

Cost-Effectiveness of Wound Care

A concept analysis

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فعالية التكلفة في العناية بالجروح تحليل المفهوم

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ABSTRACT: This review aimed to analyse the concept of cost-effectiveness within the context of chronic wound care using Walker and Avant's approach. The Cumulative Index to Nursing and Allied Health Literature® (EBSCO Information Services, Ipswich, Massachusetts, USA), MEDLINE® (National Library of Medicine, Bethesda, Maryland, USA) and Nursing & Allied Health® (ProQuest LLC, Ann Arbor, Michigan, USA) databases were searched using a combination of keywords. A total of 18 peer-reviewed articles were identified. In wound care, defining attributes for the concept of cost-effectiveness encompassed treatments which were both effective and economical. Four antecedents were identified, including the type of wound, care setting, type of dressing and patient-related characteristics. The consequences of cost-effective wound care were patient prognosis, quality of life, the economic burden on the patient and healthcare system and cost-savings. These findings will hopefully help to standardise cost-effectiveness terminology among nursing professionals in various healthcare settings.

Keywords: Cost Effectiveness; Wounds and Injuries; Healthcare Costs; Nursing; Concept Formation.

الملخص: هدفت هذه المراجعة إلى تحليل مفهوم الفعالية من حيث التكلفة في سياق الرعاية الصحية للجروح المزمنة باستخدام طريقة "وكر" و "أفانت"، تم البحث في قواعد البيانات باستخدام مجموعة من الكلمات الرئيسية في محركات البحث مثل المؤشر التراكمي للمنشورات العلمية المتعلقة بالتمريض والمهين الصحية المساندة® (EBSCO)، لخدمات المعلومات، ايسويتش، ماساتشوستس في الولايات المتحدة الأمريكية) و MEDLINE® (المكتبة الوطنية للطب، بيتسدا، ميريلاند في الولايات المتحدة الأمريكية) والتمريض و المهين الصحية المساندة® (ProQuest LLC، آن اربور، ميتشجين في الولايات المتحدة الأمريكية). وقد تم تحديد 18 مجموعة من البحوث العلمية في مجال العناية بالجروح، وفي هذه الدراسة تم تعريف السمات لمفهوم فعالية التكلفة والتي تشمل العلاجات التي كانت فعالة واقتصادية في الوقت نفسه، وتم تحديد أربع ميزات سابقة، وهي نوع الجرح، وإعدادات الرعاية، ونوع التضميد وسمات متعلقة بالمريض، كانت النتائج المترتبة على رعاية الجروح فعالة من حيث التكلفة تشمل الاستجابة للعلاج، ونوعية الحياة، والعبء الاقتصادي على المريض ونظام الرعاية الصحية والترشيد في التكاليف المستخدمة. تسعى نتائج هذه الدراسة إلى أن تساعد في توحيد مصطلحات فعالية التكلفة بين المتخصصين في التمريض في مختلف إعدادات الرعاية الصحية.

الكلمات المفتاحية: الفعالية من حيث التكلفة؛ الجروح والإصابات؛ تكلفة الرعاية الصحية؛ التمريض؛ تشكيل مفهوم.

CHRONIC OR DIFFICULT-TO-HEAL SKIN wounds—such as diabetic leg ulcers, burns or pressure ulcers—impose an economic burden on the affected patient and healthcare system due to the increased costs associated with wound care, such as additional hospital/clinic visits, dressing changes, nursing care and hospital stays.^{1,2} Unfortunately, due to the increasing ageing population worldwide and the high prevalence of chronic diseases among the elderly, it is estimated that the number of patients with chronic wounds will continue to rise.³ In addition, the growing prevalence of antibiotic resistance and comorbidities such as diabetes mellitus, obesity, venous hypertension and peripheral vascular disease also increases the cost of wound care.^{2,4} Moreover, optimal wound care often requires changes in practice, including the implementation of advanced technologies.^{5–8} This review

aimed to analyse the concept of cost-effectiveness in wound care in terms of the financial impact of wound care on patients, medical staff and healthcare institutions. These findings may serve as a guide to future researchers studying the benefits of cost-saving wound care measures.

