

ORIGINAL ARTICLE

The efficacy of hydrogel dressings as a first aid measure for burn wound management in the pre-hospital setting: a systematic review of the literature

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Abstract

The aim of this systematic review was to determine the supporting evidence for the clinical use of hydrogel dressings as a first aid measure for burn wound management in the pre-hospital setting. Two authors searched three databases (Ovid Medline, Ovid Embase and The Cochrane Library) for relevant English language articles published through September 2014. Reference lists, conference proceedings and non-indexed academic journals were manually searched. A separate search was conducted using the Internet search engine Google to source additional studies from burns advisory agencies, first aid bodies, military institutions, manufacturer and paramedic websites. Two authors independently assessed study eligibility and relevance of non-traditional data forms for inclusion. Studies were independently assessed and included if Hydrogel-based burn dressings (HBD) were examined in first aid practices in the pre-hospital setting. A total of 129 studies were considered for inclusion, of which no pre-hospital studies were identified. The review highlights that current use of HBD in the pre-hospital setting appears to be driven by sources of information that do not reflect the paramedic environment. We recommend researchers in the pre-hospital settings undertake clinical trials in this field. More so, the review supports the need for expert consensus to identify key demographic, clinical and injury outcomes for clinicians and researchers undertaking further research into the use of dressings as a first aid measure.

Introduction

Advances in burn care in the last 50 years have seen a dramatic improvement in patient survival, a reduction in complications and important improvements to cosmetic outcome. Whilst much of this care has been driven by hospital-based practices such as surgery, antibiotics and intensive care, the timely and rational addition of immediate first aid has not been quantified with evidence from pre-hospital clinical trials. Thus, its impact on important burn patient outcomes remains largely unknown.

Pre-hospital burn first aid has traditionally consisted of cooling the burn with water and covering the wound with an appropriate dressing. Experimental and animal studies have shown water-cooling to provide beneficial effects on

wound oedema (1), pain (2), reducing cell injury (3) and the inflammatory response (4) as well as having an impact on

Key Messages

- over the recent years, there has been a rapid rise in the use of alternative first aid cooling and wound-based therapies (i.e. hydrogel dressings) for patients with burn injuries in the pre-hospital setting
- we undertook a systematic review to determine if this popular, alternative first aid therapy was supported by clinical evidence supporting its efficacy in this role

- a total of 129 studies were considered for inclusion, of which no studies met the inclusion criteria
- in addition, we found various descriptions within practice guidelines of burn care advisory agencies and emergency medical services for its use as first aid measure

healing, recovery, cosmetic outcome and mortality (5,6). More recently, alternative approaches to traditional first aid using hydrogel-based burn dressings, derived from materials first developed in 1955 (7), have seeped into pre-hospital clinical practice.

The popularity of the dressing as a first aid measure was evident in a number of studies published in the emergency services setting. For instance, Allison (2002) showed that 39% of emergency medical services (EMS) in the UK used Hydrogel-based burn dressings (HBD) as a first aid cooling agent (8), whilst nearly 80% of UK fire services used HBD as both a dressing and/or cooling agent. (9) In addition, Australian studies by Cuttle *et al.* (2009) showed that 13% of paediatric patients received first aid with HBD by EMS (10), whilst Hyland *et al.* (2013) found that more than 50% of patients in a cohort subset of 455 were treated by lay first-aiders using hydrogel products (11).

The rationale for this widespread adoption of HBD into first aid practices, however, remains unclear. It may have been due to poor clinical understanding, the use of non-evidence-based treatment strategies, the absence of defined burn protocols or the emergence of a growing HBD manufacturing base keen to develop market opportunities.

Nonetheless, most EMS staff considered HBD simple to adapt to practice and appeared to solve the dual problems of improvising water cooling in transit (using bottled saline or water) whilst providing a dressing option (from a myriad of choices), features aiding the zeal of paramedics to exit the emergency scene with alacrity to definitive management in the emergency department (ED) – a long-held mantra of pre-hospital care (12).

The uses of HBD are: it is applicable to all areas of the body, provides a concomitant cooling and wound covering function, comes in many sizes and dissipates heat from the wound via convection and evaporation. Several products also incorporate additives with anaesthetic, anti-inflammatory or nutrient properties.

Given the widespread use of HBD, there was an urgent need to determine the base level of clinical evidence supporting the efficacy of HBD in the pre-hospital burn first aid role. The authors also investigated the extent and type of alternative supporting literature and approaches to practice seen in published first aid recommendations and practice guidelines of burns advisory agencies, first aid bodies, military institutions and other clinical agencies.

