Evaluation of the RAPID technology-enabled care pathway for people with diabetes-related foot problems living in remote and rural settings

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Key words

- Foot Ulceration
- Technology-enabled
- Rurality
- Specialist foot team

Article points

1. People living with diabetes and foot disease in remote and rural areas are disadvantaged when accessing centralised specialist services.
2. A community-based electronic referral pathway and video consultations are well-received and associated with equivalent outcomes to traditional referral pathways as well as reductions in travel.
3. Innovations in technology can help to provide a more equitable remote service for people living with foot ulceration and promote improved collaboration between community and specialist staff.

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Aim: People living with diabetes-related foot problems in rural areas have difficulty in accessing diabetes specialist foot services. We aimed to evaluate triage outcomes of a community-based electronic referral (eReferral) and remote video consultation (VC) service in a large rural health board area in comparison with other referral routes. Methods: Data were collected for all referrals to the diabetes specialist foot team over a 27-month period, including demographic data, foot ulcer outcomes and healing times, as well as staff and patient perceptions of the service. Results: The majority of eReferrals were from the most remote areas and 88% of all eReferrals were triaged within the pre-set level of 48 hours. Average estimated distance saved from travelling to the specialist centre for individuals reviewed by VC was 317.7 km. Remission rates (55.5% vs 61.2%, p=0.38) and time to remission (103.7 ± 16.1 days vs 81.0 ± 10.1 days, p=0.21) were similar between eReferral and other routes. Patient perceptions of quality of interaction in VC were similar to in-person consultations. Compared with other routes, staff felt the eReferral pathway was better for ulcer treatment and clinical outcomes and joint VC consultations were particularly useful for collaboration with the specialist foot team. Conclusion: An eReferral pathway and option for VC consultation was associated with reductions in distance travelled, estimated carbon emissions and potential cost savings. There were good levels of patient and staff satisfaction with the pathway and similar levels of ulcer healing. The pathway may be utilised in any environment but is particularly useful in remote and rural areas especially in winter.

Diabetic foot disease is a major cause of morbidity and mortality (Fang et al, 2023). Patients with diabetes have a high incidence of foot ulceration related to neuropathy and ischaemia (National Institute for Health and Care Excellence, 2015) with a cumulative lifetime incidence of 15–25% (Boulton, 2004; Armstrong et al, 2017). Lower limb ulcers often precede infection and amputation, and up to 20% of infected foot ulcers will require an amputation (Armstrong et al, 2017). Foot-related problems are a leading cause of hospital admissions in individuals with diabetes. Data from NHS England indicates an increasing trend in associated admissions pre-COVID-19 pandemic (National Diabetes Foot Care Report, 2022), and more than 25% of hospital admissions related to type 2 diabetes were linked to peripheral circulatory complications (AbuHammad et al, 2023). Furthermore, it has been recognised that a diabetes foot ulcer and a lower extremity amputation are independent risk factors for premature death (Armstrong et al, 2020).

Data from the Scottish Diabetes Survey suggest that the overall incidence of diabetes-related foot amputations over a 5-year period (2018–2022) remains stable, with 0.5% of people with diabetes ever having had a lower limb amputation (Scottish Diabetes Survey, 2022).

However, amputation rates are subject to variability linked to case ascertainment and misclassification (Rayman et al, 2004), and social deprivation (Healthcare Quality Improvement

Partnership, 2016; Leese et al, 2013). Local audits of diabetes foot ulceration have highlighted late presentation to specialist podiatrists or the diabetes multidisciplinary foot team in up to 55% of cases, who subsequently underwent amputation (Highland Diabetes Foot Team, Unpublished Data).

The health economic implications are significant and, based on total annual costs for diabetic foot ulcers and amputations in England (Kerr et al, 2019), this would equate to £80–96 million in Scotland. Up to 80% of these amputations in people living with diabetes are due to foot ulcer-related complications and may be preventable (Boulton, 2004). With an active prevention strategy, these can be reduced by more than 50% (Ragnarson and Apelqvist, 2001).

NHS Highland is the UK's largest and most sparsely populated health board, encompassing 41% of Scotland's landmass. Patients in rural and island settings face unique challenges due to the distance from health resources; for example, a round-trip between Thurso in the north of the Highland region and the main general hospital in Inverness is around 322 km (200 miles). Transport limitations and poor integration of community and specialist teams are compounding issues.

