Diabetes-Related Major and Minor Amputation Risk Increased During the COVID-19 Pandemic

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Background: Along with significant case transmission, hospitalizations, and mortality experienced during the global severe acute respiratory syndrome coronavirus 2 pandemic, there existed a disruption in the delivery of health care across multiple specialties. We studied the effect of the pandemic on inpatients with diabetic foot problems in a Level I trauma center in central Ohio.

Methods: A retrospective chart review of patients necessitating a consultation by the foot and ankle surgery service were reviewed from the first 8 months of 2020. A total of 270 patients met the inclusion criteria and were divided into prepandemic (n = 120) and pandemic groups (n = 150). Data regarding demographics, medical history, severity of current infection, and medical or surgical management were collected and analyzed.

Results: The odds of undergoing any level of amputation was 10.8 times higher during the pandemic versus before the pandemic. The risk of major amputations (below-the-knee or higher) likewise increased, with an odds ratio of 12.5 among all patients in the foot and ankle service during the pandemic. Of the patients undergoing any amputation, the odds for undergoing a major amputation was 3.1 times higher than before the pandemic. In addition, the severity of infections increased during the pandemic, and a larger proportion of the cases were classified as emergent in the pandemic group compared to the prepandemic group.

Conclusions: The effect of the pandemic on the health-care system has had a deleterious effect on people with diabetes mellitus (DM)–related foot problems, resulting in more severe infections and more emergencies, and necessitating more amputations. When an amputation was performed, the likelihood that it was a major amputation also increased. (J Am Podiatr Med Assoc 113(2), 2023)

The severe acute respiratory syndrome coronavirus 2 pandemic, colloquially recognized as coronavirus disease of 2019 (COVID-19), stressed health-care systems across the globe from the end of 2019 through 2020. As of October 2020, more than 42 million cases have been reported globally, with more than 1 million deaths from the continuing disease.[1] As the international community suspended societal norms to reduce the spread of the predominantly respiratory virus, traditional means of health care similarly adjusted. In March of 2020, hospitals around the United States suspended elective procedures to conserve personal protective equipment, ventilators, and potential hospital beds in anticipation of surges that would overwhelm individual health systems.[2-4] In an effort to reduce the exposure of patients at risk for developing severe symptoms of the illness, physicians turned to telehealth for patient encounters.[5]

As the utility of telehealth in the outpatient and inpatient settings varies, several manifestations continue to require in-person follow-up because of the nature of the pathology. Specifically, postoperative follow-up appointments and diabetic foot/wound checks posed a challenge, as several parameters of

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evaluation become difficult to assess over the digital medium. Despite this disturbance in traditional care, outpatient care continued, with attention to minimizing exposure risk as outlined in the Pandemic Diabetic Foot Triage System.[6] Even with the adoption of telehealth, home health visits, and reduced in-person clinic hours, care of patients was significantly disrupted.

Our primary aim was to perform a descriptive, secondary analysis, of an inpatient population requiring foot and ankle services in a Level I trauma center in the US Midwest during the COVID-19 pandemic through September of 2020. Our secondary aim was to illustrate changes in this inpatient population in terms of both volume and infection severity in relation to identified time points during the pandemic, specifically in those with diabetes.

Methods

We reviewed the electronic charts of inpatients admitted to and consulted by the foot and ankle surgery service between January 1, 2020, and August 31, 2020. Inclusion and exclusion criteria, as shown in Figure 1, allowed for the identification of patients that were admitted to Grant Medical Center (GMC) from January 1, 2020, through August 31, 2020, by the foot and ankle surgery service or consulted by the service. The group was divided into prepandemic (January 1, 2020–March 17, 2020) and pandemic (March 18, 2020–August 31, 2020). Patients who were admitted preoperatively or postoperatively for an outpatient, elective procedure and those aged younger than 18 years were excluded. Key dates in the timeline of the pandemic are shown in Table 1 and provide context for changes in health-care delivery or other social circumstances.

Data regarding demographics including age, gender, height, weight, body mass index, and race were collected. Medical history consisted of history of smoking, diabetes status, hypertension, end-stage renal disease, peripheral vascular disease, COVID-19 status, and previous wound/amputation. Severity of infection in the diabetic population was identified by laterality of infection, International Working Group on the Diabetic Foot classification, final level of amputation, and length of stay.[7] Patient data were accessed retrospectively by mean of electronic medical record and entered into Research Electronic Data Capture.[8,9] Descriptive statistics were used to describe demographics and variables for the prepandemic and pandemic groups. The Student t test, the Fisher exact test, and the χ^2 test were used to analyze variables between these groups. An odds ratio with 95% confidence interval (CI) was used to show the relationship of minor and major amputation rate from before and during the pandemic. Statistical significance was set at $P \leq .05$. This study was approved by the OhioHealth GMC Institutional Review Board (number 1638958-3).