Materials and methods

Data sources and search strategy

A structured literature search was performed in Ovid MEDLINE, Ovid EMBASE and The Cochrane Library from 1946

through to September 2014 using a series of keywords such as 'burns', 'thermal injury', 'hydrogel', with 'first aid' and 'pre-hospital setting'. A pre-defined search strategy was designed for maximal retrieval using medical subject headings and free text search terms. Search terms were also adapted using the thesaurus vocabulary of each database. In addition to the automated search strategies, the internet search engine Google was searched for additional studies from academic journals, conference proceedings, reference lists, sources of clinical practice, burns advisory agencies, resuscitation science and first aid bodies, military institutions, HBD manufacturer and EMS websites. Two authors conducted the literature search. All searches were limited to articles in English.

Study selection criteria and procedures

All published peer-reviewed studies including systematic reviews, randomised and non-randomised controlled trials, well-designed observational studies and superiority or non-inferiority comparative studies were considered for inclusion in this review. In particular, we looked for HBD studies when used as part of immediate first aid burn care management in the pre-hospital setting that reported on burn wound temperature, burn progression, analgesic benefits, infection rates, healing and cosmetic outcomes, recovery times and impact on mortality.

In vivo studies, animal studies, non-English-language studies, none peer-reviewed studies, studies not available in full text, unpublished manuscripts, narrative reviews or commentaries were excluded. The studies retrieved by the initial search underwent a scanned process by a single review author to exclude irrelevant studies, and two authors then screened titles and abstracts against the inclusion criteria. Full-text articles were retrieved and reviewed independently by two authors for the purpose of applying inclusion criteria. In all instances, differences of opinion were resolved by discussion amongst the authors.

Data extraction

Standardised data extraction techniques were to be used if we found studies reporting on the appropriate study designs, patient demographic and injury characteristics, along with the description of the intervention.

Results

In total, 115 studies were identified from searching the medical literature. Independent scrutiny of titles and abstracts by two authors identified 25 potentially relevant articles, all of which were excluded for the following reasons: studies undertaken in the non-pre-hospital setting (13–25), in clinical laboratories (26–29), involving animals (30–33); or published in non-English language (34–37).

Manual searching of non-traditional data forms (internet sources) identified a further 14 studies. These studies were also excluded because of the wrong setting (38,39) or patient group (40), the intervention was not assessed (8,41–44), were

Table 1 Burns Advisory Agencies – recommendations for first aid clinical practice

Agency	Preferred cooling method	Preferred dressing	Alternate dressing
1. BBA (66)	'Cool the burn area' (Water)	C	NS
2. ANZBA (67)	CRW	'Clean dressing'	NS
3. NZGG (68)	'Running tap water' or H where water not available"	C	'PVC film should not be used as a substitute for a dressing product'
4. NSWACISBIS (69)	CRW	C	NS
5. VABS (70)	CRW or H if no water available. H not for use in P. Do not leave H on for prolonged periods in burns>20% (A)	'Use a clean, dry dressing of plastic cling film wrap to cover the burn'	NS
6. WABS (71)	Room temperature water	Clean non-adherent dressing	NS
7. ARC (72)	'Cool tap water' H if water not available. 'Water is always the first choice for cooling a burn injury'	'Loose and light non-stick dressing preferably clean, dry, lint free (non-fluffy material (e.g. cling film))	NS
8. ERCEFAG (73)	Tap water	'After cooling apply wet wound dressings' (undefined H)	NS
9. AHA (74)	'Cold Tap Water'	NS	NS
10. RAHBU (75)	CRW or soaked towels for still water/ immersion or HBD if no water available	'Non-adherent dressing' (minor burn)	NS
11. CHWM (76)	'Cold tap water'	'A simple non-stick dressing is suitable'	NS
12. RCH (77)	CRW	'Clingfilm useful'	NS
13. POWH (78)	'Water'	NS	NS
14. WCHA (79)	CRW – H if no water available	C or 'non-adherent dressing'	NS

A, adult; C, Clingfilm; CRW, cool running water; DD, dry dressing; H, Hydrogel-based burn dressings; NS, not specified; P, Paediatric; WD, wet dressing (undefined).

Burns Advisory Agencies: 1. BBA, British Burns Association; 2. ANZBA, Australia New Zealand Burn Association; 3. NZGG, New Zealand Guideline Group; 4. NSWACISBIS, New South Wales Association for Clinical Innovation Statewide Burn Injury Service; 5. VABS, Victorian Adult Burns Service; 6. WABS, Western Australia Burns Service; 7. RC, Australian Resuscitation Council; 8. ERCEFAG, European Resuscitation Council European First aid Guidelines; 9. AHA, American Heart Association; 10. RAHBU, Royal Adelaide Hospital Burns Unit; 11. CHWM, The Children's Hospital West Mead; 12. RCH, Royal Children's Hospital; 13. POWH, Prince of Wales Hospital (Hong Kong); 14. WCHA, Women and Children's Hospital Adelaide.

unpublished manuscripts (40) or were in vitro experimental studies. (45–49).

