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The financial burden of chronic wounds in primary care: A real-world data analysis on cost and prevalence

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ABSTRACT

Background: Chronic wounds place a substantial clinical and economic burden on health systems Keywords: Health expenditures and significantly reduce the quality of life of those affected. However, there are no large-scale Diabetic foot economic evaluations to assess costs based on data in a real-world environment. Leg ulcer Objective: We aimed to analyse the costs of managing patients with chronic wounds (pressure Pressure injuries injuries, ulcers of venous aetiology, ulcers of arterial aetiology, diabetes-related foot ulcers, and Prevalence lower-limb ulcers of other aetiologies) in primary care in the southern area of Barcelona, Spain, Primary health care through a 3-year real-world data analysis. Ulcers of venous aetiology Methods: The direct costs associated with specific treatment materials and primary care consul-Data analysis Workload tations were analysed using the electronic clinical records and financial management data of 54

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primary care centres managed by the Catalan Institute of Health, which served a population ranging from 890,152 in 2015 to 939,747 in 2017.

Results: Between 2015 and 2017, total expenditure was estimated at € 34,991,854 (Euros) (USD 39,548,000 -United States Dollars-). The cost of the specific treatment materials was € 8,455,787 (USD 9,555,885), with an annual average of € 2,818,596 (USD 3,185,295) and an increase of 18.5 % over the period. The cost of the consultations for chronic wound management was € 26,536,067 (USD 29,988,409). The cumulative annual prevalence of chronic wounds per 10,000 inhabitants was 86.70%*ee* in 2015, 88.03%*ee* in 2016 and 88.7%*ee* in 2017. Pressure injuries accounted for 46.39 % to 42.86 % of all chronic wounds. The direct extrapolation of chronic wounds costs to the total population of Spain was € 1,763,037,849 (USD 1,993,409,074) (mean annual average € 587,679,283 -USD 664,136,358-) during the study period, with a prevalence of 388,777 and an estimated peak of 413,897 in 2017.

Conclusion: We found that chronic wounds have a significant economic impact and should be considered in the planning and management of healthcare resources to ensure adequate and sustainable primary care services.

Tweetable abstract: Chronic wounds represent a significant clinical and economic burden in medical devices and consultations, costing 34.99 million euros over three years. Effective planning is essential for the sustainability of primary care services

What is already known about the topic

- The treatment of chronic wounds represents a significant economic burden and workload at different levels of health systems.
- The variability of treatments and the intervention of different healthcare professionals make it difficult to estimate these costs accurately.

What this paper adds

- We found a significant economic burden of chronic wound management in primary care, with a total expenditure of approximately 34,991,854 Euros over 3 years in the southern area of Barcelona and managed mainly by nurses.
- We have highlighted the progressive increase in both consultations and treatment costs for chronic wounds, which indicated an increase in the demand for health resources for this process.
- We showed the need for more efficient and sustainable resource management strategies to cope with the increase of patients with chronic wounds and their related costs.

1. Background

A chronic wound is a skin injury that does not follow the skin's normal repair response and does not heal in the expected time. Although there is no consensus on their duration, chronic wounds are generally recognised as those that do not heal within the time that would otherwise be sufficient for healing, which is, arbitrarily, defined as one month (Falanga et al., 2022; Kyaw et al., 2018). Their aetiology is heterogeneous and diverse, the most prevalent being pressure injuries and lower extremity ulcers, the latter including those of venous, arterial, and neuropathic aetiology, especially diabetes-related foot ulcers (Falanga et al., 2022). In Spain, the annual rate of chronic wounds is estimated to be between 1 % and 2 % (Díaz-Herrera et al., 2021; Heyer et al., 2016; Martinengo et al., 2019). However, there is wide variability in the epidemiological data. The prevalence of pressure injuries in the community ranges from 0.035 % to 0.11 %, lower extremity ulcers from 0.032 % to 0.32 %, ulcers of venous aetiology from 0.013 % to 0.26 %, and diabetes-related foot ulcers from 0.016 % to 0.027 % (between 1.92 % to 6.3 % in patients with diabetes (Martinengo et al., 2019; Pancorbo-Hidalgo et al., 2019; Carter et al., 2023; Díaz-Herrera et al., 2021; Martinengo et al., 2019). There is evidence of a steady increase in the prevalence of chronic wounds over the last decade in Western countries (Ahmajärvi et al., 2019; Carter et al., 2023; Guest et al., 2020). It is estimated that in the United Kingdom (UK), between 2012/2013 and 2017/2018, the annual prevalence of pressure injuries increased by 32 %, ulcers of venous aetiology by 101 %, diabetes-related foot ulcers by 93 %, and ulcers of arterial aetiology by 244 % (Guest et al., 2020).

Chronic wounds place a substantial clinical and economic burden on health systems worldwide and significantly reduce the quality of life of those affected (Díaz-Herrera et al., 2021; Heyer et al., 2016; Martinengo et al., 2019). These pathologies are managed by different healthcare professionals in both primary care and hospital settings. However, researchers have found that 70–80 % of patients are treated in primary care (Drew et al., 2007; Gottrup et al., 2013; Nussbaum et al., 2018), which bears 85 % of the management cost (Guest et al., 2020). The average annual cost per wound in the UK National Health Service was £7800 (pounds) for diabetes-related foot ulcer care (Guest et al., 2018a) and £8700 for pressure injuries (Guest et al., 2018c), while for ulcers of venous aetiology, it was estimated at £7600 (Guest et al., 2018b) and subsequently adjusted to £4787.70 (Urwin et al., 2022). It is estimated

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that treating chronic wounds cost the UK National Health Service £6.47 billion in 2018, an increase of 56 % over 5 years (Guest et al., 2020, 2017). The annual budget for the treatment of chronic wounds in the United States (US) is estimated to be US Dollars (USD) 25 billion (Sen et al., 2009). The estimated annual health service expenditure on the treatment of chronic wounds accounts for between 2 and 5 % of total health expenditure in Europe and Australia (Graves et al., 2022; Lindholm and Searle, 2016; Phillips et al., 2016).

