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BEVA primary care clinical guidelines: Wound Management in the Horse

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Summary

Background: There are currently no evidence summaries on wounds in the horse.

Objectives: To develop evidence-based guidelines on wound management in the horse.

Study design: Evidence review using the GRADE framework

Methods: Research questions were proposed by a panel of veterinarians, and developed into PICO format. Evidence in the veterinary literature was evaluated using the GRADE evidence-to-decision framework. Searches for human evidence summaries were conducted in the NICE, Cochrane and JBI databases. Final recommendations were based on both veterinary and human evidence.
Results and recommendations: The research questions were categorised into three areas: A. Wound lavage and topical treatments; B. Wound debridement and closure; C. Therapeutics for wound healing. Three hundred and six veterinary publications were identified across thirteen different topics. Fourteen papers were assessed using the GRADE criteria. Twenty-five human evidence summaries were reviewed. The results were developed into recommendations:
A. Wound lavage and topical treatments: (i) Tap water should be considered instead of saline for lavage; (ii) Povidone iodine lavage should be considered for contaminated wounds; (iii) Topical silver sulfadiazine may not be suitable for acute wounds; (iv) Optimal lavage pressures are around 13 psi.
B. Wound debridement and closure: (i) Debridement pads should be considered for wound preparation; (ii) Larvae debridement should be considered in selected cases; (iii) Hydrosurgery should be considered in acute contaminated wounds.
C. Therapeutics for wound healing: (i) Honey may reduce duration of some phases of wound healing. There was insufficient evidence to draw conclusions on the use of chemical debridement, therapeutic ultrasound, laser therapy, wound closure with staples compared to sutures, or identify optimal concentrations of antiseptic lavage solutions.
Main limitations: Low quality evidence in veterinary literature; majority of recommendations were based on human evidence.
Conclusions: These findings should be used to inform decision-making in equine primary care practice.

Introduction

Wounds are the second most common emergency problem in the horse [1]. Treatment can be challenging due to the large variation in the type, location and severity of different wounds, and the lack of primary evidence on best management practice. The majority of literature around wound management is expert opinion or case series, and there are currently no evidence summaries to inform clinical decision-making. Primary care clinical guidelines have been developed for analgesia in the horse using the GRADE framework [2], and this study was initiated to develop these for wounds in the horse.
The aim of this study was to develop evidence-based clinical practice guidelines on wound management in the horse.
The objectives were to:

- Identify questions relevant to clinical practice on wound management through ranking by a panel of veterinary surgeons.
- Appraise the current veterinary evidence for each question through a systematic search of databases and assessment using the GRADE criteria.

Review the current recommendations from human evidence, if there was insufficient evidence in the veterinary literature.
Combine the outcomes of the veterinary and human evidence searches to develop final recommendations for veterinary practice.

Methods

Selection of clinical questions

A panel of veterinary surgeons was collated in 2017. Each of the panel members was asked to nominate clinical questions. Each question was allocated to a panel member or members who developed a PICO format as described by GRADE, comprising Question, Population, Intervention, Comparison, Main outcomes, Setting, Subgroups [3].

Review of current veterinary evidence summaries

Initial searches for current evidence summaries on equine wounds in veterinary literature were conducted in VetSRev (webapps.nottingham.ac.uk/refbase/), and Veterinary Evidence (www.veterinaryevidence.org/index.php/ve/search).

GRADE review of veterinary publications

Protocol and registration

The study and the review protocol were not registered. The study methods followed the PRISMA format.

Eligibility Criteria

Each clinical question was developed into a PICO format. Individual PICOs for each clinical question are described in Supplementary Items 1-3. The 'outcomes' were a list of potential measures that were searched for within the selected publications, based on the outcomes described in the GRADE framework [3]. If further refinement or amendment of the PICOs was required, based on the outcomes of the initial literature search, then the PICOs were refined and the searches repeated.

Information sources and search

A common strategy for database searches was developed and used as a framework for each individual question, with additional relevant search terms and inclusion criteria added as required for each clinical question. The specific amendments for each clinical question are described in Supplementary Items 1-3. Systematic searches of the Medline and CAB abstracts databases were conducted between October 2018 and April 2019, using common key word searches (with additional search terms added for each clinical question as described above) [4]:

horse*.mp OR equi*.mp OR equus.mp OR exp horse*/ OR exp equi*

wound*.mp OR injur*mp OR heal.mp OR exp wound*/OR exp injur*/OR exp heal*

The outcomes of the database searches were combined and duplicates were removed.

Study selection

The title and abstracts of the remaining publications were reviewed against inclusion and exclusion criteria to extract publications suitable for evidence appraisal. Table 1 describes the common inclusion and exclusion criteria; additional criteria were added if required for specific clinical questions, and detailed in the Supplementary Items.

Table 1: Inclusion and exclusion criteria used to review titles and abstracts of publications appropriate for GRADE appraisal of evidence on wound healing in the horse.

