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Interventions to prevent the development of surgical site infections in Germany and the Netherlands: A systematic review

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Abstract

Introduction Surgical site infections (SSIs) are wound infections which occur after surgery and result in pain for the patients, economic consequences in the form of higher costs, and an increase in antibiotic resistance. Recent statistics show that the number of SSIs has increased in the last years. There are current projects which have the goal of building a prevention network with interventions and technologies in the EUREGIO (Germany and the Netherlands). The goal of this study is to compare the German and Dutch SSI guidelines and to identify interventions which already exist that prevent SSIs. Five factors are important in the prevention of the development of SSIs: general hygiene, hand hygiene, hair removal, antibiotic prophylaxis, and normothermia. Due to the assumption that hand hygiene is the most important preventative factor, this research focuses only on interventions which influence this particular factor. **Methods** To compare the German and Dutch guidelines, an unsystematic narrative review was conducted. The German and Dutch guidelines can be compared on the following points: form of representation, evidence, rule orientation, style, and content. The interventions which already exist to decrease the numbers of SSIs are identified with a systematic review. These can be compared based on target group, focus, phase (pre-operative, peri-operative, post-operative), the component of the Theory of Planned Behavior (TPB) which is used, modality, features, implementation, function mechanism, main effects, and conclusions. **Results** There are small differences between the German and the Dutch guidelines concerning their content. More significant, however, are the differences between the guidelines regarding their outward appearance. Perceived behavior control is the component of the TPB which is used mainly during hand hygiene interventions to influence compliance with hand hygiene standards. Combining perceived behavior control with the components of attitude or subjective norms of the TPB offers the most successful results. Feedback is an important aspect of the improvement of hand hygiene compliance. The interventions identified through the systematic review are mostly very recent. **Discussion** The differences between the German and Dutch guidelines possibly emerge because of stricter legislation in Germany. There are a number of studies which show that the factor perceived behavior control is the most important during hand hygiene in hospitals and that feedback has a positive influence on hand hygiene performance.

Keywords: surgical site infections, interventions, guidelines, Germany, the Netherlands

Abstract Dutch

Introductie Actuele cijfers tonen aan, dat het aantal postoperatieve wondinfecties (POWIs) in de laatste tien jaren gestegen is. POWIs zijn wondinfecties die na een operatie ontstaan en resulteren in pijn voor de patient, economische gevolgen in vorm van stijgende kosten en een stijgende antibiotica resistentie. Er zijn projecten met als doel om een preventie netwerk en interventies tegen POWIs in de Euregio te creeren. Doel van dit onderzoek is de Nederlandse en de Duitse POWI richtlijnen te vergelijken en bestaande interventies te verzamelen, die het doel hebben om POWIs te verhinderen. Vijf factoren zijn belangrijk bij de preventie van POWIs: hygiene, hand hygiene, pre-operatief ontharen, antibioticaprofylaxe en normothermie. Vanwege de onderstelling dat hand hygiene de meest belangrijke factor is, focust dit onderzoek alleen op interventies welke hand hygiene beinvloeden. **Methoden** Om de Duitse en de Nederlandse richtlijnen met elkaar te vergelijken werd een onsystematisch narratieve review doorgevoerd. De Nederlandse en de Duitse richtlijnen kunnen worden vergeleken op de volgende punten: vorm, onderbouwing, regel orientatie, stijl en inhoud. Interventies met betrekking tot hand hygiene zijn verzameld door een systematisch review. Deze interventies kunnen worden vergeleken op de volgende punten: target groep, doel, fase, component of de Theory of Planned Behavior, modaliteit, features, implementatie, functie mechanisme, hoofd effecten en de conclusies. **Resultaten** Er zijn klein verschillen tussen de Duitse en de Nederlandse richtlijnen wat betreft de inhoud. De verschillen met betrekking tot het uiterlijk zijn significanter. De perceived behavior control is de component van de TPB die het meest door de interventies is gebruikt om de hand hygiene te verbeteren. Als de factor perceived behavior control met een van de andere factoren (attitude of subjectieve norm) wordt gecombineerd, levert dat succesvol resultaten op. Feedback is ook een belangrijk component bij het verbeteren van de hand hygiene in de operatie kamer. Bovendien zijn de interventies die door de systematisch review zijn verzameld heel actueel. **Discussie** De verschillen tussen de Duitse en de Nederlandse richtlijnen zijn mogelijk ontstaan omdat de wetgeving in Duitsland met betrekking tot hygiene richtlijnen strikter is. Er zijn vele artikelen en onderzoeken die aantonen dat perceived behaviour control de meest belangrijke factor tijdens hand hygiene is en dat feedback een heel positieve invloed op hand hygiene heeft.