The economic impact of chronic wound management is a complex issue that affects multiple aspects of health systems. The estimated global cost of treating chronic wounds is unknown due to the large number of healthcare professionals, specialties, and budgets involved. Despite the numerous economic studies conducted to date, our ability to assess the financial impact of chronic wounds remains limited due to the variety of methodologies and approaches used (Demarré et al., 2015; Lichterfeld-Kottner et al., 2017). Researchers differ depending on the population studied, the geographical location, the scope of the study, the data collection method, the type of extrapolation performed, and the variables analysed. The heterogeneity of the studies, particularly those based on outcome estimation, that estimate their results based on observational cohorts, limits their external validity and clinical applicability in real-world settings and settings other than those used in the study. Therefore, to understand the true extent of the problem, there is a need for large-scale economic evaluations that assess costs based on data in a real-world environment (Demarré et al., 2015; Lichterfeld-Kottner et al., 2017; Lindholm and Searle, 2016). Due to the substantial resources involved, rigorous and comprehensive research to properly gauge the magnitude of the problem is needed to improve the efficiency and sustainability of health systems and ensure adequate care for patients with chronic wounds.

Understanding the real-world costs of the specific materials involved in caring for patients with chronic wounds, the quantities supplied or prescribed annually, and the number and associated cost of consultations with healthcare professionals in the southern part of the Barcelona Metropolitan Area (Spain) would help to establish a baseline profile, which, in turn, would allow us to assess the economic impact of implementing new optimised models of healthcare for these pathologies.

Thus, we aimed to analyse and determine the direct costs of the materials and consultations involved in treating patients with chronic wounds in primary care settings in the identified region and to estimate the costs for the rest of Spain. In addition, we compiled information on the usage profile of the medical products involved and the number of consultations provided to patients with chronic wounds.

2. Materials and methods

2.1. Study design

We conducted a retrospective real-world data analysis of electronic clinical registries and economic management data from 2015 to 2017.

2.2. Study area and population

The healthcare system in Spain is a public health system. In Catalonia, the region where this study was conducted, the Servei Català de la Salut (Catalan Health Service administered by the Ministry of Health of the Government of Catalonia) is responsible for ensuring and managing universal and free access to healthcare services. Public primary care centres provide general medicine, paediatrics, nursing, and social services.

The funding system is tax-based, meaning that healthcare services at primary care centres are free of direct charge to individuals. However, prescribed products dispensed at pharmacies (medicines and medical supplies) are partially covered, with individuals paying a portion of the cost based on their income and the type of product. The Servei Català de la Salut maintains a registry of invoiced dressings dispensed at pharmacies.

These products are also available at healthcare centres for direct use in patient care at no cost to individuals. To ensure availability, the Institut Català de la Salut has a centralised and unified warehouse for distributing medical supplies (including specific wound care materials) to all public primary care centres and hospitals. Consumption and costs are recorded in each centre's financial registry, which is centralised and managed by the financial department in each healthcare zone.

We conducted the study in primary care settings. We included data from the 54 primary care centres managed by the Institut Català de la Salut (Catalan Institute of Health), which served a population of 890,152 in 2015, 939,747 in 2016, and 939,747 in 2017 (Informe de Salut de Catalunya 2011, 2012).

2.3. Selection criteria

Inclusion Criteria:

Data were selected and anonymised for all patients diagnosed, according to the associated ICD-10 classification, with pressure injuries, lower extremity ulcers of unknown aetiology, ulcers of venous aetiology, ulcers of arterial aetiology, and diabetes-related foot ulcers who were seen in primary care and documented in the electronic medical record in 2015, 2016, and 2017.

2.4. Data collection

The financial data were extracted from three aggregated databases. Firstly, we extracted the cost of specific materials supplied internally for the care of patients with chronic wounds: sterile dressings and compression therapy material. Secondly, we extracted the

cost of specific materials prescribed (sterile dressings) and dispensed by community pharmacies, sourced from the registry of dressings invoiced by the Servei Català de la Salut. Products that could be classified as non-specific to chronic wound care, such as sterile gauze, saline, syringes, gloves, and adhesive tape, were removed from the database as they may be used to treat pathologies other than chronic wound care. Lastly, the number of primary care consultations and the annual prevalence were extracted anonymously from electronic health records using the Business Object software solution, which is part of the SABE Business Objects Business Intelligence suite (Homs-Romero et al., 2021). The data extraction was carried out in a single extraction.

2.5. Variables

Several variables from the different databases were included. To calculate the expenditure attributable to the consumption of specific wound care products, we used the number of units supplied or prescribed annually (obtained from the internal stock financial register and the register of dressings invoiced by the Catalan Health Service) and the individual cost of the product determined by the Ministry of Health's Interministerial Commission on prices (Ministerio de Sanidad, n.d.). The products were grouped by product type (oils, surgical dressings, products with activated charcoal, creams, temporary felt pads, emulsions, fibres, films, foams, gels, meshes, matrices, pads, solutions, compression therapy products, negative pressure therapy material, and others), according to their origin (pharmaceutical prescription or internal stock) and according to their biocidal or non-biocidal action (products with silver or topical antibiotics).

