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Management of diabetic persons with foot ulceration during COVID-19 health care emergency: Effectiveness of a new triage pathway

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ABSTRACT

Aim: To define the outcomes of persons with diabetes and foot ulcers (DFUs) managed through a specific triage pathway during the COVID-19 crisis.

Methods: Patients who had an active DFU during the COVID-19 emergency were included. All participants were managed using a specific triage system driven both by ulcer's severity and concomitant co-diseases. Subjects with severely complicated DFUs were urgently referred to hospital regardless of the concomitant comorbidities. Subjects with complicated DFUs received outpatient evaluation (within 48–72 h) and were admitted to hospital if required (revascularization, surgical intervention, intravenous antibiotic therapy); after the first outpatient visit or hospitalization, patients were followed according to the number of comorbidities (in the case of 3 or more comorbidities patients were followed up by telemedicine). Patients with uncomplicated DFUs were managed by telemedicine after outpatient evaluation. Healing, major amputation, death and rate of COVID-19 infection were evaluated. The minimum follow-up was 1 month.

Results: The study group included 151 patients. The mean age was 69.9 ± 14.2 years, 58.9% were male and 91.4% had type 2 diabetes; 58.7% had severely complicated, 21% complicated and 20.3% uncomplicated DFUs. Among those, 78.8% presented with 3 or more comorbidities. One hundred and six patients had regular clinical follow-ups, while 45 were managed through telemedicine. Forty-one (27.1%) patients healed, 3 (1.9%) had major amputations and 3 (1.9%) died. One patient (0.6%) reported COVID-19 positivity due to infection acquired at home.

Conclusion: The triage pathway adopted during the COVID-19 pandemic showed adequate management of DFUs and no cases of hospital virus exposure.

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1. Introduction

The COVID-19 pandemic is leading to significant changes in the health care system and clinical practice, including the

treatment of persons with diabetes and foot ulcers. New hospital organization focused on containing the COVID-19 emergency has reduced inpatient and outpatient activity leaving a large number of patients without care. However, persons with

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diabetic foot ulcers (DFUs) often require hospitalization due to the presence of ischemia and infection, and early referral to reduce amputation and mortality [1–3].

Nonetheless, persons with DFUs usually have several comorbidities which should be carefully considered during this emergency due to the extremely high risk of fatality observed in COVID-19 patients who have showed more than one disease [4].

Recent epidemiological data of the Italian “Istituto Superiore di Sanità” reported as the risk of mortality in COVID-19 patients gradually increases with the numbers of the comorbidities [5]. Among fatal COVID-19, it was reported that, the mean number of pre-existing diseases was 2.7 (SD, 1.6), of which 25.6% had 2 co-diseases, and 48.5% had 3 or more underlying diseases. People with DF disease often present similar co-morbidities. The same comorbidities are often present in persons with DF disease [6], and it may be concluded that people with DF could be at increased risk of mortality in the case of COVID-19 infection.

Accordingly, we retain that to better manage subjects with DFUs in this scenario, it may be useful to not only understand ulcer features, but also to acknowledge patients clinical history, in order to limit hospital admission to selected cases and hence reduce the risk of COVID-19 exposure.

This study aims to evaluate the clinical characteristics and outcomes for persons with DFUs managed in our diabetic foot clinic through a specific protocol to reduce virus exposure during the COVID-19 emergency and hospital admission.

2. Subjects, materials and methods

Patients who were treated since February 2020 at diabetic foot unit because of diabetes and foot problems were considered for this study. Among those, only subjects who had an active DFU were included. Patients who lost to follow-up were excluded.

Baseline demographic, clinical and ulcer data were recorded in a local database and retrospectively evaluated.

2.1. Medical features

Ischemic heart disease (IHD) was considered in the case of previous acute coronary syndrome or coronary revascularization, evidence of angina, significant changes on electrocardiography (above or under-leveling ST, q wave, inversion of T wave, new left bundle branch block). Cerebrovascular disease was considered in the case of previous cerebrovascular ischemia, previous carotid revascularization or significant carotid artery disease (occlusion > 70%). Hypertension was considered in the case of blood pressure persistently > 130/80 mmHg or current antihypertensive therapy; hypercholesterolemia was defined as low density lipoproteins (LDL) > 70 mg/dl or needing statin therapy; heart failure (HF) was considered in the case of typical symptoms and signs of HF reduced left ventricular ejection fraction (LVEF) (<40%) or normal or only mildly reduced LVEF and elevated levels of brain natriuretic peptides (BNP > 35 pg/ml and/or NT-proBNP > 125 pg/ml) without dilated left ventricle (LV) associated to relevant structural heart disease (LV hypertrophy/left atrial

enlargement) and/or diastolic dysfunction [7]. End-stage-renal-disease (ESRD) requiring dialysis was considered in the case of chronic renal replacement therapy.

