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The Impact of Diagnostic Delay on Wound Healing—A Cohort Study in a Primary Care Setting

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ABSTRACT

The impact of diagnostic delays on wound healing has not been investigated in the primary care setting. The aim of this cohort study was to examine how diagnostic delays influence the healing of a chronic wound. This is a retrospective study on patients who were assessed by a specialized wound care team of a primary health care unit, aiming to reduce diagnostic and treatment delays among patients with chronic wounds. The data consist of 197 consecutive patients who had their first appointment with the wound care team in 2016. Patients whose wounds had appeared less than one year prior to the diagnosis ($n = 182$) were included in the analyses. Primary and secondary outcome measures: The primary outcome measure was wound healing and its association with a diagnostic delay. Delays were categorized into three groups by the date of the diagnosis: (1) less than 4 weeks ($n = 33$), (2) 4–12 weeks ($n = 94$) and (3) over 12 weeks ($n = 55$) after the appearance of the wound. A diagnostic delay had a significant effect on the wound healing time. Wounds had a shorter healing time if they were diagnosed early. The cumulative healing rate at 12 weeks was 54.5% in Group 1, 17.0% in Group 2 and 0% in Group 3. And 62.5% of the arterial ulcers and 47.8% of the diabetic ulcers were diagnosed within 4–12 weeks. Most of the venous leg ulcers were diagnosed within 4–12 weeks (54.2%). Our data clearly show that the earlier the diagnosis, the shorter the healing time in a primary care setting. The wounds that were diagnosed the earliest were mainly post-traumatic and venous leg ulcers. On the other hand, wounds requiring prompt diagnosis, such as diabetic foot ulcers and arterial ulcers, were not included in the group of early diagnosis. We conclude that a speedy diagnosis and aetiology-driven treatment of a wound has a direct impact on the wound healing time. Therefore, it is essential to improve the diagnostic pathways from the onset of the wound, starting from the primary care setting.

1 | Introduction

The burden of chronic wounds continues to increase all over the world. In the United Kingdom, wound care represents the third highest expense for the NHS, after cancer and diabetes, with an annual cost of £8.3 billion in 2017/18 and a 67% rise from 2012/2013 [1]. Most of all, wounds impair the quality of life of the affected individuals [2].

A mandatory step in successful wound management is accurate diagnosis [3] and aetiology-driven treatment. Generally speaking, guidelines place the responsibility of diagnosing wounds on physicians [3, 4], while nurses, and podiatrists, are responsible for further wound management, compression bandaging and patient education, as well as follow-up and a timely consultation of a physician if there are no signs of healing [5]. The aetiological examination and correct diagnosis of

Summary

- A diagnostic delay influences wound healing.
- The aim of this study was to evaluate the diagnostic process and the effect of a general-practitioner-led wound care team on wound healing. Data consisted of 197 consecutive patients at their first visit with a consulting wound care team in primary care. The team consists of a trained GP, three wound care nurses and a podiatrist.
- As a result, 139 wounds out of 197 patients healed, and the diagnostic delay had an effect on the wound healing.
- We also found out that, unlike post-traumatic ulcers, the chronic wounds that should have been detected early, diabetic foot ulcers and vascular ulcers, were not diagnosed within the recommended time.
- In conclusion, with education and teamwork, it is possible to achieve an early diagnosis of a chronic wound at the primary care level.

the wound is also important in recognising patients who need to be referred to a secondary or tertiary health care unit for a specialist consultation by, for instance, a dermatologist or vascular surgeon [6].

Despite the obvious importance of an accurate diagnosis, there is a paucity of studies on the effect of timing in diagnostics, and the impact of delays in it, on wound healing [6]. In our previous study, we evaluated the causes and structure of delays in the diagnostic processes of patients with a chronic wound in primary health care [7], and we recognised that the correct diagnosis is very rarely achieved in the acute situation during the first appointment in primary care. We also studied the diagnostic process in primary care and found out that, in this setting, it is possible to achieve/set a diagnosis that is accurate enough to start the aetiology-driven treatment and, on the other hand, to recognise the patients that need referral to a specialist [7]. However, this requires specialised education for the primary care physicians, nurses and podiatrists. According to a recent Swedish study, general practitioners (GPs) felt that instruction in wound management at medical schools is too scarce and does not equip graduates with tools for the assessment and treatment of these patients in real life [8].

