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Effect of transmural wound care treatments on the Wound Expertise Center of Medisch Spectrum Twente in terms of costs and wound healing

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Abstract

Objective: Patients with peripheral arterial occlusive disease (PAOD) can develop complex wounds. Treatment is fragmented over several disciplines, leading to inefficient care. Specialized, multidisciplinary Wound Expertise Centers (WEC) are needed. WECs use integrated chain-based care for faster diagnosis and to deliver the best care at the best position, based on quality of care and costs. Since 2016, the WEC of Medisch Spectrum Twente has become functional. The question remains how effective this transmural person-oriented care is, looking at wound healing and costs.

Methods: This was a retrospective observational study of PAOD-patients with complex wounds who received a conservative treatment plan at the WEC. Patients' characteristics and wound data was collected from the health records. Incomplete data was inquired via a questionnaire. An indication was made of the transmural care disciplines. Prices accompanying the treatments were identified via literature or involved organizations. The total costs for treatment was analyzed per patient until wound healing.

Results: 157 patients were included with a mean age of 76,6 years. 59,9% was male. 68,2% are (former) smokers. 38,9% had a diabetic ulcer. 59,9% was WIfI-classified with a very low risk of amputation, 62,4% with a very low risk of a revascularization procedure. 52 patients participated in the questionnaire with a mean age of 72,9 years. The mean healing time was 18,3 weeks. 71,2% received wound care via home care. The mean costs for all treatments was €7013,80. The highest costs were wound care via home care (mean €5279,89).

Conclusion: With a conservative treatment plan most wounds healed within half a year with extramural treatments. The total treatment costs until wound healing was lower than the costs for wound healing without a WEC. Therefore, can be concluded that conservative home care treatments can be effective for the WEC to heal a wound faster and cheaper than without the WEC.

Content

Introduction

Peripheral arterial occlusive disease (PAOD) is a chronic vascular disease that affects the arteries of the legs[1]. Mostly, the perfusion of the distal aorta, pelvic, femoral and/or crural arteries is decreased, because of narrowing (stenosis) or a complete blocked (occlusion) lumen of the arteries. The most important cause for PAOD is atherosclerosis that can lead to atherothromboses.[2] In 2015, over 230 million people worldwide suffered from PAOD. Because of the aging population this number is rising[3]. The prevalence of PAOD is 7% at 55 years and 56% above 85 years[2]. PAOD has several risk factors, namely higher age, smoking, diabetes mellitus (DM), hypertension, hypercholesterolemia and family history of vascular diseases[1,2]. Patients with PAOD have an increased risk of coronary and cerebrovascular diseases[2]. Also, the cardiovascular morbidity and mortality is higher in PAOD patients[1]. PAOD can be classified with the Fontaine or Rutherford classification (Table 1). The Fontaine classification is based on clinical symptoms. The Rutherford classification also included objective ankle pressure measurements. With these classifications the severity of PAOD can be determined. The classifications classify from asymptomatic to major tissue loss.[1,4,5]

Only a quarter of PAOD patients experiences symptoms[4]. Symptomatic PAOD causes a lower quality of life. These patients experience a decreased physical well-being and are less mobile and independent in their daily life[6]. The mortality rate over 5 years is 24% for symptomatic PAOD, and 19% for asymptomatic PAOD[7]. Symptomatic PAOD can be divided into claudicatio intermittens (CI) and critical limb ischemia (CLI)[1,2]. The prevalence for CI is approximately 3% at 40 years and 6% at 60 years[4]. CI results in pain on the affected leg(s) by walking, in rest the pain reduces[1]. In 10 years the risk of a major amputation is 2% for CI patients. Patients with CI have a small risk of getting CLI[4]. For CLI, the prevalence is 0,5% for patients above 60 years[2]. CLI results in pain on toes, foot or leg in rest[2]. Consequences of CLI are trophic lesions: a reduced circulation of the skin results in cold and numb feet, deviations of the nails, less hair growth on lower legs and feet, and can result in bad to non-healing wounds. In severe situations, ulcers and/or gangrene can be present at the feet.[2] The incidence for CLI is about 500-1000/million per year[4,8]. The risk of a major amputation is higher for patients with CLI. With a successful revascularization procedure the risk of a major amputation within 1 year is 8% and without a successful revascularization the risk is 25%[1]. CLI is also linked to high mortality rates of 25% in a year and 64% in four years after onset[4,8].

PAOD patients with DM have the risk of developing diabetic feet ulcers. DM causes damages of the vessels and nerves in feet and legs, which leads to reduction of the pain sensation. Therefore, small wounds are often not noticed and cannot heal.[9] The risk of an amputation for DM-patients is five to ten times higher than without DM[8]. Amputations are only performed when other treatments are failed or not possible. With amputations the patient can be relieved from pain, persistent gangrene or infections can be stopped and/or an environment where a wound can heal is created. This can eventually lead to an improved quality of life for the patient.[8]

Table 1: PAOD classification in Fontaine stages and Rutherford categories

Fontaine Stage	Clinical indication	Rutherford Category	Clinical indication
I	Asymptomatic	0	Asymptomatic
IIa	Claudicatio intermittens, can walk >200m	1	Mild Claudicatio intermittens
IIb	Claudicatio intermittens, can walk <200m	2	Moderate Claudicatio intermittens
		3	Severe Claudicatio intermittens
III	Ischemic pain at rest	4	Ischemic rest pain
IV	Critical ischemia, ulcer, gangrene, necrosis	5	Minor tissue loss
		6	Major tissue loss

Several diagnostic methods can be used to diagnose PAOD. First, an anamnesis and physical examination of the legs and feet must be performed. Walking distance without pain and experiences with pain in rest or at night will be investigated. Color, temperature and trophic state of the skin, muscle strength, shape of the feet and palpable pulses should be examined.[1,2,5] Then, the Ankle-Brachial Index (ABI) is determined, which is a non-invasive method to measure blood pressure with a cuff and Doppler instrument. The ABI is calculated by the systolic ankle pressure divided by the highest systolic arm pressure. A reduced ABI can confirm the existence of stenoses or occlusions between the heart and ankle. A good arterial blood circulation is indicated by ABI>1, PAOD is diagnosed by ABI<0,9.[2,4,5] Sometimes, especially for DM-patients, the toe-brachial index (TBI) is determined. The TBI is calculated by the systolic toe pressure divided by the systolic brachial pressure. A TBI<0,70 is indicated as abnormal.[4] The ABI measurement can also be combined with an exercise test on a treadmill. After the exercise test, the ABI is measured again, a decrease of 15-20% also results in the diagnosis PAOD.[4,5] If necessary, vascular imaging can be used for more specific information about the severity of PAOD[4]. Vascular imaging can be duplex ultrasonography, contrast-enhanced Magnetic Resonance Angiography (MRA), Computer Tomography Angiography (CTA) or Digital Subtraction Angiography (DSA)[1].

For treatment of PAOD, the main goal is controlling the cardiovascular risk factors, controlling concomitant illnesses and improving the peripheral blood circulation[1]. Control of a cardiovascular risk factor can be for example smoking cessation. Strict regulation of DM is necessary, because DM gives a higher chance of diabetic foot syndrome and amputation.[1] For patients with CI supervised exercise therapy including life style changes are recommended. Guided exercise therapy can increase the walking distance and improves the quality of life of the patients. It decreases the risk that revascularization is necessary.[4,10] Other treatments are revascularization procedures, by open or endovascular surgery. A revascularization procedure to arrange an adequate peripheral blood flow and to avoid amputations is necessary for patients with CLI within a short period of time.[11] If there is no improvement possible, an amputation is sometimes inevitable and improves the quality of life of the patient[1]. To prevent amputations, PAOD can be treated but there also has to be taken care of wounds when present at feet or legs. This can promote wound healing and prevent infections and worsening of the wounds.

Complex wounds are acute or chronic wounds that need longer healing time than normal. A normal, uncomplicated, wound is expected to heal in two to four weeks according to Zorginstituut Nederland[12]. Causes for a wound to become a complex wound can be infection, ischemia, edema, and pressure caused by for example shoes. Complex wounds are associated with a lower quality of life on physical, social and emotional level on short- and long-term, because of pain and limited mobility.[13–15] For complex wounds a classification system named Wound, Ischemia and foot Infection (WIfI) is used to classify the risk of amputation within a year and the need of revascularization (Table 2).[16] In 2014 an estimation was made about the total number of patients with complex wounds in the Netherlands. About 500.000 patients per year were treated for complex wounds. From these patients around 350.000 patients were treated for their wounds outside the hospital (extramural), which is about 2% of the Dutch population.[13] In 2020, the number of patients with complex wounds will rise, based on the prognosis of the aging population[17]. For complex wound healing, specialized care is needed. The costs of wound care are high because health care professionals are needed over a long time and also the costs of required medication and dressing materials are high. The total costs for wound care is estimated on 3.2 billion euros.[12] Patients with complex wounds have high health care expenses. The averaged health care expenditures are approximately 9500 euros per year. These expenditures are almost five times higher as the expenses of a person without complex wounds in 2012. The most important expenses were hospital care (60%), medical aids (13%) and medicines (10%).[15] The total

costs of amputations of PAOD-patients between 2012 and 2016 based on Dutch DBC's (Diagnose-BehandelCombinatie) was estimated over €135.000.000. The mean costs per patient were about €18.000 per year[18].

Table 2: WIfI-classification

Grade			
Wound			
0	No ulcer		No gangrene
1	Small ulcer		No gangrene
2	Deep ulcer with exposed bone, joint or tendon		Gangrenous changes limited to digits
3	Deep ulcer involving forefoot/midfoot		Extensive gangrene, involving forefoot/midfoot
Ischemia	***ABI****	***Ankle systolic pressure***	***TP, TcPO2****
0	≥0,80	>100 mm Hg	≥60 mm Hg
1	0,60-0,79	70-100 mm Hg	40-59 mm Hg
2	0,40-0,59	50-70 mm Hg	30-39 mm Hg
3	≤0,39	<50 mm Hg	<30 mm Hg
Foot **I**nfection			
0	No infection		
1	Local infection, 0,5 to 2,0 cm around the ulcer		
2	Local infection, erythema >2,0 cm, deep tissue affected		
3	Local infection, with signs of SIRS (systemic inflammatory response syndrome)		

*Note: ABI= Ankle-Brachial Index, TP=toe pressure, TcPO2= transcutaneous oxygen pressure

Often treatment of complex wounds is fragmented over several medical disciplines, leading to inefficient care because it takes longer to receive the most effective treatment. Patients are confronted longer with their complex wounds. Patients can be referred from the general practitioner (GP) to home care. Sometimes only home care treatment cannot close a complex wound, resulting in an average of thirty weeks of wound treatment. This affects the social life of the patients for a long time. That's why, these patients need faster and better specialized care.[19] A multidisciplinary and specialized wound care for improved healing and preventing amputations is badly needed.