Methods

The concept of cost-effectiveness was analysed using Walker and Avant's method.⁹ A literature search for articles related to cost-effectiveness was performed of the Cumulative Index to Nursing and Allied Health Literature® (EBSCO Information Services, Ipswich, Massachusetts, USA), MEDLINE® (National Library of Medicine, Bethesda, Maryland, USA) and Nursing & Allied Health® (ProQuest LLC, Ann Arbor, Michigan,

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USA) databases. Subsequently, the search was narrowed down using more specific keywords either alone or in combination, including “cost-effectiveness”, “economical”, “profitable”, “cheap”, “cost-saving”, “cost-analysis”, “nursing”, “wound care”, “wound management”, “dressing change” and “wound dressing”. However, the term “cost-effectiveness” was consistently used throughout the search process in order to maintain the focus of the analysis. Finally, all scholarly English-language articles published between 2011–2016 were identified in order to gather recent research findings related to cost-effectiveness in nursing.

Initially, 64,618 articles were identified using the term “cost-effectiveness” and related keywords; this was subsequently narrowed down to 17,445 articles with the inclusion of the term “nursing” and 2,175 articles when combined with wound care-related keywords. However, 1,771 articles were excluded as they did not meet the inclusion criteria with regards to the year or language of publication or because they were not published in scholarly peer-reviewed journals. Although the term “cost analysis” was interchangeably used with “cost-effectiveness” in some articles, such results were excluded to maintain the focus on cost-effectiveness. Articles with general information, commentaries, speeches/lectures, biographies and instructional materials/guidelines were also excluded. Finally, the remaining 32 articles were screened to ensure their relevance to cost-effectiveness in wound care, resulting in 18 articles which were included in the final analysis [Table 1].^{1,2,5–8,10–21}

Use of Concept

In nursing literature, the concept of cost-effectiveness was used mainly in relation to the cost and frequency of wound dressing changes, the duration of wound healing, the size of the wound and the use of other treatments or medications. Wound dressing results in both direct healthcare costs (encompassing both hospital and nursing costs), the cost of the actual dressing itself and the costs associated with applying the dressing or treating any systemic infections. Direct healthcare costs include the salaries of the nurses, various hospital costs, the time needed for the nurses to care for the patients, the time and costs related to home visits, if necessary, as well as visits to the primary care provider and follow-up visits.^{6,13–16} In addition, the rate of wound healing also has an effect on costs in relation to the size and duration of the wound as it progresses.¹¹ Moreover, the use of other medications and treatments also contributes to the total cost of wound care, such as analgaesics, anxiolytic medications and topical/systemic antibiotics to treat underlying infections and prevent downstream interventions.^{7,10,17}

Defining Attributes

Attributes denote the key characteristics of the concept being analysed.⁹ Overall, two defining attributes—effectiveness and economy—were identified for the concept of cost-effectiveness in wound care. For the first attribute, it is imperative that treatment modalities are effective, as evidenced via rapid wound healing and a decrease in wound size. For the second, the total cost of wound care, including both direct and indirect healthcare costs, should not be more expensive than comparable treatments available on the market while still meeting treatment needs.

The concept of cost-effectiveness is sometimes conflated with cost-saving, cost comparisons, cost analyses, cost-benefit ratios or being cost-conscious. However, these terms should not be used interchangeably. In the researchers’ opinion, cost-saving is a consequence of cost-effective measures rather than a synonym of cost-effectiveness. For example, even if a particular wound care product is cost-saving, it cannot be considered cost-effective if the treatment outcome is suboptimal. Furthermore, if a wound is not treated properly to begin with, various complications might arise requiring further treatment or surgical interventions such as wound debridement.

