ESTIMATING THE COST IMPACT OF DRESSING CHOICE IN THE CONTEXT OF A MASS BURNS CASUALTY EVENT

ESTIMATION DE L'IMPACT FINANCIER DU TYPE DE PANSEMENT DANS UN CONTEXTE DE CATASTROPHE

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SUMMARY. Mass casualty burn events (MCBs) require intense and complex management. Silver-infused longer use dressings might help optimise management of burns in an MCB setting. We developed a model estimating the impact of dressing choice in the context of an MCB. The model was developed in Excel in collaboration with experienced emergency response clinicians. The model compares use of silver-infused dressings with use of traditional dressings in patients with partial thickness burns covering 30% of their body. Costs were estimated from a UK perspective as a proxy for a funded emergency response team and limited to cost of dressings, bandages, padding, analgesia and staff time. Expected patient costs and resource use were summarised over an acute 2-week intervention period and extrapolated to estimate possible time savings in a hypothetical MCB. Per patient costs were estimated at £2,002 (silver) and £1,124 (traditional) (a daily additional spend of £63). Per patient staff time was estimated at 864 minutes (silver) and 1,200 minutes (traditional) (a daily time saving of 24 minutes). Multiplying up to a possible MCB population of 20 could result in a saving equivalent to 9 staff shifts over the 2-week intervention period. The model was sensitive to type of silver dressing, frequency of dressing change and staff costs. We found increased costs through use of silver dressings but time savings that might help optimise burns management in an MCB. Exploring the balance between costs and staff time might help future MCB response preparation.

Keywords: mass casualty incident, burns, silver dressing, SSD, cost model

RESUMÉ*. Les catastrophes demandent une planification et une organisation rigoureuse. Les pansements à base d'argent nécessitant des changements moins fréquents peuvent être un bon compromis dans ces situations. En collaboration avec des urgentistes expérimentés, nous avons développé, sur un tableur, un modèle simple pour estimer l'impact du choix du pansement lors d'événements engendrant de nombreux blessés. Il compare l'utilisation de pansements à l'argent et celui des pansements généralement utilisés pour les patients avec des brûlures du deuxième degré couvrant 30 % de la surface corporelle. Le coût a été estimé en tenant compte du volume des pansements, de l'analgésie et temps/nombre soignants pour une durée d'intervention sur site de 2 semaines. Le coût par patient a été estimé à 2 002 £ pour les pansements à l'argent et 1 124 £ pour les pansement traditionnels soit une augmentation de 63 £/j. Le temps de soins par patient a été estimé à 864 minutes (pansements à l'argent) et 1 200 minutes (pansements traditionnel) soit un gain de temps 24 mn/j. Dans une hypothèse de 20 blessés, nous arrivons à une économie 9 journées (de 8 heures) de travail. L'utilisation des pansements à l'argent est plus onéreuse en termes de matériel mais permet d'économiser du temps/soignant. Nous pourrions améliorer la prise en charge des victimes dans de telles situations en explorant les possibilités d'un meilleur équilibre entre le coût et le nombre de personnel requis.*

Mots-clés*: catastrophe, brûlures, pansements à l'argent, coût*

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Introduction

Mass casualty burn events (MCBs) are mass casualty incidents resulting in high numbers of burn-related injuries requiring intense and complex management.[1-3] MCBs impact across all geographies but have particular impact in low- and middle-resource countries (LMICs) where the full impact of the event can often go unrecorded.[4,5] Globally, there have been in excess of 2,000 deaths and 3,000 hospitalisations over the last 20 years due to oil tanker explosions alone, with 94% of those deaths occurring in LMICs.[6]

Effective response to MCBs relies on complex and rapidly instigated management networks to limit both mortality and morbidity (including longer term impacts of burn wounds, scarring, psychological distress, inability to work and reduced ability to conduct daily tasks). Management in LMICs can be additionally complicated by lack of access to care facilities at a local level, resulting in the need for ancillary medical support and deployment of emergency response teams.[7] Optimisation of basic MCB resources in an emergency response setting optimises effective treatment delivery.

Developments in dressing technology and better understanding of wound healing have led to changes in burns management and increased availability of silver-infused antimicrobial dressings. These dressings can be left in place for up to seven days compared to the more traditional daily or alternate day dressings. While in a UK clinical setting there is no consensus on use,[8,9] in an MCB scenario, where ability to change dressings on a regular basis may be limited due to the numbers of patients, staff, resources and time available, silver dressings may help optimise burn management. The WHO Emergency Medical Team (EMT) Technical Working Group on Burns is developing recommendations for the management of mass burn casualties.[10]

We report a simple economic model to estimate the impact of dressing choice in the context of an on-the-ground emergency response to an MCB, and demonstrate the balance between costs and staff time.