In multidisciplinary expertise centers, also called Wound Expertise Centers (WEC), integrated chain-based care is used to have faster diagnosis and to deliver the best care at the best position, based on quality of care and costs. This results in care carried out in hospital only when essential and as much in primary care as possible but with close contact to the hospital.[13] Patients with a complex wound without any healing tendency after three-four weeks of treatment can get a WEC-referral from the GP, geriatric specialist or a specialist in the hospital. At the WEC dermatologists, vascular surgeons, plastic surgeons, revalidation specialists and specialized wound nurses work together for a faster diagnosing and treatment plan. The WEC also provides a better communication between primary and secondary care.[19] Most patients can receive specialized wound care at home with the advice of the treatment plan and some patients need an intervention at the hospital[20]. Demonstrated in several studies is that a multidisciplinary expertise center for wound care leads to faster healing of wounds, less amputations and also less hospital stays[13,15,21,22]. Shorter treatment time results also in a reduction of healthcare expenditures in terms of hospital treatments, medications and less home care because of improved mobility[15]. This can lead to a reduction of costs between 1000-2500 euros per patient per year[15,23].

Since 2016, the WEC of Medisch Spectrum Twente (MST) hospital in Enschede (Netherlands) has become functional, where patients with non-healing complex wounds can receive fast diagnosis and a treatment plan. The WEC is functioning four years now and the number of patients referred to the WEC has increased. The question remains how effective this transmural person-oriented care is, looking at wound healing, prevention of surgery, and what the costs of this care will be. This results in the following research question:

How effective is transmural home care treatment for the Wound Expertise Centre of Medisch Spectrum Twente Enschede in terms of costs and wound healing for patients with Peripheral Arterial Occlusive Disease with complex wounds?

This research question can be divided into several sub questions:

1. *What are the characteristics of the PAOD-patients with complex wounds who received transmural home care treatments?*
2. *What are the total average costs of transmural treatments (i.e. home care) for PAOD-patients with complex wounds (after receiving a treatment plan of the WEC)?*
3. *What is the effect of the transmural home care treatments on wound healing for PAOD-patients with complex wounds with a treatment plan of the WEC?*

Methods

This is a retrospective observational study of PAOD-patients with CLI and complex wounds (DBC/DOT419 and DBC/DOT420). Patients came to the WEC for an intake consultation and received a treatment plan for conservative home care treatments. Various steps were performed to answer the research question.

For the selection of the patients, the vascular registration of the MST over the years 2017-2019 was used, consisting of a total of 1784 patients (Table 3). These specific three years were chosen because these were the years after the WEC of the MST was completely functional for one year.

Table 3: Content of obtained Vascular Registration of MST

Vascular Registration	
Patient characteristics	Patient number
	Name
	Date of Birth
Risk profiles	Smoking
	Cardiac
	Hyperlipidemia
	Cerebrovascular
	Diabetes Mellitus
PAOD classification of Rutherford	See Table 1 for explanation
Measurements	Ankle-Brachial Index (right/left)
Treatment policy	Intervention
	Conservative treatment

Together with information from the health record of the patients, the selected patients are filtered based on the following inclusion and exclusion criteria (Table 4).

Table 4: Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**

Patients with:
• PAOD classified as Rutherford 4 – 6, (critical limb ischemia)
  • Referral from primary care to WEC
  • One or more complex wounds
  • Diabetic feet ulcers
  • Open leg wounds arterial (ulcus cruris arteriosum)
  • Traumatic wounds with PAOD
  • Wounds caused by pressure with PAOD
• Conservative treatments
	Patients:
	• PAOD classified as Rutherford 0 – 3 (acute ischemia and claudicatio intermittens)
	  • Without visiting WEC
	  • Without wounds
	  • Burns
	  • Open leg wounds venous (ulcus cruris venosum)
	  • Traumatic wounds without PAOD
	  • Decubitus wounds without PAOD
	• With revascularization procedure
	• Deceased before wound healing

If available, data was extracted from the patients' health record to complete the information about the characteristics of the selected patients. This was added to the obtained information of the vascular registration from the patient files.(Table 5)

Table 5: Information from the health records

Health record data		
• Gender	• Date of last consultation WEC	• Wound(s) location
• BMI	• Number of earlier returns to WEC	• Texas classification
• Diabetes type	• Reason of earlier returns to WEC	• Wound size
• Year of confirmed Diabetes	• Toe/arm index left/right	• Conservative treatment types
• Referring specialist	• Number of wounds	• Reason of conservative treatment
• Date referral to WEC	• Type of wound(s)	• Home care organization
• Number of consultations WEC	• Wound left/right leg	• Involved specialists/care givers
• Number of gypsum consults		• DOT/DBC codes
• Date of first consultation WEC		• Information for WIfI scoring

Earlier returns to the WEC were noted to find the reasons of returning to WEC and to find how often patients return. For the effects on wound healing, information about a wound was collected from the health records, i.e. location and severity of the wounds. Also, factors that might influence the wound healing were investigated by the risk profiles.

For the severity of the wound the Texas classification[24] was used for diabetic ulcers in the health records. To analyze the severity of all wounds, WIfI scoring was used. The WIfI scoring was used for scoring the wounds by the researcher based on information from the health records. Then, the scoring was classified in categories (very low, low, medium, high) for the risk of amputation within a year and the need for revascularization to improve the health and quality of life of the patient.[16]

The year of confirmed DM was used to calculate the time patients suffer from DM. With the date of referral to WEC, the date of first and last consultation at WEC, the times between referral and visiting the WEC for the first time and the time of visiting the WEC in total were calculated.

From the patients' health record data not all information was available or complete for some of the characteristics, the type of conservative treatments they receive and how often. Also, the time of wound healing was often not available when treatments were performed outside of the WEC. Therefore, a questionnaire was made for receiving more information about those incomplete data. Some patients were not approachable for the questionnaire due to different reasons, i.e. hospitalization or nursing homes/institutions with only caregivers as contact information. The other patients were approached by phone to explain the research and the goal of the questionnaire. If they were willing to participate, the questionnaire was sent via email for an online version of the questionnaire or the questionnaire was walked through via phone. The online questionnaire was made in Qualtrics^{XM} Version 2020 (Provo, Utah, USA). In the questionnaire was asked for information about the patient that was not available in the health record, i.e. living situation; information about the wound(s), i.e. location and healing; information about the treatments, i.e. which treatments, how often and via which organization; information about the usage of medical tools, i.e. orthopedic shoes; information about smoking, i.e. total years smoking and years of stopped smoking; and information about the transportation to their treatments. The questionnaire can be found in Appendix 2.

Next, the transmural paths of the WEC (MST) were investigated. Based on literature, web page of the MST hospital, talking to employees of the WEC, health record data and questionnaire, an indication was made of the disciplines and possible care pathways regarding the WEC. The costs accompanied with the transmural treatments (i.e. specialized wound care at home) were identified via literature. Some unidentified costs were inquired via one of the involved organizations. For wound care in home care and in nursing homes, the costs were inquired via the organization Zorgschakel Enschede. The costs of podiatric treatments and the costs of orthopedic shoes were inquired via de organization

Voetcentrum Wender. The usage and costs of wound dressings were inquired via the organization Excen BV. Excen BV also provided information about the amount of orders of wound dressings per type and the costs of wound dressings per patient per medical indication.

The number of treatments per transmural treatment was received via the patients' health record for consultations at the WEC and via the questionnaire for the treatments outside of the WEC. Together with all identified costs, the costs for different paths per patient were analyzed until wound healing. For the calculation of the costs the time of wound healing was necessary to convert from the categories of the questionnaire to numbers. For wound healing within a few weeks, 6 weeks were chosen. For wound healing within a few months, 12 weeks; for within half a year, 24 weeks; for within a year, 52 weeks; for within two years, 104 weeks and for within three years, 156 weeks.

To answer the main research question, the results of the sub questions were used to get a complete overview of how effective transmural treatments are for the WEC in terms of costs and wound healing, and where improvements might be suggested for the WEC or where cost savings can be made.

Statistical analysis

The characteristics of PAOD-patients with complex wounds were described descriptively, by amount or by mean + standard deviation. To investigate differences between two groups, t-tests for continuous variables and chi^2-tests for categorical variables were used. Statistical significance was accepted for $p<0,05$. A subgroup analysis was performed to test differences between a healing time within 3 months and a healing time longer than 3 months. This time is chosen to have similar number of patients per group. A subgroup analysis to test differences between high and low transmural expenditures was performed with equal groups. The statistical analysis was performed in Microsoft Office Excel and IBM SPSS Statistics version 25.

Ethical considerations

This study was executed conform the principle of the Declaration of Helsinki and relevant law and regulation with regard to patient rights and security of information. The Dutch laws: 'Wet op de geneeskundige behandelovereenkomst (WGBO)', 'Algemene Verordering Gegevensbescherming (AVG)', 'Wet op de Beroepen in de Individuele Gezondheidszorg (BIG)', and 'Code Goed Gebruik and Code Goed Gedrag'.

The necessary data was obtained from the vascular registrations and the patients' health records of the MST. The data was coded and not traceable to the specific patient. Because of that, and because this was a retrospective study, there was no Informed Consent.

In this research patient data was used, therefore the study was a n-WMO study and approval for this study was requested for using patient data records to the local Medical Ethical Assessment Committee in Enschede ('Medisch Ethische Toetsingscommissie' (METC)). The use of the data was confidential and coded with a patient-ID. This patient-ID existed of the letters MST_WEC and three random numbers. With the patient-ID the patient and the belonging documentation could be identified. The key to this coding was kept by the researcher. All data was stored on the network of the MST and secured by the researcher with a password. The data will be kept for a maximum of 5 years and then discarded. Medical health records saved in the patient health records are saved for 15 years.

