

What are the effects of Covid-19 on diabetes and foot complications associated with diabetes?

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Key words

- Covid-19
- Foot care access
- Service provision
- Telemedicine

Article points

1. People with diabetes are more likely to be more unwell with Covid-19.
2. Foot care services were severely disrupted during the pandemic.
3. Lessons learned from the pandemic give avenues to investigate for footcare services in future.

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The Covid-19 pandemic, with its disruption of services and higher mortality risk has had far-reaching consequences for people with diabetes, contributing toward increased risk of rapid deterioration, ICU admissions and a worse prognosis. Covid-19 also affected access to diabetes related foot care and multidisciplinary services, with long-term implications for people who were unable to access care and attend clinic appointments during the pandemic. This review examines studies on the effect of Covid-19 on people with diabetes, foot complications associated with diabetes and service delivery.

Covid-19 more commonly affects people with diabetes, obesity, hypertension and cardiovascular disease (CVD), and those on immunosuppressive therapy. These patient groups typically present with elevated inflammatory markers and D-dimer levels, which contribute towards more severe complications of Covid-19 (Boulton 2021; Peric and Stulnig, 2020; Schofield et al, 2020).

Diabetes and Covid-19

A meta-analysis of 43 global studies found up to 35% of people with Covid-19 also had diabetes (Hussain et al, 2000). Mortality risk and risk of ICU admissions from Covid-19 was significantly higher in patients with diabetes compared to patients without diabetes (Hussain et al, 2000). Pulmonary and cardiac involvement increases the severity of diabetes. In patients with Covid-19, this can increase the need for invasive ventilation and may double the risk of mortality (Peric and Stulnig, 2020). People with diabetes are at higher risk of severe respiratory illnesses and morbidity, and diabetes is the most prevalent comorbidity of critically ill patients with Covid-19 (Boulton 2021; Jaly et al, 2020; Taoet al, 2020).

Covid-19 infection increases the risk of diabetic ketoacidosis (DKA) and hyperosmolar hyperglycaemic state emergencies, suggesting that acute hyperglycaemia may be a greater risk factor for adverse outcomes in Covid-19 compared to a general diabetes diagnosis (Schofield et al, 2020).

Sodium-glucose co-transporter-2 (SGLT2) inhibitors are associated with an increased risk of DKA in people who are unwell. SGLT2 inhibitors can have severe adverse effects in acute sickness during Covid-19, and modification of medication is advised (Boulton 2021; Dashora et al, 2021).

Type 2 diabetes promotes the over-expression of the angiotensin-converting enzyme (ACE) 2 receptor. Covid-19 enters the lungs via the ACE 2 receptor, so people with diabetes are of an increased risk of rapid deterioration and a worse prognosis (Kyrou et al, 2020; Ni et al, 2021).

Diabetes-related foot complications and Covid-19

The risk factors for mortality in people with diabetes and Covid-19 are similar to the risk factors for developing foot complications associated with diabetes – elderly, male, poor glycaemic control, hypertension and CVD (Boulton, 2021).

Liu et al (2020) examined the numbers of patients hospitalised with diabetes-related foot complications during the early 2020 Covid-19 pandemic compared to 2019 in a multidisciplinary team (MDT) centre in China. They found that hospitalisation of patients with diabetes-related foot complications during the first trimester of 2020 was considerably lower than in 2019.

A study by Caruso et al (2020) evaluated the risk of amputation in patients with diabetes admitted to a tertiary care centre during the early 2020 lockdown compared to the first five months of 2019. They found that patients admitted during the 2020 lockdown had more than a threefold risk of amputation compared to the previous year. Patients in 2020 also had a higher incidence of gangrene versus those in 2019, which may indicate interruption of diabetes foot services and delays in limb preservation.

Covid-19 can result in a chilblain-like appearance, known as “Covid toes” (Casciato et al, 2023). Abnormalities in coagulation and thrombosis are frequently seen in severely unwell patients with Covid-19. In one case, a patient with severe Covid-19 was admitted to ICU with thrombotic complications of the aorta and had ischaemic “blue toe syndrome”, which progressively developed into necrosis and digital amputations (Buikema et al, 2021).