Inclusion criteria	Exclusion criteria
Original research articles, systematic reviews or structured evidence summaries (including knowledge summaries, best bets, CATs)	Single case studies, personal opinion/reviews, non-peer reviewed studies, textbooks or technical literature
Study published in full, and available in English	Studies only available as abstracts, studies not available in English
Studies relating to equids including clinical case studies and trials, in vivo and in vitro equine models	
Naturally occurring or experimentally inflicted traumatic wounds	Wounds arising from other disease processes (e.g. leg ulcers, diabetic related wounds); Burns

Data collection process

Data was extracted from each publication by each researcher independently. No duplication of data extraction was performed.

Synthesis of results

Publications which met inclusion criteria were reviewed against GRADE criteria. Data from each publication were extracted and summarised in Evidence Profile tables. Data from all studies on each clinical question were summarised in a Summary of Findings Table. The outcomes from the Summary of Findings Tables were presented as an overview plus recommendations, which were circulated to all the panel members in each category for feedback and agreement.

Review of current human evidence summaries

Searches for human evidence summaries were conducted in the following databases: Cochrane (http://www.cochranelibrary.com/topic/Wounds/, NICE (https://www.nice.org.uk/guidance/conditions-and-diseases/injuries--accidents-and-wounds) and JBI (https://journals.lww.com/jbisrir/Pages/default.aspx) to identify the evidence summaries available in the human literature. Data from burns and ulcers were initially excluded (Table 1). However, if there was no evidence for traumatic wounds or surgical incisions, then reviews on burns and ulcers were considered. Primary evidence sources from human patients were not included.

Results

Selection of clinical questions

The Editors of Equine Veterinary Journal appointed the panel and defined the area for the study as wound management following nomination of topics by British Equine Veterinary Association Committees for Clinical Practice, Health and Medicine, Ethics and Welfare and Equestrian Sports and consultation with members at their Annual Congress in 2017. The panel selected the specific questions/areas. Based on the ranking, the clinical questions were grouped into three main categories: Wound lavage; Wound debridement and closure; Therapeutics to enhance wound healing. The clinical questions for each category and the panel members involved in their analysis is described in Table 2 and key recommendations are summarised in Tables 3-5.

Table 2: Categorisation and listing of clinical questions relating to wound management, following nomination by guidelines panel members.

Category of wound management	Clinical questions
A. Wound lavage and topical treatments	1. Is **tap water** as effective as **saline** for flushing wounds in horses? 2. Does use of **antiseptic solutions** for lavage reduce rate of wound infection in horses? 3. What is the best **antiseptic and best concentrations** to use for primary wound lavage? 4. Does the use of **topical antimicrobials** reduce rate of wound infection compared to systemic antimicrobials in horses? 5. Which is most effective **lavage pressure** for resolving wound infection in horses?
B. Wound debridement and closure	1. Does the use of **sharp debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses, compared to wounds that are not treated with sharp debridement? 2. Does the use of **scrub pads** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses, compared to wounds that are not treated with scrub pads? 3. Does the use of **chemical debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses, compared to wounds that are not treated with chemical debridement? 4. Does the use of **larvae debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses, compared to wounds that are not treated with larvae

	debridement? 5. Does the use of **hydrosurgery** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses, compared to wounds that are not treated with hydrosurgery? 6. Does the use of **staples** for wound closure in horses increase the risk of wound dehiscence compared to wounds closed with sutures?
C. Therapeutics to enhance wound healing	1. Does the use of **topically applied manuka honey** on contaminated equine wounds hasten the healing time or improve the cosmetic outcome? 2. Does the use of **laser therapy** reduce the duration of wound healing time/ improve the cosmetic or functional outcome in horses? 3. Does the use of **therapeutic ultrasound** reduce the duration of wound healing time/improve the cosmetic or functional outcome in horses?

Review of current veterinary evidence summaries

Two veterinary evidence databases (VetSRev) and Veterinary Evidence were searched for evidence summaries on wounds (across all species, i.e. not restricted to the horse) on 2 May 2018. This identified seven systematic reviews (VetSRev), four knowledge summaries, one prospective cohort study and one observational study (Veterinary Evidence) (Supplementary Item 4). None of the studies met the inclusion criteria.

Study selection

A total of 306 number of veterinary publications were identified between 2 May 2018 and 2 May 2019 and reviewed; 14 publications met the inclusion criteria and were reviewed using the GRADE criteria (Supplementary Item 5).

Twenty-five human evidence reviews / summaries were identified between 1 February 2019 and 9 May 2019; these were summarised and used to develop the final recommendations (Supplementary Item 5).

Study characteristics

The details of the study characteristics are presented in the Summary of Findings Tables for each clinical question, including the study design and horses in the control and treatment groups (Supplementary Items 1-3).