Methods

Construction of the economic model

We constructed a cost model in collaboration with clinicians and nurses from the Welsh Centre for Burns & Plastic Surgery and the Centre for Global Burn Injury Policy & Research, familiar with working in multiple LMIC contexts. The model compared resources associated with the use of traditional dressings (once daily or alternate daily change) to those associated with the use of silver dressings (able to remain in place up to 7 days). The core aim was to create a transparent and flexible platform to estimate the per patient cost and resource impact of dressing choice across a range of potential MCB scenarios.

A literature review helped inform the modelling. The retrieved studies included cost-effectiveness analyses (CEAs)[11-20] and cost models[21-25] but were of limited relevance to our context. The CEAs confirmed the potential cost-effectiveness of silver dressings across multiple geographies but were not conducted in field settings relevant to MCBs. The cost studies comprised one MCB study,[21] a comparison of alternate models of burns care[22] and three treatment audits,[23-25] all hospital-based. The studies highlighted core outcomes: time to heal, rate of infection and need for surgery, and the key components of management: dressings, analgesia, antibiotics, staff time, surgery, and hospital length of stay. An initial model scope was drafted which was then reviewed by the clinical team.

In an MCB, initial triage identifies appropriate management options dependent on the depth and extent of burn. There can be limited capacity for surgery, and patients are managed with dressings more so than in a non-MCB environment. We limited the scope of our model to an acute intervention period and to patients with partial thickness burns suitable for intensive management with dressings and analgesia. Patients with superficial or full thickness burns were not considered.

Important outcomes of burn management include time to heal, rates of infections and need for surgery. There is a lack of consistent evidence on the relative effectiveness of different dressings[8] and very limited examples of field-based analyses.[20] Given this, we assumed equivalent rates of healing and infection for both dressing types and focused on a simple comparison of acute resource use and cost. The approach was validated by the clinical team and the model was limited to dressings, bandages, padding, analgesia and staff time. Different intensity of management over time was incorporated into the model to reflect expected practice.

An example scenario to illustrate the model

The core objective of the analysis was to compare the resource use and costs associated with use of silver dressings versus traditional dressings in the management of partial thickness burns in an MCB.

The context of the analysis was an MCB requiring an emergency medical team response. The payer perspective is complex in an MCB scenario. In this example, we defined a UK cost base. The UK was considered a suitable proxy for potential funding of an emergency medical response team.

The target population comprised MCB casualties with partial thickness burns suitable for treatment with dressings. The model allows flexible definition of the population in terms of numbers, age, sex and the percentage total body surface area (%TBSA) impacted by the burn. For the purpose of the current paper, an example MCB profile is defined (*Table I*). A cohort of 20 patients was assumed to reasonably simulate possible numbers of partial thickness burn/dressing-managed casualties in a hypothetical large-scale MCB scenario.

Table I - MCB profile (example inputs)

Characteristic	Value
MCB hypothetical eligible cohort (n)	20
Age distribution	6% under 18, 94% aged 18 or over
% male	65%
Mean BSA[1]	1.94m^2
% TBSA impacted by burn[2]	30%

[1] BSA estimated based on reported BSA by age and gender (https://en.wikipedia.org/wiki/Body_surface_area)

[2] %TBSA estimated as a composite of casualties with TBSA categorised as <20%, 20-40% and >40% TBSA

Table II - Dressing and re-padding

Management component	Model time period		
	Period 1	Period 2	Period 3
Nurses per dressing/re-padding (n)	2	2	2
Time per dressing/nurse (minutes)[1]	60	60	60
Time per re-padding/nurse (minutes)	20	20	20
Frequency of re-padding (hours, Ag only)	4	60	60

In example analysis, Period 1 is set to 0-48 hours; Period 2, 48 hours to 2 weeks; Period 3, 2-4 weeks (SA only)

[1]Time per dressing is for TBSA 20-40%; TBSA <20% is set to 30 mins in the model; TBSA >40% is set to 80 mins

Table III - Pain medication use

Pain medication	n tablets	Percentage patients receiving defined dose (by event)		
		Continuous[1]	Re-dressing[2]	Re-padding[2]
Paracetemol 500mg	8	100%	na	na
Codeine 15mg	2	0%	50%	50%
Morphine 10mg	2	0%	50%	0%

[1] Expected daily dose (i.e. 100% patients receive 8 tablets);

[2] Expected dose per event; na = not applicable.

The time horizon of the analysis was set to a 2-week acute intervention period. This was agreed as the time point after which patients who were unhealed might progress to surgery and those that were healed might be shifted to a less intense dressing regimen. The resource intensity of acute management differs over time. Management in the first 48 hours was differentiated from the longer-term management. Alternate time horizons were explored in sensitivity analysis.