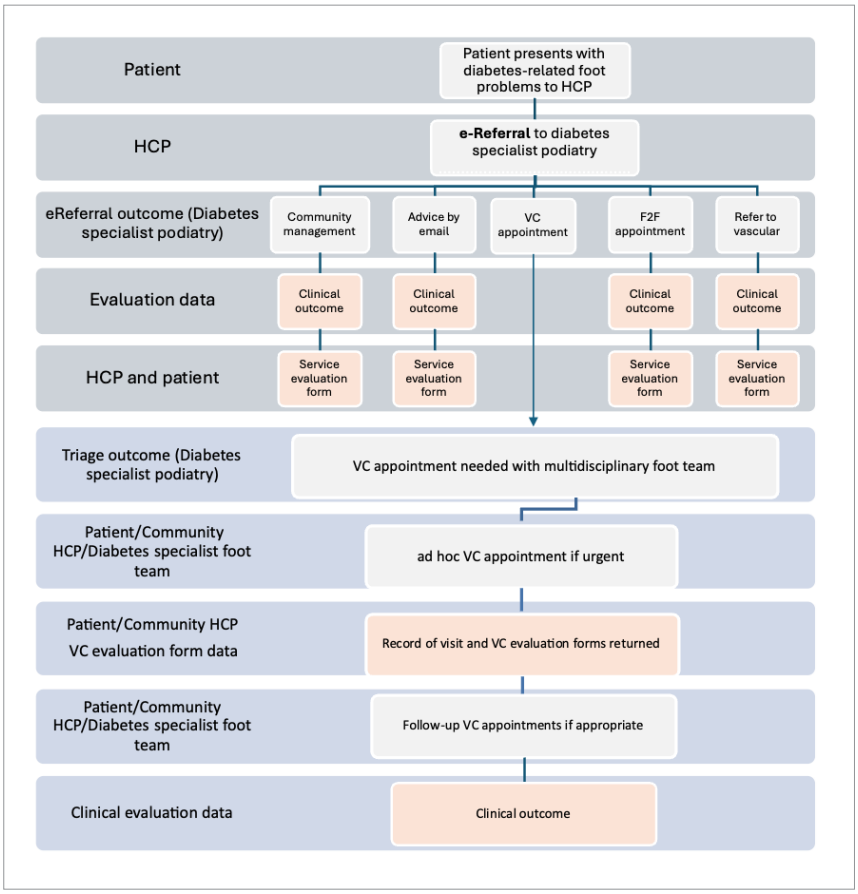

Figure 1. Pathway for referrals through the eReferral route, and resulting triage outcomes

Early prevention strategies are likely to be cost-effective (Barshes et al, 2017), and the introduction of multidisciplinary foot teams is associated with a reduction in amputation rates (Albright et al, 2020). We have conducted previous pilot studies (MacRury et al, 2018; Main et al, 2021) to assess the feasibility of a new community-based technology-enabled care pathway, RAPID (Reducing AmPutations In Diabetes), designed to improve access to specialist diabetes foot care for people living in remote and rural communities. Improving access to specialist podiatrists and the wider multidisciplinary foot team through better use of current communication channels, such as email and technology-enabled remote consultation to reduce patient travel and greenhouse gas emissions that also maintain equity of access could contribute to improved care, and reductions in amputation rates, as well as producing a social return on investment by improving quality of life. In the pilot work, we established that:

- Available router technology provides sufficient cellular connectivity coverage to support the rollout of video conference (VC) consultation from home or community health settings across remote and rural areas of the Scottish Highlands.
- Acceptable visual images can be obtained, both in terms of live foot images and photos transmitted.
- Patients found the intervention acceptable and would be willing to use the service in the future. Patients benefited from improved access to triage and specialist advice, and from reduced health and financial costs associated with accessing the service.

Recommendations from healthcare practitioners (HCPs) involved in the feasibility stages were incorporated into the wider rollout of the pathway. It was anticipated that this new care pathway would complement and enhance the existing service, thereby facilitating potential cost savings by preventing diabetic foot complications and amputations.

The primary objective of this follow-up evaluation was to determine whether the RAPID pathway delivered timely referral to the

Table 1. Number of patients with foot ulcers reviewed by the diabetes specialist podiatry team through eReferral or other routes for all URC categories and for those in non-urban categories.

	All with a URC		URC 3–8	
	eReferral (n)	Other referral route (n)	eReferral (n)	Other referral route (n)
Patients	96	98	76	58
Patients with ulcer outcome data	73	69	60	51
Ulcers	145	175	121	94
Ulcers with outcome data	103	116	87	55
Ulcers in remission	57	71	50	29

multidisciplinary foot team.