The variable used to analyse the cost of primary care consultations was the cumulative annual frequency of consultations, which were grouped according to type into patients seen by primary care nurses, primary care physicians, social workers, and laboratory extractions.

The cost of the consultations was also determined by its location (medical centre or patient's home) and by the type of scheduling (urgent or pre-programmed). The costs applicable to each laboratory, primary care physician, and primary care nurse consultation were officially published by the Ministry of Health of the Government of Catalonia in 2020 (Departamento de Salud. Generatitat de Catalunya, 2020). For social worker consultations, the cost published by the Servicio Navarro de Salud-Osasunbidea (public health

Table 1

Number of	producte cupplior	or proceribed an	d cost of specific	material from	2015 to 2017
Number of	products supplied	or presented an	a cost of specific	. materiar nom	2013 10 2017.

		Total (2015-2017) (%)	Annual Mean (SD)	Change in annual value (% change)*
OILS	Number of products	5,903 (0.6)	1,967.67 (160.8)	304 (16.5)
	Cost €	24,898.62 (0.3)	8,299.54 (872.4)	-1,734.26 (-19.0)
SURGICAL DRESSINGS	Number of products	14,738 (1.4)	4,912.67 (827.6)	1,655 (40.4)
	Cost €	71,100.57 (0.8)	23,700.19 (5,274.2)	10,515.74 (57.7)
CHARCOAL	Number of products	4,135 (0.4)	1,378.33 (119.5)	-17 (-1.3)
	Cost €	34,004.44 (0.4)	11,334.81 (391.0)	-81.11 (-0.7)
CREAMS	Number of products	54,341 (5.1)	18,113.67 (409.5)	-793 (-4.3)
	Cost €	142,439.61 (1.7)	47,479.87 (458.3)	301.70 (0.6)
FELT PADS	Number of products	1,098 (0.1)	366.00 (74.3)	111 (39.4)
	Cost €	4,205.79 (0.1)	1,401.93 (248.3)	364.73 (32.5)
EMULSIONS	Number of products	2,437 (0.2)	812.33 (49.4)	96 (12.4)
	Cost €	21,814.30 (0.3)	7,271.43 (523.5)	-625.68 (-8.5)
FIBRES	Number of products	134,887 (12.6)	44,962.33 (2,210.1)	4,248 (9.8)
	Cost €	1,656,502.77 (19.6)	552,167.59 (27,710.7)	23,554.85 (4.2)
FILMS	Number of products	194,694 (18.2)	64,898.00 (3,134.0)	6,268 (10.1)
	Cost €	517,952.04 (6.1)	172,650.68 (7,465.5)	14,913.35 (9.0)
FOAMS	Number of products	352,064 (32.8)	117,354.67 (12,454.2)	24,906 (23.72)
	Cost €	4,560,710.32 (53.9)	1,520,236.77 (142,782.4)	284,633.77 (20.8)
GELS	Number of products	14,192 (1.3)	4,730.67 (857.7)	-1,364 (-23.9)
	Cost €	119,770.77 (1.4)	39,923.59 (6,746.0)	-11,561.28 (-24.2)
MESHES	Number of products	168,221 (15.7)	56,073.67 (9,016.1)	-14,060 (-21.2)
	Cost €	674,201.73 (8.0)	224,733.91 (10,602.6)	16,867.39 (7.9)
MATRICES	Number of products	2,265 (0.2)	755.00 (299.4)	-456 (-41.6)
	Cost €	19,702.09 (0.2)	6,567.36 (2,979.4)	-5,022.10 (-50.2)
PADS	Number of products	34,290 (3.2)	11,430.00 (3,785.8)	7,490 (93.6)
	Cost €	421,284.03 (5.0)	140,428.01 (69,691.1)	138,111.52 (179.9)
SOLUTIONS	Number of products	34,251 (3.2)	11,417.00 (1,910.7)	-930 (-7.2)
	Cost €	96,188.11 (1.1)	32,062.70 (4,754.1)	607.73 (1.8)
COMPRESSION THERAPY	Number of products	6,873 (0.6)	2,291.00 (412.3)	722 (39.8)
	Cost €	82,792.02 (1.0)	27,597.34 (5,721.7)	10,366.82 (33.0)
NEGATIVE PRESSURE THERAPY	Number of products	9 (0.0)	3 (2.5)	3 (**)
	Cost €	1,089.00 (0.0)	363.00 (296.4)	363.00 (**)
OTHERS	Number of products	48,432 (4.5)	16,144.00 (13,364.9)	-22,190 (-70.4)
	Cost €	7,130.74 (0.1)	2,376.91 (1,628.6)	-2,666.36 (-62.7)
TOTAL	Number of products	1,072,830 (100.0)	357,610 (16,891.3)	5,993 (1.6)
	Cost €	8,455,786.95 (100.0)	2,818,595.65 (240,488.1)	478,909.81 (18.5)

SD: Standard Deviation, \notin : Euros, *The change in annual value (% change) represents the difference between 2015 and 2017. **Percentage is not calculable due to a 0 value in 2015, percentage over a zero value cannot be computed.

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service of the Autonomous Community of Navarra) in 2019 was used (Comunidad Foral de Navarra, 2018). The cost was adjusted for each consultation according to the year-on-year variation in the consumer price index dedicated explicitly to medicine (Catalunya, 2018). Consultations attributed to the diagnosis of amputation in patients with ulcers of arterial aetiology or diabetes-related foot ulcers were included in the calculation.