In 2013, a specialised wound care team was established in a primary health care unit in Helsinki to achieve the correct diagnoses earlier in patients with chronic wounds. The aim of the current study is to analyse the consequences of a delay on wound healing among patients referred to the wound care team.

2 | Materials and Methods

Our data were collected retrospectively from the patient records and included 197 consecutive patients who had their first appointment with the specialised wound care team between 1 April 2016 and 30 September 2016. The data have been described and published in further detail in another publication [7]. The primary care wound care team, all working in a health care centre, includes three wound care nurses and a podiatrist, and as a team leader a physician, who is a GP and specialist in general medicine with Special Competence in Wound Care. This education is for licenced specialists, also specialists in general medicine, and it was established by the Finnish Medical Association in 2015 [9]. All patients were assessed by the GP and a wound care nurse at the first appointment. There was also the possibility to consult a podiatrist and a vascular surgeon, if necessary. The detailed assessment possibilities are described in Appendix 1. Basic treatment methods included sharp debridement, negative pressure wound therapy (NPWT), compression therapy, pressure relief and foot offloading planned and followed up by a podiatrist, as well as patient education. The study data included the patients' basic demographics and risk factors, detailed information on the wound treatment pathway, such as the time points of physicians' evaluations, delays in setting the correct diagnosis and wound treatment strategies, as well as referrals to and treatments received in secondary or tertiary health care units. All tested parameters are presented in Appendix 2. Details of the delays and the patient demographics have been published previously [7]. In the current study, data on wound healing were recorded and analysed. The primary outcome measure was wound healing and its association with a diagnostic delay.

We divided the participants into three groups according to the length of the delay—(1) a delay of <4 weeks, (2) a delay of 4–12 weeks, and (3) a delay of >12 weeks—and analysed the delays and the wound healing time in each delay group (Tables 1 and 2 and Figure 1). We also examined each delay group to ascertain whether there were differences in diagnoses between the groups (Table 3).

Data were analysed using SPSS version 27.0. Cox regression analysis was used to determine whether delays, age, sex, comorbidities, medications, risk factors, mobility or living status affected wound healing. For the analysis of the delay, we included 182 patients. The inclusion criterion for the delay analysis was that the wound had not appeared more than 1 year prior to the first appointment with the wound care team.

We used Kaplan–Meier survival rates in describing actual wound healing rates for the time points of 6 months, 1 year, 18 months, and 2 years.

3 | Results

Of the 182 patients, a diagnosis was achieved within the recommended 4 weeks in 18.1% ($n=33$). For 51.6% ($n=94$) of the patients, the diagnosis was reached within 4–12 weeks, and in 30.2% ($n=55$), the diagnostic delay was over 12 weeks (Table 1). The most common aetiology was venous ulcers ($n=48$), followed by post-traumatic chronic ulcers ($n=29$), pressure ulcers ($n=27$), diabetic foot ulcers ($n=23$), and arterial ulcers ($n=16$). Infectious ulcers, foot malformations (which may also be regarded as pressure ulcers), as well as mixed and atypical ulcers comprised a minority of the diagnoses (less than 5%) (Table 3).

TABLE 1 | Diagnostic delay categorised into three groups ($N = 182$).

Diagnostic delay	Wounds (*n*)	Delays (days)			
		Mean (SD)	95% CI for mean	Median (IQR)	Range
< 4 weeks	33	17 (7)	14–20	19 (13—22)	2–28
4–12 weeks	94	54 (17)	50–57	52 (37—69)	29–90
> 12 weeks	55	162 (72)	142–181	140 (104–198)	92–358

Abbreviations: CI = confidence interval; IQR = interquartile range; SD = standard deviation.

TABLE 2 | Wound healing time after the diagnosis (first visit at the wound care team).

Diagnostic delay	Healed wounds (*n*)	Wound healing (days)			
		Mean (SD)	95% CI for mean	Median (IQR)	Range
< 4 weeks	25	73 (85)	38–108	48 (29–68)	21–415
4–12 weeks	74	128 (134)	97–159	76 (14–137)	0–825
> 12 weeks	40	167 (186)	107–226	108 (23–193)	0–927

Abbreviations: CI = confidence interval; IQR = interquartile range; SD = standard deviation.