The impact of the pandemic on foot services

Shielding

People with diabetes have co-morbidities that place them at a higher risk than the average frail person admitted with Covid-19 (Meloni et al, 2021). Increased mortality in people with diabetes is associated with uncontrolled blood glucose monitoring, mismanagement of medications and treatments, and lack of access to specialists (Tao et al, 2020). The main priority of healthcare services at the start of the pandemic was to reduce and prevent the spread of Covid-19 (Jaly et al, 2020).

Self-isolation, shielding and changes in health-seeking behaviour created complex challenges and compromises in the management of people with diabetes. Lockdowns led to reduced access to care services, and interruption in daily lifestyles, diet and exercise, and consequently favoured sedentary lifestyles. Such changes may have had a direct impact

on blood glucose levels in those with diabetes and increased anxiety, which can lead to poor adherence and worsening risk factors (Hartmann-Boyce et al, 2020; Schofield et al, 2020).

Fear of Covid-19 led to reduced attendance at outpatient hospital appointments (Boulton, 2021). Reduced hospital capacity and local transport issues meant that patients were sent to satellite care services, sometimes a long distance away, with issues for those with mobility problems (Jaly et al, 2020).

Inpatient demands, suspension of clinical work and staff shortages

Acute admissions for people with Covid-19 increased demands for patient beds, stretched inpatient capacities and filled ICUs, with fewer beds available for other patients (Jaly et al, 2020). Healthcare professionals (HCPs) had to risk stratify patients and prioritise acute care, while expediting treatment plans and minimising length of inpatient stay. Staff redeployed to wards and ICUs at short notice were faced with difficulties due to their unfamiliarity of management of chronic conditions, including diabetes (Schofield et al, 2020).

People with diabetes and hyperglycaemia who are admitted with Covid-19 have longer lengths of stay and higher mortality compared to other Covid-19 patients (Hartmann-Boyce et al, 2020). Prescribing SGLT2 inhibitors and insulin infusion to hospitalised patients with without specialist care poses risks (Dashora et al, 2021).

Mitigation measures at the beginning of the pandemic included suspension of routine clinical work, outpatient activity, patient education and liaison groups, and some elective surgeries for patients with lesser vascular pathology, but surgery was still carried out for critical cases (Schofield et al, 2020; Tao et al, 2020).

Staff redeployment and sickness rates led to a gap in service provision. This disrupted diabetes care, notably for high-risk patient groups with diabetes-related foot problems, which would normally require urgent attention and specialist care (Jaly et al, 2020).

Primary care and telemedicine

In the UK, more than 90% of people with diabetes are managed in primary care (Hartmann-Boyce et al, 2020). More emphasis was placed on providing

care via telemedicine (Peric and Stulnig, 2020).

During the pandemic, the Primary Care Diabetes Society and Association of British Clinical Diabetologists (ABCD) issued guidance on the management of patients with diabetes in primary and secondary care, including criteria for emergency and routine follow-ups and the use of telemedicine (ABCD, 2020; Ali et al, 2021). NHS England (2020) issued guidance on supporting delivery of diabetes care in the pandemic, including sick day rules, emergency department discharge packs for patients with type 1 and type 2 diabetes, and management of outpatient appointments.

A clinical strategy for diabetes multidisciplinary foot teams (MDFTs) was implemented during the initial stage of the pandemic and updated prior to the second wave. This stated that while patients are encouraged to practise self-care and have access to telemedicine, new referrals for acute diabetes-related foot complications should continue to be within 24 hours, and face-to-face access to MDFTs should continue for those with acute or limb-threatening conditions (Leigh et al, 2020; NHS England, 2020).