Results

Patient Characteristics

A total of 370 patients were included in the final analysis, as shown in the consortium flowchart (Fig. 1). There were 100 nondiabetic (non-DM) patients and

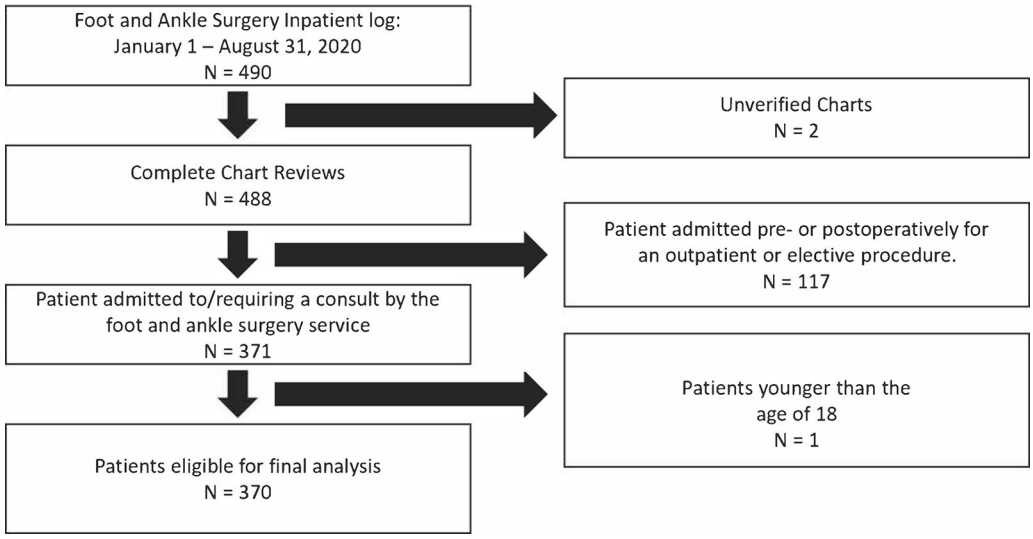

Figure 1. Inclusion and exclusion criteria applied during data collection.

Table 1. Key Dates Associated with Restrictions or Reopenings

Key Date	Restriction/Reopening
March 18, 2020	Cancellation of elective procedures
March 20, 2020	First COVID-19 death reported in Ohio
March 22, 2020	Stay-at-home order is issued
May 1, 2020	Hospital, medical, dental, and veterinary services that do not require an overnight hospital stay were able to be performed
May 12, 2020	Consumer, retail, and service businesses reopened
May 26, 2020	Gyms, fitness centers, pools, and sports leagues (only for sports involving limited or no contact) reopened
June 8, 2020	Assisted-living facilities and intermediate care facilities for people with developmental disabilities allowed outside visitation

Abbreviation: COVID-19, coronavirus disease of 2019.

270 diabetic (DM) patients, of which most were diagnosed with type 2 diabetes (type 1, 10 patients; type 2, 260 patients) as reported in Table 2. The demographics of the DM group were not statistically significantly different between the prepandemic DM group and the pandemic DM group except for age, history of hypertension, and history of peripheral artery disease. Of the 123 patients tested for COVID-19 in the DM group, four (3.25%) tested positive at least once at admission. Figure 2 illustrates the number of admissions or consultations to the GMC foot and ankle surgery service for all patients, with the DM group overlaid with the number of COVID-19 cases in Franklin County, Ohio, by calendar week. The labeled vertical lines denote important dates (Table 1) regarding State of Ohio orders, such as closing and opening services denoted by the labeled vertical lines. (Note: weeks calculated as starting on Mondays and ending on Sundays).