Results of individual studies

The details of the quality assessment for each study (study outcomes; assessment of bias, inconsistency, indirectness and imprecision; treatment effect and strength of evidence), and the evidence profile for each clinical question are presented in the Summary of Findings tables and Evidence Profile Tables in Supplementary Items 1-3). The final summary and recommendations based on these are presented below, through a series of case studies.

A. Wound lavage and topical treatments

The full methodology and results for the five topics relating to wound lavage and topical treatments are presented in Supplementary Item 1. The findings are presented around a case study requiring wound lavage, and the key recommendations presented in Table 3.

Clinical Scenario

A two-year-old thoroughbred filly presented after falling during transport. The filly pulled its shoe of and sustained this injury over the fetlock from the loose shoe whilst scrambling back to its feet. (Figure 1). The extensor tendons are exposed, but the fetlock joint capsule was intact. There are limited facilities available for cleaning the wound and the owner has limited finances.

Clinically relevant questions relating to this case considered by the panel are:

- Will tap water be as effective as saline for flushing the wound?
- Will adding antiseptic solution to the lavage solution help reduce the risk of infection?
- Which are the best antiseptic solutions and dilutions to use?
- Will topical antimicrobial treatments help reduce the risk of infection and improve wound healing?
- Which is the most effective lavage pressure for flushing this wound?

A1. Is **tap water** as effective as saline for flushing wounds?

Veterinary publications

One study was identified; none met inclusion criteria.

Human publications

No NICE guidelines were found. There were two systematic reviews in the JBI database, and one in the Cochrane database. The first JBI review concluded there was no difference in infection and healing rates of acute or chronic wounds cleansed with either tap water or normal saline [5]. The second review reported that there was no evidence that using tap water to cleanse acute or chronic wounds in adults increases infection or healing rates, and there is some evidence that it reduces infection when compared to saline. The evidence was not considered strong enough to produce best practice guidelines [6]. The Cochrane review included eleven trials [7]. This review did not find evidence that using tap water to cleanse acute wounds in adults or children increases or reduces infection. There was no difference in infection rates between wounds cleansed with saline versus tap water. Recommendations were that in acute lacerations and soft tissue wounds, drinking quality tap water should be used rather than sterile saline solutions; in the absence of potable tap water, boiled and cooled water or distilled water should be used.

Recommendations

There was no evidence on the effectiveness of tap water vs. saline for lavage in equine wounds. Tap water should be considered for the lavage of equine wounds rather than sterile saline, based on strong evidence in the human literature.

A2. Does use of **antiseptic solutions** for lavage reduce rate of wound infection in horses?
In the veterinary literature, 26 publications were identified on the search, but none met the inclusion criteria. In the human literature, there were no relevant systematic reviews relating to traumatic wounds in the Cochrane or NICE databases. There were two relevant systematic reviews in the JBI database. The first systematic review assessed wound cleansing techniques including those using solutions containing chlorhexidine and povidone-iodine [8]. This review study analysed fourteen randomised controlled trials, three of which assessed povidone-iodine. The final recommendations were that povidone-iodine was an effective cleansing solution for contaminated wounds. The second systematic review was of cleansing solutions for wound treatment, and analysed three studies [6]. There was a trend to a lower infection rate with povidone-iodine vs saline-soaked gauze, but insufficient evidence to produce best practice guidelines.

Recommendations: There were no relevant studies on the effectiveness of antiseptic lavage solutions for cleaning equine wounds. There is limited evidence in the human literature that povidone-iodine is an effective cleansing solution for contaminated wounds.

A3. What is the **best antiseptic** and best **concentrations** for use for primary wound lavage?
In the veterinary literature, 40 publications were identified on the search; none met the inclusion criteria. In the human literature, there was one relevant review in the Cochrane database, and no relevant publications in the NICE or JBI databases. The Cochrane review reported on intra-cavity lavage and wound irrigation for the prevention of surgical site infection [9]. It reviewed 59 randomised controlled trials with 14,738 participants, and compared different methods of irrigation and different solutions. They reported a lower incidence of surgical site infection in patients irrigated with antibacterial solutions compared to non-antibacterial irrigation (30 studies, 5141 participants). The evidence was low-certainty, and the anti-bacterial irrigation included use of antimicrobials as well as antiseptics.
Recommendations
There was no evidence from clinical studies on the optimal concentrations of antiseptics for wound lavage.

A4. Does the use of **topical antimicrobials** reduce rate of wound infection compared to systemic antimicrobials in horses?