Results

The patients are selected from the vascular registration based on the inclusion and exclusion criteria. This resulted in a total of 157 included patients.(Figure 1)

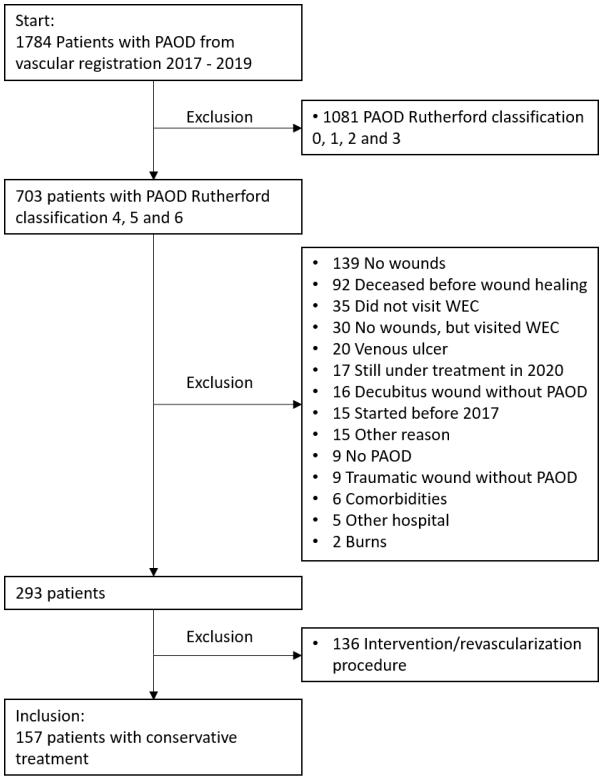

Figure 1: Flowchart inclusion and exclusion of patients

59,9% of the included patients was male. The mean age was 76,6 with a range of 44 to 97 years. 26,2% of the patients smokes and 42% of the patients stopped smoking. 53,5% of the patients are diagnosed with DM, 97,6% of them with DM type II.(Table 6)

The information obtained from the vascular registration and health records shows that 81,5% of the patients received their referral from the GP. Patients had on average 5 (SD ±4,1) consultations at the WEC. From 15,3% of the patients a return to the WEC after discharge was reported. These patients returned with a new wound (33,3%), recurrence of their ulcer (33,3%) or infection (20,8%).(Table 7)

38,9% of the wounds were diabetic ulcers. 21,7% of the wounds was present at the tibia and 15,3% at the hallux/dig1. Most patients were classified with the WIfI-classification in clinical stage 1 and had a very low risk of an amputation (59,9%). 4,5% had a high risk of an amputation. For the risk of a necessary revascularization procedure most patients were WIfI-classified in clinical stage 1 with a very low risk (62,4%). Classified in clinical stage 4 with a high risk of a revascularization was 7,0%. The most given reason for choosing conservative treatment was sufficient perfusion in rest for wound healing (37,6%) and high age (14,6%).(Table 8)

52 patients participated in the questionnaire with a mean age of 72,9 years (range 46-92), 69,2% was male and 57,7% lives with their partner. Most patients reported a healing time of their wounds as within a few months (38,5%) or within half a year (34,6%). Healing time converted to weeks, resulted in a mean healing time of 18,3 weeks. 71,2% received wound care via home care, 59,6% went to a podiatrist and 42,3% visited a medical pedicure. 25,0% of the patients also received home care for their daily life. 51,9% needed orthopedic shoes.(Table 9)

Table 6: Characteristics of the patients with risk profiles

	N	Frequency	%	Mean (SD)	Min-Max
Age	157			76,6 (11,3)	44-97
Gender	157				
Male		94	59,9		
Female		63	40,1		
BMI	54			28,5 (5,5)	20-42
Risk profile Smoking	157				
Never		42	26,8		
Stopped		66	42,0		
Yes, less than 20 cigs. per day		26	16,6		
Yes, more than 20 cigs. per day		15	9,6		
Unknown		8	5,1		
Risk profile Cardiac	157				
No		59	37,6		
Myocardial Infarction		20	12,7		
Current AP		1	0,6		
Other		76	48,4		
Unknown		1	0,6		
Risk profile hyperlipidemia	157				
No		74	47,1		
Yes		78	49,7		
Unknown		5	3,2		
Risk profile cerebrovascular	157				
No		117	74,5		
TIA		15	9,6		
CVA		23	14,6		
Unknown		2	1,3		
Risk profile DM	157				
No		72	45,9		
Yes		84	53,5		
Unknown		1	0,6		
Type Diabetes	84				
Type1		2	2,4		
Type2		82	97,6		
Time DM	81			16,5 (7,6)	1-35

Table 7: Information WEC: referrals, control consultations and returns

	N	Frequency	%	Mean (SD)	Min-Max
Referral by	157				
Within MST		13	8,3		
General practitioner		128	81,5		
Geriatric specialist		4	2,5		
Emergency department		3	1,9		
Other		2	1,3		
Unknown		7	4,5		
Nr. of control consultations	156			5,0 (4,1)	1-25
Nr. patients returned to WEC	157				
Yes		24	15,3		
No		133	84,7		
Reason of return to WEC	24				
Recurrence ulcer		8	33,3		
New wound(s)		8	33,3		
Infection		5	20,8		
Other		3	12,5		

Table 8: Information about the health and wounds

	N	Frequency* Right/ Wound 1	%	N	Frequency* Left/ Wound 2	%	Mean (SD)	Min-Max
Nr of Wounds	156						1,2 (0,4)	1-2
Rutherford classification Right/Left	157			157				
Asymptomatic		45	28,7		50	31,8		
Claudication		13	8,3		18	11,5		
Pain in rest		2	1,3		3	1,9		
Less tissue loss		94	59,9		84	53,5		
Many tissue loss		2	1,3		1	0,6		
Other		1	0,6		1	0,6		
Type Wound	157			34				
Arterial leg ulcer		11	7,0		3	1,9		
Diabetic ulcer		61	38,9		11	7,0		
Pressure ulcer		23	14,6		7	4,5		
Traumatic ulcer		30	19,1		9	5,7		
Decubitus		2	1,3		1	0,6		
Other		23	14,6		3	1,9		
Unknown		7	4,5					
Wound side	157			34				
Right		86	54,8		16	10,2		
Left		71	45,2		18	11,5		
Location	157			34				
Dig1		24	15,3		4	2,5		
Dig2		15	9,6		4	2,5		
Dig3		9	5,7		0	0,0		
Dig4		7	4,5		3	1,9		
Dig5		12	7,6		4	2,5		
Plantar medial		16	10,2		2	1,3		
Plantar Lateral		10	6,4		1	0,6		
Heel		4	2,5		1	0,6		
Instep		4	2,5		1	0,6		
Forefoot		2	1,3		0	0,0		
Medial malleolus (ankle inside)		2	1,3		3	1,9		
Lateral malleolus (ankle outside)		12	7,6		0	0,0		
Tibia		34	21,7		10	6,4		
Calf		2	1,3		1	0,6		
Other		3	1,9		0	0,0		
Unknown		1	0,6		0	0,0		
WIfI-Risk of amputation	157			34				
Clinical stage 1		94	59,9		20	12,7		
Clinical stage 2		33	21,0		8	5,1		
Clinical stage 3		22	14,0		5	3,2		
Clinical stage 4		7	4,5		1	0,6		
Unknown		1	0,6					
WIfI-Risk of revascularization	157			34				
Clinical stage 1		98	62,4		20	12,7		
Clinical stage 2		16	10,2		3	8,8		
Clinical stage 3		31	19,7		8	23,5		
Clinical stage 4		11	7,0		3	8,8		
Unknown		1	0,6					
Reason conservative treatment	157							
Age		23	14,6					
Comorbidity		14	8,9					
Prevent amputation		2	1,3					
Wish of patient		14	8,9					
Sufficient perfusion in rest for wound healing		59	37,6					
No indication for intervention		6	3,8					
Sufficient wound healing visible		11	7,0					
Try conservative first		8	5,1					
Other		5	3,2					
Unknown		15	9,5					
Antibiotics	157							
No		87	55,4					
Yes		70	44,6					

*Note: (N, frequency, %) are given in the first 3 columns for one wound and if patients had a second wound, this is given in second 3 columns of (N, frequency, %). The Rutherford classification is presented per leg (left/right) and not per wound.

Table 9: Results from questionnaire

	N	Frequency	%		N	Frequency	%
Participation	157			**Revalidation**	52		
Yes		52	33,1	*Yes*		7	13,5
No		105	66,9	*No*		45	86,5
Living situation	52			**Medical pedicure**	52		
Supported housing)		5	9,6	*Yes*		22	42,3
Nursing home		2	3,8	*No*		30	57,7
Alone		12	23,1	**Organization Home care**	37		
With partner		30	57,7	*Zorgschakel*		9	24,3
With family		3	5,8	*Liberein*		3	8,1
Wound side	52			*Livio*		7	18,9
Left		24	46,2	*Manna*		2	5,4
Right		28	53,8	*Carint Reggeland*		5	13,5
Location	52			*Maartje*		4	10,8
Dig1		7	13,5	*Other*		7	18,9
Dig2		5	9,6	**Daily home care**	52		
Dig3		4	7,7	*Yes*		13	25,0
Dig4		4	7,7	*No*		39	75,0
Dig5		4	7,7	**Orthopedic shoes**	52		
Plantar medial		7	13,5	*Yes*		27	51,9
Plantar lateral		4	7,7	*No*		25	48,1
Heel		3	5,8	**Bandage shoe**	52		
Forefoot		1	1,9	*Yes*		18	34,6
Lateral malleolus (ankle outside)		2	3,8	*No*		34	65,4
Tibia		10	19,2	**Smoking**	52		
Calf		1	1,9	*Yes, less than 20 cigs/day**		7	13,5
Wound healed	52			*Yes, more than 20 cigs/day**		5	9,6
Yes		51	98,1	*Never*		17	32,7
No		1	1,9	*Stopped*		23	44,2
Healing time	51			**Years of smoking**	35		
Within a few days		1	1,9	*<10 years*		1	2,9
Within a few weeks		8	15,4	*10-20 years*		7	20,0
Within a few months		20	38,5	*20-30 years*		8	22,9
Within half a year		18	34,6	*30-40 years*		7	20,0
Within a year		4	7,7	*40-50 years*		5	14,2
Amount of different treatments*	52			*>50 years*		7	20,0
1		1	1,9	**Years stopped smoking**	23		
2		16	30,8	*<5 years*		6	26,1
3		20	38,5	*5-10 years*		0	0,0
4		12	23,1	*10-20 years*		4	17,4
5		3	5,8	*20-30 years*		9	39,1
Home care (wounds)	52			*30-40 years*		1	4,3
Yes		37	71,2	*40-50 years*		3	13,1
No		15	28,8	**Referral stop smoking**	12		
GP	52			*Yes*		2	16,7
Yes		2	3,8	*No*		4	33,3
No		50	96,2	*No intention to stop*		6	50,0
Podiatrist	52						
Yes		31	59,6				
No		21	40,4				

**note1: amount of different treatments= how many treatments had the patients out of these five treatments: home care, GP, podiatrist, revalidation, medical pedicure.*

**note2: cigs/day= cigarettes per day*

With the information from the vascular registration, health records and questionnaire the possible routes to come to the WEC and the possible conservative treatments are investigated. The conservative treatment options can be divided into subcategories: wound care, medical aids/tools and improvement of health/prevention.(Figure 2)

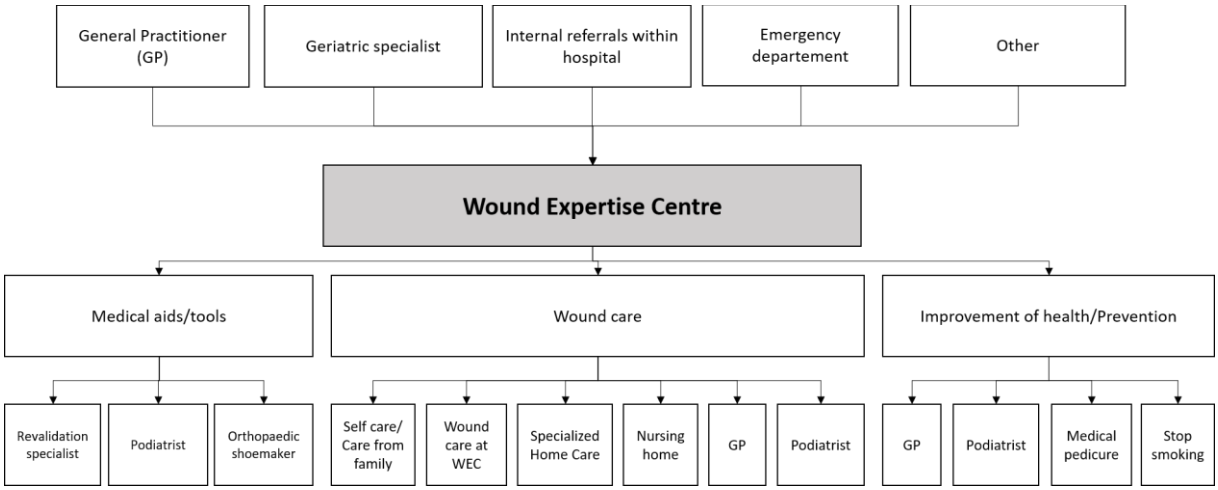

Figure 2: Possible pathways & conservative treatment options

To calculate the total costs of the transmural care patients received till wound healing, the prices of treatments and medical aids are investigated or requested by an involved organization. All prices are of the year 2019 or calculated with a conversion factor to 2019 prices (Table 10).