Infection Severity

Diabetes type, presenting pathology, and level of amputation were not statistically significantly different between the groups as shown in Table 3. Laterality was statistically significantly different between the two periods, with more bilateral presentation in the prepandemic group (14.7%) than in the pandemic group (5.33%) (P = .043). The infection severity differed between groups also, with more uninfected cases occurring in the prepandemic group (18.26%) than in the pandemic group (7.48%) (P = .04) (Fig. 3). More mild and severe cases occurred in the pandemic group (35.37% and 14.97%, respectively) than in the prepandemic group (29.57% and 9.57%, respectively). The odds of receiving any level of amputation during the pandemic period were 10.8 times higher ($P < .0001$; 95% CI, 6.5–17.8) compared with the prepandemic period. Although the extent of surgery and length of stay were not statistically significantly different between the groups (Table 4), the odds ratio of receiving a major amputation during the pandemic period was 12.5 ($P < .001$; 95% CI, 4.2–37.7) compared to the prepandemic period. Of the patients who did require an amputation, the odds of that being a major amputation was 3.1 times higher (P = .028; 95% CI, 0.98–9.7) than before the pandemic. A larger proportion of emergent cases occurred in the pandemic group (6.00%) compared with the prepandemic group (0.83%; P = .046).

Discussion

Coronavirus disease of 2019 manifested itself in a number of pathologies where exposed individuals expressed both the initial traditional fever, dry cough, and respiratory distress in addition to unique symptoms, such as delirium, anosmia, and gastrointestinal illness.[10-12] In the lower extremity, sequelae of the virus have been reported to include a dermatologic appearance of "COVID-toes" or chilblain-like lesions, although information continues to evolve.[13-16] Impacts of the pandemic indirectly linked to the virus because of fear of contracting the illness lead to neglect and an initial decrease in admission for illnesses such as acute coronary syndrome followed by an increase in mortality.[17] Similarly, the Centers for Disease Control and Prevention reported a 23% decrease in heart attack, 20% decrease in stroke, and 10% decrease in uncontrolled glycemic control emergency department visits within 10 weeks of the national emergency declared following COVID-19, although limited data examine similar effects on diabetic foot infections.[18] Our study includes data for lower extremity infection admissions at GMC from January 1, 2020, to August 31, 2020, with Figure 2 highlighting the steep and steady

Table 2. Demographics and Medical History

Characteristic	Overall	Diabetes Mellitus Group
No.	370	270
Age, years		
Mean ± SD	58.55 ± 13.35	58.59 ± 11.46
Range	22–97	29–88
Race (No. [%])		
Asian	2 (0.54)	2 (0.74)
Black	89 (24.05)	61 (22.59)
Caucasian	272 (73.51)	201 (74.44)
Hispanic or Latino	4 (1.08)	3 (1.11)
Declined/unknown	3 (0.81)	3 (1.11)
Gender (No. [%])		
Female	131 (35.41)	89 (32.96)
Male	239 (64.59)	181 (67.04)
Weight (pounds)		
Mean ± SD	210.50 ± 63.86	224.2 ± 59.71
Range	81–563	81–424
Height (inches)		
Mean ± SD	68.97 ± 4.24	69.30 ± 4.34
Range	53–84	53–84
BMI (kg/m^2)		
Mean ± SD	30.99 ± 8.57	32.80 ± 8.16
Range	14.3–68.5	14.3–62.6
Smoking (No. [%])		
Yes	228 (61.62)	169 (62.59)
No	142 (38.38)	101 (37.41)
Hypertension (No. [%])		
Yes	284 (76.76)	221 (81.85)
No	86 (23.24)	49 (18.15)
End-stage renal disease (No. [%])		
Yes	46 (12.43)	39 (14.44)
No	324 (87.57)	231 (85.56)
Peripheral vascular disease (No. [%])		
Yes	145 (39.19)	116 (42.96)
No	225 (60.81)	154 (57.04)
COVID-19 test (No. [%])		
Not tested	211 (57.03)	147 (54.44)
Yes		
Once negative	152 (41.08)	117 (43.33)
Once positive	3 (0.81)	2 (0.74)
Multiple negative	2 (0.54)	2 (0.74)
Multiple positive	2 (0.54)	2 (0.74)
Time of admission (No. [%])		
Before closure	158 (42.70)	120 (44.44)
Pandemic	212 (57.30)	150 (55.56)

Abbreviations: BMI, body mass index; COVID-19, coronavirus disease of 2019.

decline in the number of admissions following stay-at-home orders and the cancellation of elective procedures around week 10 followed by a return to baseline number of weekly admissions after reopening of businesses and medical facilities (Fig. 2 B and E).