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1. Introduction

Surgeries in Europe are conducted more and more frequently, as proven by Eurostat (2016), a statistical organization which registers surgeries in Europe. In 2006, 11,869,000 surgeries were registered in Germany, in contrast to 2014 when these numbers rose to 15,760,000 registered surgeries in German hospitals (Eurostat, 2016). There are no recent numbers in Eurostat which demonstrate the recorded surgeries per year in the Netherlands, but numbers from 2006 to 2010 show that the number of surgeries in the Netherlands also rose from 409,000 to 469,000 (Eurostat, 2016). Because of the rising number of surgeries, there has been increased attention on possible risks and complications of surgeries. Very frequently occurring complications are surgical site infections (SSIs) (WHO, 2016). According to the World Health Organization (2016), SSIs are included in the most frequent nosocomial infections. Nosocomial infections are infections which are neither present before hospital intake nor in the incubation phase (Geffers, Gastmeier, & Rüden, 2002).

1.1 Definition Surgical Site Infections

An SSI is present if one of the following symptoms occurs after surgery: pain, local swelling, redness, or warmth (World Health Organization, 2016). There are different types of SSIs, including surface SSIs, deep SSIs, infections of the organs, and anatomic gaps, which are opened during surgery and infections after vaginal surgery. According to Geffers et al. (2002), there are many factors which influence the development of an SSI. For example, the number of bacteria which enter the wound during the surgery, the sort of the micro-organisms in the infection, the type of the wound, and the resistance mechanisms of the patient all impact the emergence of SSIs. In addition, patient-based factors come into account during the development of an SSI, such as the patient's age, disease, immune status, and weight. This is also connected to the demographical aspects of patients, since the majority of patients who undergo surgery are aged 65 years or older (Geffers et al., 2002). Furthermore, emergency surgeries and re-surgeries also have a higher risk to lead to an SSI (Dohmen, 2008).

1.2 Incidence

The European Centre for Disease Prevention and Control (ECDC) collects data concerning surgeries from European countries and, at regular intervals, publishes epidemiological reports which include information regarding SSIs (European Centre for Disease Prevention and Control, 2013). Germany and the Netherlands took part in this data collection. The

information concerning SSIs in Germany is transferred to the ECDC via the German Nosocomial Infection Surveillance System (KISS). In the Netherlands, this occurs via the Prevalentieonderzoek Ziekenhuizen (PREZIES) network, which is a special network that is concerned with the registration of SSIs in Dutch hospitals. Hospitals are required to register their instances of SSIs via this network. The goal of the PREZIES network is to create a better overview of SSIs and their trends and to reduce their occurrence (RIVM, 2016). The ECDC collects information about SSIs after the following surgery types from Germany and the Netherlands: cholecystectomy, colon surgery, caesarean section, hip prosthesis, knee prosthesis, and laminectomy. In Germany, 172,424 surgeries of these types were conducted in the time span from 2010-2011. During these surgeries in German hospitals, the number of SSIs was 2,373, which equals a percentage of 1.4% SSIs in German hospitals. In the Netherlands, 47,502 surgeries of these types were conducted from 2010-2011. The total numbers of SSIs was 1,379, which implies that the SSIs in Dutch hospitals occur in 2.9% of surgeries. When comparing these numbers, it is obvious that SSIs occur more frequently after surgery in Dutch rather than German hospitals (European Centre for Disease Prevention and Control, 2013).

The numbers from the ECDC show that the type of surgery is correlated to the development of SSIs. The surgery with the highest rates of SSIs is colon surgery. The percentage of SSIs in Germany from this type of surgery is 7.5%, and in the Netherlands, it is as high as 15% (European Centre for Disease Prevention and Control, 2013).