Table 10: Prices accompanied with the transmural treatments

Category	Reference prices 2014 (€)*	Prices 2019 (€)	Source
Hospital			
Nursing day, surgery	405,00	431,73	[25]
Policlinic consultation, general hospital	80,00	85,28	[25]
Policlinic consultation, surgery	73,00	77,82	[25]
Emergency Room	259,00	276,09	[25]
Transmural			
General practitioner, standard consultation	33,00	35,18	[25]
Home Care	73,00	77,82	[25]
Wound care via Home Care per hour	76,02	81,04	[15]
Wound care via Home Care per treatment		82,00	Zorgschakel
Revalidation per treatment	153,00	163,10	[25]
Medical pedicure per treatment		30,00-40,00	[26]
Medical pedicure per treatment		33,00-40,00	[27]
Medical pedicure (average)		36,50	
Podiatric per consultation		22,00	Voetcentrum Wender
Smoking cessation program (average)		355,00	[28]
Medical aids			
Orthopedic shoes		1000,00-2000,00	[29]
Orthopedic shoes		550,00-950,00	[30]
Orthopedic shoes (average)		900,00	Voetcentrum Wender
Bandage shoes		152,00	[31]
Wound dressings: Traumatic ulcer		620,81	[32]
Wound dressings: Diabetes Mellitus ulcer		405,97	[32]
Wound dressings: Decubitus ulcer		493,92	[32]
Wound dressings: Arterial ulcer		440,47	[32]
Wound dressings: Mixed arterial-venous ulcer		632,99	[32]
Wound dressings: Erysipelas with ulcer		856,70	[32]
Wound dressings: Indication unknown with ulcer		317,42	[32]
Other			
Travel costs, car, per kilometer	0,19	0,20	[25]
Parking costs per visit, car	3,00	3,20	[25]
Public transport, costs per kilometer	0,19	0,20	[25]
Taxi, basic price	2,95	3,14	[25]
Taxi, costs per kilometer	2,66	2,84	[25]
Mean distance household-hospital (km)	7,0	7,0	[25]
Mean distance household-GP (km)	1,1	1,1	[25]

**Note: conversion factor=1,066, calculation of conversion factor from 2014 to 2019 can be found in Appendix 3*

For the patients for whom the data was completed with the questionnaire the total wound healing time is given per patient. The average healing time was 18,3 weeks. (Figure 3) For these patients the total costs for treatments until wound healing were calculated. The mean costs for all treatments was €7013,80 (Figure 4). The highest costs were the costs for wound care via home care (mean € 5279,89) (Figure 5). From the other costs the highest expenditures were for WEC consultations (mean €519,88), orthopedic shoes (mean € 467,31) and wound dressing materials (mean € 442,63).(Figure 6)