2.6. Statistical methods

A descriptive univariate analysis was performed to describe the costs of specific materials for the care of patients with chronic wounds, the number of units supplied or prescribed annually, and the number and cost of consultations with healthcare professionals. The results set out the total value for the period, percentage, mean, and standard deviation (SD) for each variable.

Prevalence was calculated by dividing patients with a diagnosis of active chronic wounds (according to the relevant ICD-10 codes) in 2015, 2016, and 2017 by the population served in the area to which they were assigned per 10,000 inhabitants and with a 95 % confidence interval (CI). Subsequently, the annual prevalence in Spain was estimated by directly applying the figure obtained in our study to the total Spanish population. This estimate assumed that the prevalence of chronic wounds in the southern part of the Barcelona Metropolitan Area was not different from the rest of Spain. It was made by comparing the age groups in the studied population to those in the total Spanish population in the 2017 period (and is included in Supplementary Material, Fig. 1).

The extrapolation of the costs directly attributable to chronic wounds at a national level was based on the direct costs and annual prevalence attributable to our cohort, assuming that the prevalence and cost data were representative and did not differ from the rest of Spain. The data on the Spanish population were extracted from Spain's National Institute of Statistics (Instituto Nacional de Estadística, 2022).

2.7. Ethical approval

The study was approved by the Research Ethics Committee of the Jordi Gol i Gurina University Institute Foundation for Research in Primary Health Care (Spanish initials: IDIAPJGol; Ref. 21/229-P; 15 December 2021). The study did not require informed consent. This study was not registered.

3. Results

3.1. Costs attributable to the specific materials used to treat chronic wounds

The total cost of the specific materials used to treat patients with chronic wounds over the 3 years of the study was \notin 8455,786.95 (Euros) (USD 10,148,775.83). The average cost per year over the period studied was \notin 2818,595.65 (USD 3383,004.68). From 2015 to 2017, the cost of the specific materials rose by \notin 478,909.81. The most used product was foam (32.8 %), followed by film (18.2 %) and meshes (15.7 %). The most expensive products were foams and fibres, together accounting for 73.5 % of the total cost. The use of compression therapy products was minimal. For more detailed data by product, see Table 1.

A total of 206,970 units of products with biocidal activity were used, with silver products accounting for 72.8 % of the total biocidal products used and 86.7 % of the costs. Topical antibiotic-containing products accounted for 13.6 % of the products used and 5.3 % of the total cost of biocidal products (Table 2).

Table 2

Number of products by origin and biocide 2015 to 2017.

			Total (2015-2017) (%)	Annual Mean (SD)	Change in annual value (% change)*
ORIGIN	Pharmaceutical prescription	Number of products	441,722 (41.2)	147,241.33 (18,961.97)	42,870 (33.9)
		Cost €	7,077,151.34 (83.7)	2,359,050.45 (267,800.77)	531,566.47 (25.2)
	Internal stock	Number of products	631,108 (58.8)	210,369.33 (29,081.29)	-36,877 (-15.5)
		Cost €	1,378,635.61 (16.3)	459,545.20 (29,944.86)	-52,656.66 (-10.9)
	Total	Number of products	1,072,830 (100.0)	358,410.33 (29,999.95)	5,993 (1.6)
		Cost €	8,455,786.95 (100.0)	2,818,595.18 (347,097.71)	478,909.81 (18.5)
BIOCIDES	Silver	Number of products	150,769 (14.1)	50,256.33 (14,780.21)	-17,553 (-27.4)
		Cost €	1,260,822.12 (14.9)	420,274.04 (42,380.23)	72,568.04 (18.2)
	Antibiotic	Number of products	28,162 (2.6)	9,387.33 (79.72)	-135 (-1.4)
		Cost €	77,588.67 (0.9)	25,862.22 (258.52)	516.75 (2.0)
	Total Biocides	Number of products	206,970 (19.3)	68,990.67 (25,468.78)	-18,582 (-22.0)
		Cost €	1,453,633.37 (17.2)	484,544.46 (42,500.82)	73,828.42 (15.8)
NON-BIOCIDES		Number of products	865,860 (80.7)	288,620.00 (12,768.11)	24,575 (8.8)
		Cost €	7,002,153.58 (82.8)	2,334,051.19 (203,060.92)	405,081.39 (19.0)
TOTAL		Number of products	1,072,830 (100.0)	357,610.33 (15,891.27)	5,993 (1.6)
		Cost €	8,455,786.95 (100.0)	2,818,595.18 (347,097.71)	478,909.81 (18.5)

SD: Standard Deviation, N: Number, €: Euros, *The change in annual value (% change) represents the difference between 2015 and 2017.

3.2. Attributable costs by origin of treatment

The cost of materials (Table 2) and per patient (Table 3) prescribed and dispensed by community pharmacies rose during the study period, accounting for >80 % of the total regarding materials. This cost also increased when incorporating the costs from the internal stock financial register and rose by 9.7 % over the study period (Supplementary Material, Table 1).

3.3. Costs attributable to consultations

From 2015 to 2017, over a half-million consultations were conducted in primary care centres, accounting for 2.4 % of the total number of primary care consultations (Table 4). By practitioner type, primary care nurses held most consultations, followed by primary care physicians. The annual time sequence shows an increase in the number of consultations in all categories except social work, and the most significant increase was in primary care nurse consultations. By diagnosis type, one out of every three consultations were for patients with pressure injuries and one out of four consultations for patients with ulcers of venous aetiology. The total cost of the consultations carried out was over ϵ 26 million (almost 32 million USD). The cost rose over the study period (Table 4). To see the total costs disaggregated by years, those data are included in Supplementary Material, Table 2.