1.3 Consequences

For a patient, an SSI means pain, fear, and anxiety (VMS, 2009). The patients must stay in the hospital approximately three weeks longer than they would without an SSI, often in the intensive care unit. In Germany, for example, this leads to 1 million additional days in the hospital per year in Germany (Grauhan, Navasardyan, Tutkun, Hennig, Müller, Hummel & Hetzer, 2014). Additionally, further treatments and sometimes further surgeries are necessary to treat such an infection. On occasion, the consequences of SSIs are fatal. Beside these consequences for the patient, SSIs have enormous consequences for the economy. Because of the prolonged hospital stays and further treatments, the treatments costs per patient vastly rise (Grauhan et al., 2014). There are varying numbers available, but in total, an SSIs costs approximately €9,000-14,000 per patient (Grauhan et.al, 2014; Geffers et al., 2002). The suffering of the patients and the financial burdens show clearly that research for the

prevention of SSIs is very important. Another consequence of SSIs which should certainly not be underestimated is the increasing worldwide antibiotic resistance (Piechota & Kramer, 2014). Every SSI must be treated with antibiotics, and an increase in SSIs signifies an increase in antibiotic use, which accordingly boosts the development of antibiotic resistance. Antibiotic resistance is an mounting threat in hospitals because it leads to prolonged periods of antimicrobial therapy, prolonged hospital stays, higher costs for treatment, and a higher mortality rate (Dohmen, 2008). These consequences of SSIs make the importance of this research obvious.

1.4 Prevention of SSIs

There are a number of factors which seem to be important in the prevention of SSIs. These are hygiene in general, hand hygiene specifically, hair removal, antibiotic prophylaxis, and normothermia (WHO, 2016). Hygiene in general concerns the hygiene in the surgery room, the hygiene of materials used in the surgery room, and the clothes of the staff and patients. Hand hygiene involves hand washing, hand disinfection, and the use of gloves before and during the surgery. The removal of hair before surgery is sometimes necessary, and there are different methods of removing hair to minimize the development of injuries and infections. Antibiotic prophylaxis refers to administering doses of antibiotics to the patient before, during, and in some cases after surgery to prevent the development of an SSI. Normothermia describes maintaining the normal temperature of the patient and preventing an undercooling during surgery, as such an undercooling increases the risk of the development of an SSI. For the above reasons, the factors which are important in the prevention of the development of SSIs are general hygiene in the surgery theatre, hand hygiene, hair removal, antibiotic prophylaxis, and normothermia. However, the German medical researchers who developed the German “clean-hands campaign” agreed that the most important means to decrease SSIs is the hand hygiene of medical staff who have contact with surgical patients (Reichardt, Gastmeier, Eberlein-Gonska, & Schrappe, 2008). In their article, they state that hand hygiene compliance is a so called “effectivity gap,” which means that medical staff know the rules and guidelines concerning hand hygiene, but the implementation of these rules and guidelines is still not up to par.

1.5 Behavioral models for hand hygiene

According to Mathur (2011), supporting hand hygiene compliance in hospitals, especially surgical units, is the "single most important, simplest, and least expensive" method to fight against the development of SSIs. A study found that hand hygiene compliance of healthcare workers is strongly connected to the workers' attitudes, norms, and the perceived behavior control towards hand hygiene procedures (White, Jimmieson, Obst, Graves, Barnett, Cockshaw, Gee, Haneman, Page, Campbell, Martin, & Paterson, 2015). Because of that, the theory of planned behavior (TPB) can be adapted to hand hygiene compliance. According to the TPB, intention is the most important determinant of behavior. Factors which influence this intention are the attitude towards this behavior, the subjective norms in the form of pressure from the social environment, and the perceived behavior control, thus how easily a certain behavior can be performed. In the case of hand hygiene compliance, the best-case scenario of an attitude toward hand hygiene would be "hand hygiene is important." A subjective norm would be "important people want me to perform hand hygiene" and a perceived behavior control towards hand hygiene would be "it would be easy for me to perform hand hygiene" (White et al., 2015). There are a number of other studies which describe the connection between the TPB and hand hygiene compliance and state that hand hygiene compliance is relatively easy to influence through interventions (Al-Tawfiq & Pittet, 2013).

