Wound Medicine 27 (2019) 100167

Contents lists available at ScienceDirect

Wound Medicine

journal homepage: www.elsevier.com/locate/wndm

Original research article

Best practice recommendations for silver wound dressings: Results of an expert survey aiming to reach a consensus☆
Best Practice zu Silber-Wundverbänden

Böttrich J G[a,*], Braunwarth H[b], Dissemond J[c], Münter K C[d], Schümmelfeder F[e], Wilken P[f]

[a] B. Braun Melsungen AG, Melsungen, Germany
[b] Coloplast GmbH, Hamburg, Germany
[c] Klinik für Dermatologie, Venerologie und Allergologie, Universitätsklinikum Essen, Germany
[d] Gemeinschaftspraxis Bramfeld, Hamburg, Germany
[e] Smith & Nephew GmbH, Hamburg, Germany
[f] URGO GmbH, Sulzbach, Germany

ARTICLE INFO

Keywords:
Best practice
Silver
Local antimicrobial therapy of wounds
Wound infection
Consensus

ZUSAMMENFASSUNG

Akute und chronische Wunden mit lokalen Infektionszeichen oder einer kritischen Kolonisation stellen in der Versorgung eine interdisziplinäre und interprofessionelle Herausforderung in der Medizin dar. Bislang existiert keine nationale Best Practice Empfehlung für die Anwendung von Silber-Wundverbänden.

Ziel dieser Arbeit war es daher, eine Sammlung von Best Practice Statements basierend auf einer strukturierten Befragung zu erstellen. Es wurden insgesamt 49 Statements formuliert und Wundexperten zur Konsentierung vorgelegt. Für insgesamt 29 Statements ergab sich eine Zustimmung von ≥ 75%.

Somit liegt jetzt zum ersten Mal eine konsentierte Zusammenstellung von Best Practice Statements für die Anwendung von Silber-Wundverbänden für die lokale antimikrobielle Wundtherapie vor.

Schlüsselwörter: Best Practice, Silber, lokale antimikrobielle Wundtherapie, Wundinfektion, Konsentierung

ABSTRACT

Acute and chronic wounds with signs of local infection or critical colonisation pose an interdisciplinary and interprofessional challenge in the fields of medicine. A national best practice recommendation for the use of silver dressings does not yet exist.

Therefore, it was the aim of this project to develop a collection of best practice statements on the basis of a structured survey. Overall, 49 statements were developed and presented to wound experts with the aim to find a consensus. For 29 statements an agreement rate of 75% or more was achieved.

Thus, for the first time a consensus-based collection of best practice statements for the use of silver dressings in the local antimicrobial therapy of wounds is available.

1. Introduction

Treating wounds with signs of local infection or critical colonisation poses a real challenge from both an interdisciplinary and an interprofessional perspective.

In the face of the growing problem of multi-drug resistance in bacteria, the World Health Organization (WHO) has warned that we are fast approaching the “post-antibiotic era” [1]. This is one of the reasons why local antimicrobial therapy is gaining more and more importance. Although there is a long tradition of using silver in local wound care, scientific evidence has often been and still is the subject of controversy. In Germany, there are no generally binding guidelines for the use of silver in local antimicrobial wound management. However, international recommendations have been published on this subject [2]. In

☆ The following paper is a translation of the original German version published under the title: Best Practice zu Silber-Wundverbänden – Ergebnisse einer Expertenumfrage mit dem Ziel einer Konsentierung. WUNDmanagement 2018; 12(6): 311–321.

* Corresponding author at: B. Braun Melsungen AG, Medical Scientific Affairs OPM, Pfieffewiesen – Europagebäude A2, 34212, Melsungen, Germany.
E-mail address: johannes_georg.boettrich@bbraun.com (J.G. Böttrich).

https://doi.org/10.1016/j.wndm.2019.100167
Received 20 May 2019; Accepted 22 July 2019
Available online 05 August 2019

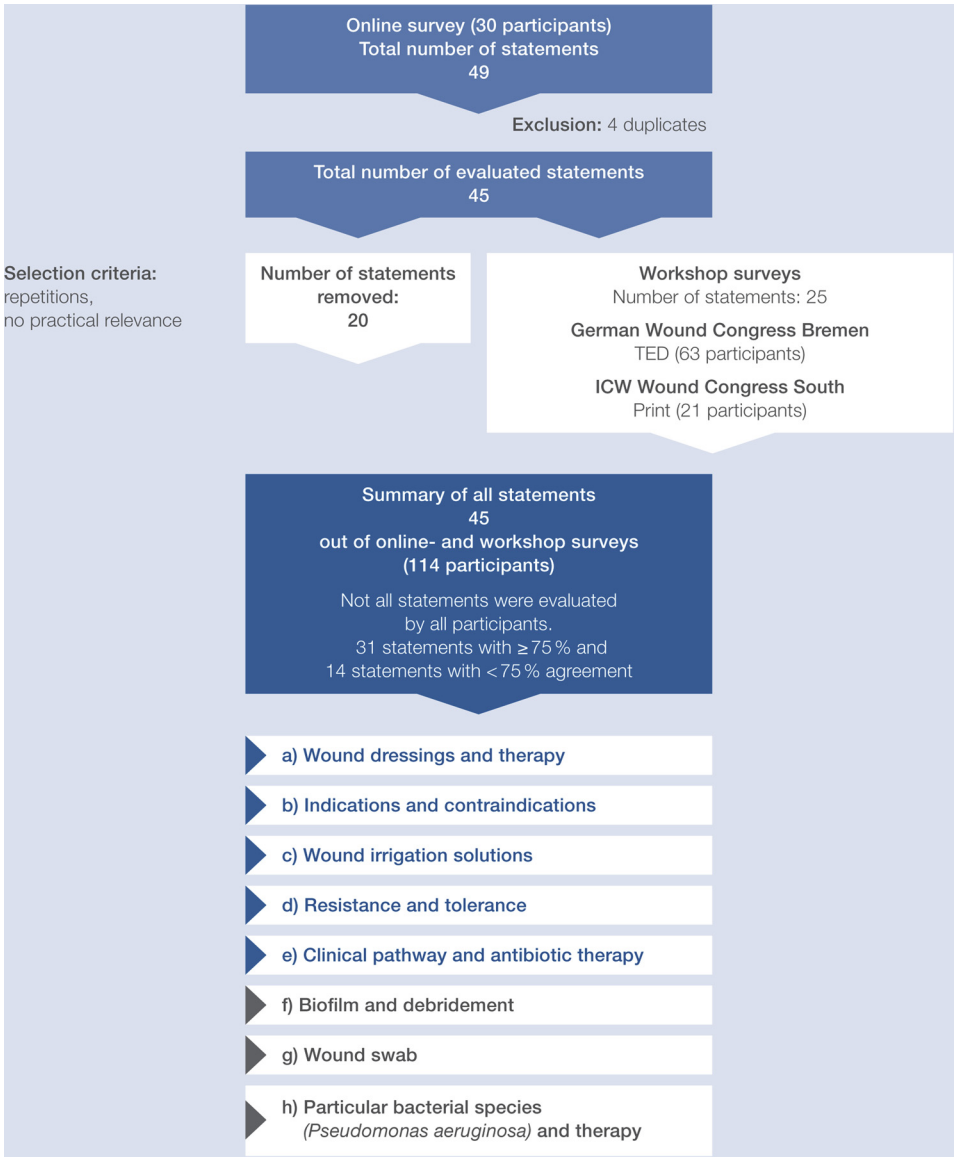

Fig. 1. Overview of the consensus procedure for Best Practice Statements. The project group developed a total of 49 statements which were then assessed in an anonymous online survey. In another two workshop surveys 25 statements were voted on anonymously using a printed questionnaire (German Wound Congress in Bremen in May 2017) and a TED voting system. The results were summarised by the project group and then analysed with the help of the external experts of this paper. The statements belonging to categories a) to e) formed part of the online survey and the two workshop surveys, while the statements belonging to categories f) to h) were only assessed in first online survey.