Lessons learned from the pandemic and considerations for the future

Remote monitoring, telemedicine and community care

Utilisation of community services was fundamental in the safe care of patients with diabetes throughout the pandemic, and the triage of clinic lists has been paramount in identifying where face-to-face support, home-visits or virtual telemedicine appointments were needed (Schofield et al, 2020). Community services helped to support wound management, identify signs of foot infection and share images with clinical triage teams to coordinate which patients required urgent care or hospitalisation (Najafi, 2020).

Remote monitoring and telemedicine partially alleviated issues around patient access, shielding and care provided in care homes. However, triage methods require more care to ensure safe management of high-risk patient groups, with standardised approaches to risk assessment, and better support is needed for primary care to identify people with diabetes at a greater risk (Diabetes UK, 2020; Peric and Stulnig, 2020).

Appropriate pathways are needed so that early

screening and investigation can be initiated if needed (Boulton, 2021).

Systematic approaches with community services need to be in place to evaluate specific characteristics and severity of diabetes-related foot complications (Meloni et al, 2021). This led to the International Diabetic Foot Care Group and D-Foot International developing a holistic Covid-19 fast track pathway designed for non-specialist HCPs, which differentiated non-limb threatening conditions from limb/life-threatening conditions to determine if a patient needs community care, referral to an MDFT or urgent hospitalisation with MDT input (Meloni et al, 2021).

Patient education, smart tools and apps

In China, during the first outbreak when hospital appointments were reduced and discharges were prioritised, the Chinese Geriatric Endocrine Society mitigation provided guidance and instructions via smartphone apps, focusing on medicines management and prevention of metabolic crises associated with diabetes. Via apps, patients are given guidance on preparing for hospital consultations safely to minimise exposure to Covid-19. In France, a web app was developed for people with diabetes that provides access to live webinars with specialists, and twice weekly mental health and viral symptom assessments (Hartmann-Boyce et al, 2020). Diabetes Digital Media is an online forum with a Covid-19 educational series and digital library, aimed to support people with diabetes via remote settings (Jaly et al, 2020).

People with diabetes and those who are advised to shield should be aware of available urgent and non-urgent community care services and prompted to access them if they require urgent advice or assessment (Kong et al, 2020).

People with diabetes should be encouraged to optimise their self-care (Diabetes UK, 2020; Hartmann-Boyce et al, 2020). Flash glucose monitoring (Free Style Libre) is a useful smart tool, but in the UK, it is offered only to patients who fit certain criteria. More work is needed on affordable access to such products.

Poor adherence in patients with foot complications associated with diabetes remains a problem. Care is needed to ensure such patients are monitored safely in remote settings or offered

face-to-face consultations where suitable (Jaly et al, 2020). Due to the vulnerability of such patient groups, more attention is needed around various types of motivational and compassionate self-care approaches, and de-stigmatising use of language. People with diabetes should be offered digital access to emotional and psychological support services (Diabetes UK, 2020). There is scope for podiatrists to encourage patient receptiveness to foot health monitoring technologies. Digital platforms such as smart insoles, with associated health coaching are currently explored to help patients with self-monitoring (Macdonald et al, 2021).

Medicines management

Blood glucose monitoring is crucial in patients admitted with Covid-19 and diabetes. Diabetes UK (2020) summarises key elements of diabetes services and recommends that blood glucose and ketones are measured and checked in all patients admitted with diabetes. Patients with type 2 diabetes admitted with Covid-19 present with diabetic metabolic emergencies due to adverse effects caused by SGLT2 inhibitors. Canagliflozin can increase the risk of digital lower-limb amputation in patients with type 2 diabetes, and reporting side-effects is urged. Diabetes specialist care in acute care units is fundamental (Medicines and Healthcare products Regulatory Agency, 2017; Food and Drug Administration, 2020; Peric and Stulnig, 2020).

Rapid access and multidisciplinary foot teams

The primary objectives in the pandemic for patients with foot complications associated with diabetes were to reduce risk of Covid-19 exposure, prevent inappropriate outpatient appointments, and reduce hospital admissions due to elective surgical interventions in patients with stable foot conditions (Meloni et al, 2021). Reconsideration and adaptation of aerosol-generating procedures were advised to reduce risk of transmission in surgery, while local anaesthetic blocks were advised to prevent risk of invasive intubation (Jaly et al, 2020; Tao et al, 2020).