Veterinary publications
There were no studies that compared topical and systemic antibiotic use. The study therefore focused on whether the use of topical antimicrobials reduced the rate of infection or increased rate of healing in horses. The primary search identified 127 publications; four met inclusion criteria and were assessed using the

GRADE framework. Three studies investigated the use of silver sulfadiazine cream [10-12], and one study investigated 1% hydrogen peroxide cream [13]. There was low evidence on the effect of topical silver sulfadiazine on the time of wound healing in the horse; most of the current evidence is that it has no effect. There was moderate and consistent evidence that topical silver sulfadiazine reduces microbial load of wounds in the horse [10-12]. Only one study was identified on the effect of topical 1% hydrogen peroxide in the horse, and this was therefore insufficient evidence to draw conclusions [13].

Human publications

There were 21 reviews identified in in the Cochrane database on use of topical silver, two of which were relevant to traumatic wounds [14; 15]. Both reviews concluded there was insufficient evidence to recommend the treatment of silver-containing dressings for infected or contaminated wounds. One review also highlighted the potential cytotoxic effects of silver [15]. The Chronic Wound Management summary in NICE stated that there was currently insufficient evidence to recommend the use of silver sulfadiazine for the treatment of infected or contaminated chronic wounds [16].

Recommendations: Current evidence from the veterinary literature is that silver sulfadiazine reduces antimicrobial load in wounds, but has limited or no effect on rate or quality of wound healing in horses. There was currently insufficient evidence in the human literature to draw conclusions on the use of silver sulfadiazine for the treatment of infected or contaminated chronic wounds. One review highlighted that silver sulfadiazine is cytotoxic and may not be suitable for use in acute wounds.

A5. Which is most effective **lavage pressure** for resolving wound infection in horses?

Veterinary publications

There were 54 papers identified; none met inclusion criteria.

Human publications

There were no publications in NICE. One study in the Cochrane database provided a systematic review of irrigation or lavage to reduce surgical site infections [9]. None of the studies investigated pressure. Two relevant systematic reviews were identified in the JBI databases [5; 6]. Only one review reported on lavage pressure. This review included four trials which assessed pressure for wound cleansing for wounds and ulcers, and concluded that a pressure of 13 psi (12ml syringe with 22g needle) was effective at reducing infection and inflammation in lacerations and traumatic wounds [5].

Recommendations: Based on the human literature, a pressure of 13 psi (12ml syringe with 22g needle) is effective at reducing infection and inflammation in lacerations and traumatic wounds.

Table 3: Summary of key recommendations for wound lavage in the horse

Recommendations for lavage of contaminated wounds in horses

- Clean, potable tap water can be considered instead of saline for lavaging wounds
- Use of povidone iodine may be beneficial for contaminated wounds
- Lavage pressures of 13psi (12ml syringe with 22g needle) are recommended for traumatic wounds
- Currently there is insufficient evidence to draw conclusions on the use of other antiseptics or topical antimicrobials (including silver)

B. Wound debridement and closure

The full methodology and results for the six topics relating to wound debridement and closure are presented in Supplementary Item 2. The findings are presented around a case study requiring wound debridement, and the key recommendations presented in Table 4.

Clinical Scenario

A horse presented after being found in its box with its leg trapped between two portions of the box wall. There was extensive soft tissue damage to the dorsal metatarsus, exposing the underlying bone and causing large areas of potentially devitalised tissue (Figure 2). There was gross contamination visible over the surface of the wound. Investigation of the wound determined that the synovial structures were not involved; the total nucleated cell count and total protein of fluid aspirated from the tarsometatarsal and tarsocrural joints were within normal limits.

Clinically relevant questions relating to this case considered by the panel are:

- Should the wound be debrided with sharp debridement, scrub pads, chemical debridement, larval debridement or hydrosurgery?
- Should the wound be closed with staples or sutures?

B1. Does the use of **sharp debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses compared to wounds that are not treated with sharp debridement?

This evidence assessment for this area was not conducted as an appropriate PICO could not be constructed.

B2. Does the use of **scrub pads** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses compared to wounds that are not treated with scrub pads?

Veterinary publications

Two publications were identified through the search. None met the inclusion criteria.

Human publications

No relevant systematic reviews were identified in the Cochrane or JBI databases. One medical technologies guidance document was identified in NICE [17]. This considered evidence from 15 multiple-patient case-series reports on the Debrisoft monofilament debridement pad. There were no randomised controlled trials. The review concluded that the Debrisoft pad should be considered as part of management of acute and chronic wounds, and is cost saving compared to the use of hydrogel, gauze or bagged larvae [17].

Recommendations

There is no evidence within the veterinary literature, and low level evidence in the human literature. Debrisoft debridement pads are recommended for acute and chronic wounds in people and should be considered for equine wounds.

B3. Does the use of **chemical debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses compared to wounds that are not treated with chemical debridement?

Veterinary publications

Fourteen publications were identified through the search. One study met the inclusion criteria and was assessed using the GRADE framework [18]. This was an interventional study which created excessive granulation tissue, and compared chemical debridement with pressure bandage application and sharp debridement. The authors described a reduction in wound healing time but no details were given of how wound healing was assessed. There was therefore insufficient evidence to draw any conclusions.