Weeks after widespread shutdown, we found that our hospital experienced a higher proportion of patients with mild and severe infections during the pandemic compared to the prepandemic period. Moreover, the number of emergent operations was greater in the pandemic period, a time when the odds of undergoing a minor or major amputation was significantly greater compared to the prepandemic period. We speculate that the increased severity of diabetic foot infections and major amputations were attributable to an abrupt interruption of and limited accessibility to care of diabetic foot wounds and limb preservation, and a patient's perception of safety of care during the

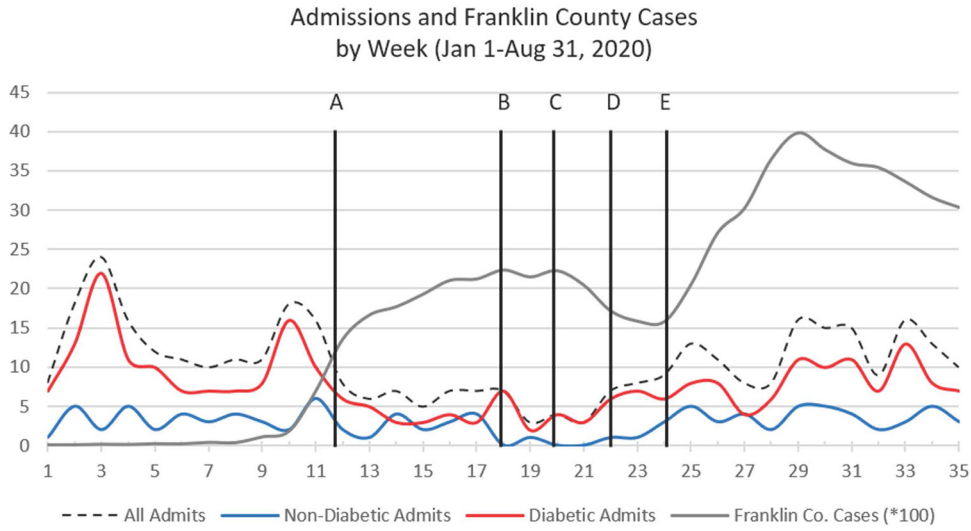

Figure 2. Franklin County coronavirus disease of 2019 cases and lower extremity infection admissions with respect to (A) cancellation of elective procedures. (B) Hospital, medical, dental, and veterinary services that do not require an overnight hospital stay were able to be performed. (C) Consumer, retail, and service businesses reopened. (D) Gyms, fitness centers, pools, and sports leagues (only for sports involving limited or no contact) reopened. (E) Assisted-living facilities and intermediate care facilities for people with developmental disabilities allowed outside visitation.

Table 3. Pathology and Final Level of Amputation of the DM Group

Characteristic	Prepandemic	Pandemic	*P* Value
No.	120	150	
Diabetes (No. [%])[a]			
Type 1	4 (3.33)	6 (4.00)	
Type 2	116 (96.67)	144 (96.00)	
Presenting pathology (No. [%])[a]			0.524
Diabetic foot infection	111 (92.50)	137 (90.73)	
Postoperative complication	5 (4.17)	8 (5.33)	
Traumatic foot injury	2 (1.67)	4 (2.67)	
Intravenous drug use infection	0 (0.00)	1 (0.67)	
Other	2 (1.67)	0 (0.00)	
Laterality (No. [%])[b]			0.043
Left	48 (40.00)	69 (46.00)	
Right	55 (45.83)	73 (48.67)	
Bilateral	17 (14.17)	8 (5.33)	
Most proximal level of amputation of the side of presenting illness (No. [%])[a]			0.06
Digital	18 (34.62)	27 (54.00)	
Forefoot	21 (40.38)	19 (38.00)	
Midfoot	11 (21.15)	4 (8.00)	
Rearfoot	2 (3.85)	0 (0.00)	
NA	68	100	

Abbreviations: DM, diabetes mellitus; NA, not applicable.
[a]Fisher test.
[b]χ^2 test.

COVID-19 pandemic. Similar findings were noted in Italy, correlating with rapid and critical worsening of diabetic foot infections, and in The Netherlands, where significantly more major amputations occurred in 2020 than in the previous 2 years in patients with critical limb-threatening ischemia.[19,20] Lancaster et al[21] saw a similar incre-ase in foot infections and an increase in the ratio of major to minor amputations, with a threefold increase in major amputations from prepandemic levels.