1.6 Projects against antibiotic resistance

As mentioned above, a threatening consequence of SSIs is increasing antibiotic resistance. Projects which are invested in antibiotic resistance are the EurHealth-1Health project and the Health-i-care Project. The EurHealth-1Health project is focused on prevention against antibiotic resistance. The goal of this integrated project is to prevent the development of life-threatening infections, through the notion that the health of humans and animals is directly associated and co-determined by the environment. The starting point of this project is antibiotic resistance. The Health-i-care project is associated with the EurHealth-1Health project and focuses on antibiotic resistance, including resistance in combination with SSIs. This project is made up of 30 different consortia consisting of partners from universities, other knowledge institutes, and small- and medium-size enterprises. One factor which contributes to high rates of antibiotic resistance are nosocomial infections, especially SSIs (Dohmen, 2008). This is why the Health-i-care project focuses on the prevention of SSIs in Dutch and German hospitals. This trans-border project has several goals, including the goal to

reduce the development of SSIs in German and Dutch hospitals through an e-health intervention, which focuses on the behavior of medical staff. Firstly, it is important to know which guidelines exist in Germany and the Netherlands in general and what the similarities and differences are between these guidelines. A harmonization between the guidelines of the two countries is important to achieve the aim of designing one e-health technology which fits German and Dutch hospitals. In addition, it is necessary to research which interventions to reduce SSIs already exist and which effects these interventions have had. Due to the fact that hand hygiene seems to be the most important factor in the prevention of SSIs and the approach that hand hygiene compliance is relatively easy to influence, this research is only concerned with the existing interventions in the field of surgical hand hygiene.

For this reason, the goal of this literature research is to identify which general guidelines are defined in Germany and the Netherlands, which interventions exist to improve the most important factor hand hygiene, and how projects can best influence the field of SSI prevention. This adds up to the following research questions:

(1) What are similarities and differences between the German and Dutch SSI guidelines based on the factors of general hygiene, hand hygiene, hair removal, antibiotic prophylaxis, and normothermia?
(2) Which hand hygiene interventions exist to prevent the development of surgical site infections and what are the effects of these interventions?

2. Methods

2.1. Comparison of the German and Dutch guidelines

2.1.1. Design

To answer the first research question concerning the similarities and differences between the German and the Dutch guidelines, an unsystematic narrative review was conducted.

2.1.2. Literature search

For the narrative review concerning the comparison of the German and the Dutch guidelines, the literature about the official SSI guidelines described in the introduction was used. The guidelines were compared on five points: their form of representation, evidence, rule-orientation, style, and content. It was decided to compare the guidelines concerning their content on the five aforementioned factors of general hygiene, hand hygiene, hair removal, antibiotic prophylaxis, and normothermia because these are the main factors of both the German and Dutch guidelines.

2.1.3. Analysis

The SSI guidelines of Germany and the Netherlands were compared on the following points: form of representation, evidence, rule orientation, style, and content. A previous comparison of methicillin-resistant staphylococcus (MRSA) guidelines of Germany and the Netherlands served as a basis for the development of these points of comparison (Verhoeven, van Gemert-Pijnen, Hendrix, Friedrich, & Steehouder, n.d.).

2.2. Hand hygiene interventions

2.2.1. Design

For the second research question, a systematic review was conducted to research which interventions exist to reduce the development of SSIs in hospitals.

2.2.2. Literature search

To conduct a systematic review based on existing interventions to reduce SSIs, the relevant databases were first determined. Databases which were used in this research are Scopus, Web of Science, PubMed, and PsycInfo. Scopus and Web of Science were utilized because of the multidisciplinary quality and high number of the peer-reviewed articles which are available.

PubMed was employed because of its biomedical focus and the extent of available medical articles and books, in contrast to the other databases. PsycInfo was useful because its focus on behavioral and psychological subjects. As a next step, a search strategy in the form of a search matrix was developed. Terms which were used to browse the databases were derived from recent literature about SSIs. The constructs for the literature search for existing interventions to reduce SSIs were “surgical site infections,” “intervention,” and “hand hygiene.” With these constructs as the foundation, a search word matrix was designed with related terms which are synonyms to these constructs (table 1). To avoid obtaining too many useless search hits, it was decided to pursue these terms only in the title, abstract, and keywords of the articles. A pilot test of the search strategy was completed to test whether these terms provided relevant hits. For a strong overview of the entire literature search, a search log was created where the researcher noted which database was searched, which search strategy was used, and how many hits were obtained. Finally, all retrieved articles were stored in the Endnote program.