The cost of the consultations per patient treated was over thousand Euros (similarly in USD). The mean number of annual consultations per patient with chronic wounds was almost 22 (Table 3).

3.4. Prevalence of chronic wounds

The cumulative annual prevalence of chronic wounds per 10,000 inhabitants was 86.70‰, 88.03‰ and 88.7‰ for the years 2015, 2016 and 2017, respectively. By aetiology, the most prevalent chronic wounds were pressure injuries. Ulcers of venous aetiology decreased in annual prevalence over the period, and the prevalence of diabetes-related foot ulcers increased (Table 5).

3.5. Extrapolation of prevalence and costs to a national level

The direct extrapolation of our annual prevalence to the total population of Spain suggested a mean figure of 388,776.96 patients with chronic wounds and an estimated maximum of 413,897 in 2017 (Supplementary Material, Table 1). The estimated total cost of products specifically used for chronic wound care amounted to \notin 425,942,392.63 (USD 510,277,820.07). The extrapolation of the total costs was \notin 1763,037,849.42 (USD 2113,856,379.25) during the study period. The annual cost was estimated at \notin 587,012,283.14 (USD 703,637,746.82) (Supplementary Material, Table 1).

4. Discussion

We used real-world data to describe the actual costs of treating and caring for chronic wounds in a population of 939,940 patients over 3 years (2015–2017) in primary care settings in the south of Barcelona (Spain). The total cost of this care was €34,991,853.55 (USD 41,924,108.41) over the 3 years. The highest annual figure was €12,262,205.89 (USD 14,701,505.86) in 2017, which meant a specific cost (curative products and consultations) per patient treated of €1437.27 (USD 1723.57). Of the total expenditure, the consultations carried out at primary care centres or in patients' homes accounted for 73.7 % of the care costs. Most of these consultations were conducted by nurses. The most-used products were foams and fibres. The estimated annual prevalence rose from 86.70% in 2015 to 88.7% in 2017.

There is a paucity regarding cost studies based on real-world primary care costs in such a large population and over such a long period. Thus, only one similar study has been located, recently published in Australia (Wilkie et al., 2023); we do not rule out that there could be others. This type of study allowed us to analyse the volume of resources spent by the health system in primary care for the treatment of chronic wounds and how this cost increased annually during the study period.

The cost attributable to the use of specific wound care products for the different chronic wound aetiologies is comparable to other

Table 3

Mean and difference in the number of consultations, costs in Euros	per chronic wound patient	and per capita for the	period (2015/2017).
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	Annual Mean \in (SD)	Change in annual value (% change)*
Number consultations per person with chronic wound	21.65 (0.10)	-0.05 (-0.23)
Cost of consultations per patient	1,090.03 (14.54)	26.25 (2.44)
Cost of consultations per capita	9.58 (0.24)	0.45 (4.83)
Cost per patient (products)	347.24 (16.98)	32.46 (9.67)
Cost per patient (pharmacy)	290.77 (21.26)	43.43 (15.89)
Cost per patient (stock)	56.48 (4.44)	-10.97 (-17.52)
Cost of products per capita	3.05 (0.18)	0.36 (12.41)
Total cost per person with chronic wound	1,437.27 (29.04)	58.71 (4.16)
Total cost per capita	12.88 (0.31)	0.81 (6.63)

SD: Standard Deviation, €: Euros, *The change in annual value (% change) represents the difference between 2015 and 2017.

Table 4

Number of consultations and costs for people with chronic wounds from 2015 to 2017.

			Total (2015-2017) (%)	N° annual visits' Mean (SD)	Change in annual value (% change)*
TOTAL		Number of visits	526,715 (100.0)	175,571.89 (8,525.53)	13,979 (8.37)
		Cost €	26,536,066.60 (100.0)	8,845,022.20 (443,003,30)	886,058.10 (10.7)
PROFESSIONAL	LABORATORY	Number of visits	21,202 (4.00)	7,400.67 (164.23)	252 (3.69)
		Cost €	1,365,146.00 (5.10)	455,382.67 (12,490.64)	22,849.40 (5.2)
	NURSING	Number of visits	329,621 (62.60)	109,207.00 (5,425.34)	10,535 (10.14)
		Cost €	15,558,060.70 (58.60)	5,185,020.57 (282,485.92)	655,400.60 (13.6)
	GP	Number of visits	163,895 (31.10)	54,631.67 (2,521.73)	2,491 (4.77)
		Cost €	9,132,080.20 (34.40)	3,044,026.73 (131,915.02)	218,136.60 (7.6)
	SOCIAL WORKER	Number of visits	11,997 (2.30)	4,332.33 (137.72)	-299 (-7.21)
		Cost €	480,779.70 (1.80)	160,593.90 (4,167.61)	-10,328.50 (-6.2)
PLACE OF CARE	HEALTH CENTRE	Number of visits	406,614 (77.20)	135,871.33 (4,598.14)	8,518 (6.56)
		Cost €	18,631,399.30 (70.20)	6,210,799.10 (243,532.82)	496,459.40 (8.4)
	HOME-BASED CARE	Number of visits	120,101 (22.80)	40,033.67 (2,955.10)	4,461 (11.99)
		Cost €	7,904,667.30 (29.80)	2,634,555.10 (163,769.95)	389,598.70 (16.1)
TYPOLOGY OF THE CONSULTATION	NON-URGENT	Number of visits	456,765 (86.70)	152,255.00 (5,647.41)	9,119 (6.24)
		Cost €	19,969,826.00 (75.30)	6,656,275.33 (213,758.59)	485,440.40 (7.7)
	URGENT	Number of visits	69,950 (13.30)	23,650.00 (1,816.15)	3,860 (18.19)
		Cost €	6,566,240.60 (24.70)	2,188,746.20 (182,130.48)	400,617.70 (20.2)
TYPOLOGY OF CHRONIC WOUNDS	AMPUTATION	Number of visits	47,335 (9.00)	15,778.33 (1,247.39)	-594 (-3.81)
	PRESSURE INJURY	Cost € Number of	2,415,608.50 (9.10) 165,582 (31.40)	805,869.17 (39,938.89) 55,194.00 (3,004.15)	-9,268.20 (-1.2) 4,791 (9.29)
		visits Cost €	8,875,521.40 (33.40)	2,958,173.47	301,497.70 (10.9)
	DIABETIC FOOT ULCER	Number of visits	49,648 (9.40)	(130,983.24) 16,882.67 (4,038.46)	8,996 (72.28)
		Cost €	2,433,634.40 (9.20)	811,878.47 (190,183.26)	403,938.30 (66.3)
	ISCHAEMIC ULCER	Number of visits	14,534 (2.80)	4,844.67 (510.41)	999 (22.88)
	VENOUS ULCER	Cost € Number of	717,709.80 (2.70) 137,917 (26.20)	239,569.60 (30,640.54) 45,639.00 (4.160.79)	64,258.70 (30.7) -8.923 (-17.74)
		visits			-, (-/ ./ ./
		Cost €	6,562,205.00 (24.70)	2,187,735.00 (190,711.42)	-386,383.80 (-16.3)
	LOWER- EXTREMITY ULCERS	Number of visits	111,699 (21.20)	37,899.67 (4,404.36)	8,711 (26.67)
		Cost €	5,531,387.50 (20.80)	1,843,462.50 (210,736.48)	512,015.40 (32.4)