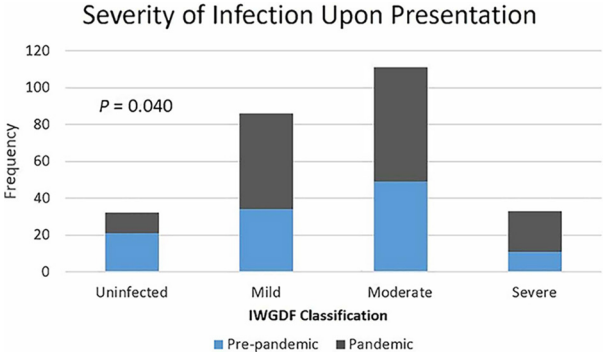

Figure 3. Severity of infection on presentation of patients between prepandemic and pandemic periods. IWGDF, International Working Group on the Diabetic Foot.

The sequelae of COVID-19 on patients with diabetic foot disease support the need for further investigation into methods of health-care delivery such as telemedicine to assess and treat this vulnerable patient population.[22] Current literature assists in the management of the diabetic foot, emphasizing triaging patients to dictate the appropriate site and urgency of care needed to limit diabetic foot–related hospitalizations.[6] Similarly, the strategies to reduce severe diabetic foot infections and complications protocol demonstrated efficacy in triaging patients, resulting in similar rates of diabetic foot ulcer–related hospitalizations and minor amputation rates during the pandemic compared to the same study period 1 year prior.[23] Overall, the restrictions of patient encounters during the pandemic reinforce the importance of clinical observation and, as Shin et al[24] noted, will result in a paradigm shift in the management of diabetic foot ulcers with emphasis on alternatives such as larval therapy for at-home wound debridements or oral antibiotics to treat osteomyelitis that would have otherwise necessitated resection.

We recognize that our study has several limitations, and because of its retrospective nature, we can only make correlational claims. Notably, patients were not analyzed for rates of direct admission or scheduled admission from an outpatient setting before the pandemic and during the pandemic. Our study was limited to patients from the foot and ankle surgery service roster. We did not account for patients with infection severity deemed beyond salvageable and those who did not receive a consultation from our service. Because this study examines only one institution, the sample size is not as large as those publications using databases across multiple hospitals. Thus, the present study focuses only on lower extremity infections in patients who presented to the hospital during this initial period. We plan to continue the investigation through the end of the pandemic.

Conclusions

In conclusion, the results of this study illustrate the initial decrease followed by increase in lower extremity infection hospitalizations during the COVID-19

Table 4. Surgery-Related Variables for the DM group

Variable	Prepandemic	Pandemic	*P* Value
No.	120	150	
Extent of surgery/final level of amputation (No. [%])[a]			0.093
0 (soft-tissue/bone debridement)	13 (22.41)	24 (22.64)	
1 (digital amputation)	19 (32.76)	22 (20.75)	
2 (forefoot amputation)	19 (32.76)	38 (35.85)	
3 (midfoot [Lisfranc] amputation)	0 (0.00)	2 (1.89)	
4 (rearfoot [Chopart] amputation)	3 (5.17)	1 (0.94)	
5 (below/above-the-knee amputation)	4 (6.90)	19 (17.92)	
NA	62	44	
Number of emergent cases (No. [%])[a]			0.046[b]
Yes	1 (0.83)	9 (6.00)	
No	119 (99.17)	141 (94.00)	
Length of stay[c]			0.246
Mean ± SD	7.1 ± 6.28	6.30 ± 4.65	
Range	0–35	0–22	

Abbreviations: DM, diabetes mellitus; NA, not applicable.
[a]Fisher test.
[b]Statistically significant.
[c]*t* test.

pandemic, an experience shared across medical specialties during this period. Moreover, the rise in severity of infections further shows the indirect toll the pandemic placed on patients at risk for limb loss, as their neglected care and follow-up for fear of contracting the virus led to more proximal amputations. The findings in this investigation show the vital role podiatrists play, from routine follow-up to limb salvage, for at-risk populations. Furthermore, as this pandemic continues, this study shows the need for effectively triaging patients at risk of limb loss, specifically in instances where face-to-face encounters have been replaced by telemedicine. We will continue to collect data through the remainder of the pandemic and report future trends in lower extremity infections, amputations, and other complications to understand the full impact that COVID-19 placed on our patients.

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Conflict of Interest: None reported.

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