Post-traumatic ulcers were the most common diagnosis in the group that was diagnosed in less than 4 weeks ($n = 12/33$, 36.4%). Venous ulcers were the most common aetiology in the group of wounds diagnosed within 4–12 weeks ($n = 26/94$, 27.7%) and in the group where the delay was more than 12 weeks ($n = 17/55$, 35.4%) (Table 3). When the wound healing times were analysed in the three most common etiological groups separately (diabetic, arterial, venous leg ulcers and pressure ulcers), we found that length of the diagnostic delay was associated with the wound healing time in venous leg ulcers and pressure ulcers, but not in diabetic foot ulcers (Table 4). Regarding diabetic foot ulcers, it is shown in the Appendix 3 that the seven out of nine diabetic foot ulcers which did not heal, were amputated shortly after the diagnosis (Appendix 3). The most often underdiagnosed wounds (diagnosis after 4 weeks) were arterial and diabetic foot ulcers, as well as venous ulcers (or ulcers due to chronic leg oedema) and therefore wound healing was delayed in this group (Table 3). Eventually, the wound healed in 75.8% (25/33) of the cases in the shortest delay group, in 78.7% (74/94) of the cases in the medium delay group and 72.7% (40/55) of the cases in the longest delay group as for the comparison the total wound healing times are shown in Appendix 4 (Table 5, Appendix 4).

4 | Factors Associated With Wound Healing

During the 12-month follow-up, wound healing was associated with the diagnostic delay. The 3-month wound healing rate was 54.5% when the diagnostic delay was less than 4 weeks, 17.0% when the delay was 4–12 weeks and 0.0% when the diagnostic delay was more than 12 weeks. At 6 months, the respective wound healing rates were 69.7%, 50.0% and 16.4%, and at 12 months 72.7%, 71.3% and 47.3% (Figure 1 and Table 5).

Factors that were independently associated with wound healing in the univariable analysis are presented in Table 6. A list of all tested parameters is presented in Appendix 2.

According to the multivariable analysis, the following factors were independently associated with wound healing: diagnostic delay (< 4 weeks vs. 4–12 weeks [OR 0.31, 95% CI 0.18–0.52] and < 4 weeks vs. > 12 weeks [OR 0.17, 95% CI 0.10–0.30]); a referral and visit to specialist care health services (OR 0.51, 95% CI 0.36–0.74); and the use of some medications (non-opiate painkillers paracetamol and non-steroidal anti-inflammatory drugs [OR 0.42, 95% CI 0.29–0.62], ACE inhibitors [OR 1.73, 95% CI 1.23–2.42], and anti-incontinence medication [OR 1.93, 95% CI 1.09–3.41]) (Table 7).

5 | Discussion

The present research studied an existing model in use at a primary care unit, consisting of a specialised GP, wound care nurse and podiatrist. The aim of the model is to achieve the assessment, diagnosis and treatment of patients with chronic wounds at an early stage.

Our study shows that the timing of diagnosis is proportionally correlated with the outcome of wound healing—that is, the earlier the diagnosis, the shorter the wound healing time.

Our results also highlight the importance of well-educated primary care providers who can make the differential diagnoses of wounds at an early stage and, if necessary, refer patients to tertiary wound clinics or multidisciplinary care units. A recently published document by the European Wound Management Association (EWMA) also highlighted the importance of accurate diagnoses of lower leg ulcers [6]. The topic is currently under-investigated but recognised as an area of interest, as accurate diagnostics affect wound healing and, therefore, the quality of life of wound patients, in addition to chronic wounds causing a burden on health care organisations and economies.

Previously, it has been recognised that physicians, especially GPs, have an important role and responsibility as part of a team