Table 1. Search terms

Constructs	**Related terms/ synonyms**
interven* OR AND	interven*, method*, workshop*, practi*, training*, program*, coach*
surgical site infection* OR AND	postoperative wound infection*, surgical infection*, surgical wound infection*, operati* room, surgery room, operati* theatre, surgery theatre
hand hygien* OR	hand disinfection, hand clean*, hand rub*, hand wash*

2.2.3. Inclusion and exclusion criteria

The next step was the selection of articles which were relevant to read. For this reason, a title screening followed by an abstract screening were conducted to select which articles were in the range of relevance to be read completely. To conduct a title and abstract screening, inclusion and exclusion criteria were determined by the researcher. For the second research question concerning existing interventions for the prevention of SSIs in Germany and the

Netherlands, seven criteria of exclusion were determined: (1) focus of interest, so only interventions which support the compliance of guidelines concerning hygiene, hair removal, antibiotic prophylaxis, and normothermia were included; (2) language, so only English, Dutch, and German language literature remained; (3) date of publication, only between January 2000 and April 2017; (4) target group, so only interventions for surgical staff or surgical patients were used; (5) content, meaning the intervention must focus only on hand hygiene; and (6) evidence, so that the intervention must be a point of evaluation.

2.2.4. Data extraction

The articles which were selected for the full-text reading were pooled in one database in Endnote. For the full-text reading of these articles, there were extraction forms used (see appendix B). These extraction forms defined which information was to be retrieved from the articles to ensure that the same sort of information was retrieved from every article and to easily compare this information. The extraction forms resulted in an overview of the study identification and the intervention which was designed, including the implementation, design, effects, and shortcomings of the intervention.

2.2.5. Analysis

For the analysis of the information that was retrieved from the articles, the extraction forms were used. The extraction forms made it possible to compare the different interventions that were identified in the literature and view the information from the articles side by side. For every article which was selected for the full-text reading, an extraction form was completely filled. At the end of the data collection, every article was summarized by means of an extraction form, which gave a proper overview of the interventions and allowed for a comparison. The points of comparison between the intervention were participants, goal of the intervention, phase (pre-operative, peri-operative, post-operative), which component(s) of the TPB was used, the way the intervention is offered (modality), the features used during the intervention, the implementation, the function mechanism, and the main effects and conclusions. These points of comparison were chosen because they were the most important points of the data extraction forms. The interventions are compared by the employed component of the TPB, because as described previously, the TPB plays an important role in the hand hygiene behavior of medical staff.

3. Results

3.1 Comparison German and Dutch guidelines

3.1.1 Description of the guidelines

In Germany, there is an official document about the prevention of SSIs published by the Gemeinsamer Bundesausschuss (G-Ba), which is the highest healthcare decision council in Germany (Gemeinsamer Bundesausschuss, 2017). The G-Ba focuses on the development of guidelines and methods for quality assurance of the ambulant and steady realms of German hospitals. The G-Ba developed a recent document for 2017 in which guidelines and rules for quality management in German hospitals are presented. Among other ideas, there is a chapter about the prevention of SSIs. These guidelines are based on recent data from hospitals and health insurance companies. The defined goals of these guidelines are to reduce the development of all sorts of SSIs to a minimum and, as a consequence, reduce the number of nosocomial infections in general (Gemeinsamer Bundesausschuss, 2017). This guideline is available for everyone via the website of the G-Ba. In addition to this document of the G-Ba, there is a second document which was published by the Robert Koch institute based on the G-Ba guidelines (Oldhafer, Jürs, Kramer, Martius, Wist, & Mielke, 2007).

In the Netherlands, the Werkgroep Infectie Preventie (WIP) is responsible for the development of guidelines concerning SSIs. The WIP is a workgroup of the Rijksinstituut voor Volksgezondheid, which is a governmental organization that works on many healthcare topics in the Netherlands and takes a stance in the prevention of infections in the Netherlands (WIP, 2011). The most recent guideline they developed is from 2011 and focuses on the prevention of SSIs in Dutch hospitals. It is available for everyone via the website of the RIVM (WIP, 2011). There is a separate guideline from the Stichting Werkgroep Antibioticabeleid (SWAB) which focuses on antibiotic prophylaxis before, during, and after surgeries to reduce SSIs (Bauer, van de Garde, van Kasteren, Prins, & Vos, 2017). There is a recent conceptual version of the official guideline which will become law in 2017. This conceptual version is available via the website of the SWAB.