2.2. Ulcer features

Baseline ulcer’ characteristics (size, depth, infection) reported at the first assessment were recorded. Infection was considered in case of clinical signs according to IWGDF [8]. Ulcer was considered deep to the bone in the case of bone exposure or positive probe-to-bone test. Neuropathic ulcers were considered in the case of patients with loss of peripheral sensitivity detected through vibration perception (128 Hz tuning fork) and absence of peripheral arterial disease; ischemic ulcers were considered in the case of patients with PAD regardless of the presence or not of peripheral neuropathy. PAD was considered in the case of absent pulses and ankle-brachial index < 0.9 or TcPO₂ < 50 mmHg and concomitant evidence of stenosis and/or obstruction at duplex ultra-sound [8,9].

2.3. Grading of ulcer severity

Ulcer severity was stratified according to fast-track-pathway (FTP) classification [3]. Uncomplicated ulcers were considered in the case of superficial, not infected, not ischemic DFUs; complicated ulcers were considered in the case of ischemic, deep, and infected (mild infection) DFUs, and severely complicated ulcers were considered in the case of abscess, wet gangrene, necrotizing fasciitis, fever, and sepsis.

2.4. Patient’ management and new triage pathway

All patients received revascularization in the case of ischemic/neuro-ischemic ulcers, antibiotic therapy for infected wounds, appropriate off-loading and wound care according to Guidance recommendations [8].

Until the beginning of the spread of COVID-19 infection in Italy and the imposed lockdown (on 12th March 2020) subjects with active ulcer were regularly followed up as outpatients on a weekly or monthly basis, according to each individual condition, while healed patients were regularly checked as outpatients every 1 or 3 months [8].

Accordingly, since the beginning of COVID-19 health care emergency, we have adopted a new triage system driven both by ulcer severity and concomitant co-diseases to offer an appropriate ulcer’s management and reduce the risk of virus exposure, as described below. Table 1.

Critical patients with severely complicated DFUs (wet gangrene, abscess, presence of fever, signs of sepsis and acute critical limb ischemia) were urgently referred to hospital for early management regardless of the concomitant comorbidities. Table 1.

Patients with complicated DFUs (necrosis or wet gangrene in a subset of chronic limb ischemia, mild/moderate infected ulcers or deep to tendon, muscle or bone ulcers) received early outpatient evaluation (within 48–72 h and were hospitalized in the case of critical limb ischemia requiring lower limb revascularization, moderate infection requiring surgical intervention and intravenous antibiotic therapy and deep ulcers (mainly with bone involvement) requiring surgical

Table 1 – The proposed new triage pathway for managing DFUs patients according to ulcer features and comorbidities.

Grading of ulcer' severity	Number of comorbidities	Management
Severely complicated ulcers - Wet gangrene - Abscess - Necrotizing fasciitis - Acute limb ischemia - Fever - Sepsis	Action required regardless of the number of comorbidities.	Urgent hospitalization
Complicated ulcers - Mild infection - Chronic limb ischemia - Deep to tendons, muscles or bone ulcers	≥ 3 comorbidities	First visit and follow-up by telemedicine. In the case of ulcer impairment clinical re-evaluation should be performed.
Complicated ulcers - Mild infection - Chronic limb ischemia - Deep to tendons, muscles or bone ulcers	≤ 2 comorbidities	First visit and regular follow-up, according to individual circumstance
Uncomplicated ulcers - Superficial - Not infected - Not ischemic	Action required regardless of the number of comorbidities.	First visit and follow-up by telemedicine
Healed ulcers	Action required regardless of the number of comorbidities.	Follow-up by telemedicine

intervention and hospital management. After hospitalization or outpatient evaluation, patients were managed according to the presence of one or more comorbidities: patients affected by diabetes alone or diabetes + only one comorbidity were regularly followed up as outpatients according to each individual condition, while patients with 3 or more comorbidities were managed by telemedicine and only received new clinical evaluation in the case of ulcer impairment. [Table 1](#).

Patients with uncomplicated DFUs (not ischemic, not infected, superficial ulcers) were only managed by telemedicine after the first outpatient evaluation. This was also the case for patients with healed ulcers. [Table 1](#).

During the visit, all operators wore appropriate personal protective equipment, and as patients wore personal or surgical masks. Patients included in the telemedicine pathway were regularly followed up by phone and/or ulceration pictures.