existing guidelines on local treatment of chronic wounds [3], on the management of postoperative wound infections [4] as well as on wounds and wound healing [5] local antimicrobial treatment is explicitly excluded [3] or only generally mentioned [4,5], or these guidelines merely provide a drug-based evaluation of little practical relevance [6–9]. A national data-based best practice recommendation for therapists has so far not been issued.

Based on a literature analysis, this article therefore presents Best Practice Statements derived from expert opinions. It was prepared under the guidance of an intercompany project group named “Local antimicrobial management of wounds using silver” within the German Medical Technology Association (BVMed).

2. Material and method

On the basis of a structured literature analysis on antimicrobial wound therapy using silver dressings, the project team developed recommendations from a practical perspective in the form of 49 statements.

These 49 statements were then submitted for online approval and independently of each other to wound care experts from medicine and nursing. The wound care experts had been individually addressed in writing by members of the project group and invited to participate in the online survey. The experts could anonymously evaluate each statement choosing from “fully agree”, “mainly agree”, “neither agree nor disagree”, “mainly disagree” and “fully disagree”. Following the analysis of the results of the online survey, these 49 statements (minus 4 duplicates = 45) were condensed by the project group to give 25 statements which were then – within the scope of a survey – presented to a total of 84 wound care experts in two different workshops with the aim of finding a consensus (Fig. 1).

For each statement the level of agreement was determined. To this purpose, the ratings “fully agree” and “mainly agree” were added together and interpreted as approval. A level of agreement of 75% or more was viewed as consensus [10].

3. Qualification and experience of experts participating in the evaluation

In February 2017, a total of 63 wound care experts from the fields of medicine and nursing were invited to participate in the first online consensus survey of the final statements; 30 of these experts voted anonymously. Overall, 84 experts participated in the two surveys that were conducted during the workshop “Silver – at the crossroads

Table 1
Basic data on the persons participating in the evaluation*.

Professional data	Online evaluation (n = 30)	ICW Süd Würzburg (n = 21)	German Wound Congress Bremen (n = 63)	Total (n = 114)
Qualified nurse	22	11	55	88
Physician	8	2	1	11
Other	0	3	4	7
	30	16	60	106
Works in …				
Inpatient facility	12	11	37	60
Outpatient facility	13	3	15	31
Physician's practice	4	1	6	11
Home care service	–	2	2	4
Nursing facility	1	3	–	4
	30	20	60	110
Number of years of professional experience				
< 1	0	0	0	0
2-3	0	0	4	4
4-5	0	0	5	5
> 5	30	20	54	104
	30	20	63	113
Wound care experts				
ICW	22	13	34	69
DGfW	5	4	7	16
Other qualification	0	2	8	10
No wound care expert	4	2	12	18
	31	21	61	113

* For reasons of clarity, cases where no information was provided by the respondent were not included in the count; this may result in inconsistencies between the sums given in the first three columns and the total number of participants (n).

between evidence and practice in wound care", which was part of the ICW-Süd Congress in Würzburg on March 10, and the workshop "Best Practice Statements on Silver Dressings – Results of an Expert Consensus Survey", which took place at the German Wound Congress DeWu on May 11, 2017 in Bremen. The wound care experts predominantly worked in the field of nursing (83%) and had many years of practical experience (Table 1). Overall, 92% of the respondents claimed to have more than five years of professional experience, and slightly more than half of the participants came from inpatient care settings (54%) (Table 1). Information about the participants is listed in Table 1.

4. Results

For 31 statements (Table 3 and 4) the level of agreement was 75% or more (i.e., in 69% of the cases), and for 14 statements (Table 2) it was below 75% (i.e., in 31% of the cases). A level of agreement of 90% or more (i.e., in 24%) was achieved for 11 statements (Table 4).

Agreement was highest (100%) with statement 6 ("… adjuvant systemic antibiotic therapy should only be used with strict medical indications and should under no circumstances be applied in a general fashion"). The lowest level of agreement (30%) was recorded for statement 18 ("The use of silver dressings alone without antibiotic wound irrigation is basically adequate") and statement 22 ("When changing wound dressings, the wound must, first of all, be irrigated with an antimicrobial / antiseptic solution").

The particular statements and their evaluations are shown in Table 2.

5. Discussion

The majority of statements has gained a high level of acceptance of 75% or more, which confirms that there is a common understanding among practitioners and a uniform approach although a binding