EFFECTIVENESS

Rapid healing is a hallmark of effective treatment. Several studies reported faster wound healing times and smaller wound sizes with the use of newer, more cost-effective wound dressing technologies.^{5,7,12} Jemec *et al.* found that the use of silver dressings resulted in wound closure occurring approximately three weeks earlier among patients with chronic leg ulcers compared to those treated with non-silver dressings.¹⁹ Although the initial cost of silver dressings was higher than that of non-silver dressings during the first four weeks of treatment, the average total treatment cost per patient was lower due to the shorter healing time.¹⁹ Hämmerle *et al.* also found that patients with venous leg ulcers treated with octenidine gel had significantly faster healing rates and decreased wound sizes compared to those treated with modern wound dressings.¹¹

Brown *et al.* compared treatment costs in relation to healing rates and changes in wound size among paediatric burn victims.¹ Wounds treated with single-use negative pressure wound therapy (NPWT) resulted in a marked decrease in wound size, with an average reduction in size of 21% per week. As such, the expense of NPWT was offset by the reduction in wound size, as this form of treatment resulted in wound healing occurring after two weeks compared

Table 1: Concept analysis of cost-effectiveness in wound care^{1,2,5-8,10-21}

Author and year of publication	Type of article	Treatment	Type of wound	Findings	Possible attributes
Anthony ⁶ (2015)	Meta-analysis	NPWT	Various	<ul style="list-style-type: none"> NPWT requires a shorter treatment duration and fewer dressing changes. NPWT is effective in different settings. 	<ul style="list-style-type: none"> Cost of treatment Safety of treatment Efficiency of treatment Size of wound Duration of treatment
Augustin <i>et al.</i> ⁷ (2016)	Comparative study	Hydroactive dressing containing a nano-oligosaccharide factor versus a neutral foam dressing	Vascular leg ulcers	<ul style="list-style-type: none"> The hydroactive dressing was more effective in reducing the wound area compared to the neutral foam dressing. 	<ul style="list-style-type: none"> Efficiency of treatment Type of dressing Size of wound
Brown <i>et al.</i> ¹ (2015)	RCT	Nonpharmacological DITTO intervention versus standard wound care	Paediatric burns	<ul style="list-style-type: none"> On average, the DITTO intervention resulted in lower direct healthcare costs, direct non-healthcare costs and overall costs per child. Wounds treated with the DITTO intervention re-epithelialised an average of three days faster. 	<ul style="list-style-type: none"> Cost of treatment Efficiency of treatment Type of treatment Rate of wound closure
Browning ¹⁰ (2014)	Review	Various	Various	<ul style="list-style-type: none"> The total cost of treatment is dependent on the cost of specialised medical staff and the number of dressing changes required per week. The cost of treatment for infection is dependent on the number of treatments required and the need for surgical debridement. 	<ul style="list-style-type: none"> Cost of treatment Duration of treatment Number of dressing changes Occurrence of complications
Butcher <i>et al.</i> ¹³ (2014)	Review	Various	Chronic wounds	<ul style="list-style-type: none"> The total cost of care depends on the frequency of interventions and dressing changes and costs associated with staff time and resources. Other costs include disposable items such as dressing packs, pain relief measures, inpatient/outpatient hospital costs and nursing time. Pharmaceutical interventions such as analgesics and anxiolytic medications also contribute to costs. 	<ul style="list-style-type: none"> Cost of treatment Duration of treatment Number of dressing changes
Carter ² (2014)	Review	Various	Chronic wounds	<ul style="list-style-type: none"> One study of diabetic foot ulcers demonstrated that IGC in conjunction with optimal foot care was more cost-effective compared to standard care. 	<ul style="list-style-type: none"> Cost of treatment Cost of preventative care
Evans ¹⁷ (2014)	Review	Various	Various	<ul style="list-style-type: none"> Soft silicone wound contact dressings have a wide range of wound care applications. Such dressings are more cost-effective in a community setting as one single product can be used for a variety of different types of wounds. 	<ul style="list-style-type: none"> Rate of healing Effectiveness of treatment Versatility of treatment
Gilligan <i>et al.</i> ²⁰ (2015)	Retrospective study	Becaplermin gel plus GWC versus GWC alone	Diabetic foot ulcers	<ul style="list-style-type: none"> Becaplermin gel plus GWC resulted in better outcomes at lower costs compared to GWC alone. 	<ul style="list-style-type: none"> Duration of treatment Rate of wound closure Cost of treatment
Hämmerle <i>et al.</i> ¹¹ (2014)	RCT	Octenidine-based wound gel versus modern dressings	Chronic venous leg ulcers	<ul style="list-style-type: none"> Octenidine gel resulted in a greater reduction in wound size and faster healing rates compared to modern dressings. The overall cost of treatment with octenidine gel was lower. 	<ul style="list-style-type: none"> Cost of treatment Safety of treatment Efficacy of treatment Size of wound Incidence of local infections Rate of healing (granulation tissue and bioburden)