Human publications

There no recommendations within NICE and no relevant reviews in the JBI database. One relevant systematic review was identified in the Cochrane database. It evaluated the evidence on chemical debridement of infected surgical wounds [19]. This identified five randomised clinical trials (159 participants), which investigated streptokinase/streptodornase (one trial) and dextramoner beads or paste (four trials) [19]. The variation and poor methodological quality meant that no conclusions could be drawn to guide clinical decision-making.

Recommendations

There is currently insufficient evidence in either the human or veterinary literature to draw any conclusions about the use of chemical debridement in wounds.

B4. Does the use of **larvae debridement** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses compared to wounds that are not treated with larvae debridement?

Veterinary publications

Two publications were identified through the search [20; 21]. Both met the inclusion criteria and were assessed using the GRADE framework. Both were retrospective case series, and the evidence was of very low quality. No recommendation can be made for the use of maggot therapy as an appropriate method of wound debridement in horses [20; 21]. However, a positive outcome was reported in selected cases where conventional methods of wound debridement had failed or were not practical, for example: necrotic hoof defects and deep-seated abscesses on the trunk.

Human publications

There were no Cochrane or JBI reviews on traumatic wounds. One systematic review was identified in the Cochrane database on "the debridement of diabetic foot ulcers" [22]. This reviewed six Randomised Controlled Trials (RCTs), one of which compared the use of maggots to hydrogels for the debridement of diabetic foot ulcers [23]. The RCT had significant limitations, mainly due to the short duration of the study (10 days), but did show good evidence of a more rapid wound contraction rate (50% wound contraction rate) in larval treated wounds compared to hydrogels for wound debridement.

Recommendations

There is currently only very weak evidence to show the use of maggot therapy is an effective method of wound debridement in both the veterinary and human literature. However, a positive outcome was reported in selected equine cases where conventional methods of wound debridement have failed or are not practical, for example: necrotic hoof defects and deep-seated abscesses on the trunk.

B5. Does the use of **hydrosurgery** reduce the duration of healing/reduce the rate of infection/improve the cosmetic or function outcome of wound healing in horses compared to wounds that are not treated with hydrosurgery?

Veterinary publications

Six publications were identified through the search. One met the inclusion criteria and was assessed using the GRADE framework [24]. This study measured *Staphylococcus Aureus* colony forming units post debridement in equine cadaver muscle tissue. It reported that these were significantly reduced with hydrotherapy compared to sharp debridement, lavage, and lavage and sharp debridement. The evidence has limitations around applicability to clinical situations, and only addressed one aspect of wound healing so further evidence is needed.

Human publications

No systematic reviews were identified in the Cochrane database, but there were 15 trials listed; six involved burn injuries, and five involved ulcers, so were therefore excluded. Two studies reported reduction in surgery times, and one reported a reduction in bacterial burden with hydrosurgery compared to sharp surgery. No systematic reviews were identified in the JBI database.
NICE had one Medtech Innovation Briefing document on the Versajet II hydrosurgery system published in 2014 [25]. This reported on six randomised controlled trials and four non-randomised comparative studies for the original Versajet, and there was no evidence on the Versajet II. The conclusions were: the Versajet system was similar or faster to comparators for wound debridement, healing or wound closure was no different or shorter with the Versajet system, the degree of pain experienced was no different.

Recommendations

There is very limited evidence that hydrosurgical debridement reduces bacterial load in equine tissue, but this has not been evaluated equine clinical practice, with typical contaminated and infected wounds. In humans there is limited evidence that hydrosurgery reduces the time to closure of acute contaminated wounds compared to sharp debridement, and very limited evidence that it can reduce the rate of infection in contaminated wounds.

B6. Does the use of **staples** for wound closure in horses increase the risk of wound dehiscence compared to wounds closed with sutures?

Veterinary publications

Thirteen publications were identified. None related to traumatic wounds. The search was expanded to include surgical wounds two studies then met the inclusion criteria. These were assessed using the GRADE framework. One study compared staples with sutures for closing laryngotomy incisions and the other for celiotomy incisions. Based on these, there was conflicting very low quality evidence on the risk of surgical site infections for surgical incisions closed with sutures compared to staples in the horse.

Human publications

There were no recommendations in NICE and no systematic reviews in Cochrane or JBI databases on differences between staples and sutures for closure of traumatic wounds. Two systematic reviews were identified in the human literature that compared skin sutures and staples for closure of surgical incisions [26; 27]. One was a systematic review of 11 systematic reviews, including 13,661 cases across a range of surgical procedures. The conclusions were that closure of the wound with staples reduced mean operating time, but there was no clear evidence that use of staples compared to sutures affected the rate of surgical site infection, post surgical complications, or length of hospital stay [27]. The other was a systematic review comparing skin closure with staples or sutures for orthopaedic

surgery, which reviewed 13 studies. The findings were again that the only difference was in closure time, and there were no significant differences in the rate of surgical site infection or wound complications between incisions closed with staples or sutures [26].