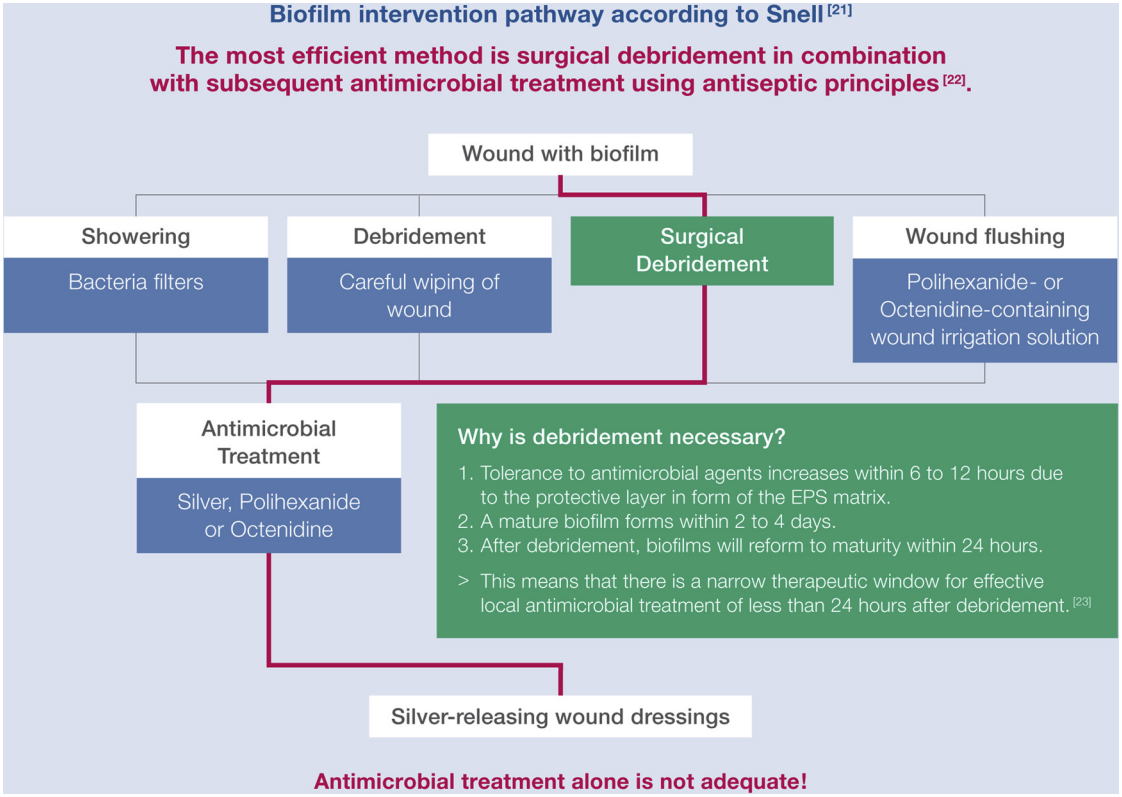

Fig. 2. General clinical pathway for treating biofilms in wounds. Surgical debridement combined with antimicrobial follow-up care making use of antiseptic modes of action has proven to be the most effective method [21–24]. EPS: extracellular polymeric substances.

Table 2
Results of votes on the evaluation of statements. The table indicates the number of times that the respective rating was mentioned.

Nr.	Statement	1) I fully agree	2) I mainly agree	3) I neither agree nor disagree	4) I mainly disagree	5) I fully disagree	6) Total	7) Agree-ment 1 + 2 absolute	8) Agree-ment 1 + 2 in %
1	The decisive factor when selecting a silver wound dressing is not the form of the silver (e. g., ionic or metallic), but the availability of silver ions (Ag^+): in all forms, silver ions are the active principle.	44	42	9	11	6	112	86	77
2	The decisive factor in the choice of a wound dressing is that silver ions are released and that the selection of the silver dressing is made dependent on the condition of the wound and the level of exudate.	18	10	2	0	0	30	28	93
3	The distinction between locally infected and critically colonised wounds has no influence on the practitioner's treatment decision, the choice of silver dressing, and the frequency and form of the wound assessments.	26	44	8	13	18	109	70	64
4	In wounds with established local infection the principle applies that "local infection is treated by local antimicrobial therapy".	43	43	11	13	4	114	86	75
5	Wound contamination / colonisation is not an indication for the use of silver wound dressings.	43	29	10	20	11	113	72	64
6	Practitioners often use adjuvant systemic antibiotics to treat locally infected / critically colonised wounds. However, adjuvant systemic antibiotic therapy should only be used with strict medical indications and should under no circumstances be applied in a general fashion.	25	5	0	0	0	30	30	100
7	Contrastingly, contamination / colonisation with multidrug-resistant organisms (MDROs) *is* an indication for silver dressings.	42	38	13	12	6	111	80	72
8	The criteria for selecting silver dressings do not differ from those for selecting wound dressings without silver. The appropriateness of a wound dressing is mainly determined by the status of the wound (slough, level of exudate, wound depth) and the condition of the surrounding skin.	77	20	5	10	2	114	97	85
9	The criteria for silver dressing selection (alginate, fibre, foam, gauze etc.) do not depend on the aetiology of the wound.	43	37	8	17	2	107	80	75
10	The clinical pathway (see Fig. 2) for the use of silver dressings is relevant to clinical practice and considered applicable.	58	36	11	6	2	113	94	83
11	There is no classic 'resistance' to the silver contained in wound dressings as it is seen with antibiotics; at most, there is a risk of tolerance to silver.	63	29	13	6	2	113	92	81
12	There is no classic 'resistance' to the silver contained in wound dressings as it is seen with antibiotics; at most, there is a risk of tolerance to silver.	5	11	3	8	3	30	16	53
13	The following principles apply: local infection is treated by local antimicrobial therapy; systemic infection is treated systemically (by systemic antibiotics). Since transition from local to systemic infection can happen seamlessly, adjuvant systemic antibiotic therapy should in certain cases be considered at an early stage, e. g., in multimorbid, immunocompromised patients or patients with a similar wound condition.	45	27	2	1	2	77	72	94
14	The level of silver required in the wound has not yet been conclusively identified. The reason is that it is very difficult to determine the concentration of active silver ions in a wound and that some of them are bound in the wound exudate, e. g. by proteins.	15	10	4	1	0	30	25	83
15	The total amount of silver or silver ions contained in the various wound dressings varies considerably. If local antimicrobial action in the wound is desired, it is essential that the dressing delivers silver ions to the wound site and that there is in-vitro and clinical evidence of antimicrobial efficacy.	20	9	1	0	0	30	29	97
16	In support of systemic therapy, it can be useful to perform local antimicrobial wound therapy with silver dressings since the effective concentration of antibiotics can be lowered by tissue- and bone penetration.	18	10	1	1	0	30	28	93
17	Topical antiseptics do not permeate into the deeper tissue layers. Their effect is largely limited to the wound surface, and this is also true of silver dressings.	9	3	2	6	0	20	12	60
18	The use of silver dressings alone without antibiotic wound irrigation is basically adequate.	3	6	5	10	6	30	9	30
19	Basically, wound cleaning is recommended, if necessary, by using an irrigation solution with or without preservative (antimicrobial) additives.	75	29	3	4	3	114	104	91
20	The use of silver dressings after applying a wound irrigation solution with or without preservative (antimicrobial) additives should be well targeted and limited to the critical phase of wound healing.	56	32	5	10	11	114	88	77

(*continued on next page*)

Table 2 (*continued*)