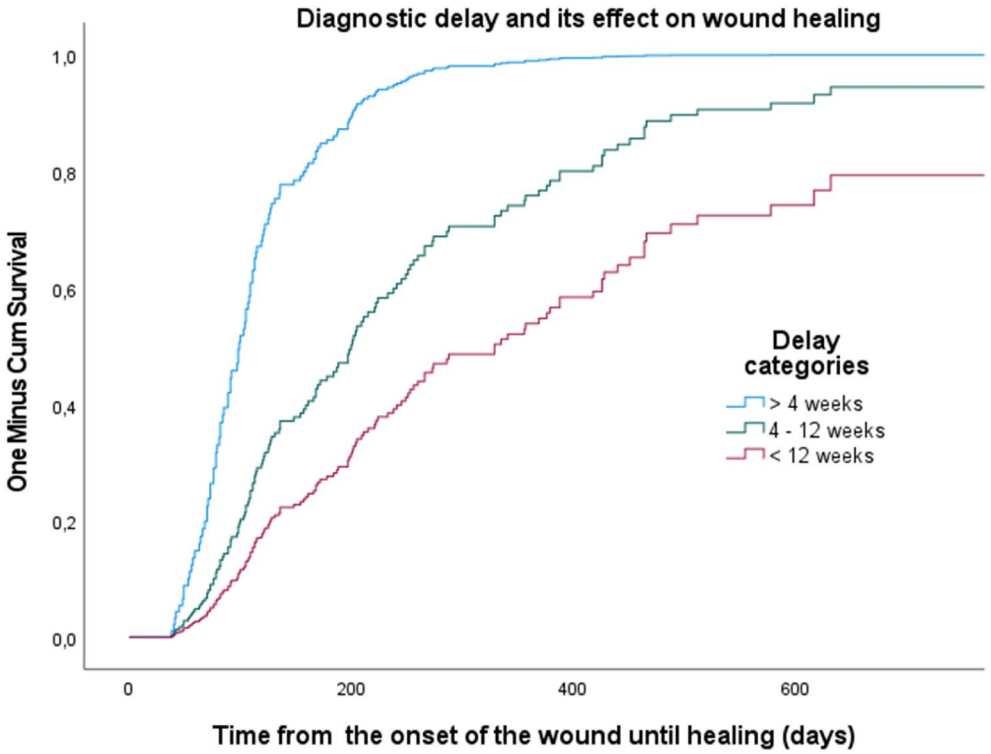

FIGURE 1 | Diagnostic delay and its effect on wound healing.

in diagnosing and treating chronic wounds. Friman et al. have studied GPs' perceptions regarding their role in wound care in primary care. They conducted a thematic interview of 16 GPs and categorised the results into four themes: 'GP's role as a consultant for district nurses', 'physicians' responsibilities for diagnoses', 'continuity in wound care', and 'collaboration within the organization'. The role of a consultant was considered problematic due to late consultations in the case that consultation only occurs when a wound has not shown any progress because adequate wound assessment had not been carried out in the beginning. The study also revealed that the diagnostic processes were unclear, and GPs were not aware of whether the wounds treated at their health care units had been adequately diagnosed. Another problematic aspect was also that consultations occurred in emergency settings, leading to a lack of time for a comprehensive assessment [10].

Differential diagnostics entail a process that is based on the knowledge, previous experience and intuition of the professional [11]. Physicians tend to treat patients according to a hypothesis and the most common diagnosis and rely on their previous experience [12, 13]. If there is a lack of knowledge about chronic wounds starting from medical school, it may be difficult to construct a complete diagnostic picture of the wounds [14–16]. The process of wound diagnostics can be simplified with mnemonic rules, such as the 3 I's and the ADP [17, 18], which mean that, for every wound patient, infection, ischemia, diabetes, atypical causes, leg oedema, and pressure injury should be excluded [6]. As wounds are becoming more and more complicated in clinical practice, checklists have also been recommended for comprehensive assessment [19, 20]. A study on checklists used by emergency room physicians or primary care physicians implied that checklists did not eliminate diagnostic errors but that the physicians who used the checklists had a larger diagnostic range [21]. The checklists can also help to identify patients who need specialist consultations, as diagnostic delays are especially common in atypical wounds, such as malignancies or post-operative pyoderma gangrenosum [22, 23]. Additionally, a recent study shows that a delayed diagnosis of Charcot's foot may worsen the patient's outcome. The study demonstrated that, in more than half (53.2%; CI 28.9%–77.4%) of all Charcot's foot problems, there was a delay from the onset of the symptoms to correct diagnosis [24].

The Swedish study by Öien and Forssell showed that, after the implementation of the Registry of Ulcer Treatment (RUT), the healing time of hard-to-heal-ulcers was significantly reduced. The authors discussed that this reduction in healing times seemed to be due to more structured wound management and accurate diagnoses [25]. Importantly, they also showed a significant reduction in the use of antibiotics after the implementation of the registry, most probably due to the same reasons. Over-diagnosing of infections does not occur when patients are assessed comprehensively and not only in emergency settings. Accordingly, a literature review underlined that, while increasing pain could suggest an infected wound [26], the diagnosis of an infection is challenging in real life, as it currently relies only on the clinical signs of infection, which poses a demand on the clinician's experience [27].