The secondary objectives were to evaluate whether the new pathway:

- Reduced ineffective or inappropriate travel time for people with diabetic foot problems.
- Impacted healing rates of diabetes-related foot ulcers compared to the existing pathway.
- Increased collaborative working between community and specialist teams.

Methods

Data were collected over 27 months, commencing in May 2020, for all referrals to the diabetes specialist foot team (DST), including follow-up data on ulcer outcomes. These data were pseudo-anonymised to enable a service evaluation of all patients referred through the new eReferral pathway to the DST, compared with those referred to the team through other routes, including letters, phone calls, ward referrals, etc. A specific proforma was available for eReferrals and submitted to a dedicated email account, which was accessed daily by the DST. In addition to demographic data, information was collected on ulcer outcome, including time to healing.

The Scottish Government Urban Rural Classification index was used (Urban Rural Classification, 2022). The database included an automatic urban–rural classification (URC) lookup table (to prevent postcodes from being disclosed to the university evaluation team), and the round-trip mileage between the patient's home and the Diabetes Centre was calculated. The University of the Highlands and Islands Research and Ethics Committee approved the study (UHI 1624).

The pathway for those who were eReferred via the new system, along with the various triage outcomes, is shown in **Figure 1**.

Patient perception of the new care pathway system was assessed at two points in the service:

- At the initial VC appointment for those patients in whom a VC appointment with the multidisciplinary DST was the triage outcome following eReferral. This was at the end of the VC appointment **[Supplementary File 1]**.

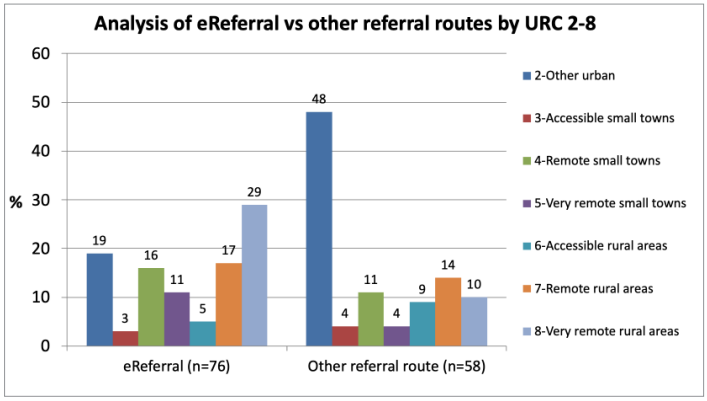

Figure 2. URC breakdown (%) for patients with ulcer outcome data

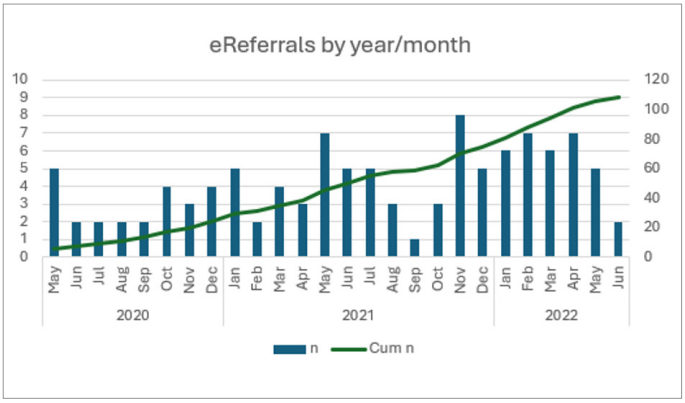

Figure 3. Actual (n) and cumulative (cum n) eReferrals over the period of

Table 2. Conversion factors, total emissions and emissions saved per VC based on average car size and assumption of 50:50 ratio of diesel and petrol fuelled cars.

Vehicle	Conversion factor		Total estimated emission (kg CO2e)			VCs (n)	kg CO2e/VC
	Diesel	Petrol	Diesel	Petrol	50:50		
Average car	0.16984	0.16382	1044	1012	1028	28	37

Table 3. Ulcer outcome for eReferrals and other referral routes for all URCs and URC 3–8.