The model compares a 'mixed basket' of available silver-based (Ag) dressings against traditional dressing, defined as standard dressing plus silver sulphadiazine (SSD).[26] The model includes Acticoat (Smith & Nephew Healthcare Ltd), Aquacel Ag (ConvaTec Ltd) and Mepilex Ag (Molnlycke Health Care Ltd) as examples of Ag dressings. In our base case, we assume an equal mix of use across the three Ag dressings (i.e. one third of patients receive Acticoat, one third Aquacel and one third Mepilex) but this can be adjusted to reflect treatment requirements (e.g. Acticoat might only be used on more complex burns). SSD use is estimated under the assumption that 1m^2 of coverage requires 250g of SSD. Each dressing choice follows the 4-layer dressing model with either SSD or Ag dressing followed by a dry gauze, a layer of Gamgee and a final layer of bandaging. Assumptions around expected use of dressing are explored in sensitivity analysis.

The model is a simple resource and cost comparison based on the expected patient pathway associated with management of partial thickness burns (defined by the clinical team). The primary outcome of the model is an estimate of mean per patient cost and mean per patient staff time, reported across the total intervention period and as a daily estimate. Costs are reported graphically to illustrate the breakdown of cost by resource category. Secondary outcomes include estimate of total staff shifts associated with dressing management in our example MCB scenario.

Resource use associated with dressing change was defined in consultation with the clinical team and differentiated by time period (*Table II*). All patients are managed with standard dressings for the first 48 hours of treatment and then either maintained on this regimen or switched to silver dressings. In the base case, we assume that silver dressings would be used for 5 days before changing rather than the maximum 7 days. This is a conservative assumption but is in line with the clinical team's experience and WHO discussions on use. Dressing, padding and bandage use are estimated according to expected TBSA plus 'wrap' margin (assumed +10% for dressings, +200% for bandaging). Staff time for dressing changes and re-padding was provided by the clinical team and reflects their experience in management of partial thickness burns impacting 30% TBSA. Re-padding was assumed to occur half way through use for the Ag dressing and was not considered for SSD (as these dressings are changed every 48 hours). Analgesic use was split by underlying use (constant) and additional use (given when dressings were changed or re-padded). The amount of pain medication differed according to re-padding or re-dressing (*Table III*). Staff/team changes were assumed to occur every 12 hours (based on clinical team input). This was only needed to estimate the secondary outcome of potential staff shifts saved.

In this example, costs were applied from a UK perspective. Staff time was costed based on PSSRU cost tariffs.[27] Costs were assigned according to staff grade, assuming a 50/50 split of Grade 5 and 6 nurses in the team. Dressings, paddings, bandages, paraffin gauze and pain medication were costed based on BNF list price[28] or where this was unavailable, based on price lists from a UK online provider.[29] In this illustration, we assume use of the lowest cost option for dressing, padding and bandages. Unit costs are available on request.

In order to assess uncertainty within the model, core inputs were varied within plausible limits using the user-defined options in the model. The model is designed to model different scenarios in which we might expect quite different results. As this is an illustrative example, based on a hypothetical scenario, only a limited selection of targeted univariate and multivariate analyses are reported.

Please note that differential healing and infection rates, rates of surgery, hospital length of stay and longer-term outcomes such as differential incidence of scarring/contracture were not considered in this model. Quality of life measures were not included given that the outcomes were assumed constant across the patient groups.

Results

The inputs described above were used to run the model and create a set of illustrative outputs.

Over the acute intervention period, mean per patient costs for silver dressing use were estimated at £2,002 compared to mean per patient costs with traditional dressing use estimated at £1,124 (an additional cost of £878). *Fig. 1* summarises per patient costs by resource category. The composition of costs differed by study arm with the majority of costs in the silver dressing arm accounted for by the cost of dressing (£1,300 or 65% of total cost) and the majority of cost in the traditional dressing arm accounted for by the cost of staff time (£820 or 73% of total cost).

Mean staff time over the acute intervention period was estimated at 864 minutes per patient with use of silver dressing (an average of 62 minutes per day) compared to 1,200 minutes with use of traditional dressing (86 minutes per day). This was equivalent to a total per patient saving (across the acute intervention period) of 336 minutes or 24 minutes per day. Note that the acute period includes intense management across both arms for the first 48 hours of the intervention.

Multiplying up to estimated size of an MCB population eligible for inclusion in the model (n = 20), the time saving was estimated at 112 hours, equivalent to a total of 9 staff shifts (under the assumption of a field shift change every 12 hours) over the 2-week acute intervention period.

Model costs were sensitive to the relative frequency of dressing change, choice of Ag dressing, %TBSA and cost of staff time. The finding of time saving was robust to variations in all key parameters although the magnitude of time saved was impacted. Results of targeted sensitivity analyses, provided in order to illustrate the flexibility of the model, are provided in *Table IV*.