GP: General Practitioner, SD: Standard Deviation, ℓ : Euros, *The change in annual value (% change) represents the difference between 2015 and 2017.

studies using different methodological approaches. The cost percentage attributable to materials (dressings, curative products, and compression therapy products), which in our study in 2017 was 25.04 %, is close to the 29.2 % estimated by Urwin et al. (Urwin et al., 2022) for ulcers of venous aetiology and is higher than previous studies of chronic wounds (6 % to17 %) (Guest et al., 2020; Vowden et al., 2009). This indicates that the direct costs of curative products accounted for a quarter of all related health expenditures. This finding might be considered in future intervention strategies, as the increasing prevalence of chronic wounds has three times more impact on human resources than on medical supplies. However, the percentage increase in chronic wound products was almost double the percentage increase in consultations.

Foam is the material most commonly used to medically dress chronic wounds, although there is no evidence of its cost and

Table 5

Annual prevalence of chronic wounds from 2015-2017.

		2015	2016	2017
POPULATION ATTENDED		890,152	939,747	939,940
PRESSURE INJURY	Count (%)	3,580 (46,39)	3,993 (48,27)	4,029 (48,32)
	prevalence,%co (95% CI)	40.22 (38.92, 41.55)	42.49 (41.20, 43.83)	42.86 (41.56, 44.21)
ISCHAEMIC ULCER	Count (%)	194 (2,51)	189 (2,28)	197 (2,36)
	prevalence,%co (95% CI)	2.18 (1.89, 2.51)	2.01 (1.74, 2.32)	2.10 (1.82, 2.41)
LOWER- EXTREMITY ULCERS	Count (%)	1,626 (21,07)	1,876 (22,68)	2,032 (24,37)
	prevalence,%co (95% CI)	18.27 (17.40, 19.18)	19.96 (19.08, 20.89)	21.62 (20.70, 22.58)
VENOUS ULCER	Count (%)	2,441 (31,63)	2,234 (27,00)	2,007 (24,07)
	prevalence,% co (95% CI)	27.42 (26.36, 28.53)	23.77 (22.81, 24.78)	21.35 (20.44, 22.31)
DIABETIC FOOT ULCER	Count (%)	560 (7,26)	789 (9,54)	1,061 (12,72)
	prevalence,% co (95% CI)	6.29 (5.79, 6.83)	8.40 (7.83, 9.00)	11.29 (10.63, 11.99)
	prevalence in type 2 DIABETICS,%co (95% CI)*	70.31 (64.74, 76.36)	97.13 (90.62, 104.11)	128.76 (121.29, 136.69)
TOTAL	Count (%)	7,718 (100)	8,273 (100)	8,338 (100)
	prevalence,% (95% CI)	86.70 (84.80, 88.65)	88.03 (86.17, 89.94)	88.71 (86.83, 90.62)

CI: Confidence Interval, * Population attended with Type 2 Diabetes Mellitus (T2DM) (79,647 in 2015, 81,229 in 2016 and 82,399 in 2017).

effectiveness (O'Meara and Martyn-St James, 2013; Walker et al., 2017) over other types of dressings. We believe its high utilisation is due to its ability to maintain healing in a moist environment and its function as both a primary and secondary dressing. Its usage is notable because, during the study period, it rose by 23.7 % and accounted for 53.9 % of the total budget for products specifically used to treat chronic wounds. The use of foam or other materials, excluding negative pressure therapy, is not influenced by availability, prescribing limitations, or funding constraints, owing to public healthcare system financing.

A change in the patterns of usage of some products was observed. Specifically, the use of meshes fell by 21.2 %, and the use of pad products doubled, with an associated increase in cost of 179.9 % compared to 2015. These changes in the use of certain products did not correspond to changes in the existing protocols and guidelines in the centres; however, they could be due to the incorporation of silicone in foams, which removes the need for the intermediate barrier used to protect the wound bed and to the emergence of new pad-type products. These new products, related to bioactive dressings and new debridement systems, were rapidly adopted in daily practice prior to being included in guidelines and protocols.