2.5. Outcomes

The rate of healing, major amputation and death were evaluated; in addition, the rate of COVID-19 infection in our patients was reported. Healing was considered in the case of complete wound closure; major amputation was considered as any amputation above the ankle; COVID-19 infection was considered in the case of positive virus isolation by nasopharyngeal swab.

The minimum follow-up was 1 month.

2.6. Statistical analysis

Statistical analysis was performed by SAS (JMP12; SAS Institute, Cary, NC) for personal computer. Data are expressed as means \pm SD.

3. Results

Overall 154 patients with active DFUs were included. Among those 3 patients were lost to follow-up.

Baseline demographic and clinical data were reported in [Table 2](#). Ulcer characteristics were reported in [Table 3](#).

The mean age was 69.9 ± 14.2 , the majority of patients were male (58.9%) with a 91.4% prevalence of type 2 diabetes

Table 2 – Baseline demographic and clinical characteristics of the study group.

Variables	Values
Age	69.9 \pm 14.2
Sex (male)	89 (58.9%)
Diabetes type (2)	138 (91.4%)
Diabetes duration (years)	18.9 \pm 12.2
HbA1c (mmol/mol) (%)	(59 \pm 8)(7.5 \pm 1)
Hypertension	144 (95.4%)
Dyslipidemia	120 (79.5%)
Ischemic heart disease	58 (38.4%)
Heart failure	40 (26.5%)
End-stage-renal-disease	22 (14.6%)
Chronic pulmonary obstructive disease	22 (14.6%)

Table 3 – Characteristics of foot ulcerations at first clinical evaluation.

Variables	Values
Neuro-ischemic/ischemic ulcers	54.7%
Infection	64%
Size (>5 cm ²)	66.6%
Depth (to muscle, tendons and/or bone)	79.7%
Gangrene	42%

and a mean diabetes duration of 18.9 ± 12.2 years. Hypertension and dyslipidemia were the most frequent comorbidities [Table 2](#).

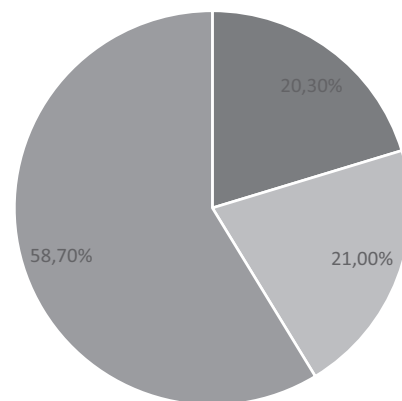
The majority of DFUs were ischemic, infected and deep to muscle, tendon or bone [Table 3](#).

Among patients included, 58.7% reported severely complicated, 21% complicated and 20.3% uncomplicated DFUs. [Fig. 1](#).

The number of concomitant co-diseases is reported in [Table 4](#) and [Fig. 2](#). Most of patients reported 3 or more concomitant comorbidities.

One hundred and six patients had regular clinical follow-up, while 45 were managed by telemedicine. The mean follow-up was 42 days (range 34–58 days).

Forty-one (27.1%) patients healed, 3 (1.9%) had major amputation due to untreatable critical limb ischemia and 3 (1.9%) patients died because of heart complications.



■ Uncomplicated DFUs ■ Complicated DFUs ■ Severely complicated DFUs

Fig. 1 – Severity of DFUs according to fast-track pathway classification.

Table 4 – Number of concomitant comorbidities.

Number of comorbidities	Values (n) (%)
1 comorbidity	6 (4%)
2 comorbidities	26 (17.2%)
3 comorbidities	49 (32.4)
4 comorbidities	28 (18.5%)
5 comorbidities	22 (14.6%)
6 comorbidities	15 (9.9%)
7 comorbidities	5 (3.3%)

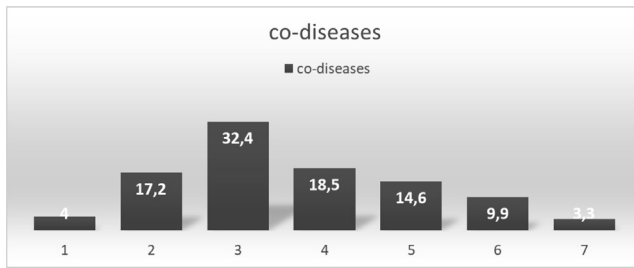


Fig. 2 – Rate of concomitant co-diseases.

Table 5 – Outcomes of the study group.