Table 1 (contd.): Concept analysis of cost-effectiveness in wound care^{1,2,5-8,10-21}

Author and year of publication	Type of article	Treatment	Type of wound	Findings	Possible attributes
Hampton ⁵ (2015)	Cohort study	NPWT versus standard care	Hard-to-heal leg ulcers or pressure ulcers	<ul style="list-style-type: none"> The average weekly reduction in wound size was 21% with NPWT. Although the weekly cost of NPWT was expensive, the total cost was lower compared to standard care due to the shortened treatment duration. 	<ul style="list-style-type: none"> Rate of healing Size of wound Cost of treatment Duration of treatment
Jemec <i>et al.</i> ¹⁹ (2014)	Comparative study	Silver dressings versus non-silver dressings	Hard-to-heal chronic venous leg ulcers	<ul style="list-style-type: none"> Patients treated with silver dressings had faster rates of wound closure compared to those treated with non-silver dressings. Silver dressing treatment resulted in a cost-saving of £141.57 compared to non-silver dressings. 	<ul style="list-style-type: none"> Rate of healing Cost of treatment
Lima <i>et al.</i> ¹⁴ (2016)	Descriptive study	Various	Pressure ulcers	<ul style="list-style-type: none"> Hydrocolloid dressings were the most cost-effective type of dressing. 	<ul style="list-style-type: none"> Rate of healing Type of treatment Cost of treatment Duration of treatment
Maunoury <i>et al.</i> ²¹ (2015)	RCT	Antimicrobial chlorhexidine gluconate-containing securement dressings versus non-antimicrobial transparent dressings	ICU venous/arterial catheter insertion sites	<ul style="list-style-type: none"> The chlorhexidine dressing was better in terms of infection prevention compared to the non-antimicrobial dressing. 	<ul style="list-style-type: none"> Cost of treatment Effectiveness of treatment Rate of healing Cost of treatment Duration of treatment Incidence of infection
Othman ¹⁸ (2012)	Review	NPWT	Chronic wounds	<ul style="list-style-type: none"> NPWT reduces the cost of chronic wound care management and increases QOL, due to faster wound healing rates. 	<ul style="list-style-type: none"> Cost of treatment Duration of treatment Rate of healing
Pham <i>et al.</i> ¹⁵ (2012)	RCT	4LB versus SSB compression techniques	Venous leg ulcers	<ul style="list-style-type: none"> Both 4LB and SSB compression techniques were effective and had comparable cost-effectiveness when used by trained registered nurses. 	<ul style="list-style-type: none"> Rate of healing Effectiveness of treatment Cost of treatment Duration of treatment
Sibbald <i>et al.</i> ⁸ (2015)	CME article/validation study	Noncontact infrared skin thermometers	Patients at high risk of developing diabetic foot ulcers	<ul style="list-style-type: none"> Noncontact infrared skin thermometers were easy to use and available at a considerably lower cost compared to contact infrared thermometers. Due to its ease of use and availability, this tool could be used on a daily basis at home. 	<ul style="list-style-type: none"> Cost of treatment Effectiveness of treatment Cost of preventative care Effectiveness of preventative care
Tricco <i>et al.</i> ¹² (2015)	Review	Various complex wound interventions	Chronic hard-to-heal wounds and pressure ulcers	<ul style="list-style-type: none"> A total of 22 complex wound interventions were identified to be effective and less expensive compared to other methods. 	<ul style="list-style-type: none"> Rate of healing Cost of treatment Type of treatment Duration of treatment
Whitlock <i>et al.</i> ¹⁶ (2014)	Cross-sectional study	Various	Chronic wounds and ulcers	<ul style="list-style-type: none"> Only half of the general practitioners' time was covered by patient billing. In most cases, the total cost was greater than the total income, resulting in a net loss to the practice. 	<ul style="list-style-type: none"> Cost of treatment

