Does the point of healthcare contact affect successful diagnosis of diabetic Charcot neuroarthropathy?

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Background: Charcot neuroarthropathy (CN) is a lesser-known and commonly misdiagnosed diabetic foot complication. Delays in diagnosis increase the risk of severe long-term foot complications. Aims: To undertake a retrospective audit of patients with active CN, recording the time to diagnosis, misdiagnosis rates, healthcare professional (HCP) and setting type at each contact since symptom onset prior to their referral to a multidisciplinary foot team (MDFT) clinic in a circumscribed part of England. Methods: Clinical notes of 46 consecutive patients attending a MDFT clinic in the East Midlands region of England during a 2-month period, with active CN were assessed. Results: Of the 46 included patients, 22 developed CN while in primary care. These patients had a mean time from symptom onset to confirmed diagnosis of 68 days, with 64% receiving a misdiagnosis. Non-specialist HCPs failed to suspect CN in 85% of contacts compared to 20% in specialist HCPs. Conclusions: Non-specialist HCPs need a greater degree of awareness and understanding of CN to reduce diagnostic delays and misdiagnosis rates.

I t is estimated that by 2025 there will be 4.4 million people in the UK living with diabetes (Public Health England, 2016), accounting for 10% of the NHS budget, with 80% of this being spent on preventable complications, such as diabetic foot disease (Hex et al, 2012).

Charcot neuroarthropathy (CN) is a lesser known complication of the diabetic foot, with a point prevalence of just over 4 people per 10,000 people with diabetes in the East Midlands region of England (Metcalf et al, 2018). CN has been described as a complex syndrome, characterised by inflammation in its active phase with or without pain, followed by varying degrees of destruction to the skeletal architecture of the foot, eventually leading to the classic 'rocker bottom foot' shape (Jeffcote, 2015).

CN is arguably one of the more devastating complications affecting people with diabetes and peripheral neuropathy, severely reducing the physical functioning and quality of life for those affected (Pakarinen, 2009). Early detection and management by immobilisation are imperative in acute CN to avoid permanent foot deformity and

associated complications, such as ulceration and amputation (Lowry et al, 2012).

Amputation rates associated with CN have recently been estimated at 15% (Yammine et al, 2022), with a 2-year mortality rate of 18.6% (van Baal et al, 2010), with multiple studies showing an increased rate of complications in patients with delayed or misdiagnosis (Rogers et al, 2011; Game et al, 2012; Wukich et al, 2011). Two recent systematic literature reviews have estimated misdiagnosis to occur in half of patients with CN (Korst et al, 2022; Shazadeh Safavi et al, 2021). Additionally, Korst et al (2022) identified an average delay of 86.9 days from symptom onset to diagnosis confirmation, reducing optimal management and creating poorer long-term patient outcomes compared to those that received early diagnosis (Chantelau, 2005).

It is still unknown if there are links between these missed clinical opportunities and the type of healthcare setting that the patient seeks assessment at, once their CN symptoms develop. Several papers have attributed misdiagnosis to healthcare professionals (HCPs) overlooking the possibility of a CN diagnosis due to a lack of awareness, relative

rarity of the condition and gaps in professional education (Gill et al, 2004; Milne et al, 2013; O'Loughlin et al, 2017). Knowing the types and locations of HCPs that are more likely to miss a diagnosis of CN could provide grounding for large-scale research and targeted education workshops to help increase recognition of CN nationally, improving outcomes for both patients and the NHS.

This paper examines the results of a single-centre audit of patients attending a multidisciplinary foot team (MDFT) clinic in the East Midlands, UK, with an active diagnosis of CN. This is the first audit, to the authors' knowledge, that records both time to diagnosis and misdiagnosis rates along with the HCP and healthcare setting type at each contact since symptom onset prior to their referral to MDFT.

Methods

Sampling and participant identification:

The audit was conducted retrospectively using opportunistic sampling of patients who were attending a MDFT clinic in the East Midlands region of England.

To be included in the audit, patients needed to have a diagnosis of diabetes, according to World Health Organization criteria and have a diagnosis of active CN between 31/12/2023 and 01/11/2023. For the purpose of this audit, this was defined as: otherwise unexplained inflammation, detected either clinically or by magnetic resonance imaging of the foot, with or without evidence of skeletal damage (Metcalf et al, 2018).

CN is not routinely coded during clinical attendance, so it was not possible to find a list of eligible patients from the hospital database. Instead, specialist diabetic foot clinics during December and November 2023 were screened manually for patients that met the above criteria by a member of the patient's usual care team and a Case Report Form completed for each eligible patient.