Remote home visits by specialist MDTs have been suggested as a way to relieve hospital pressures (Rogers et al, 2023). Due to postponed surgery, in some hospitals vascular teams have taken over from diabetologists in the management of foot

complications, which could be a positive step in the transformation of MDFTs (Kong et al, 2020). NHS England (2020) suggested that the location of MDFTs change in some areas, with non-critical podiatry and non-urgent revascularisation and surgical debridement urged to transfer from larger hospitals to remote centres for treatment.

In some countries, podiatry care was deemed “non-essential” (Rogers et al, 2023). The UK National Diabetes Inpatient Covid-19 response group maintained that diabetes services would need to continue to manage high-risk patients safely, especially those with acute and severe foot complications associated with diabetes (Kyrou et al, 2020). High-risk patients with diabetes at particular risk of foot deterioration should continue to be accounted for, and provisions should be in place to capture such patients quickly via rapid-access clinics in urgent care settings or accident and emergency units (Jaly et al, 2020).

X-rays and probe to bone tests are important clinical markers for diagnosing osteomyelitis, and the inability to carry out such investigations can have adverse effects on the management of foot complications (Boulton, 2021). NHS England (2020) recommended continuation of MDFTs during the pandemic and declared them to be an essential service. The International Working Group on the Diabetic Foot (2021) guidance advised that while efficient triage and avoidance of unnecessary hospital admissions is important, patients with high-risk foot lesions and limb-threatening diseases should be seen immediately in a clinical face-to-face setting.

Caruso et al (2021) suggested that antimicrobial treatment of foot infection associated with diabetes is becoming increasingly challenging due to high prescribing of antibiotics, which also contribute towards rising antibiotic resistance. A single tertiary care centre investigated the rate of antibiotic resistance in patients with foot infections associated with diabetes during the 2020 Covid-19 pandemic in comparison to 2019 and found higher rates of antibiotic resistance in the 2020 patient cohort. These findings were consistent with higher rates of amputations performed because of severe infections in 2020 compared to 2019. Casciato et al (2023) noted that increased severity of foot infections and major amputations associated with diabetes was caused by interruption of wound care and limb

Table 1. 2019-2021 lower-limb amputation rates and lower limb revascularisation surgeries carried out in the vascular surgery department at the Royal Free Hospital, London.

	2019	2020	2021
Minor lower-limb amputations	112	107	108
Major lower-limb amputations	63	57	57
Total number of lower-limb amputations	175	164	165
Angioplasty lower-limb revascularisation surgeries	120	121	152
Bypass lower-limb revascularisation surgeries	82	70	62
Total number of revascularisation surgeries	202	191	214

preservation services. A retrospective chart review of patients in an Ohio trauma centre found that the proportion of patients with mild and severe infections was significantly higher during the pandemic, in comparison to the pre-pandemic period (Casciato et al, 2023). Interestingly, this could suggest an interconnection between increased levels of antibiotic resistance and increased numbers of foot infections and amputations associated with diabetes in 2020 compared to 2019.

The secondary user service data that contains data on inpatient care for hospital admissions in England identified that in 2020 major amputations were 7% lower, minor amputations were 21% lower and revascularisation procedures were 23% lower, compared with means from equivalent time periods in 2017-19. However, reductions in major amputations were confined to the over-65 age group, and Covid-19 mortality may have contributed. Minor amputation rates may have resulted from reduced numbers of foot ulcers associated with diabetes, which may have resulted from reduced ambulation due to lockdowns (Valabhji et al, 2021).

The experience at the Royal Free

Table 1 shows the total number of lower-limb amputations and revascularisation surgeries carried out in the vascular surgery department at the Royal Free NHS Foundation Trust, London in 2019, 2020 and 2021. There was a 6% decrease in lower-limb amputations in 2020–2021 compared to 2019. This could be suggestive of reduced services during the pandemic, or increased Covid-19 severity and mortality rates of people with diabetes. The 2020 data show a 5% decrease of revascularisation surgeries compared to 2019, indicative of disruption

of best practices for limb preservation of people with diabetes and reduced attendances of primary and secondary services.