The use of biocidal products, for which there is no clear evidence of benefit (Díaz-Herrera et al., 2020; Hussey et al., 2019a; Norman et al., 2016), decreased by 22.0 %. We interpret this as a positive given the doubts about their benefit. Their utilisation ranged from 23.2 % to 17.8 % at the end of the period, which is lower than in other studies (Urwin et al., 2022). The presence of silver products within biocidal products decreased by 5.2 %; nevertheless, it remained the most used biocidal product in 2017, accounting for 70.6 % of biocidal products. This finding is in contrast to other studies where this percentage is much lower: 36.1 % (Gray et al., 2018). The decrease in the use of biocidal products and increase in the use of non-biocidal products is similar to the results from the 2011 to 2015 study in the UK National Health Service (Hussey et al., 2019b), in which they attributed the finding to the recommendations published in that period by the Scottish Intercollegiate Guidelines Network (2010). However, in our study, the decrease in use did not translate to a reduction in costs. Similarly, given the fact that the different clinical practice guidelines do not recommend topical antibiotics their usage was excessive, accounting for around 2.5 % of the total number of products used. Furthermore, we posit that this frequency of use may have been even higher, as most cream-based products are distributed in multi-dose packaging, allowing use across different individuals and potentially extending their application beyond initial estimations.

The sharp annual increase in the use of products prescribed and dispensed in community pharmacies, 86.0 % of the total cost of the specific products used and 21.0 % of the total expenditure in 2017, corresponded to the funding system used by the centres. The purchase of prescribe-and-dispense products from community pharmacies, in contrast to products from internal warehouse, is not directly reflected in the management costs of primary care centres, and they are usually 30–40 % more expensive than the products dispensed by the centres, which are allocated following a competitive bidding process. The use of products distributed by the community pharmacies and the centres themselves (Ministerio de Sanidad - Profesionales de la Salud - nomenclator, n.d.).

The use of compression therapy products, a standard treatment recommended by clinical practice guidelines (Díaz-Herrera et al., 2020; Wounds UK, 2019), was minimal throughout the study period, reaching 2537 units in 2017 for a total of 2007 patients with ulcers of venous aetiology and 2032 patients with lower-limb ulcers. These results are lower than those reported by other studies, where >50 % of patients were prescribed compression therapy (Gray et al., 2018; Guest et al., 2018b; Petherick et al., 2013; Urwin et al., 2022). According to our findings, they account for between 0.8 and 1.1 % of total product costs, which is much lower than reported for other European countries and in the literature (Kolluri et al., 2022). This underutilisation of compression therapy materials aligns with previously documented trends in Spain (Díaz-Herrera et al., 2021; Torra Bou et al., 2004) and also with the low levels of use observed in Australia (Weller et al., 2020a). Factors such as insufficient training for primary care professionals, limited availability, high costs of compression materials, organisational barriers hindering the implementation of standardised protocols, and patient resistance due to perceived discomfort all contribute to this low adherence (Weller et al., 2020b). However, the implementation of structured interventions, evaluated through registry systems, can reverse this situation, achieving reductions in both healing times and associated costs (Öien et al., 2016).

The use of negative pressure therapy products was anecdotal, as their use was not authorised in primary care at the time of the study

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and was derived from the follow-up of hospital patients. These results on negative pressure therapy represent a major challenge and an opportunity to improve the quality of treatment for patients with chronic wounds. Accordingly, aspects such as the increase in compression therapy in patients with ulcers of venous aetiology, stricter control of biocidal products, and the inclusion of new treatment options in primary care, such as extracellular matrices, negative pressure therapy material, postage stamp micro-grafts, or platelet-rich plasma, can be transformative in primary care for patients with chronic wounds.

The cost per patient treated with specific wound care products was (368.3 (USD 441.29) in 2017), exceeding the public pharmaceutical expenditure per patient of (303.3 (USD 363.07) in 2017) and the expenditure per patient treated with anti-diabetics, which stood at (226.6 (USD 271.66) (Agència de Qualitat i Avaluació Sanitàries de Catalunya, n.d.). These costs are similar to those reported by Guest et al. (2018c). The average cost per patient treated in primary care included consultations and treatment materials and is therefore not comparable with studies that included other services and hospitalisation costs (Guest et al., 2020; Kolluri et al., 2022; Nussbaum et al., 2018; Urwin et al., 2022).

The most significant cost in chronic wound management was generated by consultations, accounting for 73.73 % of the total, in line with other published studies (Guest et al., 2020; Kolluri et al., 2022; Urwin et al., 2022). During the study period, most patients were seen by primary care nurses, both in primary care centres and at home, and nurse consultations accounted for 63.6 % of the total number of consultations carried out with these patients in 2017. According to other researchers, the percentage of consultations conducted by primary care nurses can sometimes be as much as 85 % (Guest et al., 2020; Urwin et al., 2022). This cost is escalating annually, widening the gap between the needs of patients cared for in the community and the resources available to provide that care, increasing the risk of missed nursing care as a result (Willis and Brady, 2022). Health policies need to analyse the possible reasons behind the reduced availability of community nursing care to avoid the risks this entails for the community (Phelan et al., 2018; Senek et al., 2020). We were unable to determine the relative cost of treating patients in the community compared to the total costs generated by inpatient care.