NPWT = negative pressure wound therapy; RCT = randomised controlled trial; DITTO = computerised multimodal procedural preparation and distraction; IGC = intensive glycaemic control; GWC = good wound care; ICU = intensive care unit; QOL = quality of life; 4LB = four-layer bandage; SSB = short-stretch bandage; CME = continuing medical education.

to an average of 3.2 weeks of treatment with standard care.¹ Similar findings were reported in a recent meta-analysis; although the initial cost of NPWT was higher during treatment, the overall cost was reduced due to the lower costs incurred for personnel-related expenses and the shorter duration of treatment.⁶

Augustin *et al.* explored the cost-effectiveness of treating vascular leg ulcers using UrgoStart[®] (Urgo Ltd., Loughborough, UK), a hydroactive dressing containing a nano-oligosaccharide factor, and UrgoCell Contact[®] (Urgo Ltd.), a neutral foam dressing.⁷ According to an economic model, the hydroactive dressing was less expensive than the neutral foam dressing after eight weeks of treatment (USD \$849.86 versus \$1,335.51). In addition, the hydroactive dressing resulted in a $\geq 40\%$ reduction in wound size, with greater healing observed over a shorter treatment period.⁷

Gilligan *et al.* investigated the expected cost of treatment per week and the number of weeks needed for wound closure using becaplermin gel and good wound care (GWC) versus GWC alone among patients with diabetic foot ulcers.²⁰ As with NPWT, although treatment with becaplermin gel and GWC was initially more expensive compared to GWC alone, the former treatment method resulted in accelerated wound closure and lowered the risk of amputation, thus reducing overall long-term costs.²⁰

ECONOMY

A treatment is considered cost-effective only if it is economical in terms of both time and money. As mentioned earlier, the duration of treatment is often directly linked with costs as the shorter the duration of treatment, the less expensive the total costs of treatment.^{11,19} However, apart from increasing the rate of wound healing, a treatment may also be economical in that it reduces the number of wound dressing changes needed or decreases the time required to apply the dressing. In a cohort study, both the frequency of dressing changes and the time required to change dressings was reduced using NPWT in comparison to standard treatment.⁵

MODEL CASE

A 60-year-old man developed a diabetic foot ulcer after wearing a new pair of shoes for one week. He had initially been diagnosed with diabetes mellitus five years previously. The surface area of the wound was 10 cm² at baseline prior to starting treatment. After six months of standard wound care, the surface area of the wound had decreased to 7 cm². The cost of each standard dressing was USD \$24, with the dressing changed every other day. As a result, the total cost of treatment was USD \$3,456 over a six-month period. Subsequently, the patient's

primary care provider advised changing treatment methods from standard dressings to becaplermin gel due to poor wound healing. After three months, the wound size had decreased to 3 cm². The becaplermin gel dressing was re-applied three times a week at a cost of USD \$30 each time. In total, the cost over three months of treatment was USD \$1,040.

This case highlights the two defining attributes of cost-effectiveness.⁹ Treatment with becaplermin dressing gel was more effective compared to standard wound care, as evidenced by the rapid wound healing and the greater decrease in wound size over a shorter period of time (a 4 cm² decrease over three months versus a 3 cm² decrease over six months). Moreover, although the cost per dressing change of becaplermin gel was higher than standard wound care, it was more economical in the long term (USD \$1,040 versus USD \$3,456).