3.1.2. Form of representation

There are five points on which the German and the Dutch guidelines are compared (table 2). The first point is the form of representation. In Germany, there are two different documents about the guidelines to prevent the development of SSIs. First, there is a document with

official guidelines developed by the G-Ba. This document provides only policies in the form of indicators and their quality goals which should be achieved by the hospitals. Additionally, there is a second document worked out by the Robert Koch Institute (Oldhafer, Jürs, Kramer, Martius, Weist, & Mielke, 2007), which describes the practical implementations of these guidelines. The document of the G-Ba only discusses the goals concerning the prevention of SSIs which should be achieved by German hospitals. The Robert Koch institute provided suggestions for the implementation of these goals which can be used in practice. According to an article by the Institut für angewandte Qualitätsförderung und Forschung im Gesundheitswesen GmbH (AQUA) in cooperation with the G-Ba, the recommendations of the Robert Koch Institute play an essential role in the prevention of SSIs in German hospitals and are thus mainly used in hospitals (AQUA, 2013). For this reason, this document is taken as the basis for the comparison between the Germany and Dutch regulations. In contrast to the German guidelines, in the Netherlands, there are three documents which discuss the prevention of the development of SSIs. First, a document was published by the WIP (2011) which provides the guidelines for hygiene including the clothes and materials used during surgery and normothermia. Second, there is a document by the WIP (2013) especially concerning hand hygiene. Finally, the Netherlands has special guidelines for antibiotic prophylaxis for surgeries published by the Stichting Werkgroep Antibiotica Beleid (SWAB, 2017).

3.1.3. Evidence

The second point on which these guidelines can be compared is their foundational evidence. The German guidelines in their entirety are based on the guidelines of the Centers for Disease Control and Prevention from 1999 and further international studies which discuss information about SSIs (Mangram, Horan, & Pearson, 1999; Roy, 2003; Wong, 2004). Furthermore, the German guidelines make use of scientific literature and studies to offer evidence for their recommendations (figure 1). The Dutch document which describes general guidelines to prevent the development of SSIs is based mainly based on known facts of pathogenesis and risk factors of SSIs, which are based on scientific literature (WIP, 2011). The document for hand disinfection guidelines was developed based on the European norm NEN-EN12791, the WHO “Handhygiene” guideline, and a Cochrane review of surgical hand antisepsis from 2008 (Tanner, Swarbrook, & Stuart, 2008). The antibiotic guideline of SWAB has taken a further version of this document as a starting point but also relied on a document from the

American Society of Health-System Pharmacists (ASHP), the Infectious Diseases Society of America (IDSA), the Surgical Infection Society (SIS) and the Society for Healthcare Epidemiology of America (SHEA) regarding antibiotic guidelines (Bratzler, Dellinger, Olsen, Perl, Auwaerter, & Bolon, 2013). With this in mind, this guideline is mainly based on recommendations from the United States (SWAB, 2017). Furthermore, all three guidelines use scientific literature to prove their recommendations and motivations (figure 2).

4.1.9 Chirurgische Händedesinfektion

Die chirurgische Händedesinfektion hat das Ziel, die transiente Flora zu eliminieren und die residente Flora so weit wie möglich zu reduzieren. Durch das Anlegen steriler OP-Handschuhe wird das Kontaminationsrisiko weiter reduziert. Die effektive Händedesinfektion ist an bestimmte Voraussetzungen geknüpft. Die Haut muss intakt (frei von infizierten Läsionen) und regelmäßig gepflegt sein [19]. Das Tragen künstlicher Nägel konnte als Quelle von Ausbrüchen nosokomialer Infektionen identifiziert werden [148–157]. Eine Studie belegt die erhöhte Perforationshäufigkeit von OP-Handschuhen beim Tragen von Ringen [158]. Im Übrigen behindern Schmuckstücke die sachgerechte Hygiene.