Data collection:

Demographic data including age, diabetes type and duration was recorded, along with the CN location, namely forefoot, midfoot and rearfoot and whether they had a previous history of the condition. Patients' vascular surgery history and the dates of the most recent surgery prior to the development of their CN symptoms was also recorded.

For patients whose CN symptoms occurred in primary care prior to their referral to the MDFT, information was recorded for each contact with a HCP following their symptom development. For the purpose of this audit, symptoms of CN were defined as: a foot that has one or more of the following presentations: hot, painful, swollen, red and fractures or dislocations (National Institute for Health and Care Excellence [NICE], 2015).

For each contact, date, location and HCP type were recorded, along with foot ulcer status and whether a diagnosis of CN was suspected. For the purpose of this audit, the suspected diagnosis was defined as the following: the time at which the diagnosis was first considered was that at which the decision was made to manage the person if they had active CN, specifically with advice regarding reduced weight-bearing, whether or not the necessary investigations had been completed (Metcalf et al, 2018). The date of diagnosis confirmation was recorded but if CN was not suspected then the alternative diagnoses were also recorded.

Data analysis

As this is an audit, only descriptive statistics were performed for analysis, by calculations of frequency, means and standard deviation.

Governance

As patient management was not influenced and only information collected as part of their usual care was used, the present study was conducted as an audit without the need for ethical approval. This was approved by the Caldicott Guardian in both the community and hospital trusts involved. Any data leaving the treating site were anonymised.

Results

In total, 1,296 patient appointments were screened for potential patients from 20 MDFT clinics within the same centre. Forty-seven potential participants were identified, with 46 included; one participant had suspected CN during the specified dates but was lost to follow-up before diagnostic confirmation. Participant characteristics are summarised in *Table 1*.

Table 1. Participant Characteristics (Total patients, *n*=46).	
Demographics	
Female	10 (22%)
Male	36 (78%)
Type 1 Diabetes	14 (30%)
Type 2 Diabetes	32 (70%)
Age (years) mean ±SD	59 ± 9.9
Diabetes duration (years) mean ±SD	19 ± 3.6
CN characteristics	
Forefoot	5 (11%)
Midfoot	28 (61%)
Rearfoot	5 (11%)
Multiple foot sites	8 (18%)
Unilateral CN	44 (97%)
Bilateral CN (treated as separate cases)	2 (4%)
History of previous CN	17 (37%)
No history of previous CN	29 (63%)
Revascularisation prior to CN	3 (7%)

Around half (*n*=22) of patients developed their CN symptoms while in primary care, with 24 patients developing them while already under the care of the MDFT with foot ulceration. Of the patients identified in primary care, 13 (59%) were referred to the MDFT clinic with suspected CN, 7 (32%) patients were referred with CN already confirmed on diagnostic imaging, 2 patients were referred coincidentally for foot ulceration and CN was suspected at their first visit.

Misdiagnosis figures

Patients initially assessed in primary care received a mean number of 3.8 contacts prior to their referral to the MDFT clinic and a mean of 2.6 missed opportunities with 64% (*n*=14) of patients experiencing a missed opportunity. Patients with a history of CN had a mean of 1.5 contacts prior to referral, with a mean of 0.4 missed opportunities compared to patients with no previous history of CN who had a mean of 5.3 contacts prior to referral and a mean of 4.2 missed opportunities. Patients received a mean of 2.6 alternative diagnosis prior to their referral with conditions including: cellulitis (*n*=19, 35%), infection (*n*=6, 11%), swelling/oedema (*n*=5, 9%), osteoarthritis (*n*=5, 9%), DVT (*n*=3, 6%), soft tissue injury (*n*=2, 4%) and gout (*n*=2, 4%).

Time to diagnosis

The mean time from first HCP contact to suspected diagnosis was 40.7 days; in patients with a history of CN, this was 8.2 days; in patients without a history of CN this was 63.2 days. The mean time from the first HCP contact to confirmed diagnosis was 67.5 days; in patients with a history of CN this was 48.4 days; and in patients without a history of CN this was 80.76 days.

Contact locations

Of the healthcare settings where the contacts prior to referral were located, 40 occurred in GP practices where 85% (*n*=34) were missed; 17 occurred in outpatient clinics where 41% (*n*=7) were missed; 9 occurred in urgent treatment centres where 100% (*n*=9) were missed; 9 occurred in A&E where 67% (*n*=6) were missed; 4 occurred in domiciliary settings where 100% (*n*=4) were missed; and 4 occurred on inpatient wards where none were missed.