Antecedents

Antecedents refer to the factors, events or incidents that must arise or be present prior to the occurrence of the concept.⁹ Four antecedents were identified in the concept of cost-effectiveness in wound care, including the type of wound, the setting at which the wound care takes place, the type of dressing/treatment used and patient-related characteristics. In terms of wound type, injuries and wounds may be classified as either acute or chronic (e.g. pressure ulcers, venous/arterial leg ulcers, diabetic ulcers and burns). This will therefore have an impact on duration of care and treatment costs. Generally, chronic wounds are more expensive and difficult to treat than acute wounds.²⁶ However, certain treatments for acute wounds might be less cost-effective, particularly when used only for short periods of time.⁵

Wound care can take place in a variety of settings which will affect cost of treatment, such as in a hospital, outpatient department, home-care facility or an ambulatory clinic. For instance, the cost of treatment might be higher in a hospital setting in contrast to an outpatient setting.⁸ The type of dressing or treatment utilised will also have an impact on cost-effectiveness. Common treatments include becaplermin gel, infrared thermometry, bandages, hydroactive/neutral foam dressings, antimicrobial dressings and NPWT.^{5,7,8,20,21} Finally, certain patient-related characteristics will affect care costs, such as age and the presence of comorbidities such as diabetes mellitus or other conditions affecting health such as decreased immunity or immobility.²⁻⁴

Consequences

Consequences are the events or outcomes that arise as a result of the occurrence of the concept.⁹ In terms of the concept of cost-effectiveness in wound care, four consequences were identified: patient prognosis, economic burden, quality of life (QOL) and cost-savings. As cost-effective wound dressings result in more rapid wound healing and reduce the risk of complications such as infection, the prognosis of the patient is improved.¹⁰ Additionally, as cost-effective treatments are more affordable and result in desired outcomes within shorter periods of time, the economic burden of wound care on the part of the patients and, ultimately, the healthcare system is reduced. Moreover, the patient's QOL is significantly improved as a result of the more rapid recovery and reduced costs associated with the use of cost-effective treatments.¹⁸ Finally, there are obvious cost-savings that come with the use of wound dressings which are cost-effective.

Empirical Referents

Empirical referents indicate actual factors or events that, by virtue of their presence, demonstrate the occurrence of the concept.⁹ The empirical referents for the concept analysis of cost-effectiveness in wound care were divided into observable referents and measurable referents. Observable referents are factors associated with wound healing, such as photographs which showcase observable changes in wound healing after the application of dressings.¹¹ Measurable referents include measuring the size of the wound throughout its progression and estimating the total cost of wound dressings. The following formulae may be used to calculate wound size:¹¹

$$\text{Wound area} = r^2 \times \pi \quad [\text{Equation 1}]$$

$$\text{Mean wound area} = L \times \frac{(W_{Min} + W_{Max})}{2} \quad [\text{Equation 2}]$$

where r is the radius of the wound, L is the length of the wound and W_{Min} and W_{Max} are the minimum and maximum widths of the wound, respectively. Equation 1 is used mainly to calculate the size of circular wounds, while Equation 2 is used for wounds of other shapes.

Implications

Clinicians and managers should have a better understanding of the effect that clinical decision-making has on financial budgets and how the concept of cost-effectiveness can benefit various stakeholders,

including both patients and healthcare facilities. As a result, clinicians should consider ways to reduce costs of care while maintaining optimal clinical outcomes. This will allow nurses and clinicians to support patients and their families in choosing effective treatments with a reduced economic burden and fewer financial constraints.

Conclusion

Nurses and clinicians should promote cost-effectiveness in wound care in terms of both efficacy and economy, by considering healing rates and patient prognosis while maintaining low treatment costs in light of the duration of treatment. Further research is recommended to investigate nurses' perceptions of cost-effective wound care.

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