Ulcer outcome	All with a URC		URC 3–8	
	eReferrals (n=103), n (%)	Other referral routes (n=116), n (%)	eReferral (n=87), n (%)	Other referral route (n=55), n (%)
In remission	57 (55.3%)	71 (61.2%)	50 (57.5%)	29 (52.7%)
Healing	10 (9.7%)	8 (6.9%)	9 (10.3%)	3 (5.5%)
Non-healing	14 (13.6%)	9 (7.8%)	8 (9.2%)	6 (10.9%)
Deteriorating	16 (15.5%)	24 (20.7%)	14 (16.1%)	13 (23.6%)
Palliative	6 (3.6%)	4 (3.4%)	6 (6.9%)	4 (7.3%)

- Once DST input was no longer required for a given foot problem, or if the patient was transferred for vascular intervention. This was via a service evaluation form posted by the diabetes specialist podiatrist to the patient and returned using a freepost envelope to the evaluation team at UHI [**Supplementary File 2**].

Staff perceptions of the new care pathway system were assessed at three points:

- The community podiatrist presents with the patient at the VC consultation at the end of each VC appointment [**Supplementary File 2**].
- By the staff responsible for the eReferral via a service evaluation form [**Supplementary File 3**] posted by the diabetes specialist podiatrist to the staff member and returned using a freepost envelope to the evaluation team at UHI, either:
  - Once DST input was no longer required for a given foot problem; OR
  - The patient was transferred to the vascular team; OR
  - Following email advice if this was the outcome and no requirement for DST appointment (via VC or face-to-face [F2F])

Data analysis

As an observational study, no power calculation was carried out. Descriptive analysis was used, and two-sample t-tests were carried out to examine differences between groups. Values are expressed as mean and SEM.

Results

Over the period of data collection, 96 patients with 145 ulcers were referred through the eReferral pathway compared with 98 patients and 175 ulcers referred by other routes, for whom a URC was available. Of these, 76 with 60 ulcers and 58 with 51 ulcers were referred from non-urban areas (URC 3–8) via the eReferral and other routes, respectively [**Table 1**].

As per protocol design, the greatest number of eReferrals were from the most remote areas (46%; URCs 7 and 8), compared with 19% from more urban areas (URC 2). The complete breakdown of URC is shown for each group in **Figure 2**. There are no large urban areas (URC 1) in the Highland region.

The number of eReferrals increased gradually throughout the COVID-19 pandemic and continued to rise following the resumption of normal NHS services [**Figure 3**].

Timing of referrals

Around 65% of all eReferrals were triaged the same day, 83.5% within 24 hours of referral and 88% within the preset target of 48 hours.

Travel distances and carbon emissions

For each VC (n=28), return journey distances to the patient's usual F2F appointment location were determined from each patient's postcode using Google Maps. Estimated travel distances to the main specialist centre for eReferral patients

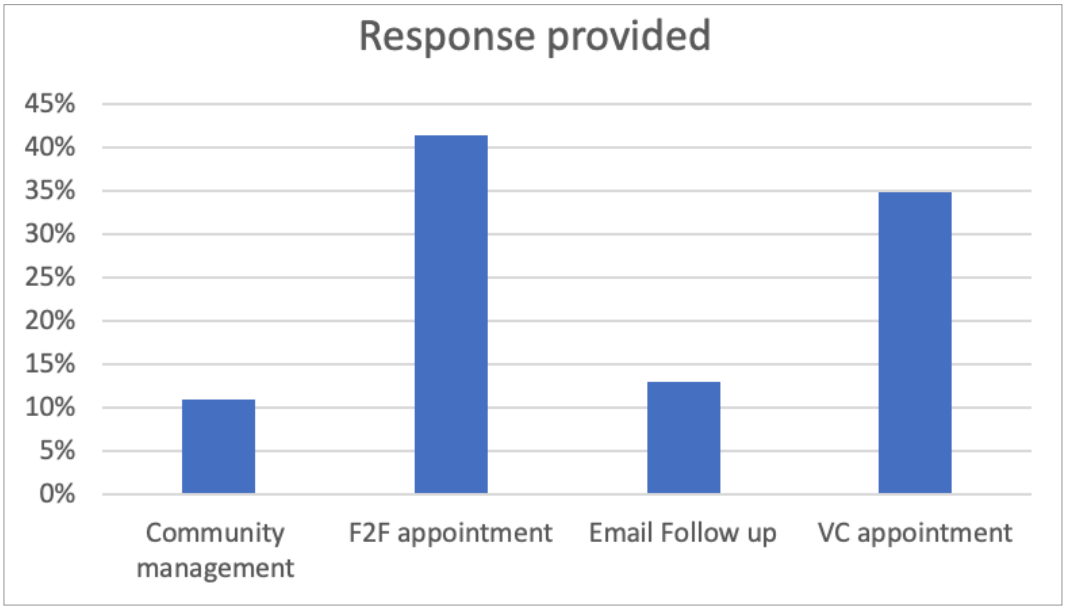

Figure 4. Response provided by the diabetes specialist team to a community health care professional's eReferral

living in remote and rural areas, including island communities, who were reviewed by the specialist team by VC consultation, ranged from 51–566 km (return journey), with a mean of 317.7 km.