intensive care unit linked to artificial nails. Infect Control Hosp Epidemiol 25:210–215
149. Hedderwick SA, McNeil SA, Lyons MJ, Kauffman CA (2000) Pathogenic organisms associated with artificial fingernails worn by healthcare workers. Infect Control Hosp Epidemiol 21:505–509
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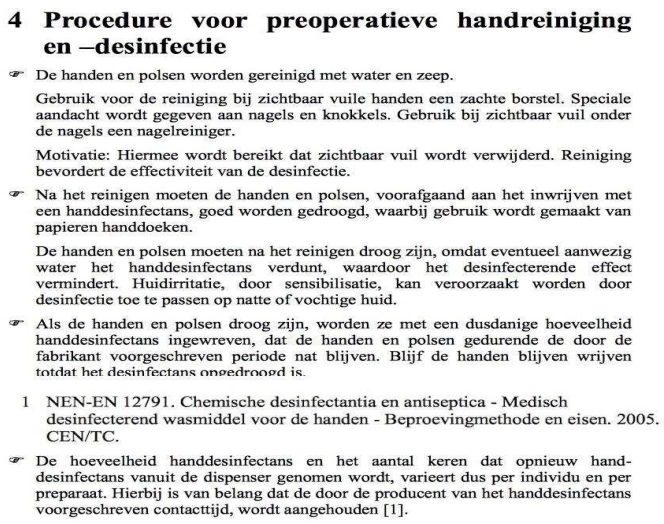
155. Saiman L, Lerner A, Saal L et al. (2002) Banning artificial nails from health care settings. Am J Infect Control 30:252–254
156. Toles A (2002) Artificial nails: are they putting patients at risk? A review of the research. J Pediatr Oncol Nurs 19:164–171
157. Winslow EH, Jacobson AF (2000) Can a fashion statement harm the patient? Long and artificial nails may cause nosocomial infections. Am J Nurs 100:63–65

Figure 1. Example evidence German guidelines



4 Procedure voor preoperatieve handreiniging en –desinfectie

- De handen en polsen worden gereinigd met water en zeep.

  Gebruik voor de reiniging bij zichtbaar vuile handen een zachte borstel. Speciale aandacht wordt gegeven aan nagels en knokkels. Gebruik bij zichtbaar vuil onder de nagels een nagelreiniger.

  Motivatie: Hiermee wordt bereikt dat zichtbaar vuil wordt verwijderd. Reiniging bevordert de effectiviteit van de desinfectie.

- Na het reinigen moeten de handen en polsen, voorafgaand aan het inwrijven met een handdesinfectans, goed worden gedroogd, waarbij gebruik wordt gemaakt van papieren handdoeken.

  De handen en polsen moeten na het reinigen droog zijn, omdat eventueel aanwezig water het handdesinfectans verdunt, waardoor het desinfecterende effect vermindert. Huidirritatie, door sensibilisatie, kan veroorzaakt worden door desinfectie toe te passen op natte of vochtige huid.

- Als de handen en polsen droog zijn, worden ze met een dusdanige hoeveelheid handdesinfectans ingewreven, dat de handen en polsen gedurende de door de fabrikant voorgeschreven periode nat blijven. Blijf de handen blijven wrijven totdat het desinfectans opgedroogd is.

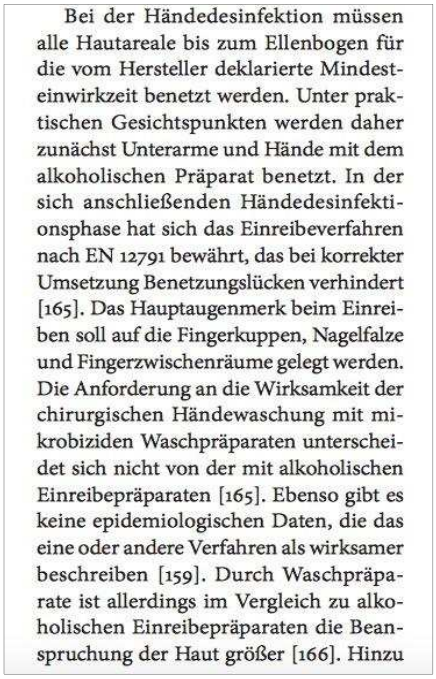
1 NEN-EN 12791. Chemische desinfectantia en antiseptica - Medisch desinfecterend wasmiddel voor de handen - Beproevingmethode en eisen. 2005. CEN/TC.

- De hoeveelheid handdesinfectans en het aantal keren dat opnieuw handdesinfectans vanuit de dispenser genomen wordt, varieert dus per individu en per preparaat. Hierbij is van belang dat de door de producent van het handdesinfectans voorgeschreven contacttijd, wordt aangehouden [1].

Figure 2. Example evidence Dutch guidelines

3.1.4. Rule-orientation

The documents from both countries are less policy based and more practically based, which means that they give clear instructions for the implementation of these guidelines in practice. A small point in which the documents differ in their rule orientation is the way they provide instructions. The German guidelines also describe how to implement the guidelines in practice, but they are less adapted to practicality than the Dutch guidelines (figure 3). The Dutch documents have a stronger focus on clearly stating a set of instructions which medical staff have to follow step by step (figure 4). For this reason, these documents can be used easily in practical situations. However, the documents from both countries also clearly describe why certain recommendations are given, which means that they are not only instructive also declarative.