Assessing HCPs

Non-specialist HCPs failed to suspect CN in 85% of contacts compared to 20% in specialist HCPs (*Table 2*). For the purpose of this audit, specialist HCPs were grouped as such due to their profession's routine inclusion in MDFTs in England; non-specialist HCP were professions not routinely included in such teams (NICE, 2015).

Discussion

Demographic data including patient age, gender and diabetes duration and the fact that most patients

Table 2. Missed and suspected diagnosis rates of CN per HCP type.			
Healthcare professional (HCP) type		**Missed**	**Suspected**
Specialist HCPs	Diabetes Consultant	0	3
	Vascular Consultant	0	1
	Orthopaedic Consultant	0	1
	Orthopaedic Registrar	1	3
	Endocrine Registrar	0	1
	Podiatrist	3	7
	Total:	**4**	**16**
	Percentage:	**20%**	**80%**
Non-Specialist HCPs	GP	34	6
	A&E Consultant	3	2
	DVT Clinic Consultant	1	0
	Ambulatory Care Clinic Registrar	1	0
	Ambulance Staff/ Paramedic	2	0
	Practice Advanced Nurse Practitioner	1	0
	Practice Nurse	2	1
	DVT Clinic Nurse	2	0
	A & E Nurse	2	0
	UTC Nurse	8	0
	Unknown Consultant	0	1
	Unknown HCP	2	0
	Total:	**58**	**10**
	Percentage:	**85%**	**15%**

had CN occurring in the midfoot mirrored recent UK data (Goodhay et al, 2023). Thirty-seven percent (*n*=17) of patients had a previous history of CN, which is higher than previous studies have suggested (Osterhoff et al, 2013; Fabrin et al, 2000) but in both of these studies patients were only followed up for 4 years, so it is possible that CN reoccurred outside of this timeframe.

Revascularisation occurred in just 3 of the 46 patients prior to their CN diagnosis, all preceding condition development within 12 months. This is lower than a recent study by Meloni et al (2022), which reported 18% in their CN study population but failed to stipulate if the revascularisation occurred before the development of the Charcot foot or after.

Misdiagnosis was shown to be common, with 64% of people experiencing a misdiagnosis or missed opportunity, with a mean of 3.8 contacts prior to referral, with two patients receiving 10 contacts with HCPs before CN became a suspected diagnosis. Conditions suspected other than CN mirrored that of other studies, with cellulitis/infection being the most common (Milne et al, 2013).

Interestingly, patients with a previous history of CN suffered far fewer missed opportunities, with a mean time to suspected diagnosis of just 8.2 days compared to 63.2 days in patients with no history of CN. This is likely due to patient awareness once their symptoms develop and documentation in the patients' records making HCPs quicker to consider a diagnosis of CN; patients with previous CN should also be under the care of a foot protection service and, therefore, in closer contact with specialist HCPs.

The mean time to confirmed diagnosis in patients initially assessed in primary care was 67.5 days, which was slightly lower than the 86.9 days reported by Korst et al (2022) but still showed a significant delay to specialist treatment.

Seventy-seven percent of patients with symptoms of CN presented to non-specialist HCPs, where 85% of contacts resulted in missed opportunities. This demonstrates an obvious lack of knowledge around CN and showcases the need for greater awareness in the wider HCP field. Additionally, only 60% of patients were referred with a suspicion of CN, and 30% by the time that active radiological changes had been allowed to occur, which suggests

that the earliest stages of CN is being overlooked by HCPs.

This audit does have inherent limitations due to the opportunistic nature of the sampling of patients attending just a single centre during a short period of time. Like many studies involving CN, it focuses on a small cohort of patients due to the laborious and time-consuming nature of identifying patients as there is no standardised system to record patients with a diagnosis of CN.

Conclusion

Non-specialist HCPs need a greater degree of awareness and understanding of CN to reduce diagnostic delays and misdiagnosis rates. A full-scale research study mirroring this audit could potentially highlight trends in misdiagnosis and diagnostic delays nationally and explore whether targeted HCP education sessions could improve patient outcomes.

This audit highlights the need for a robust national auditing system for CN, such as that used by the National Diabetic Foot Care Audit (NHS England, 2018), to enable large-scale data collection around this condition, which is significantly lacking. ■

Declaration of competing interests

The authors declare that there is no conflict of interest.

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