Nr.	Statement	1) I fully agree	2) I mainly agree	3) I neither agree nor disagree	4) I mainly disagree	5) I fully disagree	6) Total	7) Agree-ment 1 + 2 absolute	8) Agree-ment 1 + 2 in %
21	Because of potential interactions between silver dressings and the ingredients of wound irrigation solutions, manufacturers' instructions should be followed.	28	1	1	0	0	30	29	97
22	When changing wound dressings, the wound must, first of all, be irrigated with an antimicrobial / antiseptic solution.	4	5	3	9	9	30	9	30
23	Clinical signs of successful local antimicrobial wound therapy with silver dressings are: – reduction of wound odour, – decrease in the amount of exudate, – reduction in wound size, – reduction of microbial burden in the wound (swab / biopsy), – reduction of the classic signs of infection. The five classic signs of infection are: redness (rubor), swelling (tumor), heat (calor), pain (dolor) and loss of function (functio laesa).	87	23	1	2	0	113	110	97
24	The diagnosis of local wound infection is based on the five classic clinical signs of infection: redness (rubor), swelling (tumor), heat (calor), pain (dolor) and loss of function (functio laesa). Local wound infection, however, does not require the presence of all five signs of infection; for example, patients with neuropathy may be unable to perceive wound pain.	67	12	0	0	2	81	79	98
25	Prophylactic use of silver wound dressings is the exception rather than the rule: they can be a sensible choice for patients at high risk of infection or for cases where the risk of infection is increased by the location of the wound. Examples are: – ulcerating cancer wounds in the palliative setting, – delayed amputation in patients with peripheral artery disease, – CEAP 6 accompanied by severe sclerosis (CEAP 6: active venous leg ulcer), – wounds in the perianal region which are at risk of contamination with intestinal bacteria, – immunosuppressed patients, – entry / exit sites of tracheostomy tubes, external fixators, postoperative wound drainages, chest tubes, central venous catheters, dialysis- and epidural catheters.	50	32	11	17	2	112	82	73
26	Silver dressings should be applied to "sloughy" wounds only after debridement and / or removal of biofilms, i.e., after preparation of a (preferably) viable wound base.	15	10	2	2	1	30	25	83
27	In the presence of biofilms, local antimicrobial wound therapy alone is not adequate.	17	4	3	4	2	30	21	70
28	The most effective method of biofilm treatment is surgical debridement combined with local antimicrobial follow-up care, e. g. with silver dressings (sustainability) (see Fig. 2).	63	31	7	9	2	112	94	84
29	In the palliative setting, infection control is usually not the prime concern of wound therapy. Therefore, the use of silver dressings is to be conditional on the treatment goal and may, thus, depart from the otherwise strict medical indications.	59	33	9	8	3	112	92	82
30	Certain silver dressings should not come into direct contact with exposed organs, tendons or bone. (Manufacturers' instructions should be followed.)	24	4	1	0	1	30	28	93
31	When silver is used to treat wounds with bone or tendon exposure it is essential to avoid desiccation of the bone or the tendon.	100	7	0	1	4	112	107	96
32	When using silver for the local therapy of wounds with exposed bone or tendons, an (enzyme-free) hydrogel dressing should be applied to the exposed structure together with a secondary cover dressing, depending on the condition of the wound.	12	10	5	2	1	30	22	73
33	Moistening the silver dressing can be useful in treating wounds that produce only small amounts of exudate, thereby accelerating the release of the silver ions.	56	37	11	6	4	114	93	82
34	Under no circumstances should the silver wound dressing be soaking wet because this might overwhelm the absorption capacity of the dressing and thus shorten its wear time.	70	21	8	3	2	104	91	88
35	The decision to choose a silver wound dressing and to discontinue this kind of local antimicrobial wound therapy does not require that a bacteriological wound swab is taken as part of the diagnostic evaluation.	39	40	9	13	13	114	79	69

(*continued on next page*)

Table 2 (*continued*)

Nr.	Statement	1) I fully agree	2) I mainly agree	3) I neither agree nor disagree	4) I mainly disagree	5) I fully disagree	6) Total	7) Agree-ment 1 + 2 absolute	8) Agree-ment 1 + 2 in %
36	Wound swabbing is a particularly important diagnostic procedure when a silver dressing is to be used – on chronic wounds showing signs that a local or systemic infection has spread, – on infected chronic wounds that do not respond to antimicrobial treatment or deteriorate appropriate antimicrobial therapy, – in order to meet the requirements of local protocols for surveillance of antibiotic resistant microorganisms, – in patients presenting with signs of sepsis where blood cultures are important and cultures of other likely sources of infection should be considered, – in high-risk patients / settings (e.g. intensive care units), such as delayed (or stalled) wound healing in patients with diabetes mellitus or peripheral artery disease or patients taking immunosuppressive drugs or corticosteroids.	19	7	4	0	0	30	26	87
37	For medicolegal reasons, it is advisable to include a bacteriological wound swab in the diagnostic evaluation if a silver wound dressing is to be used.	35	35	21	13	9	113	70	62
38	The frequency of dressing changes is determined by the overall situation. With clinically established local wound infections the wound dressing should be changed on the day after the first application, and a treatment review should occur. Depending on the wound healing stage and the condition of the wound the frequency of dressing changes can be reduced.	14	0	3	1	2	20	14	70
39	The use of silver dressings in local wound care for children or infants is possible in the individual case on the basis of medical judgement and under medical supervision. The use of silver dressings needs to be carefully targeted and limited to a short period of time. Manufacturers' instructions should be followed.	12	14	2	2	0	30	26	87
40	Fig. 4 presents a clinical pathway for the use of silver dressings in the exudative / proliferative stage and in the epithelialisation phase of the wound healing process. What is your opinion about this clinical pathway? *When multidrug-resistant organisms (MDROs) are present in the wound (even if it is just a case of contamination or colonisation), local wound therapy with silver dressings may become necessary on medical grounds (see Fig. 4).	29	39	24	10	8	110	68	62
41	The aim of treating wound infections by *Pseudomonas aeruginosa* is to remove moisture from the wound in order to create unfavourable conditions for growth and to eliminate the pathogen through adjuvant local antimicrobial action.	14	10	3	1	2	30	24	80
42	Local treatment of wounds infected by *Pseudomonas aeruginosa* can, for example, be achieved by combining a mesh dressing containing silver and an absorbent pad (superabsorber). Over the course of wound healing, with lower exudate levels, silver-foam dressings or silver-alginate / hydrofibre dressings can be used.	12	14	2	2	0	30	26	87
43	Skin discolouration caused by silver dressings may occur, but this is only silver deposition **on** the skin, which is not to be confused with silver deposition **in** the skin (so-called argyria).	60	27	15	7	3	112	87	78
44	Staining of the surrounding skin may develop if the silver dressing overlaps the wound margins. If these stains cannot be completely removed by mechanical cleaning, they usually disappear after regular epidermal regeneration which takes about 28 days.	14	12	3	1	0	30	26	87
45	When using silver dressings, the manufacturers' product-specific Instructions for Use regarding the removal and prevention of skin / tissue staining should be followed.	72	27	8	2	2	111	99	89

Table 3
Summary of all statements with a level of agreement of 75% or more (viewed as consent) [10].