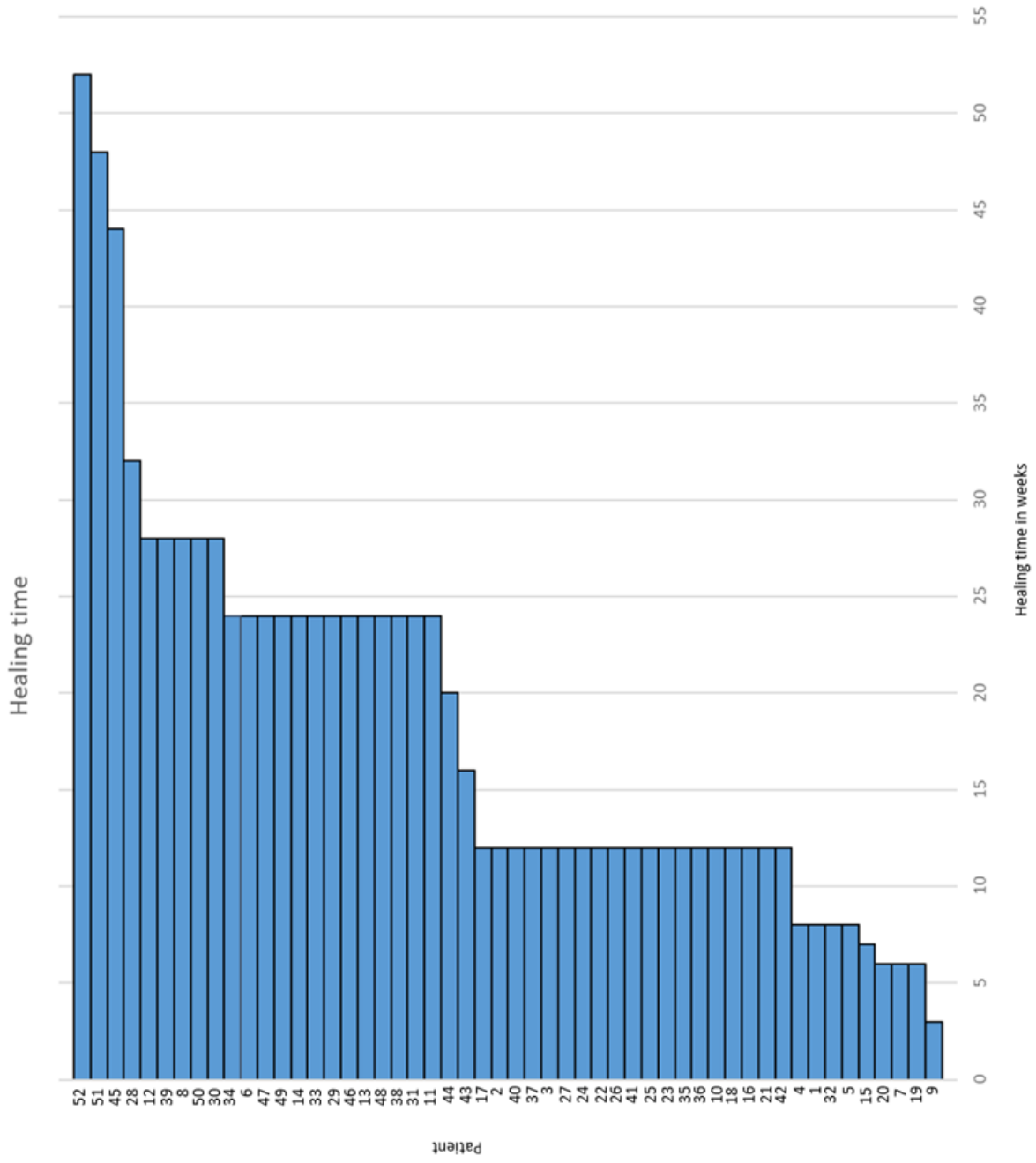

Figure 3: Healing time in weeks per patient

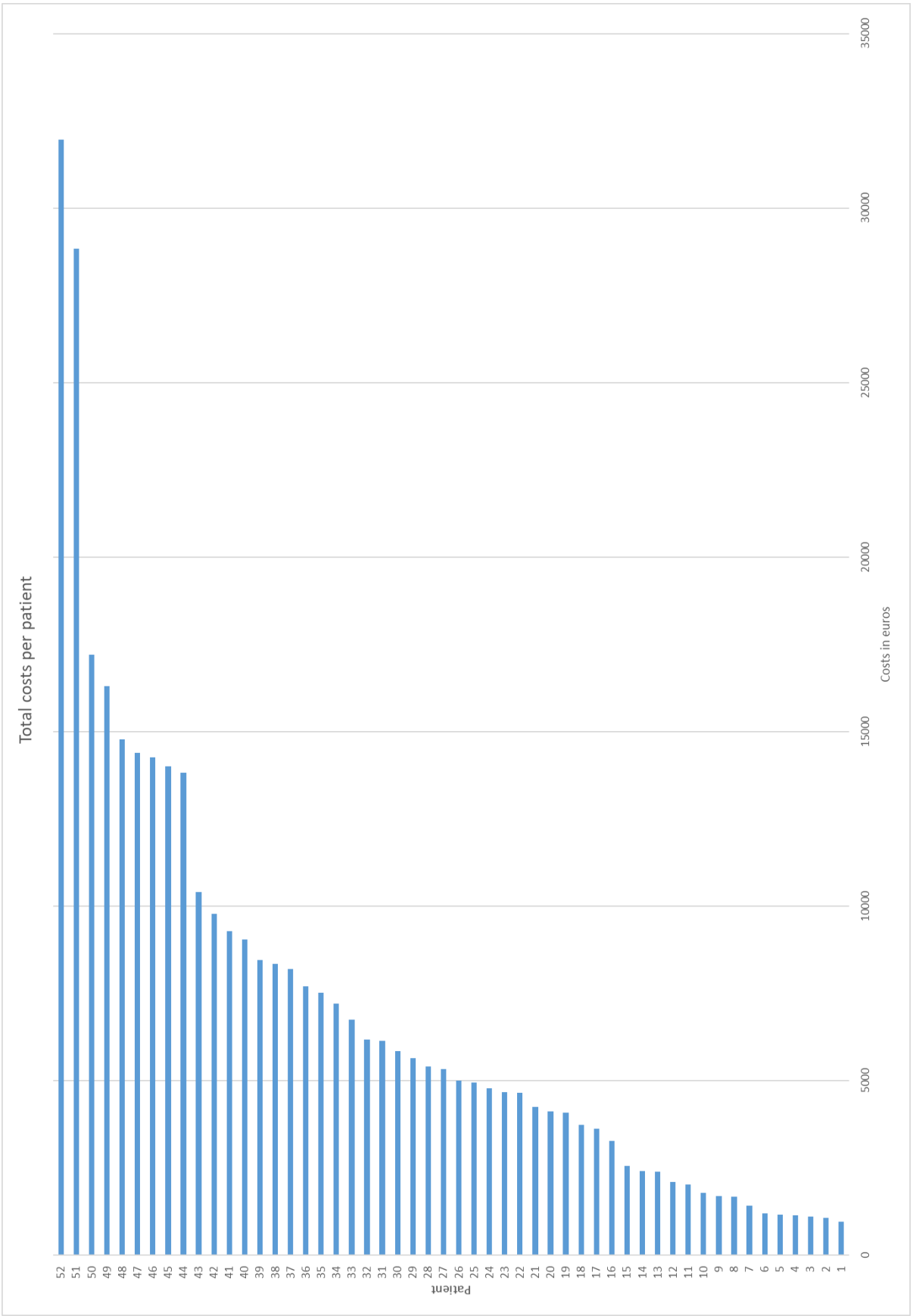

Figure 4: Total costs of transmural treatments until wound healing per patient

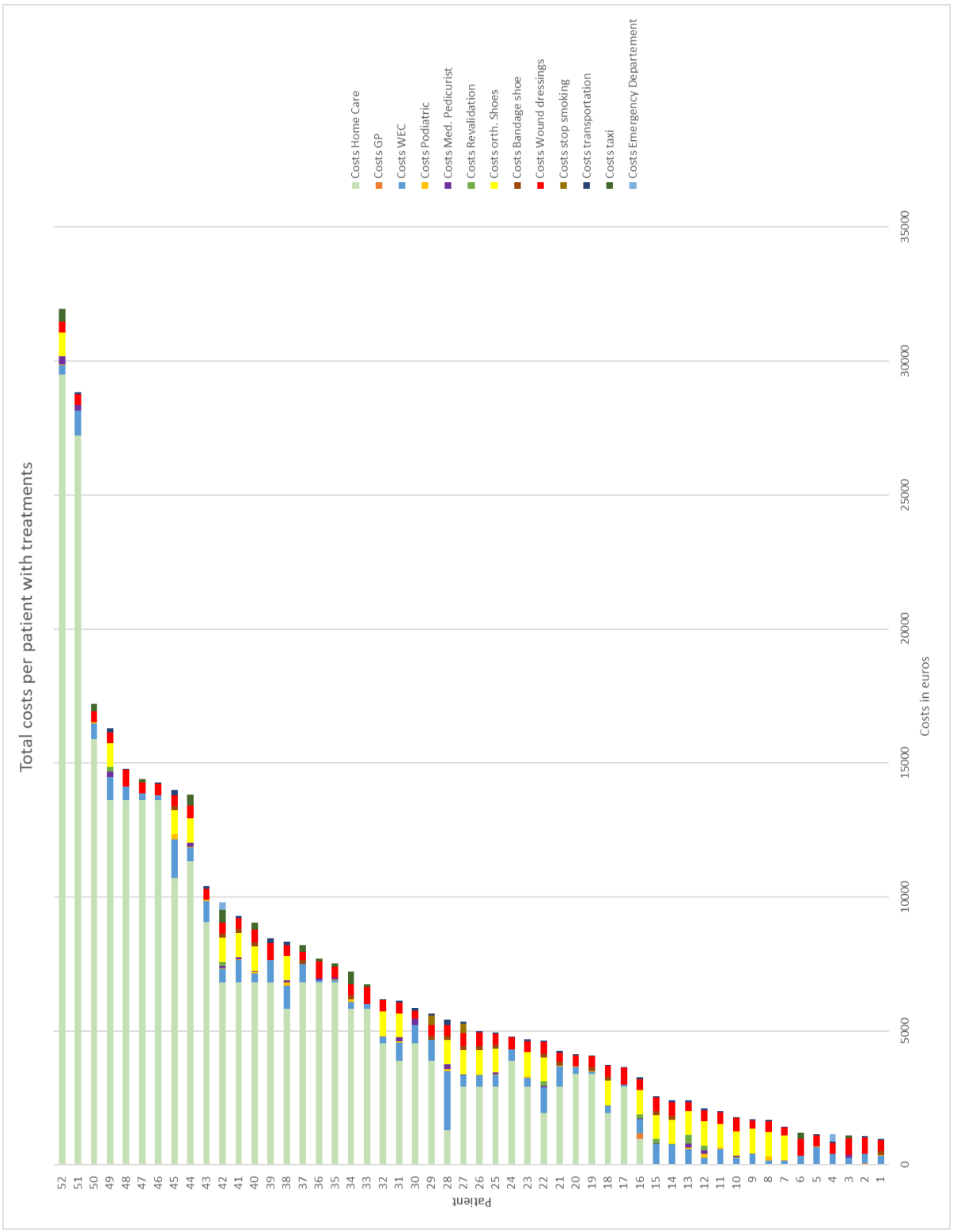

Figure 5: Total costs per transmural treatment per patient

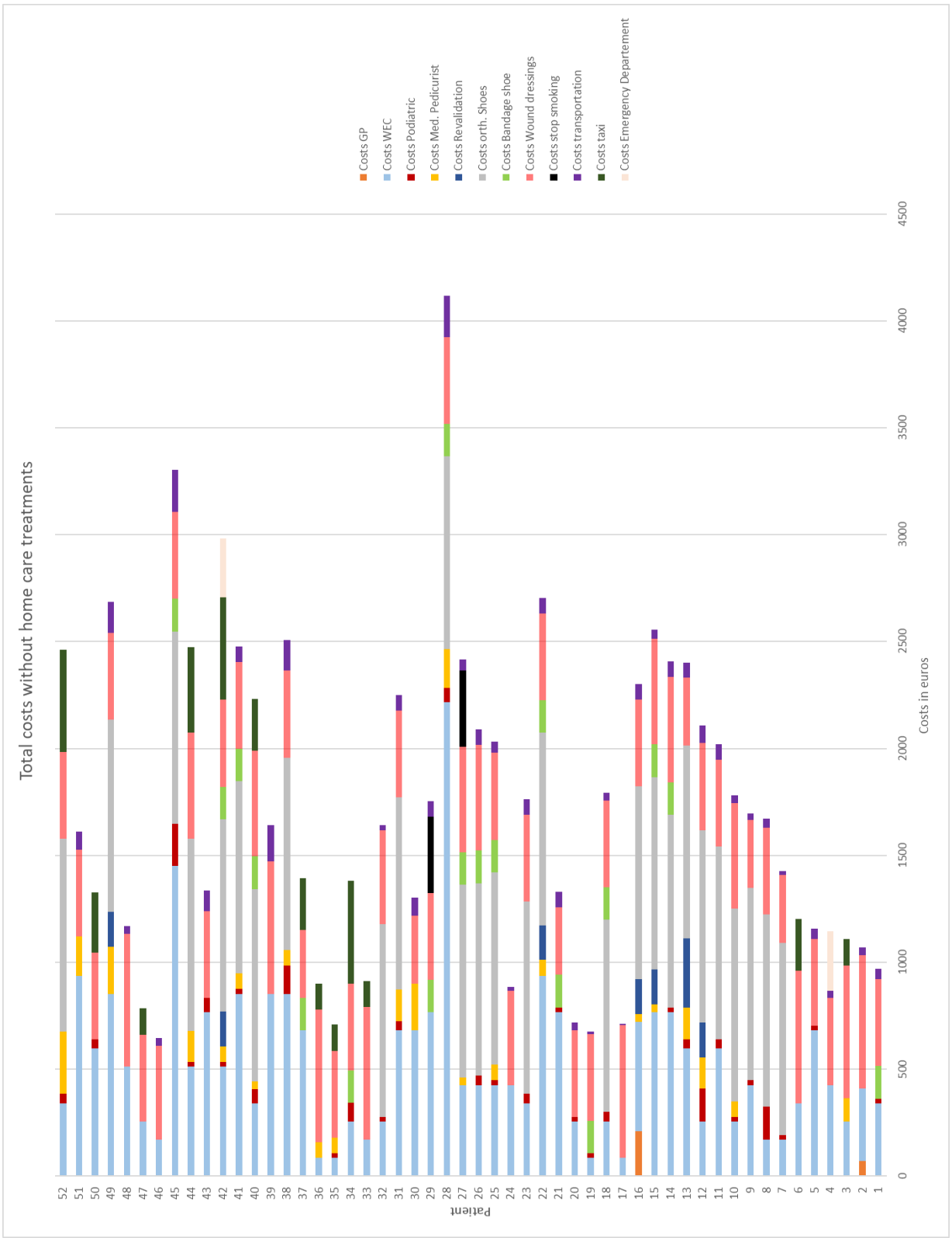

Figure 6: Total costs per treatment without home care treatments per patient

According to the data received from Excen BV, the amount of wound dressing orders is the highest for arterial and traumatic ulcers (3,9 and 3,8). The amount is the lowest for mixed arterial-venous ulcers and ulcers with an unknown indication (3,2 and 2,7).(Table 11) In 2019 for WEC patients with a complex wound, most of the wound dressings were ordered via home care (in total €256.436,91), at the outpatient clinic (€236.910,09) and by the patient self (€133.938,08). Only for € 183,26 was ordered by the GP.

Table 11: Orders of wound dressings

	Mean costs/patient (2019) €	Mean costs per order €	Mean amount of orders
Wound dressings: Traumatic ulcer	620,81	163,14	3,8
Wound dressings: Diabetes Mellitus ulcer	405,97	118,77	3,4
Wound dressings: Decubitus ulcer	493,92	132,00	3,7
Wound dressings: Arterial ulcer	440,47	111,96	3,9
Wound dressings: Mixed arterial-venous ulcer	632,99	197,81	3,2
Wound dressings: Erysipelas with ulcer	856,70	230,65	3,7
Wound dressings: Indication unknown with ulcer	317,42	119,03	2,7

A subgroup analysis to compare healing within three months with a healing time longer than three months results in a significant difference between both groups for the variables of the patient characteristics for Rutherford classification left leg (p=0,038). Within the variables describing the treatment process a significant difference between both groups was found for the variables time between first and last consultation (p=0,001), number of control consultations WEC (p=0,006), total of home care treatments till wound healing (p=0,009), number of podiatric treatments (p=0,047) and number of medical pedicure treatments (p=0,026).(Table 12)

A subgroup analysis of equal sized groups with a comparison of low and high transmural care costs gives a significant difference of the patients' characteristics for the variables age (p=0,051) and risk profile cardiac (p=0,028). Within the variables describing the treatment process a significant difference between both groups was found for the variables time between first and last consultation in days (p=0,050), healing time in weeks (p=0,000), number of home care treatments per week (p=0,000) and the number of medical pedicure treatments (p=0,031).(Table 13)