In our study, an appointment with a specialist seemed to have the opposite effect on wound healing. Obviously, some wounds have long healing times despite a minimal diagnostic delay [28]. According to our data, ulcers that should have been diagnosed within 4 weeks were diabetic foot ulcers ($n = 5$, 21% of total diagnosed DFUs) and arterial ulcers ($n = 1$, 6% of total arterial

ulcers), but they were mainly diagnosed between 4 and 12 weeks from their appearance. Importantly, 21 amputations were performed among these patients who suffered from arterial disease and or diabetes [7]. A recent study showed that early ABI index measurement prevented amputations [29].

Therefore, our assumption is that patients who need specialist care to treat their wounds have wounds that are, in general, difficult to heal. This has also been demonstrated by the study by Zorge et al. [30], who reported that hard-to-heal ulcers were more frequent in academic hospitals than in community hospitals or home care units. The median duration of wound healing was 9 months in the academic hospital compared to 2 months in the home care unit. However, if wound patients do not undergo a comprehensive assessment in the beginning of the treatment pathway, there is an additional delay over the entire healing process. A diagnostic delay may also lead to remarkable harm to the patient, such as a limb amputation or an infection that may progress to life-threatening septicaemia [31, 32].

Interestingly, we found three groups of medications that influenced wound healing: non-steroidal anti-inflammatory drugs (NSAID) and paracetamol, as well as anti-incontinence drugs and ACE inhibitors. Previous studies suggest that the use of anti-inflammatory drugs may affect the early phases of wound healing by effecting the inflammation process by delaying angiogenesis, epithelialisation, fibroblast proliferation and reducing wound contraction [33, 34]. Additionally, NSAIDs have antiplatelet effects, and, therefore, they are not recommended prior to surgery. According to the studies of anti-inflammatory drugs, they delay the healing of soft tissue [35]. We might also propose that, while pain delays wound healing, the need for analgesics is reduced as the wound heals, and, in contrast, the need for anti-inflammatory drugs is increased when the wound is in an 'active' inflammation phase [36–38]. Opiates were investigated separately, and they were not related to wound healing.

On the other hand, anti-incontinence drugs help patients by improving their skin condition, which, in turn, affects wound healing by ensuring optimal moisture conditions and keeping the surrounding skin in a good condition. Interestingly, we also found that the use of ACE inhibitors had a positive impact on wound healing. ACE inhibitors affect the renin-angiotensin-system (RAS) which in turn is participating in the inflammatory process via angiotensin receptors 1 and 2 (AT1R and AT2R receptors). In earlier studies, it has been shown that those medications affecting RAS might diminish scarring and wound healing [39]. There are studies that propose the use of enalapril in the prevention of hypertrophic scarring as they promote proteases of extra cellular matrix (ECM) [40, 41]. To our knowledge, there are no studies in humans exploring the effect of medications affecting RAS on wound healing, but this effect has been discussed [39, 42, 43]. Our study showed interestingly that ACE inhibitors might have a beneficial effect on wound healing, but this has to be verified in further prospective studies.

In response to the need for accurate wound diagnostics at the primary care level, a specialised wound care team in primary care was established in Helsinki in 2013. With the present study, we demonstrate that a specialised primary-level wound care unit can reduce the diagnostic delay for patients with wounds.

TABLE 3 | Variation in diagnoses set at different time points: 0–4 weeks, 4–12 weeks and over 12 weeks, in the order of frequency.

Diagnostic delay[a]	*n*	Venous ulcer	Post-traumatic ulcer	Pressure ulcer	Diabetic foot ulcer	Arterial ulcer	Wound without specific aetiology[b]	Foot malformation	Infectious ulcer	Mixed ulcer	Atypical wound	No diagnosis[c]
< 4 weeks	33	5	12	4	5	1	1	3	1	0	0	1
4–12 weeks	94	26	13	12	11	10	8	3	6	2	2	1
> 12 weeks	55	17	4	11	7	5	2	1	2	4	2	0
Total	182	48	29	27	23	16	11	9	7	6	4	2

[a]Diagnosis made by the wound care team physician.
[b]Unspecific ICD-10 code used for a leg ulcer, S81 or L97.
[c]No ICD-10 code used by a physician.

TABLE 4 | Healing time in days after diagnosis in the subgroups.