Carbon emissions associated with each journey were estimated using conversion factors for passenger transport greenhouse gas emissions published by the UK Department for Business, Energy and Industrial Strategy (2024 release) (Blenkinsop et al, 2021). Calculations were based on average car size and a 50:50 mix of diesel and petrol fuel types. Electric cars were not considered due to low usage in rural areas with long travel distances (County Councils Network, 2023).

The total return distance that would have been travelled was 6151 km. Using the average car conversion factor, this leads to a total of 1012 kg CO2e and 1044 kg CO2e for petrol and diesel, respectively [**Table 2**].

Ulcer outcomes data

An Independent-samples proportions test was performed to compare the proportions of ulcers in remission between eReferrals and other referral routes for all URCs and for URCs 3–8.

For all URCs: The difference in remission rates between eReferrals and other referral routes was not significant (p=0.38).

For URC 3–8: The difference between eReferrals and other referral routes was not significant (p=0.58).

The proportion of ulcers in each of five categories at the end of the review period for eReferral and other routes is shown in **Table 3**.

A two-sample t-test was performed to compare time to in remission between eReferrals and other referral routes for all URCs and for URC 3–8.

For all URCs: There was no significant difference in mean time to in-remission between eReferral (103.72 ± 16.12 days) and other referral routes (81.00 ± 10.07 days), p=0.21.

For URC 3–8: There was no significant difference in time to in-remission between eReferral (99.08 ± 16.31 days) and other referral routes (74.00 ± 15.89 days), p=0.31.

Patient survey responses

Surveys were returned by 30 patients (two with second appointments), and 24 HCPs, on behalf of 44 patients (three with second appointments), were assessed through the eReferral service. The majority of patients had diabetes-related foot problems for >2 years (70%), with 23.3% for <6 months. Of all who responded, 80% had been seen by a podiatrist three or more times in the preceding year,ss although not in a home setting, with 50% of contacts being with a diabetes specialist podiatrist.

13.3% had prior experience with a home VC consultation, and 20.7% had a VC from another setting.

Following the eReferral contact, 82.2% of those referred were unaware of the new pathway, and 46.7% were unaware that they had been referred. Overall, 60.9% were reviewed in F2F appointments, and 34.3% were reviewed via VC from a variety of locations.

Of patients who had experience of VC (home or community health care setting) and F2F appointments, 57.1% felt that a VC from a GP practice or community setting was more convenient than a VC from home (14.3%) or a F2F appointment (28.6%). Individuals were split in their perception of the quality of interaction during their appointment: 42.9% preferred F2F, 42.9% preferred VC in a community healthcare setting, and 14.3% reported no difference. All agreed on the financial savings of VC vs F2F and on convenience in the winter months (57.2% vs 14.3%), though 28.6% did not feel there was any difference.

If given a choice about appointment method, among those who had experience with both VC and F2F with the DST, 45.5% would choose F2F, 36.4% would choose VC in a community healthcare setting, and 18.2% had no preference.

Healthcare staff survey responses

The outcomes of initial responses from community HCP eReferrals are shown in Figure 4, with 41.3% recommending a F2F appointment and 34.8% recommending a VC appointment. Only two of the responses were felt not to be appropriate, one because a vascular opinion was required, and one because the specialist team had recently reviewed the patient and there was no plan to change treatment at that point.

Compared with previous referral routes, HCPs felt the eReferral pathway was better or considerably better for treatment received by patients (62.2%), the speed of treatment (67.4%) and clinical outcome (62.2%).

There were 14 HCP responses regarding the impact of joint VC appointments. These included a positive impact on wound care (64.3%), offloading (78.6%), confidence in managing diabetes foot problems (64.3%), and collaboration with the specialist diabetes foot team (78.6%).