Table 12: Subgroup analysis of healing time

	Healing ≤ 3 months			Healing > 3 months			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**Sig.**
Patient characteristics							
Gender	29	0,28	0,46	23	0,35	0,49	0,585
Age	29	72,97	11,12	23	72,70	10,45	0,929
BMI	13	30,39	5,80	11	27,6	4,99	0,231
Risk profile smoking	29	2,86	2,31	23	2,09	0,95	0,109
Risk profile Cardiac	29	1,72	1,85	23	1,96	2,40	0,695
Risk profile Hyperlipidemia	29	0,59	0,50	23	1,48	2,41	0,094
Risk profile Cerebrovascular	29	0,31	0,66	23	1,26	2,56	0,096
Risk profile DM	29	0,69	0,47	23	0,74	0,45	0,703
Years of DM	20	14,10	7,98	17	17,88	7,30	0,144
Rutherford right	29	3,38	2,29	23	2,38	2,67	0,426
Rutherford left	29	2,21	2,41	23	3,61	2,27	0,038*
EAI right start	27	102,33	29,36	23	115,04	41,60	0,213
EAI left start	28	110,23	39,78	22	116,09	34,90	0,588
Wound right/left	29	0,34	0,48	23	0,61	0,50	0,060
Location wound	29	4,93	4,04	23	6,57	4,62	0,180
WIfI- risk of amputation	29	1,69	1,00	23	1,39	0,84	0,258
WIfI- risk of revascularization	29	1,59	1,02	23	1,52	0,95	0,816
Reason conservative treatments	29	4,28	2,49	23	4,22	2,02	0,928
Antibiotics yes/no	29	0,76	0,44	23	0,52	0,51	0,084
Treatment process							
Time between referral and first consultation WEC (days)	27	2,70	2,96	22	2,68	2,30	0,977
Time between first and last consultation WEC (days)	29	55,38	28,12	22	119,73	79,65	0,001*
Nr of control consultations	29	4,17	2,30	23	6,74	3,68	0,006*
Nr of gypsum treatments	29	0,83	2,22	23	0,74	3,33	0,909
Nr of home care per week	29	3,35	2,96	23	3,37	2,92	0,976
Total home care	29	37,24	34,17	23	100,35	102,85	0,009*
Nr of GP	29	0,28	1,16	23	0,00	0,00	0,212
Nr of podiatric treatments	29	0,86	0,88	23	2,09	2,71	0,047*
Nr of revalidation treatments	29	0,14	0,35	23	0,17	0,49	0,759
Nr of medical pedicure treatments	29	0,72	0,96	23	2,09	2,64	0,026*
Orthopedic shoes	29	0,52	0,51	23	0,52	0,51	0,975
Bandage shoes	29	0,45	0,51	23	0,22	0,42	0,079

*Sig= Significance at p<0,050

Table 13: Subgroup analysis of low and high transmural care costs

	Low costs*			High costs*			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**Sig.**
Patient characteristics							
Gender	26	0,23	0,43	26	0,38	0,50	0,238
Age	26	69,96	11,23	26	75,73	9,55	0,051*
BMI	12	30,25	5,69	12	28,00	5,30	0,327
Risk profile smoking	26	2,54	1,65	26	2,50	2,10	0,942
Risk profile Cardiac	26	1,19	1,65	26	2,46	2,32	0,028*
Risk profile Hyperlipidemia	26	0,65	0,49	26	1,31	2,31	0,164
Risk profile Cerebrovascular	26	0,27	0,60	26	1,19	2,43	0,071
Risk profile DM	26	0,65	0,49	26	0,77	0,43	0,368
Years of DM	17	14,71	8,67	20	16,80	7,07	0,424
Rutherford right	26	3,15	2,40	26	3,12	2,57	0,956
Rutherford left	26	2,31	2,38	26	3,35	2,42	0,125
EAI right start	25	104,60	36,81	25	111,76	34,96	0,484
EAI left start	26	110,21	43,85	24	115,63	29,71	0,615
Location wound	26	5,23	4,14	26	6,08	4,57	0,487
WIfI- risk of amputation	26	1,54	0,91	26	1,58	0,99	0,884
WIfI- risk of revascularization	26	1,54	0,99	26	1,58	0,99	0,889
Reason conservative treatments	26	4,54	2,27	26	3,96	2,29	0,366
Treatment process							
Time between referral and first consultation WEC (days)	25	2,28	2,91	24	3,13	2,34	0,270
Time between first and last consultation WEC (days)	26	65,46	34,69	25	101,52	81,78	0,050*
Nr of gypsum treatments	26	0,81	2,33	26	0,77	3,14	0,960
Nr of home care per week	26	1,46	2,12	26	5,25	2,31	0,000*
Nr of GP	26	0,31	1,23	26	0,00	0,00	0,212
Nr of podiatric treatments	26	1,31	1,83	26	1,50	2,18	0,732
Nr of revalidation treatments	26	0,23	0,51	26	0,08	0,27	0,186
Nr of medical pedicure treatments	26	0,73	1,28	26	1,92	2,40	0,031*
Healing time (weeks)	26	13,38	7,21	26	23,23	11,32	0,000*
Orthopedic shoes	26	0,58	0,50	26	0,46	0,51	0,415
Bandage shoes	26	0,35	0,49	26	0,35	0,49	1,000

*Sig=Significance of p<0,050; equal size groups are used for this subgroup analysis to have most differences between the groups, resulting in low costs <€5300 and high costs >€5300.

Discussion

To answer the research question on how effective home care treatments are for the WEC in terms of costs and wound healing can be concluded that based on this research wounds healed with conservative treatments mostly within half a year. With mean costs for all treatments of €7013,80 it can be said that these costs are lower than the average costs of approximately €9500,00 per year for a patient with complex wound without an intervention who did not visit a WEC.[15] This agrees literature, where is described that multidisciplinary expertise centers can lead to a reduction of costs between 1000-2500 euros per patient per year[15,23]. Also, the mean costs of the conservative treatments were lower than the costs of an intervention/amputation. The costs for a patient that received an amputation was according to literature €18.000 per patient per year[18].

Before WECs were implemented, treatment was fragmented over several medical disciplines, leading to inefficient care because it takes longer to receive the most effective treatment. Patients were directly referred from the GP to home care with no specific treatment plan. This treatment could not always close complex wounds, resulting in an average of thirty weeks of wound treatment[19]. With the implementation of the WEC it was expected to have better organized care. Care is carried out in hospital only when essential and as much in primary care as possible but with close contact to the hospital.[13] Because the patients in this research visited the WEC first for a fast diagnosis and a treatment plan, it was expected that the average healing time of the wounds would be less than the thirty weeks of wound treatment without visiting the WEC. The results showed that the average healing time was 18,3 weeks, which is less than thirty weeks.

Tautenhahn et al. showed that in their study 92,0% of the patients receiving a revascularization healed in 24 weeks[33]. In this research, 90,4% healed within a half year with conservative treatments. Of this 90,4%, 55,8% was healed within 12 weeks. So, the healing time with conservative treatment was equal to or faster than the healing time with a revascularization. The same study showed that only small wounds healed completely with conservative treatments[33]. In this current research the WIfI-classification showed most small wounds, which may explain the high healing rate. The healing time within half a year, might be shortened when conservative treatments would be improved too. It might be useful to have an even better communication between primary and secondary care. Now, in the health records often can be found that home care nurses or podiatrist call to the WEC to elucidate the arranged wound care. When the necessary wound care procedures are explained and communicated better, the transmural wound care would improve and be more effective. Based on this information, can be concluded that conservative treatments are effective for the wound healing with lower costs than a revascularization.

As described in the introduction risk factors of PAOD are higher age, smoking, DM, hypertension, hypercholesterolemia and family history of vascular diseases[1,2]. Also, patients with PAOD have an increased risk of coronary and cerebrovascular disease[2]. The results match with these risk factors. The mean age of the study population was high (76,6 years) and the majority are (former) smokers. In this research, only the family history for vascular diseases was not included. 53,5% of the patients was diagnosed with DM. DM causes damages of the vessels and nerves in feet and legs, which leads to reduction of the pain sensation and small wounds are often not noticed and cannot heal.[9] That's why, it was expected that the most reported wound was the diabetic foot ulcer (38,9%). Based on the WIfI-classification it was expected that most of the patients were classified in clinical stage 1 or 2, with a very low or low risk on amputation or revascularization. When patients were classified in the more severe stages, they were more likely to undergo a revascularization or amputation. The patients who had an intervention were excluded in this research. It was expected that the patient characteristics, such as the risk factors could have influence on the healing time, but this was not found. This might be

explained because of a smaller sample size. For the influence on the costs, there was found a significant difference for the cardiac risk profile. It might be explained that when patients have more advanced cardiac problems, also the PAOD is more advanced and the healing is more complicated than for patients with less advanced cardiac problems.

In this research, the total average costs for extramural treatments per patient until wound healing was €7013,80. To compare this with literature, the average health care expenditure for a patient with complex wound without an intervention was approximately €9500,00 per year. The most important expenses were hospital care (60%), medical aids (13%) and medicines (10%).[15] This matches with the current research where the highest costs were part of the home care treatments (mean €5279,89, about 75% of the total). Other important expenses were for medical aids, as orthopedic shoes (mean €467,31) and wound dressing materials (mean €442,63), together about 13% of the total costs. The costs of medication use are not taken into account in this research. Based on the results of the total costs of the treatments there were two outliers visible. When comparing Figure 3 with Figure 4, it is visible that these two patients had a long healing time. Within this long healing time, these patients received home care every day, which increased the costs as is visible in Figure 5. In Figure 3 there were two other patients who had a longer healing time, but they received less home care per week, so these costs were lower. Figure 3 also showed six patients who had a healing time of half a year, but with very low costs. These patients did not receive home care (Figure 5). Because of the longer healing time, it might have been beneficial when these patients received a new treatment plan, with for example home care to have a faster healing.

The results showed as expected that patients with a longer healing time also visited the WEC more often. These patients had more severe wounds or needed for example a total contact cast to reduce all pressure of the wounds for a short period. For this, patients had more consultations at the WEC. This resulted also in the longer time between the first and last consultation at the WEC than for the patients with a healing time within 3 months. When there are more consultations at the WEC, it might be investigated if it is possible to have some consultations digitally, to reduce the burden and costs of travelling to the hospital.

Based on the WIfI classification, when patients are classified in clinical stage 1 and 2, the chance wounds will heal without an intervention is high. Therefore, these patients can receive conservative treatments. For the higher clinical stages, a wound can be healed with conservative treatments, for example when an infection can be treated with antibiotics. But when a severe occlusion or stenosis results in ischemia, it might be possible that conservative treatments cannot heal the wounds and a revascularization or amputation is needed. It was expected that the WIfI-classification can show an influence on the wound healing, but this was not visible. This might be explained with the high amount of WIfI-classifications in the clinical stage 1 and 2, which indicated a substantial percentage of uncomplicated wounds. A minority of the wounds were classified as complicated, which might explain that no influence was found based on the severity of the wound with the risk of amputation and revascularization. To investigate if the WIfI-classification can show an influence on wound healing, more research with a larger sample size is needed, where more patients are classified in clinical stage 3 and 4.