Delay categories	Venous leg ulcer		Diabetic foot ulcer		Pressure ulcer		Arterial leg ulcer	
	n	Delay in days; median (IQR)	*n*	Delay in days; median (IQR)	*n*	Delay in days; median (IQR)	*n*	Delay in days; median (IQR)
Delay < 4 weeks	5	48 (40–163)	4	34 (13–235)	4	114 (51–241)	1	
Delay 4–12 weeks	26	74 (40–206)	11	58 (37–217)	12	168 (130–348)	10	96 (40–234)
Delay > 12 weeks	17	156 (72–344)	7	52 (43–119)	11	220 (126–365)	5	224 (108–379)
Censored (*n*)	6		9		8		7	

Abbreviations: Censored = wounds which were unhealed; IQR = interquartile range.

TABLE 5 | Healing rates at different time points: Kaplan–Meier survival analysis.

Diagnostic delay group	*n*	Wounds healed 3 months	Wounds healed 6 months	Wounds healed 12 months	Wounds healed 18 months	Wounds healed 24 months
< 4 weeks	33	18 (12)	23 (6)	24 (3)	25 (0)	
4–12 weeks	94	16 (75)	47 (39)	67 (15)	73 (5)	73 (3)
> 12 weeks	55	0 (54)	9 (42)	26 (24)	35 (9)	38 (4)

Note: Time points are 3, 6, 12, 18, and 24 months. Remaining events are in parentheses. Total $n = 182$.

TABLE 6 | Factors affecting wound healing in the univariate Cox regression analysis.

	B (exp)	Adjusted HR (9%5 CI)	*p*	*n*
Diagnostic delay				
Less than 4 weeks	Ref		< 0.001	33
Between 4 and 12 weeks	−0.85	0.43 (0.27–0.68)	< 0.001	94
Over 12 weeks	−1.57	0.21 (0.12–0.35)	< 0.001	55
Mobility, walking outdoors	0.58	1.79 (1.18–2.71)	0.006	134
Residence, living at home	0.61	1.83 (1.07–3.15)	0.028	160
Referral to a specialist	−0.64	0.53 (0.37–0.74)	< 0.001	94
Specialist appointment	−0.62	0.54 (0.38–0.76)	< 0.000	96
Blood flow improvement	−0.81	0.44 (0.23–0.85)	0.013	22
Compression therapy	0.44	1.55 (1.11–2.16)	0.011	72
Revision; primary care	0.81	2.24 (1.26–3.99)	0.006	14
Anti-incontinence medicine	0.75	2.11 (1.21–3.68)	0.009	16
Cortisone per oral	0.67	1.95 (1.12–3.42)	0.019	16
Analgesia	−0.49	0.61 (0.43–0.86)	0.005	82
ACE blocker	0.61	1.85 (1.32–2.60)	< 0.000	78
Dementia or memory disorder	−0.51	0.60 (0.38–0.96)	0.034	32
Cancer	−0.55	0.58 (0.34–0.99)	0.046	27
Atrial fibrillation	−0.38	0.68 (0.47–0.99)	0.044	60
fP-Gluk	0.10	1.10 (1.02–1.19)	0.021	158

Our study also encourages the allocation of resources to primary health care, with the aim of building multidisciplinary teams who are experienced in using specific diagnostic tools and are capable of recognising patients who need specialist or multidisciplinary care (podiatrist, physiotherapist, nutritional therapist, etc.). The teams should have knowledge of the overall treatment

TABLE 7 | Factors related to wound healing after diagnosis.

Multivariable Cox regression: $n = 139$ (events of wound healing)				
Factor	***B***	**Adjusted HR (95% CI)**	***p***	***n***
Diagnostic delay				
Less than 4 weeks		Ref	< 0.001	33
Between 4 and 12 weeks	−1.18	0.31 (0.18–0.52)	< 0.001	94
Over 12 weeks	−1.78	0.17 (0.10–0.30)	< 0.001	55
Specialist appointment	−0.67	0.51 (0.36–0.74)	< 0.001	96
ACE blocker	0.55	1.73 (1.23–2.42)	0.002	78
Analgesia	−0.86	0.42 (0.29–0.62)	< 0.001	82
anti-incontinence medication	0.66	1.93 (1.09–3.41)	0.024	16

methods of chronic wounds, and they should also be familiar with wound care products and special products, such as compression therapy, NPWT, and so forth.