Recommendations

There is currently no evidence in the human or veterinary literature that the rate of surgical site infection is higher with staples or sutures for the closure of surgical incisions. The only difference identified was a reduction in surgery time associated with the use of staples. The final decision on which type of skin closure to use will depend on individual aspects of each case (including skin tension/area to be closed, cost of materials, and need for reduced surgery time).

Table 4: Summary of key recommendations for wound debridement and closure in the horse

Recommendations for lavage of contaminated wounds in horses
• Scrub pads should be considered for mechanical debridement of wounds • Larval debridement can assist with debridement of wound that are chronic/difficult to access • Hydrosurgery should be considered for heavily contaminated wounds • There is currently insufficient evidence to determine if the use of staples compared to sutures affects the likelihood of wound infection

C. Therapeutics to enhance wound healing

The full methodology and results for the three topics relating to therapeutics to enhance wound healing are presented in Supplementary Item 3. The findings are presented around a case study requiring long term wound management and an injury that will cause extensive scarring, and the key recommendations presented in Table 5.

Clinical Scenario

In the horse presented in Figure 1, the dorsal fetlock wound was initially treated with debridement and has been healing by secondary intention, and at approximately 3 weeks, the wound is now filled with granulation tissue (Fig 3). There is a large defect remaining, and the owner is keen to explore options of enhancing wound healing.

Clinically relevant questions relating to this case considered by the panel are:

- Will the use of topical Manuka honey, laser therapy or therapeutic ultrasound improve healing time or cosmetic outcome?

C1. Does the use of **topically applied manuka honey** on contaminated equine wounds, hasten the healing time or improve the cosmetic outcome?

Veterinary publications

Five publications were identified; four met the inclusion criteria and were assessed using the GRADE framework [28-31]. The quality of evidence for two studies was low [28; 31], and for one study was very low [30]. The evidence that manuka honey improves the speed of healing was moderate quality and for the early phase (up to 21 days) only. There was a lack of good quality evidence that manuka honey improves the overall duration of wound healing or the final cosmetic appearance.

Human publications

There were no recommendations in NICE or relevant reviews in the JBI or Cochrane databases on Manuka honey.

When the search was broadened to "honey" there were NICE recommendations regarding chronic wounds, which stated that there was little good quality evidence to support the use of antimicrobial dressings (e.g. honey, iodine or silver) in the treatment of chronic wounds [32]. The Cochrane database had one systematic review on honey [33], which reported that there was good quality evidence that partial-thickness burns heal more quickly when treated with honey compared to other dressings. There was no difference in healing time with honey compared to silver sulphadiazine, although there was moderate evidence of fewer adverse effects with honey compared to silver sulphadiazine. There was poor quality evidence that honey caused a more rapid healing in acute and chronic wounds, and moderate quality evidence that honey applied to post-operative wounds resulted in a quicker resolution compared to antiseptics and gauze.

Recommendations: Based on the veterinary literature, manuka honey improves the speed of early healing only (up to 21 days) (moderate quality evidence), but there is insufficient evidence of a positive effect long term or on final cosmesis. Based on the human literature, honey may increase the speed of healing in acute and chronic wounds (poor quality evidence), post-operative wounds (moderate quality evidence) and partial-thickness burns (good quality evidence).

C2. Does the use of **laser therapy** reduce the duration of wound healing time/improve the cosmetic or functional outcome in horses?

Veterinary publications

Two studies met the inclusion criteria and were assessed using the GRADE criteria [34; 35]. There was low quality evidence that the use of laser therapy had no effect on duration of healing or cosmetic outcome in horses.

Human publications

There were no recommendations in NICE or relevant reviews in the JBI database. Two reviews were identified in the Cochrane database [36; 37], which assessed 15 randomised controlled clinical trials investigating the effect of phototherapy (including laser therapy) on healing of pressure ulcers (seven articles) and foot ulcers (eight articles). The quality of the evidence was judged to be very low with

regards to pressure ulcers and low with regards to foot ulcers. The low evidence with foot ulcers suggested that phototherapy (including laser therapy) compared to placebo may increase the proportion of wounds that healed and may reduce wound size. Studies with standardised settings (type and energy of laser) and randomised controls are required.

Recommendations: There is currently insufficient evidence to determine whether laser therapy provides benefits in wound healing in the horse.

C3. Does the use of **therapeutic ultrasound** reduce the duration of wound healing time/improve the cosmetic or functional outcome in horses?
Veterinary publications.
No relevant publications were identified.