The estimated annual prevalence of chronic wounds ranged from 86.70⁶⁶⁶ in 2015 to 88.71⁶⁶⁶ in 2017. This result is similar to that estimated by Heyer et al. (Heyer et al., 2016) of 104⁶⁶⁶ in 2012, which uses a similar methodology. Other researchers whose results differ from ours used different methodologies, such as estimating annual prevalence from point prevalences (Guest et al., 2020; Urwin et al., 2022) and report very wide ranges of annual prevalence. We believe that estimating annual prevalences from point prevalences in chronic wounds is complex because of the disparate healing times and may alter the extrapolation of results and cost per patient. Our data on the prevalence of diabetes-related foot ulcers in patients with type 2 diabetes mellitus for the entire period highlights the progressive increase in prevalence for those types of ulcers, from 70.31⁶⁶⁶ in 2015 to 128.76⁶⁶⁶ in 2017. This coincides with a change in the model of care for patients with chronic wounds in primary care in the last quarter of 2017. During this process, an implementation activity on the diagnostic adequacy of medical history records was carried out, and a series of training sessions on diabetes-related foot ulcers involved in our study. It is worth highlighting the concordance of our results for 2015 with the prevalences published in more specific epidemiological studies about diabetes-related foot ulcers in patients with type 2 diabetes mellitus in Catalonia, in which they defined an annual prevalence of 68.20⁶⁶⁰ (Bundó et al., 2022).

According to our study, in 2017, around 6609 million (almost USD 731 million) would have been spent in Spain to treat patients with chronic wounds in primary care. These estimates must be treated with caution, as they are not supported by any sensitivity analysis and may be underestimates. However, a comparison of our study population with the population of Spain in the same period shows a comparable distribution (Supplementary Material, Fig. 1). In earlier approximations of the costs of treating chronic wounds (Soldevilla Agreda et al., 2007), the cost of treating pressure injury, including hospital treatment, was 6461 million (USD 553 million). Soldevilla's Study referred that the cost attributable to primary care was only 23 %, and the total annual cost to the system of chronic wounds could be 62.7 billion (USD 3.2 billion), which is much lower than in neighbouring countries, such as the UK, where the estimated costs were £8.3 billion (USD 11.2 billion). The increase in costs and prevalence over the study period is corroborated by other studies in the region that already point to this trend (Ahmajärvi et al., 2019; Guest et al., 2020). This effect is likely to be exacerbated by the current ageing process in the European population.

The large sample size and the long 3-year follow-up period allowed us to deliver reliable estimates of the prevalence and true cost of chronic wound management. However, there are some limitations that must be considered. The non-inclusion in the cost analysis of materials commonly used in care (such as normal saline, gloves, gauze, and syringes) and intermediate products (analytical tests, diagnostic imaging tests, and other similar diagnostic tests) could have led to an underestimation of the costs of products. The lack of information on the use of oral and intravenous antibiotics, as well as the high percentage of topical antibiotics used from multi-purpose vials, limits the interpretation of the results and leads us to believe that the use of antibiotics and antimicrobials may well be higher. In Spain, the public healthcare system coexists with a private healthcare system. Private healthcare is compatible with public coverage, allowing individuals to choose either or both services. We did not consider the cost associated with treating chronic wounds in private hospitals and the follow-up of patients in private practices, yet the cost of financing the products, which is financed by the public system, leads us to believe that private follow-up of these patients is minimal. As other researchers report, it is possible that not all consultations were related to wounds; even so, we can assume that patients likely used other scheduled visits to receive chronic wound care (Guest et al., 2015). Third-party billing prices were used to calculate costs. While this may not accurately reflect actual costs, it does allow for comparison with other studies using the same methodology. Diagnostic validation analyses were performed to minimise bias in the diagnostic adequacy and accuracy of the data obtained by the use of secondary data analysis (Homs-Romero et al., 2021). The above limitations worthy of being considered to prevent any misinterpretation of the results and to facilitate more accurate research in the future.

5. Conclusions

We have shown that the treatment and management of chronic wounds in one area of Spain incurred a cost of almost \in 35 million (USD 42 million) from 2015 to 2017. The total cost of the treatment material used was \in 8.5 million (USD 10 million), an increase of 18.5 % over the period. The most commonly used product types were foams, films, and meshes, and the highest costs were divided among these products. We observed a low utilisation of compression therapy products. The number of primary care consultations for patients with chronic wounds was the most significant cost, accounting for 2.4 % of all primary care consultations and increasing over the period. The prevalence of chronic wounds increased during the study period. Chronic wounds have a significant economic impact and need to be considered in the planning and management of healthcare resources to ensure adequate and sustainable primary care services.

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CRediT authorship contribution statement

Miguel Ángel Díaz-Herrera: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Mónica González-Durán:** Writing – original draft, Visualization, Investigation, Data curation. **Francisco Javier Rodríguez-Martínez:** Writing – original draft, Visualization, Methodology, Investigation, Data curation. **Gema Tujillo-Flores:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Gema Tujillo-Flores:** Writing – original draft, Resources, Project administration, Funding acquisition, Formal analysis, Data curation. **Jose Verdú-Soriano:** Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Funding acquisition, Formal analysis, Conceptualization. **Vicente Gea-Caballero:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Jose Verdú-Soriano:** Project administration, Methodology, Formal analysis, Data curation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization. **Albert Sanllorente-Melenchón:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation. **Josú Almeda-Ortega:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Data curation. **Oriol Cunillera-Puértolas:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Investigation, Formal analysis, Data curation. **José Ramón Martínez-Riera:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Investigation, Formal analysis, Data curation. **José Ramón Martínez-Riera:** Writing – review & editing, Writing – original draft, Validation, Software, Resources, Investigation, Formal analysi

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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