Discussion

The RAPID pathway was targeted at individuals with diabetes-related foot ulceration living at a distance from the hospital-based DST, with the aim of reducing travel distances and times and improving timely and equitable access to advice or triage from the DST (MacRury et al, 2018; Main et al, 2021). It was anticipated that the majority of eReferrals to the team for triage would come from remote rural areas rather than urban areas, which proved to be the case, with the largest percentage coming from areas categorised as very remote and rural (URC 8). The vast majority of all eReferrals were triaged within 24–48 hours. Foot ulcer guidelines state that new diabetes-related foot problems should be referred within one working day and triaged within one further working day (NICE, 2015). As community staff became more familiar with the eReferral process, the number of entries into the system via this route continued to rise. They exceeded those referred through alternative pathways, including for more urban areas (URC 2).

There was a substantial reduction in distance travelled, with associated large estimated carbon emission savings when the eReferral pathway was used. In this context, transportation is considered the major driver of greenhouse gas. While other factors contribute, the estimated carbon emissions associated with VC consultations are substantially lower, ranging from 400 g for a typical video visit (Thielet al, 2023) to 1.85 kg for a 1-hour consultation using desktop equipment (Holmner et al, 2014). Although the distance to be travelled to specialist care centres remains unchanged, a shift to greater use of electric vehicles in rural areas would reduce both carbon emissions and the cost of travel (US Department of Transportation, 2025). There are, nevertheless, still barriers to more widespread use of these vehicles in rural areas (Barber et al, 2024).

Patient and staff satisfaction with the eReferral pathway was high. However, despite understanding the savings in travel time and the financial benefits of VC-based appointments, if given a choice, a number of patients would still choose F2F over VC when interacting with the DST, although the relatively low response rate should be acknowledged. These findings are consistent with those of other studies, which cite more accurate diagnosis and better clinical examination by clinical staff as reasons for selecting

in-person consultations (Moulaei et al, 2023). Despite this, a partial multidisciplinary virtual review service involving specialist and community staff in a semi-rural area of south England demonstrated a reduction in amputations associated with diabetes-related foot problems (Watt et al, 2021). Moreover, evaluation of the use of VC by allied health professionals, including podiatry, during the COVID epidemic suggested that VC integrated with F2F consultations could be transformative in improving efficacy and efficiency of services (Williams et al, 2023). Uniquely, in our pathway, VCs were recommended by specialist HCPs and facilitated by a community HCP, which offers a hybrid model with an active link between the community and specialist secondary care services. This provides choice, particularly in winter, and contributes to reducing emissions, even if adopted by only a percentage of patients.

Around one-third of all referrals through the eReferral pathway resulted in a VC consultation, and, interestingly, among those who had experience of both VC and F2F consultations beyond interaction with the DST, there was a preference for community-based VC appointments over home-based VC or F2F consultations. This order of preference for VC consultations delivered in a healthcare setting close to home rather than within the home has been demonstrated in other healthcare settings (Snoswell et al, 2023). However, it is not clear which factors may influence this choice, for example, age or patient mobility.

The majority of community staff who used the eReferral service found it better than other referral routes for treatment and outcomes. It also improved referral ease, with the added benefit of a structured referral form. All those involved in facilitating VC appointments with patients felt that it had a positive impact on wound management and on their own knowledge, learning, and confidence. In particular, they reported high levels of satisfaction with collaboration with their colleagues in the specialist team.

Ulcer outcome data indicated that the new eReferral system appeared equivalent to conventional referral routes in terms of outcome categories, with no significant difference between the pathways in rates or time to healing. The numbers in the various categories were, however, low, which may have affected statistical differences. This means the pathway has become part of the regional integrated podiatry service. Further evaluation would be useful to assess the benefits to learning and knowledge for community staff, the ongoing use and location of VC consultations, and the cost benefits to assist with further service development and the long-term implementation of change.

Limitations

There was a low return rate from patient questionnaires, which may have influenced reporting of awareness of the pathway, recording of previous contact with specialist services and consultation preferences. Furthermore, given the non-randomised observational nature of the study, we were unable to control for other factors among individuals living in remote and rural locations that could have influenced ulcer healing rates.

Conclusion

An eReferral pathway with remote consultation enables community staff to gain timely access to and advice from the diabetes specialist foot team, which aids community staff learning in the management of diabetes-related foot ulceration, promoting collaboration between generalist and specialist podiatry staff. Foot ulcer healing rates are similar to those of other forms of referral, and there are considerable savings in terms of distance travelled, carbon emissions, and patient and health service costs. The system is particularly beneficial in remote and rural communities but can also serve as a suitable alternative referral pathway in more urban areas. ■

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