Human publications.
There were no relevant publications in NICE or the JBI database. The Cochrane database had two systemic reviews of therapeutic ultrasound and wound healing [38; 39]. These reviews included 11 clinical trials (venous leg ulcers) and three trials (pressure ulcers). Both reviews concluded that there was no evidence that ultrasound therapy improved wound healing of venous or pressure sores. There was very low quality evidence from one review that ultrasound therapy may increase the risk of non-serious adverse events (pain and bleeding) [38].

Recommendations: There is currently no evidence that evaluates whether therapeutic ultrasound improves wound healing in the horse.

Table 5: Summary of key recommendations for therapeutics to enhance wound healing in the horse.

Recommendations for lavage of contaminated wounds in horses
• Topical application of honey may reduce the duration of wound healing for some wounds • There is currently insufficient evidence to determine if laser therapy or therapeutic ultrasound improves wound healing

Discussion

Summary

Evidence summaries were collated and used to generate guidelines on 13 topics relating to wound management in the horse. Evidence was only available within the veterinary literature for six topics, and the quality of evidence for these was low. The majority of recommendations are therefore based on the human literature. The recommendations covered three main areas – wound lavage, treatment and therapeutics. High quality evidence was lacking for most areas, due to either lack of high quality studies, or conflicting results between different studies. There was low quality evidence that povidone-iodine lavage solutions may reduce the risk of infection, but no conclusions on optimal concentrations. There was high quality evidence that tap water could be used instead of sterile saline for wound lavage, and low quality evidence to support the use of lavage pressures of 13 psi. The debridement questions related to the use of mechanical and chemical debridement techniques. It highlighted the potential value of mechanical debridement techniques, including debridement pads, larvae debridement and hydrosurgery, although the evidence on these was low quality due to limited studies. The therapeutics questions covered the use of honey, laser therapy and therapeutic ultrasound. There was some evidence that honey increased the speed of healing for some types of wounds (partial burns in humans) and some phases of early wound healing, but there was limited or no evidence that it improved the overall healing time or cosmetic outcome. This study has highlighted that there is currently a lack of evidence to draw conclusions on the use of a range of treatments, including the use of silver dressings, chemical debridement, laser therapy and ultrasound therapy.

Study limitations

The panel did not receive formal training in database search methodology, or receive formal training in GRADE evidence appraisals. Each of the study appraisals were performed by a single panel member, and were not duplicated. A full systematic review for each topic was not performed, as the time and resources required to perform this was beyond the scope of this study. This project was aimed at developing guidelines for clinical equine practice, and therefore limited to primary evidence appraisal to studies conducted in horses or horse models. Data from other species is likely to be transferrable however. There is a large body of evidence on wounds from human studies and experimental studies in other animal models, which would require a significant time and resource investment to review. This study used a similar approach to the initial stages of an umbrella review - identifying key sources of human literature, and using PICO questions and inclusion criteria to identify evidence [40]. An umbrella review would then require critical appraisal of each study, and tabulated data extraction and summary of findings [40]. Again, this was not performed, due to limitations of time. This study therefore represents a review of the current equine and human evidence, but a full appraisal would require systematic and umbrella reviews to be performed for each topic.

Justification for search methodology

The initial searches in evidence databases were conducted to determine whether bodies of appraised and consolidated evidence already existed. There are two main sources for veterinary evidence summaries. VetSRev is a database maintained by the Centre of Evidence Based Veterinary Medicine, University of Nottingham (webapps.nottingham.ac.uk/refbase/). It is an open access resource which collates lists of systematic reviews relating to veterinary medicine, established in 2013, and is currently updated monthly. This database was searched first to identify whether there were any recent or existing evidence summaries relevant to the categories and clinical questions. Veterinary Evidence is the online journal developed by the Royal College of Veterinary Surgeons (www.veterinaryevidence.org/index.php/ve/search). It publishes knowledge summaries and studies relating to evidence-based veterinary medicine. It is available free online, and was launched in 2015, the articles published there are not currently available through the main medical databases (CAB abstracts, PubMed or Medline).

There are a number of databases that include publications of veterinary studies. This study was being conducted by a range of different researchers, working at different locations, including private practice and University, and therefore two key databases were used to simplify the search strategies. Medline and CAB abstracts are the two main databases identified by Grindley *et al*. (2012) as most appropriate for evidence searches for veterinary studies [4].

The human evidence summary searches were conducted in Cochrane, NICE and JBI reviews (http://www.cochranelibrary.com/topic/Wounds/, https://www.nice.org.uk/guidance/conditions-and-diseases/injuries--accidents-and-wounds, https://journals.lww.com/jbisrir/Pages/default.aspx). Cochrane is one the leading sources of evidence-based health care information, with the Cochrane Library holding over 7500 systematic reviews. It collates evidence on relating to human health and medicine. NICE is the National Institute for Health and Care Excellence, based in the UK, and provides national guidance and advice to improve health and social care. Their guidance information includes NICE guidelines (evidence-based recommendations on topics), technology appraisal guidelines (assessing the clinical and cost effectiveness of health technologies), medical technologies and diagnostics guidance, and interventional procedures guidance. JBI reviews is the journal that publishes systematic reviews conducted using the JBI methodology, as well as implementation reports. These were selected as key sources of information for human medicine, but a number of other databases and evidence sites are also available for human medicine.