Special topic	Key points
a) Wound dressings and treatment (Statements *1, 2, 8, 9, 14, 15, 33, 34, 43, 44, 45)*	• Silver ions (Ag^+) are the active principle. (Statement 1) • The criteria for selecting the appropriate wound dressing (apart from the release of silver ions) include the condition of the wound and the level of exudate. (Statement 2) • The criteria for wound dressing selection do neither depend on whether they contain silver (Statement 8), nor on the aetiology of the wound. (Statement 9) • The silver level required in the wound has not yet been conclusively identified. (Statement 14) • In order to exert local antimicrobial action in the wound the dressing should release silver ions, and there should be in-vitro and in-vivo evidence of antimicrobial efficacy. (Statement 15) • Moistening can be useful in treating wounds producing small amounts of exudate in order to accelerate the release of the silver ions. (Statement 33) • The silver wound dressing must not be soaking wet since this might shorten its wear time. (Statement 34) • Skin discolouration caused by silver is reversible. (Statements 43 and 44) Manufacturers' instructions should be followed. (Statement 45)
b) Indications and contraindications (Statements 4, 5, 6, 13, 16, 20, 24, 29, 30, 31, 39)	• The principle applies that "local infection is treated by local antimicrobial therapy". (Statement 4) • Wound contamination is not an indication for local antimicrobial therapy. For multimorbid, immunocompromised patients or patients with a similar wound condition adjuvant systemic antibiotic therapy may be required. (Statement 13) • Adjuvant local antimicrobial therapy along with systemic antibiotic therapy should only be used with strict medical indications (Statement 6) since the availability of the antibiotic agent could become compromised. (Statement 16) • The use of silver-containing dressings should be appropriate for the wound type (Statement 20). • Diagnosis relies on the five classic signs of infection (Statement 24). • In the palliative setting infection control is not the prime concern. (Statement 29) • With organ, bone or tendon exposure it is essential to prevent the risk of desiccation; direct contact with silver wound dressings should therefore be avoided. (Statement 30, 31). • The use in children and infants should be limited to particularly strict therapeutic indications. (Statement 39)
c) Wound irrigation solutions (Statements 19, 21)	• Basically, wound irrigation is the preferred method of wound cleansing. (Statement 19) • Manufacturers' instructions should be followed when applying wound irrigation solutions. (Statement 21)
d) Resistance and tolerance (Statement 11)	• There is no classic resistance to silver in wound dressings, but at most a risk of tolerance to silver. (Statement 11).
e) Clinical pathwaysand antibiotic therapy (Statements *6, 10, 13, 23)*	• Adjuvant systemic antibiotic therapy should only be used with strict medical indications. (Statement 6) • The clinical pathway shown in Fig. 1 is relevant to practice and considered applicable. (Statement 10) • The following principles apply: local infection is treated by local antimicrobial therapy, and systemic infection is treated systemically (by systemic antibiotic therapy). Adjuvant systemic antibiotic therapy should be considered (e.g. in multimorbid, immunocompromised patients). (Statement 13) • Clinical signs of successful local antimicrobial wound therapy include: reduction of wound odour, amount of exudate, wound size, microbial burden and clinical signs of infection. (Statement 23)
f) Biofilms and debridement (Statements 26; 28)	• Silver-containing wound dressings should only be applied to a viable wound bed after debridement has been performed. (Statement 26) • Surgical debridement combined with local antimicrobial follow-up treatment is the most effective procedure for treating biofilms. (Statement 28)
g) Wound swabs (Statement 36)	• Obtaining a wound swab is indicated in the following cases: • spreading local or systemic infection • non-response to local antimicrobial therapy • in the context of surveillance programmes • patients at risk (Statement 36)
h) Particular bacterial species (*P.aeruginosa*) and treatment (Statements 41, 42)	• Goals of treatment of wounds infected by *P. aeruginosa*: • remove wound moisture • create unfavourable conditions for growth • destroy bacteria (Statement 41). • Local treatment options: mesh dressings with silver and superabsorbent wound dressings, and, for wounds with lower exudate levels, foam, alginate or hydrofibre silver dressings (Statement 42)

standard for best-practice local antimicrobial wound management has not yet been defined. Some of the statements have been inconsistently perceived and assessed and have therefore received a much lower level of agreement (Table 2).

A high level of agreement was found with regard to, e.g., the mechanism of action of silver ions, the criteria for wound dressing selection, the application of strict medical indications, the monitoring of treatment success and the duration of application, and to the treatment algorithm.

This collection of Best Practice Statements underlines the importance of the appropriately indicated and temporary use of silver wound dressings (Fig. 3). The dressing wear time follows from the medical indication as well as the individual course of wound healing.

The high degree of practitioners' approval on the principle of local antimicrobial therapy in the management of wounds with local signs of infection confirms that this principle enjoys a high level of acceptance. Against the background of the highly topical issue of the proliferation and spread of multidrug-resistant organisms (MDROs) in medical settings and the environment, which has become a subject of debate in both science [11] and the media [12], this high level of acceptance is a vital prerequisite for adequately managing and addressing this challenging task.

The central role of monitoring and surveillance systems for the control of antibiotic resistance and antibiotics consumption is highlighted by the high degree of agreement with strict indications for systemic antibiotic therapy in the statement of this best practice recommendation [13]. This recommendation thus meets the requirements of the current scientifically based European and national political guidance on antibiotic stewardship [14–16].

The reluctance to use silver wound dressings for local antimicrobial therapy of wounds for fear of resistance risks is supported by the consulted experts who highly agree (81%) with statement 11 ("There is no classic 'resistance' to silver in wound dressings as it is seen with antibiotics; at most, there is a risk of tolerance to silver"). The risk of tolerance to silver has no clinical significance since bacteria with reduced susceptibility to silver can also be effectively eliminated within the

Table 4
Statements with a level of agreement of 75% or more.