Outcomes	N (%)
Healing	41/151 (31.8%)
Major amputation	3/151 (2%)
Deaths	3/151(2%)
Foot ulceration impairment in telemedicine patients	3/45 (6.6%)
COVID-19 infection	1/151 (0.7%)

One patient (0.6%) managed by telemedicine reported COVID-19 positivity due to home infection. Table 5.

Three (6.6%) patients monitored by telemedicine needed urgent evaluation for superimposed infection during the follow-up; in 2 cases due to mild infection and 1 case due to moderate infection. Table 5.

4. Discussion

The spread of SARS-CoV-2 in Italy and the lockdown has changed the organization of health care systems dramatically reducing the possibility of admitting or assessing many patients who needed clinical evaluation.

Until the April 23rd 2020, in Italy, approximately 23,000 persons died because of SARS-CoV-2 infection [10]. The majority of patients were older than 60, of which the main concomitant comorbidities were hypertension (approximately 70%), type 2 diabetes (32%), ischemic heart disease (approximately 28%) and chronic renal failure (22%). Furthermore, 13.5% of subjects had one comorbidity, 22.5% had two comorbidities and 62.3% had three or more, highlighting concomitant co-disease as strong risk factor for death [10].

Our study offers a complete overview of the characteristics of patients with diabetes and foot ulceration, by looking at patients treated at our foot clinic, since the beginning of the COVID-19 emergency, 2 months ago. These data showed that approximately 95% of patients had hypertension, 38% ischemic heart disease and 15% end-stage-renal-disease, in addition to having diabetes and 80% reported 3 or more concomitant comorbidities.

Therefore, we have been managing patients who could be at high risk of fatality in the case of SARS-CoV-2 infection and we are forced to limit their exposure to the virus, and consequently hospital admissions. Nonetheless, the majority of our patients showed ischemic, infected and deep ulcers. It is well known that ischemia and infection are two risk factors for non-healing and amputation and these kind of DFUs need

close follow-up [8,11,12]. On the other hand, patients with complicated DFUs should be referred within 72 h to specialized diabetic foot centers while severely complicated DFUs need urgent hospitalization for managing infection with or without superimposed ischemia [3].

The new COVID-19 scenario has highlighted a link between the need for adequate management of DFUs and limiting virus exposure, reducing hospital admissions. According to the burden of comorbidities, the specific triage pathway we have adopted in our diabetic foot unit showed good early-term results with reduced cases of major amputation and mortality, and no hospital-acquired infection with COVID-19. Furthermore, only three patients among those managed by telemedicine reported an impairment of foot ulceration due to a superimposed infection.

Despite the fact that a pathway for the management of DFUs was recently proposed only ulcers features were considered in the pathway and not the general health status [13]. Conversely, we retain that the clinical approach should be driven by ulcer severity and concomitant co-diseases, in order to reduce the risk of exposure in very fragile subjects.

Therefore, the presence of diabetes and comorbidities, as well as patient's general health status should be taken into account in the management of persons with DFUs, to reduce the exposure to COVID-19 in hospital. Nevertheless, the severity of each DFU should be carefully considered and patients should be managed promptly and hospitalized if required, to reduce the risk of major amputation and mortality. As similarly suggested by the International Working Group on the Diabetic Foot, the healthcare professional should advocate a short hospital stay, adopt oral antibiotic therapy, instead of intravenous therapy when possible, depending on the clinical condition, and perform minimal surgery on an outpatient basis, instead of hospital settings [14].

We retain that this study shows an overview of patients with DFUs who are currently managed at our diabetic foot unit, including a glance at both ulcer features and clinical characteristics and the proposed new triage pathway could be useful within this specific health emergency period and in the coming months, due to the spread of COVID-19.

In addition, to the best of our knowledge, this is the first study to report on the outcomes of persons with DFUs treated during the new organization of health care system, as a result of the COVID-19 pandemic.

5. Limitations

Study data refer to a single center and are related to a specific population in our metropolitan area. The results are related to a timely follow-up and future analysis is needed to evaluate if this recommended approach will reduce virus exposure, and prevent an increase in major amputation in the long-term follow-up during the COVID-19 crisis.

6. Conclusion

We retain that this study shows a complete overview of patients with DFUs referred to our diabetic foot unit, including both ulcer features and clinical characteristics. The

Authors highlighted that patients with DFUs are very fragile patients and should be carefully protected to reduce the risk of COVID-19, although they should not be left without clinical care. The proposed pandemic care pathway for DFUs reported good early outcomes in terms of limb salvage and patient safeguarding and could be useful to limit virus exposure and to ensure appropriate care in this specific health emergency period, due to the spread of COVID-19.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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