136 patients were compatible with the other inclusion criteria but received an intervention instead of a conservative treatment. These patients were possibly too late for a conservative treatment, which can have different causes. It is possible that these patients waited too long to visit a doctor, or the GP did not send them immediately to the WEC. It is also possible that other causes like an infection resulted in a unsavable toe, foot or leg. This resulted in higher costs for an amputation or intervention. To save these costs in future, the GPs should have more instructions on when to refer to the WEC, so

these patients can visit the WEC in an earlier stage of their wound and it may prevent interventions and high costs. In future research it can be good to include the patients with an intervention also, to see if these patients had a conservative treatment first, or maybe received an intervention when conservative treatment had been possible first.

For the exclusion criteria Rutherford classification 0-4 should have been chosen to find the patients with a wound, because Rutherford 5 and 6 represent tissue loss. But one vascular surgeon reports sometimes via the Fontaine classification, where classification 4 represents tissue loss. To make sure these patients were not lost, the exclusion criteria of Rutherford 0-3 was chosen. This might explain the high number of excluded patients without a wound.

Table 11 showed that according to the data of Excen BV, the amount of wound dressing orders differs between types of ulcers. The highest amount of orders per patient in 2019 was found for arterial and traumatic ulcers (3,9 and 3,8). The amount is the lowest for mixed arterial-venous ulcers and ulcers with an unknown indication (3,2 and 2,7). It is unclear what caused these differences. It is possible that different types of wound dressing materials were used with different amounts of materials per order. In future research can be investigated what causes these differences, looking at the type of materials used, the amount of materials used, the amount of wound dressing materials per order or if there are other causes for these differences.

A limitation of this research was that it was not possible to notice the difference between patients who receive the conservative treatments only extramural and the patients who stayed for their conservative treatment at the WEC. The patients with the extramural treatments also visited the WEC multiple times, with a mean of 5 visits at the WEC. However, the patients who had their treatment at the WEC can also have regular appointments at a podiatrist or medical pedicurist for prevention of new wounds. In this research there was no distinction between these two groups, because at the start of the research it was expected that patients who received their conservative treatment extramural did not visit the WEC more than one or two times. But in practice, patients often visited the WEC a few times more, before handing over the care to the extramural treatments. In future research, there has to be made a clearer distinction between these two groups. A recommendation for this would be to have more clearly described what the main care is, the WEC or extramural home care. When these groups are formed, the other treatments, such as the podiatric treatments can be part of the additional care in both groups.

There was limited reporting of patients returning to the WEC. Only a few patients returned to the WEC with severe complications, for which they had to be hospitalized. The reasons patients returned to the WEC were a recurrent ulcer, new wounds, or infections. Mostly, patients received a new treatment plan and went back to their extramural treatments. To prevent these types of returns, the causes of the ulcers has to be taken away. Patients can get for example more adjustments to their shoes to prevent pressure at the same or other places of the foot. Another possible explanation for the limited returns can be that these consultations at the WEC were noticed as control consultations and not as a return, when the return was in a small time frame with the first consultations at the WEC and it was not clearly described as return from extramural care. To improve this, there should be made clearer at the start of the research what reasons can be for returns to the WEC, so this is easier to recognize between the control consultations.

Because this was a retrospective study, not all information could be found in the health records or the information was inconsistent. Tautenhahn et al. showed that wound size was an important measure for the possibility to heal a wound with conservative treatment[33]. But in this current study wound size could not be used, because it was not present in the health records or not clearly described. Also, the

records were not consistent in the notation of the location of the wound at what leg (left/right) the wound was present. The type of wound was not always clear to find in the health records. When patients suffer from DM and the cause of the wound was pressure or trauma, sometimes the wound was classified as a diabetic ulcer, sometimes as a pressure/traumatic ulcer. It was unclear what the reason of this distinction is. For the WIfI classification, the researcher estimated the classification based on the information from the health records. The ABI can be an important measure for the severity of PAOD and is necessary for the WIfI classification, but this was not measured for every patient. Also, the severity of the infection was not described clearly, so the distinction between a small local infection, and an infection with deeper tissue affected was not always clear.

It is possible that not all costs are complete. The costs that were not described in the manual for economic evaluations are collected via other sources and can be lower than costs from the economic evaluations. In these costs presumably, not all costs are added like overhead costs for the use of a room/building and other incurred costs. The price used for orthopedic shoes is an average, because there is a lot of variation for orthopedic shoes, according to the orthopedic shoemaker of Voetcentrum Wender. There is a variation between low, medium, and high shoes and shoes with or without adjustments. In this research the specifications of orthopedic shoes were not included, therefore an average price is used in the analysis. The costs are calculated until wound healing, but patients can for improvement of their health or prevention of new wounds still have to go to a podiatrist, medical pedicurist, or GP for regular consultations. This are ongoing costs.

Because there was no reporting in the MST of the transmural treatments outside the WEC, the questionnaire was made to investigate more about the transmural treatments and the wound healing. But for the questionnaire it was not possible to approach all 157 patients. For example patients with a mental disability or advanced dementia, and people in a nursing home of whom only the contact information from the care organization is mentioned are not possible to approach, because the nurses/caretakers do not have time for a questionnaire or they do not have all necessary information. Also, the study population consists of a high mean age. These patients are difficult to approach and to convince to participate in a questionnaire. These patients often forgot the exact information about their healing process and treatments, which lead to estimations. Another issue is the current COVID-19 situation, which can also lead to more reluctant patients to participate in a research. It is possible that because of these issues there is a chance of bias of the results. It can be possible that the results differ from the results when all patients could have been approached. It might be that when all patients were approached, there would be a longer mean healing time, higher costs or more WIfI-classification in the stages 3 and 4. In future research, it will be better to have a prospective study where the patients are followed over time, to have the exact data per patient in terms of treatments and healing process. For this it would also be good to have a system like PatDoc as described by Excen BV to have a place where all information can be stored and communication between primary and secondary care is easier. Based on the information in a news article, the idea for such a system was present, but has to be implemented[19]. The costs of such a system and the time and effort needed for implementation should be investigated. With this system of Excen a transmural platform is used to register all information about the wound treatments, the healing process, materials used etc. Treatment protocols can be shared where every involved specialist and wound nurses can use the same protocol for the best treatment, which result in better wound care. When there is a deterioration of the wound noticed or other problems occurred in the home situation, an alert will be sent immediately to the main treating specialist.[34] With such a transmural system, transmural care would be improved and patients would receive better treatments which can result in a faster wound healing. Also, the stored information about the care progress, wound healing, material use and costs can be used for research purposes to keep improving the transmural wound care.

Conclusion

In this research PAOD-patients with complex wounds were referred to the WEC for a fast diagnosis and treatment plan. With a conservative treatment plan most wounds healed within half a year with extramural home care treatments. The total costs of the treatment of the wounds until wound healing was lower than the costs for wound healing without a WEC. Also, the total costs of conservative treatments were lower than the costs of an amputation or revascularization. Therefore, can be concluded that conservative home care treatments can be effective for the WEC to heal a wound faster and cheaper than without the WEC.

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Appendix

Appendix 1: List of variables

Variable	Unit
PatientID	Number (MST_WEC001, MST_WEC002, MST_WEC003..)
Age	Number (0-100)
Gender	0 = Male, 1= Female
Deceased	0= No 1= Yes
Risk profile smoking	1= never, 2= stopped, 3= Yes, less than 20 per day, 4= Yes, more than 20 per day, 9= unknown
Risk profile Cardiac	0= no, 1- myocardial infraction, 2= Current AP, 4= Other, 9= Unknown.
Risk profile hyperlipidemia	0= No, 1= Yes, 9= Unknown
Risk profile Cerebrovascular	0 = No, 1= TIA, 2= CVA, 9= Unknown
Risk profile Diabetic	0= No, 1 = Yes (treated), 9= Unknown
Diabetes since	Year
BMI	Number
WEC consultation	0= No 1= Yes
Number of consults in WEC	Number
Referral to WEC by	0= Within MST, 1= General practitioner, 2= Geriatric specialist. 3= Emergency department 4= Other
Date Referral	Date
Time of existence wound	Weeks
Date first consult WEC	Date
Date last consult WEC	Date
Earlier return	0=no, 1=yes
Date earlier return	Date
Reason earlier return	0= recurrent ulcer, 1= new wounds, 2= infection, 3= other
Number of gypsum consults	Number
Policy	0= conservative treatment 1= Intervention
Date determining policy	Date
Rutherford classification right	0= asymptomatic, 1=mild claudication, 2=moderate claudication, 3=severe claudication, 4= pain in rest, 5= less tissue loss, 6= many tissue loss, 8= Other, 9= Unknown
Rutherford classification left	0= asymptomatic, 1=mild claudication, 2=moderate claudication, 3=severe claudication, 4= pain in rest, 5= less tissue loss, 6= many tissue loss, 8= Other, 9= Unknown
E/A index right start	Number
E/A index right end	Number
E/A index left start	Number
E/A index left end	Number
Toe/arm index right start	Number
Toe/arm index right end	Number
Toe/arm index left start	Number
Toe/arm left end	Number
Number of wounds	Number
Type wound	1= Arterial leg ulcers, 2= Diabetic ulcers, 3=Pressure ulcers 4= Burns 5= Traumatic ulcers 5= Decubitus 6= Other
Wound side (right/ left)	0= Right 1= Left
Location wound	0=Dig1, 1=dig2, 2=Dig3, 3=Dig4, 4=Dig5, 5=Plantar medial, 6=Plantar Lateral, 7=Heel, 8=instep, 9= Forefoot, 10=Medial malleolus (ankle inside), 11=Lateral malleolus (ankle outside), 12=Tibia, 13=Calf, 14=Other
Texas classification	text
Wound size	In cm
WIFI	W → 0= No wound 1= Small wound 2= Deep ulcus, exposed bone, tendon or joint 3= extensive gangrene I → 0= Ankle pressure > 100 mmHg 1= Ankle pressure 70- 100 mmHg 2= Ankle pressure 50-70 mmHg 3= Ankle pressure < 50 mmHg FI → 0= No Infections 1= Local infection, 0,5 cm – 2 cm only skin 2= locale infection, erythema > 2 cm, deep tissue affected 3= Infections with SIRS (fever)
WIfI- risk of amputation	1= clinical stage 1, 2= clinical stage 2, 3= clinical stage 3, 4= clinical stage 4
WIfI- risk of revascularization	1= clinical stage 1, 2= clinical stage 2, 3= clinical stage 3, 4= clinical stage 4
Reason conservative treatments	0= age, 1= comorbidity, 2=prevent amputation, 3= wish of patient, 4=sufficient perfusion in rest for wound healing, 5= no indication for intervention, 6= good wound healing visible, 7= first try conservative, 8= other, 9= unknown
Antibiotics	0=no, 1=yes
DBC-code	Code
Care products	Code
Number of DBC-codes	Number

Appendix 2: Questionnaire

UNIVERSITEIT TWENTE.