Of the 14 sampled burns advisory agencies, four provided recommendations on HBD as an (alternative) cooling medium (28.6%) (Table 1 Agency Number: 3, 8, 10, 14), whilst one advised against its use in paediatric burn population (Table 1 Agency Number: 12). None of the 14 bodies advocated the use of HBD as a primary first aid dressing (i.e. as a covering post cooling). Of 23 sampled EMS agencies, ten agencies (44%) specified HBD as the preferred or alternate method for cooling and dressing a burn wound in published clinical practice guidelines (Tables 2 EMS agencies Numbers: 15–21, 34–35, 37).

Discussion

Overview of the evidence

Despite major advances in hospital burn care over the past few decades, minimising burn wound progression with targeted cooling whilst avoiding hypothermia, effectively managing pain without resorting to excessive use of opioid medication and determining the best approach to wound covering to protect the injured integument whilst impacting infection rates, remain complex and difficult areas of pre-hospital care. In the absence of a clear evidence-based strategy, there has been a gradual shift in clinician behaviour towards the use of alternative therapies such as HBD.

Following an exhaustive search of medical databases, websites and first aid agencies using burn and pre-hospital search terms, the systematic review did not identify any studies describing an equivalent or superior effect of HBD in respect of addressing these critical areas in comparison with current recommended therapies. Moreover, we did not find any evidence supporting the efficacy of HBD when applied to a burn wound for a specific time frame (e.g. 20 minutes) (50) or its value as a delayed first aid cooling therapy (e.g. 'up to 3 hours post injury') (51).

The safety, suitability and effectiveness of HBD as a method of immediate cooling in specific patient groups (i.e. paediatric population) or in patients with burns of significant size and/or depth remains an area of both concern and controversy in the absence of adequate research (43). Nonetheless, HBD remain a widely used alternative burn first aid option in the USA, Asia, Europe, the UK, Australia, Canada and many other regions where they may be used to treat all sizes and depths of burn injury.

Considering the absence of evidence, a number of sampled agencies involved in providing first aid recommendations and guidelines for practice used a variety of animal, laboratory and observational studies, unpublished materials or manufacturer-commissioned reports or testimonials, in various clinical settings other than pre-hospital, to piece together a series of clinically led, consensus-based statements almost exclusively on the water-cooling component of burn first aid.

For example, Singer *et al.* (2010) compiled an evidence summary for the American Heart Association (AHA) 'International Consensus on First aid Science with Treatment Recommendations' providing evidence to demonstrate the benefits of water cooling on healing and reducing pain but included studies in other health care settings and amongst animal populations (52). The summary described the HBD burn first aid situation as a 'knowledge gap' (1) and the AHA did not provide a recommendation on HBD use in pre-hospital setting.

In addition, the use of HBD as a first aid dressing (i.e. as a covering *after* cooling) also remains poorly researched. For example, a more recent systematic review by Wasiak *et al.* (2013) did not identify any pre-hospital HBD studies on its use as a management for superficial or partial thickness burns, whilst hospital-based studies in the review did not explore the product in the first aid scenario or were unrelated variants containing a hydrogel component not used in the pre-hospital clinical environment (53).

Recommendations and guidelines for practice

Despite the limited evidence base within the pre-hospital setting, and the emphasis placed on various settings (i.e. animal and laboratory-based studies), there is a level of consensus amongst clinicians to consider the 'best available' evidence in the early first aid management of patients with burn injury.

Although consensus-based care may have expanded clinical knowledge, clinical features of HBD function remain controversial. For example, anecdotal clinical observations from ED clinicians have suggested that wound heat may accumulate in HBD thereby potentially exacerbating burn progression. This may occur in the large, very hot, deep burn, when HBD is covered by blankets during patient warming if used only as a wound dressing during transport to the ED or where HBD is covered with an improvised overwrap, for example, a roller bandage or Clingfilm – a practice used by many paramedics to retain the easily dislodged, slippery dressing. However, this concern has not been quantified in studies to date. Coats *et al.* (2002) alludes

to the practice of overwrapping the HBD in-line with manufacturers' instructions but drew no clinical conclusions (25).

