender					
Female	Reference				
Male	0.021	0.003	0.016	0.026	<.001
Smoking status					
Never smoker	Reference				
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	Reference				
Yes	−0.038	0.006	−0.050	−0.026	<.001
Coronary artery disease					
No	Reference				
Yes	−0.018	0.003	−0.024	−0.011	<.001
Congestive heart failure					
No	Reference				
Yes	−0.026	0.004	−0.033	−0.019	<.001
COPD					
No	Reference				
Yes	0.007	0.004	−0.000	0.015	.059
Diabetes					
No	Reference				
Yes	0.021	0.004	0.014	0.028	<.001
Peripheral vascular diseases					
No	Reference				
Yes	−0.086	0.003	−0.092	−0.080	<.001
Plegia					
No	Reference				
Yes	−0.092	0.007	−0.106	−0.079	<.001
Hypertension					
No	Reference				
Yes	0.012	0.003	0.005	0.018	<.001
Number of concurrent chronic wounds					
1	Reference				
2	0.007	0.003	0.002	0.014	.010
>2	−0.040	0.003	−0.046	−0.034	<.001
Wound location					
Foot	Reference				
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	Reference				
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	Reference				
Arterial ulcer	−0.027	0.007	−0.040	−0.013	<.001
Other	0.136	0.005	0.126	0.147	<.001
Pressure ulcer	−0.014	0.005	−0.025	−0.004	.007
Venous ulcer	0.120	0.005	0.111	0.130	<.001
Necrotic					
No	Reference				
Yes	0.131	0.007	0.117	0.145	<.001
Infected					
No	Reference				
Yes	0.107	0.007	0.094	0.119	<.001
Heavily exudate					
No	Reference				
Yes	0.077	0.007	0.063	0.091	<.001
Eschar formation					
No	Reference				
Yes	0.053	0.010	0.033	0.073	<.001

(*continued on next column*)

The ordinary least squares model includes clinic- and state-level fixed effects (not shown).

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	1612	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 Dakoda	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	.011
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

Age Group	Unadjusted 12-wk Healing Rates by Year*		
	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
Age Group	**Adjusted Year-to-Year Change in 12-wk Healing Rate**		
	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 article. 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

Wound Type	Unadjusted 12-wk Healing Rate by Year*		
	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
Wound Type	**Adjusted Year-to-Year Change in 12-wk Healing Rate**		
	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-wk healing rate by year.