Interestingly, 2021 data show a 26% increase of angioplasty lower-limb surgeries compared to 2020. This coincides with re-establishment of access to revascularisation plans, 24-hour MDFT inpatient reviews of people with foot complications associated with diabetes. In contrast, lower-limb bypass surgeries had a 24% decrease in 2021 compared to 2019 and 11% decrease compared to 2020. This may again represent increased mortality rates because of increased cardiac involvement of high-risk patient groups with diabetes during the Covid-19 pandemic (Buikema et al, 2021).

Data from the Royal Free Hospital predominantly demonstrates continuation of minor and major lower-limb amputations throughout the pandemic, with increasing numbers of angioplasty surgeries of the lower-limb following the second wave. However, the true impact of Covid-19 on lower-limb amputation rates with diabetes requires more exploration and is still unknown in the UK (Valabhji et al, 2021).

Conclusion

Some of the greatest challenges in the management of diabetes and diabetes-related foot complications are lack of knowledge, patient awareness and poor adherence. It is vital that further education is provided for patients and HCPs on the understanding of DKA, risks of SGLT2 inhibitors, reporting of suspected side-effects and careful patient monitoring (Dashora et al, 2021).

Challenges associated with patient education and adherence, along with demographic factors, may prevent accessibility of telemedicine. Uncomplicated diabetes care and minor foot complications can be managed remotely or in community settings, but post-operative follow-ups and foot screening are challenging to carry out in this manner (Casciato et al, 2020). Careful clinical examination and foot risk assessments require full examination of the lower limbs. Innovative triage systems need to be implemented to determine urgency of patient care (Boulton, 2021). Data on outcomes for care of foot ulcers and lower-limb trauma in people with diabetes managed virtually throughout the pandemic are sparse. Therefore, the validity,

effectiveness, and quality of virtual consultations in comparison to face-to-face visits need to be explored further (Jaly et al, 2021; Rastogi et al, 2021).

Management of acute foot complications associated with diabetes requires complex medical and surgical treatments. Ineffective antibiotic management can compromise the healing of foot infections associated with diabetes. Management, including soft tissue sampling and review of sensitivities is strongly dependent on continuous MDFT input.

Studies analysing risk of antibiotic resistance in people with diabetes-related foot complications during the pandemic are sparse and this needs to be explored further to gain a better understanding of the association with amputation (Caruso et al, 2021).

Secondary user service data has been useful in identifying numbers of major and minor lower-limb amputations and revascularisation during the first and second waves of the pandemic (Valabhji et al, 2021). Local and national audits are important in capturing data to establish patient outcomes for foot complications associated with diabetes, and statistics captured during the pandemic will be useful.

Data on acute diabetes-related complications and specific recommendations for people with diabetes during the pandemic are limited and often use single disease categories, with less focus on differences between outcomes for type 1 and type 2 diabetes.

Clinical awareness is needed for early recognition of distal embolisms in patients admitted to ICU with severe cases of Covid-19, using D-dimer measurements to prevent adverse venous/arterial thromboembolic events (Buikema et al, 2021).

It is possible that levels of mortality and morbidity in the aftermath of Covid-19 will be higher than during the pandemic. It has been predicted that significant numbers of non-attendances could lead to a “tsunami of late complications of diabetes” after the pandemic (Boulton, 2021). MDFT cooperation and relationships between vascular surgery, diabetology, infectious disease and podiatry teams are important. Coordination of patient care within the MDFT should be implemented on a case-by-case basis to manage surge plans and promote limb-preservation and salvage (Tao et al, 2020).

Regulatory bodies are advised to update

recommendations with new supporting evidence, and hospitals and HCPs are urged to persevere in providing data to support future healthcare crises that may occur. ■

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