No.	Statement	Level of agreement [in %]
1	The decisive factor when selecting a silver wound dressing is not the form of the silver (e.g., ionic or metallic), but the availability of silver ions (Ag^+): in all forms, silver ions are the active principle.	77
2	The decisive factor in the choice of a wound dressing is that silver ions are released and that the selection of the silver dressing is made dependent on the condition of the wound and the level of exudate.	93
4	In wounds with established local infection the principle applies that "local infection is treated by local antimicrobial therapy".	75
6	Practitioners often use adjuvant systemic antibiotics to treat locally infected / critically colonised wounds. However, adjuvant systemic antibiotic therapy should only be used with strict medical indications and should under no circumstances be applied in a general fashion.	100
8	The criteria for selecting silver dressings do not differ from those for selecting wound dressings without silver. The appropriateness of a wound dressing is mainly determined by the status of the wound (slough, level of exudate, wound depth) and the condition of the surrounding skin.	85
9	The criteria for silver dressing selection (alginate, fibre, foam, gauze etc.) do not depend on the aetiology of the wound.	75
10	The clinical pathway (see Fig. 2) for the use of silver dressings is relevant to clinical practice and considered applicable.	83
11	There is no classic 'resistance' to the silver contained in wound dressings, as it is seen with antibiotics; at most, there is a risk of tolerance to silver.	81
13	The following principles apply: local infection is treated by local antimicrobial therapy; systemic infection is treated systemically (by systemic antibiotics). Since transition from local to systemic infection can happen seamlessly, adjuvant systemic antibiotic therapy should in certain cases be considered at an early stage, e.g., with multimorbid, immunocompromised patients or patients with a similar wound condition.	94
14	The level of silver required in the wound has not yet been conclusively identified. The reason is that it is very difficult to determine the concentration of active silver ions in a wound and that some of them are bound in the wound exudate, e.g. by proteins.	83
15	The total amount of silver or silver ions contained in the various wound dressings varies considerably. If local antimicrobial action in the wound is desired, it is essential that the dressing delivers silver ions to the wound site and that there is in-vitro and clinical evidence of antimicrobial efficacy.	97
16	In support of systemic therapy, it can be useful to perform local antimicrobial wound therapy with silver dressings since the effective concentration of antibiotics can be lowered by tissue- and bone penetration.	93
19	Basically, wound cleaning is recommended, if necessary, by using an irrigation solution with or without preservative (antimicrobial) additives.	91
20	The use of silver dressings after applying a wound irrigation solution with or without preservative (antimicrobial) additives should be well targeted and limited to the critical phase of wound healing.	77
21	Because of potential interactions between silver dressings and the ingredients of wound irrigation solutions, manufacturers' instructions should be followed.	97
23	Clinical signs of successful local antimicrobial wound therapy with silver dressings are: – reduction of wound odour, – decrease in the amount of exudate, – reduction in wound size, – reduction of microbial burden in the wound (swab / biopsy), – reduction of the classic signs of infection. The five classic signs of infection are: redness (rubor), swelling (tumor), heat (calor), pain (dolor) and loss of function (functio laesa).	97
24	The diagnosis of local wound infection is based on the five classic clinical signs of infection: redness (rubor), swelling (tumor), heat (calor), pain (dolor) and loss of function (functio laesa). Local wound infection, however, does not require the presence of all five signs of infection; for example, patients with neuropathy may be unable to perceive wound pain.	98
26	Silver dressings should be applied to "sloughy" wounds only after debridement and / or removal of biofilms, i.e., after preparation of a (preferably) viable wound base.	83
28	The most effective method of biofilm treatment is surgical debridement combined with local antimicrobial follow-up care, e.g. with silver dressings (sustainability) (see Fig. 2).	84
29	In the palliative setting, infection control is usually not the prime concern of wound therapy. Therefore, the use of silver dressings is to be conditional on the treatment goal and may thus depart from the otherwise strict medical indications.	82
31	When silver is used to treat wounds with bone or tendon exposure it is essential to avoid desiccation of the bone or the tendon.	96
33	Moistening the silver dressing can be useful in treating wounds that produce only small amounts of exudate, thereby accelerating the release of the silver ions.	82
34	Under no circumstances should the silver wound dressing be soaking wet because this might overwhelm the absorption capacity of the dressing and thus shorten its wear time.	88
36	Wound swabbing is a particularly important diagnostic procedure when a silver dressing is to be used – on chronic wounds showing signs that a local or systemic infection has spread, – on infected chronic wounds that do not respond to antimicrobial treatment or deteriorate appropriate antimicrobial therapy, – in order to meet the requirements of local protocols for surveillance of antibiotic resistant microorganisms, – in patients presenting with signs of sepsis where blood cultures are important and cultures of other likely sources of infection should be considered, – in high-risk patients / settings (e.g. intensive care units), such as delayed (or stalled) wound healing in patients with diabetes mellitus or peripheral artery disease or patients taking immunosuppressive drugs or corticosteroids.	87
39	The use of silver dressings in local wound care for children or infants is possible in the individual case on the basis of medical judgement and under medical supervision. The use of silver dressings needs to be carefully targeted and limited to a short period of time. Manufacturers' instructions should be followed.	87
41	The aim of treating wound infections by *Pseudomonas aeruginosa* is to remove moisture from the wound in order to create unfavourable conditions for growth and to eliminate the pathogen through adjuvant local antimicrobial action.	80
42	Local treatment of wounds infected by *Pseudomonas aeruginosa* can, for example, be achieved by combining a mesh dressing containing silver and an absorbent pad (superabsorber). Over the course of wound healing, with lower exudate levels, silver-foam dressings or silver-alginate / hydrofibre dressings can be used.	87
43	Skin discolouration caused by silver dressings may occur, but this is only silver deposition **on** the skin, which is not to be confused with silver deposition **in** the skin (so-called argyria).	78
44	Staining of the surrounding skin may develop if the silver dressing overlaps the wound margins. If these stains cannot be completely removed by mechanical cleaning, they usually disappear after regular epidermal regeneration which takes about 28 days.	87
45	When using silver dressings, the manufacturers' product-specific Instructions for Use regarding the removal and prevention of skin / tissue staining should be followed.	89

minimum wear time of 24 h [17].

In this context it is uncontroversial that wound debridement in preparation of a viable wound base is an essential prerequisite to successful local antimicrobial therapy. However, the statement "In the presence of biofilms, local antimicrobial therapy alone is not adequate" obtained only 70% agreement. In the case of biofilms, the authors recommend a combination of mechanical cleansing or debridement with subsequent use of silver wound dressings [18].

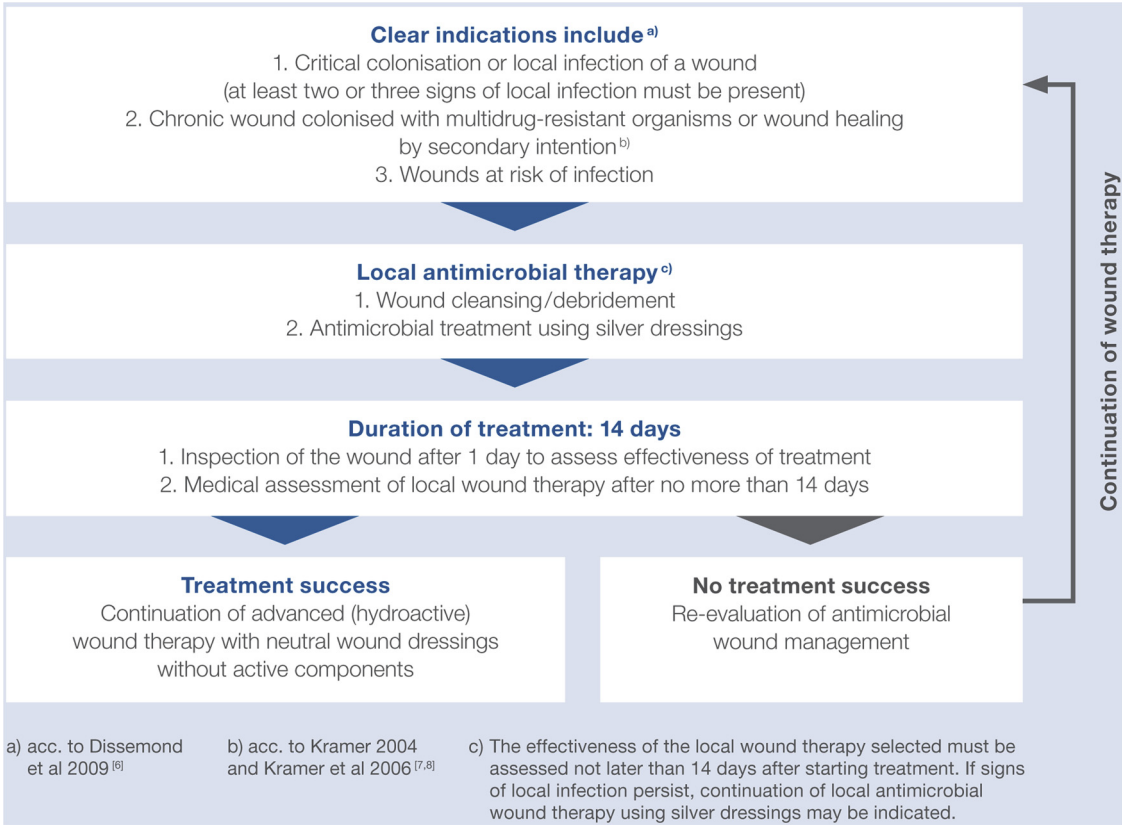

Fig. 3. Clinical pathway for the treatment of local wound infections, wounds contaminated with multidrug-resistant organisms or wounds at risk of infection. There must be a clear indication for starting local antimicrobial wound therapy.