Patientcode: MST_WEC_XXX

Geachte heer/mevrouw,

Na aanleiding van uw bezoek(en) aan het Wond Expertise Centrum van het Medisch Spectrum Twente in Enschede bent u telefonisch benaderd om een vragenlijst in te vullen voor een onderzoek naar de kwaliteit van het Wond Expertise Centrum. Dit onderzoek heeft betrekking op conservatieve behandelmethodes (behandelingen zonder operaties). De vragen hebben betrekking op behandeltrajecten gestart tussen 2017 t/m 2019. De gegevens die u hebt ingevuld zullen anoniem worden verwerkt in verdere analyses.

U wordt gevraagd de vragen te beantwoorden vanaf dat u voor het eerst met uw wond bij het Wond Expertise Centrum bent geweest. Als u een vraag niet exact weet, wordt gevraagd om een schatting te maken. Graag uw antwoorden invullen op de daarvoor beschikbare lijntjes en antwoorden aan te kruizen welke bij u van toepassing zijn. Indien u toevoegingen, vragen of opmerkingen heeft kunt u deze aan het einde van deze vragenlijst invullen.

Vriendelijke groet,

Dana Bokhoven

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Mail: d.m.bokhoven@student.utwente.nl

(Onder begeleiding van vaatchirurg prof. Dr. R. Geelkerken)

***Vraag 1**: Gegevens.*

a. Wat is uw geboortedatum?

.....

b. Wat is uw woonsituatie?
- ☐ Zelfstandig
  - ☐ Alleen
  - ☐ Met partner
  - ☐ Met andere familieleden
- ☐ Aanleunwoning
- ☐ Verzorgings-/verpleegtehuis
- ☐ Anders, namelijk.....

***Vraag 2**: Heeft u een conservatief behandelplan ontvangen via het Wond Expertise Centrum (dat wil zeggen **géén** behandeling op de operatiekamer)?*

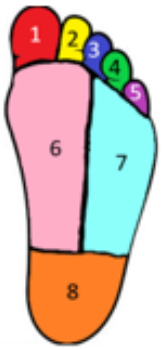
☐ Ja ☐ Nee

***Vraag 3a**. Had u uw wond(en) aan uw linkerbeen, rechterbeen of beide benen?*

☐ Links ☐ Rechts ☐ Beide

***Vraag 3b**. Wat was de locatie van uw wond(en)? Of een combinatie van locaties?*

- ☐ Voet:
  - ☐ Locatie 1
  - ☐ Locatie 2
  - ☐ Locatie 3
  - ☐ Locatie 4
  - ☐ Wreef/ bovenzijde voet
  - ☐ Locatie 5
  - ☐ Locatie 6
  - ☐ Locatie 7
  - ☐ Locatie 8
- ☐ Enkel:
  - ☐ Binnenzijde
  - ☐ Buitenzijde
- ☐ Been:
  - ☐ Scheenbeen
  - ☐ Kuit



***Vraag 3c**. Wanneer was uw wond/waren uw wonden ontstaan of voor het eerst opgemerkt?*

.....

***Vraag 4a**. Is uw wond/ Zijn uw wonden op dit moment genezen?*

☐ Ja, ga door naar vraag 4b. ☐ Nee, ga door naar vraag 4c.

***Vraag 4b**. Wanneer was uw wond/waren uw wonden genezen?*

- ☐ Precieze datum bekend: .....
- ☐ Binnen enkele dagen
- ☐ Binnen enkele weken
- ☐ Binnen enkele maanden
- ☐ Binnen een half jaar
- ☐ Binnen één jaar
- ☐ Binnen twee jaar
- ☐ Binnen drie jaar

***Vraag 4c**. Ziet u verbetering van uw wond(en) ten opzichte van toen u bij voor het eerst met de wond bij het Wond Expertise Centrum bent geweest?*

- ☐ Ja,
  - zo ja wat is er verbeterd?
  - .....
    .....
- ☐ Nee,
  - zo nee, is de wond hetzelfde gebleven of verslechterd?
  - .....
    .....

***Vraag 5**: Heeft u één of meerdere behandeling(en) gekregen via één van de volgende opties, meerdere opties mogelijk:*

- ☐ U deed uw wondverzorging zelf/ Uw partner deed de wondverzorging.
- ☐ U bezocht het Wond Expertise Centrum voor de wondverzorging.
- ☐ U kreeg wondverzorging via de (wond)verpleegkundige van de thuiszorg.
- ☐ U hebt uw huisarts bezocht voor de wondverzorging.
- ☐ U bent bij een podotherapeut geweest voor de wondverzorging.
- ☐ U hebt een revalidatiearts bezocht voor de verdere behandeling.
- ☐ U bent verder behandeld via een medisch pedicure.
- ☐ Anders, namelijk .....

***Vraag 5a**. Hoe vaak per dag/week/maand/jaar heeft u wondverzorging via een (wond)verpleegkundige van de thuiszorg ontvangen voor dezelfde wond tussen 2017-2019?*

- ☐ 1-3x per dag
- ☐ Vaker dan 3x per week
- ☐ 1-3x per week
- ☐ Vaker dan 3x per maand
- ☐ 1-3x per maand
- ☐ 1x per 3 maanden
- ☐ 1x per half jaar
- ☐ 1x per jaar
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 5b**. Hoe vaak per week/maand/jaar heeft u uw huisarts bezocht voor wondverzorging van dezelfde wond tussen 2017-2019?*

- ☐ Vaker dan 3x per week
- ☐ 1-3x per week
- ☐ Vaker dan 3x per maand
- ☐ 1-3x per maand
- ☐ 1x per 3 maanden
- ☐ 1x per half jaar
- ☐ 1x per jaar
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 5c**. Hoe vaak per maand/jaar heeft u een podotherapeut bezocht voor wondverzorging van dezelfde wond tussen 2017-2019?*

- ☐ Vaker dan 3x per maand
- ☐ 1-3x per maand
- ☐ 1x per 3 maanden
- ☐ 1x per half jaar
- ☐ 1x per jaar
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 5d**. Hoe vaak per maand/jaar heeft u een revalidatiearts bezocht voor wondverzorging van dezelfde wond tussen 2017-2019?*

- ☐ Vaker dan 3x per maand
- ☐ 1-3x per maand
- ☐ 1x per 3 maanden
- ☐ 1x per half jaar
- ☐ 1x per jaar
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 5e**. Hoe vaak per maand/jaar heeft u een medisch pedicure bezocht voor wondverzorging van dezelfde wond tussen 2017-2019?*

- ☐ Vaker dan 3x per maand
- ☐ 1-3x per maand
- ☐ 1x per 3 maanden
- ☐ 1x per half jaar
- ☐ 1x per jaar
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 5f**. Als u wondverzorging via een andere optie dan hierboven genoemd hebt ontvangen. Via welke weg hebt u deze dan ontvangen en hoe vaak per week/maand/jaar?*

.....
.....
.....

***Vraag 6a**. Als u thuiszorg heeft ontvangen met betrekking tot de behandeling van uw wond(en), via welke organisatie heeft u dit ontvangen?*

- ☐ Zorgschakel Enschede
- ☐ Liberein
- ☐ Livio
- ☐ Manna
- ☐ Carint Reggeland
- ☐ Trivium Meulenbelt Zorg (TMZ)
- ☐ Maartje
- ☐ Niet van toepassing
- ☐ Anders, namelijk.....

***Vraag 6b**. Ontving u buiten de wondzorg, andere thuiszorg voor bijvoorbeeld uw algemeen dagelijkse verzorging?*

- ☐ Ja
- ☐ Nee

***Vraag 6c**. Als u revalidatiezorg hebt ontvangen met betrekking tot de behandeling van uw wond(en), via welke organisatie heeft u dit ontvangen?*

- ☐ Roessingh Revalidatie
- ☐ Anders, namelijk.....

***Vraag 7a**. Heeft u via een podotherapeut, orthopedisch schoenmaker of revalidatiearts aangepaste schoenen aangemeten gekregen?*

- ☐ Ja
- ☐ Nee

***Vraag 7b**. Heeft u andere hulpmiddelen aangemeten gekregen?*

- ☐ Ja, namelijk.....
  .....
- ☐ Nee

***Vraag 8a**. Rookt u of heeft u gerookt?*

- ☐ Ja, meer dan 20 sigaretten per dag
- ☐ Ja, minder dan 20 sigaretten per dag
- ☐ Gestopt
- ☐ Nooit gerookt

***Vraag 8b**. Als u rookt of heeft gerookt, hoe lang rookt u al of hoelang heeft u gerookt?*

.....

***Vraag 8c**. Als u gestopt bent met roken, hoe lang bent u al gestopt met roken?*

.....

***Vraag 8d**. Als u rookt of heeft gerookt tijdens de periode 2017-2019, bent u toen verwezen naar de huisarts of de stoppen-met-roken-poli in het ziekenhuis om het roken te staken?*

- ☐ Ja, verwezen naar de huisarts
- ☐ Ja, verwezen naar de stoppen-met-roken-poli
- ☐ Ja, wel verwezen maar niet van plan te stoppen met roken
- ☐ Nee, niet verwezen

***Vraag 9**. Hoe vaak per maand heeft u (naar schatting) gebruik gemaakt van de volgende vervoersmiddelen met betrekking tot het reizen voor uw wondverzorging (ziekenhuis, huisarts, enz.)?*

- ☐ Eigen vervoer: x
- ☐ Taxi: x
- ☐ Openbaar vervoer: x
- ☐ Anders: x

***Vraag 10**. Heeft u nog toevoegingen over uw wondverzorging?*

.....
.....
.....
.....

***Vraag 11**. Heeft u nog vragen of opmerkingen na aanleiding van deze vragenlijst?*

.....
.....
.....
.....

Appendix 3: Conversion price index factor

For the economic evaluations prices of 2014 had to be converted to prices of the year 2019. For this the price index factor of the Centraal Bureau voor Statistiek (CBS) were used. The left side of the table shows the conversion factor per year. The right side of the table shows the calculation of the conversion factor from every year to the year 2019. Source: https://opendata.cbs.nl/#/CBS/nl/dataset/83133NED/table?searchKeywords=consumer%20prijsindex

Table Appendix 3.1: Conversion price index factors

From	To	Percentage	Factor	From	To	Percentage	Factor
2010	2011	2,3	1,023	2010	2019	14,9	1,149
2011	2012	2,5	1,025	2011	2019	12,6	1,126
2012	2013	2,5	1,025	2012	2019	10,1	1,101
2013	2014	1,0	1,010	2013	2019	7,6	1,076
2014	2015	0,6	1,006	2014	2019	6,6	1,066
2015	2016	0,3	1,003	2015	2019	6,0	1,060
2016	2017	1,4	1,014	2016	2019	5,7	1,057
2017	2018	1,7	1,017	2017	2019	4,3	1,043
2018	2019	2,6	1,026	2018	2019	2,6	1,026