The main limitation of our study was its retrospective nature and the inclusion of several aetiologies of wounds. The number of different aetiologies was selected to compare the diagnostics and treatment within different groups. Also, we did not take socio-economic status or psycho-social factors into account, although it has been discussed that they affect wound healing [43–45].

6 | Conclusion

According to our findings, the healing time of chronic wounds is associated with a diagnostic delay: early diagnosis leads to faster wound healing. The best wound healing was achieved when the correct diagnosis was achieved within 4 weeks. Furthermore, the healing time was also significantly shorter in the group in which the correct diagnosis was made between 4 and 12 weeks, when compared to the group in which the correct diagnosis was not made until after 12 weeks. Therefore, it is highly recommendable to reach a diagnosis that is based on current guidelines and best practices as early as possible but at least within 12 weeks from the onset of the wound.

Disclosure

All authors have completed the ICMJE uniform disclosure form in Helsinki and declare the following: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

Ethics Statement

This is a retrospective registry-based study. Data were anonymized before the authors assessed them for the purpose of the study. As no data were collected directly from the patients, according to Finnish regulations, no ethical approval was needed. The study and data collection were approved by the IRB of the Abdominal Center of Helsinki University Hospital and by the IRB of the City of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Research data are not shared.

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Appendix 1

The Assessment of the Patients by the Primary Care Wound Care Team

Patient history	Comorbidities, medication, smoking, living status, abilities in daily living, mobility and so forth
Assessment of the patient	General condition, blood pressure, heart rate, cardio-respiratory status, laboratory results, body weight, obesity, skin and extremities (pulses, oedema, malformations, etc.)
Assessment of the wound	According to guidelines, TIME concept
Assessment of the skin	According to guidelines, signs of infection, signs of pressure, dermatoporosis, signs of vena insufficiency, oedema, erythema, irritation, moisture damage, hematomas, atrophy blanche, spider changes and so forth
Vascular status	Pulse palpation, ABI measurement (hand doppler)
Infection	Clinical evaluation of infection, bacterial swabs and laboratory results
Neuropathy	Monofilament test and foot deformation
Atypical wounds	Biopsy
Diabetes, infection, kidney, liver function and so forth	Blood tests, haematological, leukocytes, fasting blood sugar, lipids, liver and kidney functions, other if needed
Osteomyelitis, deformities	Native x-rays
Consultations	Podiatrist, nutritionist, physiotherapist, social worker and other specialties

Appendix 2

Data Collection and Analysis With SPSS 27.0 to Find Correlation for Wound Healing

Age
Sex
Residence
Mobility
Location of the wound
Previous wounds
Comorbidities:
Hypertension
Ischaemic heart disease
Diabetes
Chronic atrial fibrillation
Cardiac failure
Peripheral atherosclerosis
Dyslipidaemia
Obesity
Venous insufficiency
Respiratory condition
Malignancy
Mental health disorder
Dementia or memory disorder
Cerebrovascular disorder
Rheumatoid arthritis
Hypothyroidism
Kidney malfunction
Liver malfunction
Dermatological condition
Spinal stenosis
Arthrosis or musculoskeletal disorder
Gout
Haematological condition
Chronic pain disorder
Urinary condition
Comorbidities total
Risk factors:
Previous wounds
Previous deep vein thrombosis
Chronic cellulitis
Chronic oedema
Venous insufficiency
Previous amputation
Drug abuse
Alcohol abuse
Smoking
High blood glucose (fasting sugar, HbA1c)
Obesity (BMI over 30)
Overweight (BMI over 24)
High cholesterol (fP-Kol LDL over 3.0)
MRSA chronic invasion
Hemiplegia
Joint malformation or disorder
Neuropathic
Total risk factors
No comorbidities
Medication:
Anticoagulant

- Antithrombotic
- Beta blocker
- Diuretic
- Ca-blocker
- ACE inhibitor
- Statin
- Inhaler nebulizer (asthma or chronic obstructive pulmonary disease)
- Oral diabetes medicine
- Insulin
- Antidepressant
- Benzodiazepine
- Sleep medicine
- Analgesia
- Opiate
- Thyroxin
- Calcium supplement
- Folic acid supplement
- B12 vitamin supplement
- Cholecalciferol supplement
- Nutrition supplement
- Magnesium supplement
- Potassium supplement
- Cancer drug
- Dementia
- Proton pump inhibitor
- Aranesp
- Antihistamine
- Osteoporosis
- Immunosuppressives
- Cortisone per oral
- Cortisone cream
- Skin cream
- Anti-incontinence medication
- Multi-medication