Coats *et al.* also observed that paramedics often abandoned this approach in order to achieve the best cooling efficiency via the evaporative pathway. However, this approach potentially contributes to clinical hypothermia, an area of particular concern to clinicians. Nonetheless, existing evidence in this area of concern also remains controversial (43,54–56).

In practice, avoiding hypothermic complications from HBD (and burn wound cooling generally) has been partially addressed in paramedic practice guidelines through the application of protocol caveats such as age and total burn surface area (%TBSA) restrictions. However, there does not appear to be any standardisation in these practices. For example, some Australian EMS services use HBD only where water is inaccessible (57,58) or stipulate based upon patient age and/or TBSA (59), whilst one suggests several alternatives all considered appropriate (60). Variations in Australian EMS practice are replicated in overseas jurisdictions (Table 2 Agency Numbers: 20–37).

Some EMS guidelines advocate no cooling of the burn with any means (HBD or otherwise) irrespective of the TBSA. Only two of the sampled EMS agencies stipulated a burn depth caveat for use with HBD (Table 2 Agency Numbers: 34–35).

Recommendations from international and national first aid agencies reflect the general consensus on early water-cooling of burn injury seen in those from major burns advisory agencies but fail to demonstrate a consensus on other aspects of burn first aid where HBD is used (61–63). Non-traditional data sources also show similar variations in HBD use as noted in military first aid protocols (64,65).

There remains no consensus amongst first aid providers sampled for this review as to whether HBD is suitable as the preferred burn dressing in pre-hospital as seen in previous studies (10). Amongst burns advisory agencies, polyvinyl film is the most widely recommended choice principally for its practicality, simplicity and nominal sterility. One agency suggests HBD as an alternative dressing in major burns (Table 1

Table 2 Summary of results: EMS Agencies state based Clinical Practice Guidelines

EMS Agencies by region	Percentage of sample total (n = 23)	Review sample as approximately percentage of published state based EMS practice guidelines	Percentage EMS using HBD as preferred cooling method	Percentage EMS using HBD as preferred dressing method	Percentage EMS using HBD as alternate dressing method
Australia (Nos: 15–19)	21.74 (n = 5)	71 (n = 5/7)	0	40 (n = 2/5)	80 (n = 4/5)
UK and Ireland (Nos: 20–21)	8.7 (n = 2)	100, 33 [n = 1/1 (UK†, n = 1/3]	0	50 (n = 1/2)	100 (n = 2/2)
Canada (Nos: 22–26)	21.74 (n = 5)	38.4 (n = 5/13)	0	0	0
USA (Nos: 27–37)	47.8 (n = 11)	44 (n = 11/25‡)	9.1 (n = 1/11)	36.36 (n = 4/11)	0

EMS Agencies: 15. QAS: Queensland Ambulance Service (57). 16. ACTAS: Australian Capital Territory Ambulance Service (80). 17. SJWA: St John Western Australia Ambulance Service (58). 18. NSWAS: New South Wales Ambulance Service (81). 19. SAAS: South Australia Ambulance Service (82). 20. PHECC: Pre-Hospital Emergency Care Council of Ireland (83). 21. UKAS: United Kingdom Ambulance Services (76). 22. Alberta Health Services EMS (84). 23. Nova Scotia EHS (85). 24. Ontario EMS (86). 25. Manitoba EMS (87). 26. Saskatchewan EMS (88). 27. Montana EMS Emergency Care (89). 28. Alabama EMS (90). 29. North Carolina EMS (91). 30. Massachusetts EMS (92). 31. New York State EMS (93). 32. Pennsylvania EMS (94). 33. Connecticut EMS (95). 34. Alaska EMS (96). 35. Florida EMS (97). 36. Nebraska EMS (98). 37. Maine EMS (99).

*JRCALC National Clinical Practice Guidelines for UK Ambulance Services (14 NHS ambulance Trusts) (100).

†Of 50 US states, only 50% have state based EMS Clinical Practice Guidelines (101).

Agency Number: 10). Only one of three sampled resuscitation councils specifies a preferred pre-hospital burn dressing post wound cooling (Table 1 Agency Number: 8 – ‘wet wound dressings’ – unspecified).

Conclusions

This systematic review failed to identify studies of any design examining the use of HBD as first aid measure in the pre-hospital setting. Studies were identified from other clinical settings (i.e. hospital, laboratory and animal), but they did not meet our inclusion criteria. More so, the search of non-traditional data sources also showed no additional studies meeting inclusion criteria. Study data to establish the bonafides of HBD as an effective burn First aid intervention thus appear lacking quantitatively and qualitatively making definitive conclusions on the efficacy of the technology in this role unclear.

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