A 97% agreement was reached for the following criteria for successful treatment with silver wound dressings: reduction of wound odour, decrease in the amount of exudate, reduction in wound size, reduction of microbial burden in the wound, and reduction of the classic signs of infection.

64% and thus slightly more than half of the respondents agreed with the statement "Wound contamination or colonisation is not an indication for the use of silver dressings". This statement, however, is in accordance with the opinion expressed in the literature [9] and with current practice since strictly bacterial contamination / colonisation is not an indication for silver-containing wound dressings. According to the authors' opinion contamination or colonisation of a wound **without** accompanying signs of a wound healing disorder is not an indication for the use of silver wound dressings, while contamination or colonisation **with** accompanying signs of a wound healing disorder is.

Only 72% gave support to statement 7 ("Wound contamination / colonisation with multidrug-resistant organisms (MDROs), by contrast, **is** an indication for the use of silver dressings"); this is not in line with the corresponding literature [9,19]. The authors argue that contamination / colonisation with MDROs like methicillin-resistant *Staphylococcus aureus* (MRSA) alone can be a clear indication for the use of silver dressings.

The 30% agreement to statements 18 and 22 may at first glance appear relatively low. Statement 18 advocates the general applicability of silver dressings without antimicrobial wound irrigation, while statement 22 requires mandatory antimicrobial/antiseptic wound irrigation with wound dressing changes. 70% of the wound care experts disagreed with this approach, and this may be interpreted in the sense that such an approach must always be based on the results of the wound assessment.

The widespread practice of taking bacteriological wound swabs for medico-legal reasons was approved by only 62% of the respondents. Due to the broad spectrum of antimicrobial activity, local antibacterial therapy of wounds using silver dressings is not pathogen-specific and therefore not dependent on the wound culture result. Wound swabs should thus be taken in accordance with surveillance (monitoring) recommendations as well as quality assurance- and hygiene requirements [20].

6. Conclusion

While there is still no national best-practice recommendation for local antimicrobial wound therapy using silver dressings, this paper shows that the crucial measures have generally been accepted in practice. Individual statements that received less support from the respondents, need further discussion and evaluation.

Limitations

The survey participants do not represent an adequate cross-section of experiences with antimicrobial and silver-containing dressings. Data were obtained on the participants' general qualification and their professional experience. No information was collected on the participants' experience with antimicrobial and silver-containing wound dressings.

Ethical statement

We confirm that the ethical information for authors have been read.

The submitted paper is a translation of the original article published under the following title in German language: Best Practice zu Silber-Wundverbänden – Ergebnisse einer Expertenumfrage mit dem Ziel einer Konsentierung. WUNDmanagement 2018; 12(6): 311–321.

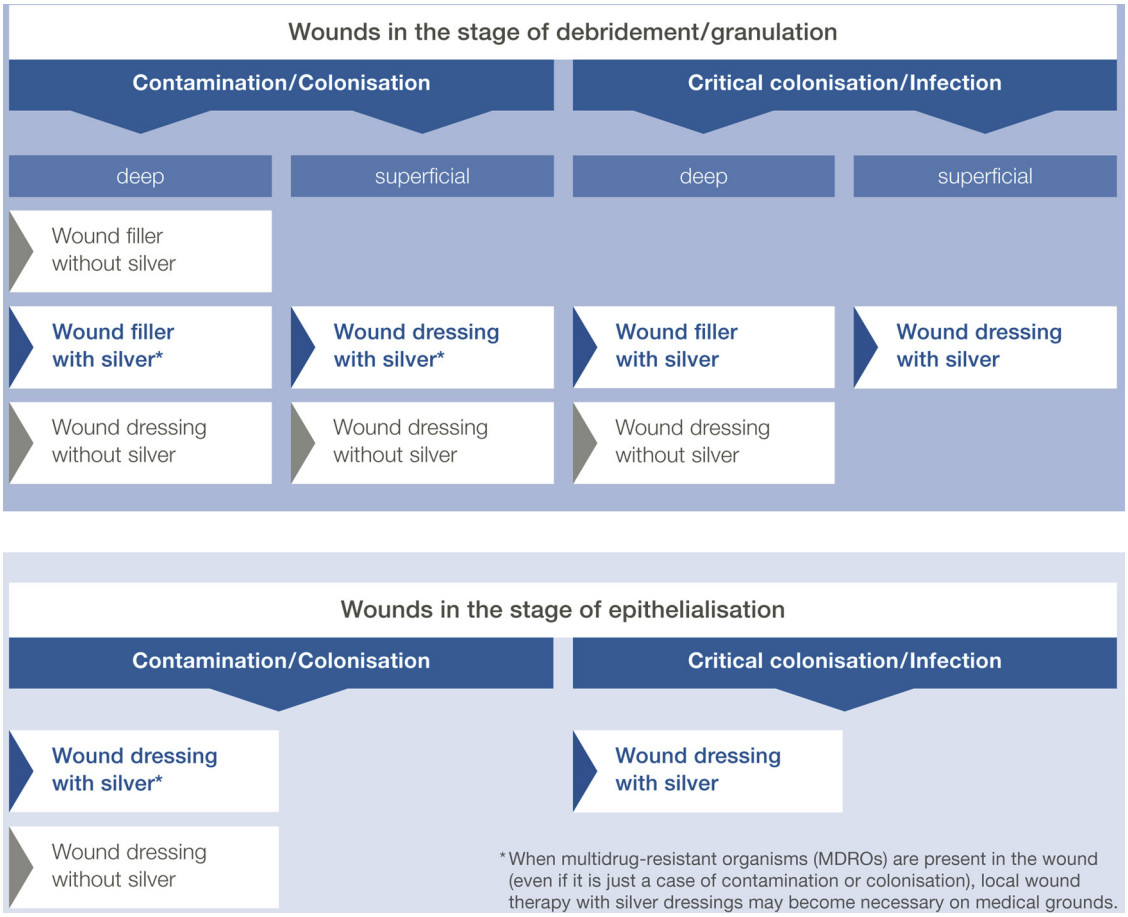

Fig. 4. Clinical pathway for the use of silver dressings during the wound healing process in the exudative / proliferative and epithelialisation phases (authors' recommendations).

Financial disclosure

As mentioned within the conflict of int erest, J.G. Böttrich, H. Braunwarth, F. Schümmelfeder and P. Wilken are employees of the said companies. The said companies supported literature research, costs for printing and the booking of the workshops including a TED-system. Under a scheme of notified and approved outside business activities J. Dissemond received consulting fees from 4M, Beiersdorf, B. Braun, BSN, Coloplast, Convatec, Draco, Engelhard, Flen Pharma, Hartmann, Lohmann & Rauscher, Medi, Serag-Wiessner and Urgo. K.C. Münter received consulting fees from Urgo, Coloplast, and Smith & Nephew.