Fig. 1 - Estimated per patient costs

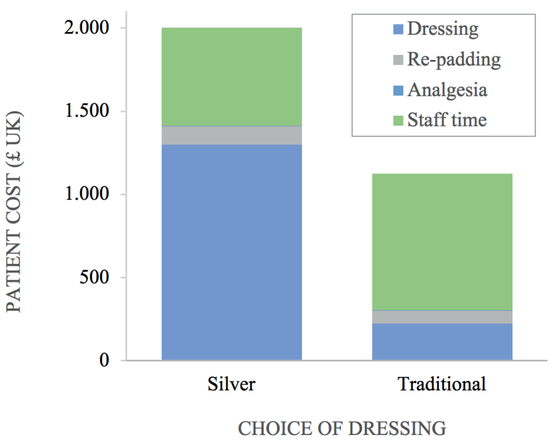

Table IV - Sensitivity analyses

Analysis description	Mean PP cost difference[1] (£)	Mean PP time difference[1] (mins)	Minutes saved per day
Base case[2]	£878	-336	-24
7 day use Ag dressing	£446	-446	-32
Aquacel only	£285	-336	-24
Acticoat only	£1,984	-336	-24
Mepilex only	£365	-336	-24
Burn 40% TBSA	£244	-1,056	-75
Burn 20% TBSA	£1,223	-372	-27
1 day use SSD	£583	-228	-16
50% reduction in staff cost	£936	-336	-24
50% increase in staff cost	£763	-336	-24

PP = per patient; TBSA = total body surface area;
SSD = sulphadiazapine (traditional dressing)
[1]Difference in cost or time over the intervention period through use of silver dressings in place of traditional dressing; [2]Base case assumptions: silver dressing 'basket' is an equal split of available Ag dressings; Ag dressing change: 5 days, SSD dressing change: 2 days; Burn 30% TBSA, staff costing: equal split across nursing grades 5 and 6.

Discussion

Based on the illustrative example reported here, silver dressings were more costly than traditional SSD-based dressings but saved staff time, potentially allowing for greater throughput of patients.

Under the assumptions outlined above, estimated additional spend was in the region of £878 per patient (a daily additional spend of £63), with savings in terms of nursing minutes in the region of 336 minutes per patient (a daily saving of 24 minutes). Time is at a premium in MBCs so the time saving might be considered to offset the additional spend (cost per minute saved of £2.62). Results of the sensitivity analyses suggest that the finding of time saved is robust. Additional cost was most sensitive to changes in dressing type, duration of use and %TBSA, with outputs ranging from +£22 (Aquacel AG only, 7 days use) to +£1,984 (Acticoat only, 5 day use). Extending the expected duration of the time horizon to 4 weeks, not unexpectedly, approximately doubled the expected cost of choosing silver dressings over SSD (note that all other model parameters were held constant).

The model is based on a set of candidate inputs that were considered relevant to a UK cost perspective. Current results are in line with other published analyses[20] but may not be generalisable to other country or third sector settings. The analysis applies an hourly staff rate based on NHS cost tariffs.[27] This reflects the opportunity cost of assigning UK-based staff on an emergency medical team but may not reflect the true structure of funding in this situation. The model takes the UK list price for all materials (bandages, dressings, analgesia). This assumes that all materials are provided by the response team with no use of local materials (which may be available more cheaply) or negotiation of discounts. The former (use of a high staff tariff) is likely to overestimate staff-based savings, while the latter may overestimate dressing-based costs.

The current model does not include patient outcomes. The underlying assumption of equivalent healing and impact on infection may be conservative[30] but the evidence base remains equivocal.[8] A recent 10-year retrospective study assessed the use of silver dressing for the management of burns in the US military.[20] The study compared two patient groups, one managed with silver dressing and one with traditional antimicrobial dressings, with analysis indicating a trend toward reduced wound infection rates in the silver dressing group. In line with our study, the authors emphasise the minimal wound management required with the silver dressing and highlight the suitability of silver dressing for use in mass casualty events. Inclusion of wound heal/infection rates in our model would tend toward cost offsets in the silver dressing arm if robust evidence in favour of silver dressings was available.

Burns are a serious global public health problem. The WHO estimates 180,000 deaths a year, with the majority occurring in low- and middle-resource countries.[10] The level of public health impact led to the development of a global strategy for the prevention and treatment of burns in 2007 and, more specifically, the current initiative to improve management of burns in MCBs.

Conclusion

This model was developed iteratively in collaboration with clinicians with MCB experiences and as part of a broader exploration of burns management in LMICs. The purpose of model development is to share a flexible platform to estimate the relative cost and resource associated with choice of dressing. An illustration of the balance between costs and staff time across a range of MCB scenarios might usefully input to MCB response preparation discussions.

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Conflict of interest. The authors declare no relevant competing interests in the conduct of this study.