Justification for GRADE evidence appraisal.

There are a number of different evidence appraisal systems, including detailed data assessments such as the Cochrane and JBI-Mastari systematic reviews, and condensed evidence summaries such as CATs, BestBets and Knowledge Summaries. The GRADE system is more flexible, and allows for interpretation of evidence against the clinical environment [41; 42]. This includes assessing whether outcomes are important or critical, whether the outcomes are applicable to different clinical settings and subgroups, and any clinical, ethical or financial constraints that may affect how the data is interpreted. The GRADE system

is the system recommended by BEVA for the development of clinical practice guidelines [2], and has been previously used by ACVIM [43]. A full systematic review for each topic was beyond the scope of this study.

Summary

This evidence review has highlighted the need for high quality evidence in the veterinary literature across all areas of wound management. The majority of the recommendations are based on data from human studies. The main recommendations on wound lavage were for the use of tap water instead of saline for lavage, the use of medium lavage pressures (13psi), and the potential use of antiseptics for contaminated wounds. In human medicine, there is insufficient evidence to draw conclusions around the use of topical silver for infected or contaminated wounds, and evidence of cytotoxicity. Silver is commonly used in veterinary practice and further research is required to determine whether it is used appropriately. The main recommendations on wound debridement related to the potential benefits of mechanical debridement methods (debridement pads, larvae and hydrosurgery) for selected cases, and there was insufficient evidence to make recommendations on the use of chemical debridement. In terms of therapeutics for wound healing, there is currently insufficient evidence on the effects of therapeutic ultrasound and laser therapy, and the evidence on honey shows some benefits for specific types of wounds or phases of healing, but limited or no evidence of an increase in overall healing or cosmetic outcome. The findings of this study should be incorporated into evidence-based veterinary practice and considered against each individual case to determine the optimal treatment.

Authors' declaration of interests

No competing interests have been declared.

Ethical animal research

Not applicable.

Owner informed consent

Not applicable.

Data accessibility statement

Not applicable.

Authorship

All authors contributed to the generation of clinical questions, the study design and evidence appraisal. The involvement of each author for each topic is provided in Supplementary Items 1-3. All authors contributed to, reviewed and approved the final recommendations, and the final paper for submission.

Figure legends

Fig 1: A two-year-old Thoroughbred filly presented after falling during transport. The filly pulled its shoe off and sustained this injury over the fetlock from the loose shoe whilst scrambling back to its feet. The extensor tendons are exposed, but the fetlock joint capsule was intact. There are limited facilities available for cleaning the wound and the owner has limited finances. The pertinent topics being addressed by the panel were whether they could make recommendations on lavage techniques and whether antimicrobial treatments help reduce the risk of infection and improve wound healing? *Image provided courtesy of Dr G. Quinn*.

Fig 2: This horse presented after being found in its box with its limb trapped between two portions of the box wall. There was extensive soft tissue damage to the metatarsus, exposing the underlying bone causing large areas of potentially devitalised tissue. There was gross contamination visible over the surface of the wound. Investigation of the wound determined that the synovial structures were not involved; the total nucleated cell count and total protein of fluid aspirated from the tarsometatarsal and tarsocrural joints were within normal limits. The pertinent topics being addressed by the panel related to wound debridement and closure. *Image provided courtesy of Dr C. Osborne.*

Fig 3: In the horse presented in Figure 1, the dorsal fetlock wound initially treated with debridement has been healing by secondary intention, and at approximately 3 weeks (Fig 3), the wound is now filled with granulation tissue. There is a large defect remaining, and the owner is keen to explore options of enhancing wound healing. The pertinent topics being addressed by the panel related to interventions to enhance wound healing. *Images provided courtesy of Dr G. Quinn.*

Supporting Information

Supplementary Item 1: Full methodology and results for five topics relating to wound lavage and topical treatments, including details of PICO questions, and GRADE summary of findings and evidence profiles for veterinary publications, where appropriate.

Supplementary Item 2: Full methodology and results for six topics relating to wound debridement and closure, including details of PICO questions, and GRADE summary of findings and evidence profiles for veterinary publications, where appropriate.

Supplementary Item 3: Full methodology and results for three topics relating to therapeutics to enhance wound healing, including details of PICO questions, and GRADE summary of findings and evidence profiles for veterinary publications, where appropriate.

Supplementary Item 4: Publications related to wounds identified from searches of veterinary evidence databases (VetSRev and Veterinary Evidence).

Supplementary Item 5: Number of publications identified in the literature searches and included in the final evidence appraisals for the veterinary and human publications.

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