Wound appearance (date)

First appointment in primary care (date)

First appointment with primary care physician (date)

First appointment with wound care team (date)

First appointment in specialist care (date)

END point wound healed

END point amputation

END point unhealed within 365

END point death

Time from wound appearance until end point (days)

Delay in patient seeking first contact in health care

Delay from wound appearance to first visit with primary care physician

Delay from first contact with health services to a visit with a primary care physician

Delay from wound appearance to appointment with wound care team (first visit)

Delay from first contact in health services to the wound care team

Delay from first contact in health services to specialist care

Delay from primary care physician to specialist care

Delay from the wound team to specialist care

Delay from the first contact with health services to the end point

Delay from the first contact with a primary care physician to the end point

Delay from the wound care team to the end point

Delay from specialist care to the end point

Investigation and treatment by primary care:

- ABI—in primary care
- Pulse status— primary care, wound care team
- Mechanical debridement
- Oedema present/investigated
- Neuropathy investigated
- Infection investigated
- Skin assessment
- Foot off-loads
- Podiatrist consultation
- Pressure off-loads by repositioning and devises (mattresses, cushions)
- Compression therapy
- Antibiotic treatment
- Bacterial swab
- Laboratory investigation
- X-ray
- Venous ultrasound
- Biopsy
- Consultation of specialist care
- Referral to specialist care
- Which specialists
- Treatment plan drawn up in primary care

Investigation and treatment by specialist care:

- ABI
- Toe pressure— in specialist care (not available in primary care)
- Pulse status— primary care, wound care team, specialist care

Ultrasonography
X-ray
Angiography
Revascularization PTA
Bypass
Amputation
Venous ablation
Sclerotherapy
Compression therapy
Biopsy
Excision
Revision
Flap reconstruction
Skin graft
Conservative treatment
Other specialist consultation (orthopaedist, rheumatologist, endocrinologist, etc.)
Diagnosis primary care (ICD-10)
Diagnosis wound care team (ICD-10)
Diagnosis specialist care (ICD-10)
The same diagnosis by primary care, wound care team and specialist care
The same diagnosis by primary care and wound care team
The same diagnosis by wound care team and specialist care
The same diagnosis by primary care and specialist care
Number of appointments with primary care nurses and doctors
Number of wound care sessions (nurses)
Numbers of appointments with wound care team nurses and physicians
Numbers of appointments with specialist care (nurses and physicians)
Days on primary care and specialist care wards

Appendix 3

Censored Unhealed Wounds by Four Common Etiological Groups and Their Endpoints (Days After Diagnosis)

		Unhealed	Deaths	Amputation
No.	**Cat**	**Days after diagnosis**		
DFU1	1			0
DFU2	2			1
DFU3	2			1
DFU4	1			25
DFU5	3			43
DFU6	2			58
DFU7	2			558
DFU8	1	1189		
DFU9	3		67	
AU1	3	365		
AU2	2			30
AU3	3			37
AU4	2			41
AU5	1			186
AU6	2			204
AU7	2			812
VLU1	3	365		
VLU2	2	474		
VLU3	2	521		
VLU4	2	717		
VLU5	3		339	
VLU6	3		348	
PU1	2	334		
PU2	2	365		
PU3	3	365		
PU4	2		158	
PU5	1		163	
PU6	3		185	
PU7	1		267	
PU8	3		424	

Abbreviations: AU = arterial ulcer; cat = diagnostic delay categorised in three groups; DFU = diabetic foot ulcer; PU = pressure ulcer; VLU = venous leg ulcer.

Appendix 4

Wound Healing Time From the Appearance of the Wound Until Wound Healing

		Wound healing (days)			
Diagnostic delay	**Healed wounds (n)**	**Mean (SD)**	**95% CI for mean**	**Median (IQR)**	**Range**
< 4 weeks	25	91 (83)	57–125	70 (49–91)	38–426
4–12 weeks	74	180 (133)	149–210	126 (100–217)	42–861
> 12 weeks	40	335 (225)	263–407	249 (190–410)	98–1233

Abbreviations: CI = confidence interval; IQR = interquartile range; SD = standard deviation.