Declaration of Competing Interest

J.G. Böttrich, H. Braunwarth, F. Schümmelfeder and P. Wilken are employees of the said companies. Under a scheme of notified and approved outside business activities J. Dissemond received consulting fees from 4M, Beiersdorf, B. Braun, BSN, Coloplast, Convatec, Draco, Engelhard, Flen Pharma, Hartmann, Lohmann & Rauscher, Medi, Serag-Wiessner and Urgo. K.C. Münter received consulting fees from Urgo, Coloplast, and Smith & Nephew.

Acknowledgements

We would like to thank all the experts who contributed with a high level of professional expertise in the use of silver dressings to a critical and constructive dialogue. Our thanks go to Jörg Hilt for participating in the project group, to Dorothee Schmidt for preparing the graphs and diagrams, and to Werner Sellmer for his engagement in a constructive discussion.

Finally, we would like to say thank you to the participants of the online survey, of the workshop held during the ICW-Süd Congress in Würzburg in March 2017 and the workshop organised on the occasion of the German Wound Congress, which was held in Bremen in May 2017.

References

[1] S. Reardon, WHO warns against 'post-antibiotic' era – agency recommends global system to monitor spread of resistant microbes, Nature (2014) Nature https://www.nature.com/news/who-warns-against-post-antibiotic-era-1.15135.
[2] B.A. Lipsky, C. Honey, Topical Antimicrobial Therapy for Treating Chronic Wounds, Clin. Infect. Dis. 49 (10) (2009) 1541–1549.
[3] AWMF-Leitlinie der Deutschen Gesellschaft für Wundheilung und Wundbehandlung e. V.: Lokaltherapie chronischer Wunden bei Patienten mit den Risiken periphere arterielle Verschlusskrankheit, Diabetes mellitus, chronisch venöse Insuffizienz. 2012; Stand 12.06.2012; http://www.awmf.org/leitlinien/detail/ll/091-001.html; Entwicklungsstufe S3; Registrierungsnummer 091-001.
[4] AWMF-Leitlinie des Arbeitskreises „Krankenhaus- & Praxishygiene "der AWMF: Postoperative Wundinfektionen: Strategien zur Prävention. Registernummer: 029-031; Entwicklungsstufe: S1; Stand 01.02.2014; http://www.awmf.org/leitlinien/detail/ll/029-031.html.
[5] AWMF-Leitlinie der Deutschen Gesellschaft für Kinderchirurgie: Wunden und Wundbehandlung. Registernummer 006-129; Klassifikation S1; Stand: 30.09.2014; http://www.awmf.org/leitlinien/detail/ll/006-129.html.
[6] J. Dissemond, V. Gerber, A. Kramer, G. Riepe, R. Strohal, A. Vasel-Biergans, Eberlein T: Praxisorientierte Expertenempfehlung zur Behandlung kritisch kolonisierter und lokal infizierter Wunden mit Polihexanid, Zeitschrift Für WUNDmanagement (2009) 62–68.
[7] A. Kramer, et al., Konsensusempfehlung zur Auswahl von Wirkstoffen für die Wundantiseptik, Zeitschrift Für Wundheilung (2004) 110–120.
[8] A. Kramer, J. Kremer, O. Assadian, et al., The classification of antiseptic products to be administered to wounds – another borderline case between medicinal products and medical devices? Int. J. Clin. Pharmacol. Ther. 44 (12) (2006) 677–692.

[9] A. Kramer, J. Dissemond, S. Kim, C. Willy, D. Mayer, R. Pape, F. Tuchmann, Assadian O: Consensus on Wound Antisepsis – Update 2018, Skin Pharmacol. Physiol. 31 (2018) 28–58.
[10] Bundesärztekammer (BÄK), Kassenärztliche Bundesvereinigung (KBV), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF). Programm für Nationale Versorgungs-Leitlinien – Methodenreport, 5. Auflage; Version 1, (2017).
[11] Hohmann-Jeddi C: Mulitresistente Erreger – in der Umwelt angekommen; PZ - Pharmazeutische Zeitung online; Ausgabe 07-2018; https://www.pharmazeutische-zeitung.de/index.php?id=74352.
[12] Röhrlich D: Medizin – Der Kampf gegen multiresistente Keime; Deutschlandfunk, 07.07.2017; http://www.deutschlandfunk.de/medizin-der-kampf-gegen-multiresistente-keime.724.de.html?dram:article_id=390505.
[13] DART Deutsche Resistenz Antibiotika Strategie. https://www.bundesgesundheitsministerium.de/themen/praevention/antibiotika-resistenzen/antibiotika-resistenzstrategie.html.
[14] Antimicrobial Stewardship European Center for Disease Prevention and Control. https://ecdc.europa.eu/en/publications-data/directory-guidance-prevention-and-control/prudent-use-antibiotics/antimicrobial.
[15] C. Lanckohr, Bracht H: "Antibiotic Stewardship" Maßnahmen zur Optimierung der Verordnung von Antiinfektiva, Anaesthesist 67 (1) (2018) 3–8.
[16] https://www.rki.de/DE/Content/Infekt/Antibiotikaresistenz/Dt_Antibiotikaresistenzstrategie/Dt_Antibiotikaresistenzstrategie_node.html.
[17] J.G. Böttrich, F.H.H. Brill, J. Dissemond, J. Steinmann, K.C. Münter, F. Schümmelfeder, P. Wilken, H. Braunwarth, A Systematic Review of the Risk of Bacterial Resistance to Silver, E-Poster; EWMA, 2018 May 2018.
[18] P.L. Phillips, R.D. Wolcott, J. Fletcher, Schultz GS: biofilms made easy, Wounds Int UK 1 (3) (2010) 2–6 http://www.woundsinternational.com/media/issues/288/files/content_8851.pdf.
[19] K. Protz, Möglichkeiten der Keimreduktion, Wunden. Teil 1 11 WUNDmanagement, 2017, pp. 246–248 (6).
[20] Empfehlung der Kommission für Krankenhaushygiene und Prävention (KRINKO) beim Robert Koch-Institut zur Prävention und Kontrolle von MRSA in medizinischen und pflegerischen Einrichtungen, Bundesgesundheitsbl 57 (2014) 696–732.
[21] Snell L: A Guideline for the Assessment and Treatment of Bacterial Biofilms in Chronic Wounds. University of Utah, School of Nursing. In partial fulfilment of the requirements for the Doctor of Nursing Practice; http://cdmbuntu.lib.utah.edu/utils/getfile/collection/ehsl-gradnu/id/72/filename/61.pdf.
[22] R. Edwards, Harding KG: bacteria and wound healing, Curr. Opin. Infect. Dis. 17 (2) (2004) 91–96.
[23] P.L. Phillips, R.D. Wolcott, J. Fletcher, G.S. Schultz, Biofilme Einfach Erklärt Band 1 Wounds International, 2010 Mai 2010 Ausgabe 3 https://www.icwunden.de/fileadmin/Fachinfos/2010_biofilm_woundsinternational.pdf.
[24] A. Alavi, et al., Diabetic foot ulcers, part II. Management, J. Am. Acad. Dermatol. 70 (1) (2014) 21–24.