Bei der Händedesinfektion müssen alle Hautareale bis zum Ellenbogen für die vom Hersteller deklarierte Mindesteinwirkzeit benetzt werden. Unter praktischen Gesichtspunkten werden daher zunächst Unterarme und Hände mit dem alkoholischen Präparat benetzt. In der sich anschließenden Händedesinfektionsphase hat sich das Einreibeverfahren nach EN 12791 bewährt, das bei korrekter Umsetzung Benetzungslücken verhindert [165]. Das Hauptaugenmerk beim Einreiben soll auf die Fingerkuppen, Nagelfalze und Fingerzwischenräume gelegt werden. Die Anforderung an die Wirksamkeit der chirurgischen Händewaschung mit mikrobiziden Waschpräparaten unterscheidet sich nicht von der mit alkoholischen Einreibepräparaten [165]. Ebenso gibt es keine epidemiologischen Daten, die das eine oder andere Verfahren als wirksamer beschreiben [159]. Durch Waschpräparate ist allerdings im Vergleich zu alkoholischen Einreibepräparaten die Beanspruchung der Haut größer [166]. Hinzu

Figure 3. Example rule orientation German guidelines

4 Procedure voor preoperatieve handreiniging en –desinfectie

- De handen en polsen worden gereinigd met water en zeep.

  Gebruik voor de reiniging bij zichtbaar vuile handen een zachte borstel. Speciale aandacht wordt gegeven aan nagels en knokkels. Gebruik bij zichtbaar vuil onder de nagels een nagelreiniger.

  Motivatie: Hiermee wordt bereikt dat zichtbaar vuil wordt verwijderd. Reiniging bevordert de effectiviteit van de desinfectie.

- Na het reinigen moeten de handen en polsen, voorafgaand aan het inwrijven met een handdesinfectans, goed worden gedroogd, waarbij gebruik wordt gemaakt van papieren handdoeken.

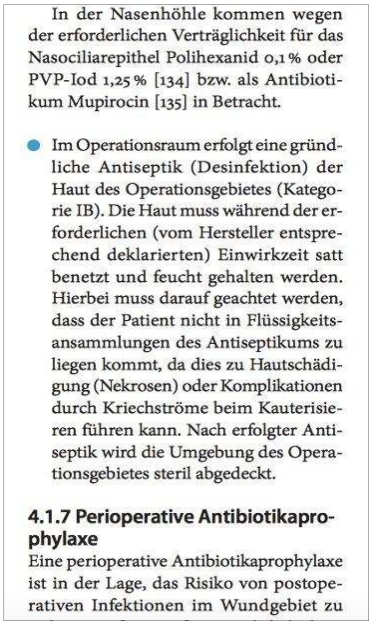
  De handen en polsen moeten na het reinigen droog zijn, omdat eventueel aanwezig water het handdesinfectans verdunt, waardoor het desinfecterende effect vermindert. Huidirritatie, door sensibilisatie, kan veroorzaakt worden door desinfectie toe te passen op natte of vochtige huid.

- Als de handen en polsen droog zijn, worden ze met een dusdanige hoeveelheid handdesinfectans ingewreven, dat de handen en polsen gedurende de door de fabrikant voorgeschreven periode nat blijven. Blijf de handen blijven wrijven totdat het desinfectans opgedroogd is.

Figure 4. Example rule orientation Dutch guidelines

3.1.5. Style

Another point of comparison of the guidelines is the style. The German document of the Robert Koch institute is written in fluent text, and at the end of each topic, there is a summary in bullet points which gives the most important information from the text; these bullet points still contain fluent text. Foreign words are also described with more easily understandable words (figure 5). The Dutch guidelines are written in easily understandable language. All documents from the Netherlands use very short sentences which are easy to read and are mainly represented in bullet points (figure 6). In this way, both countries use easy language and bullet points to make reader-friendly guidelines that are easy to understand, however, the Dutch guidelines do this more extensively because of their easy sentence structure and extensive use of bullet points. Another difference between the documents from Germany and the Netherlands is that information is easier to find in the Dutch documents. They first suggest the general guideline, then what to do and what not to do, and finally they offer a motivation for such information. If someone is searching for certain information, it would be much easier to find in the Dutch guidelines than in the German guidelines, where information is mainly presented in fluent text.



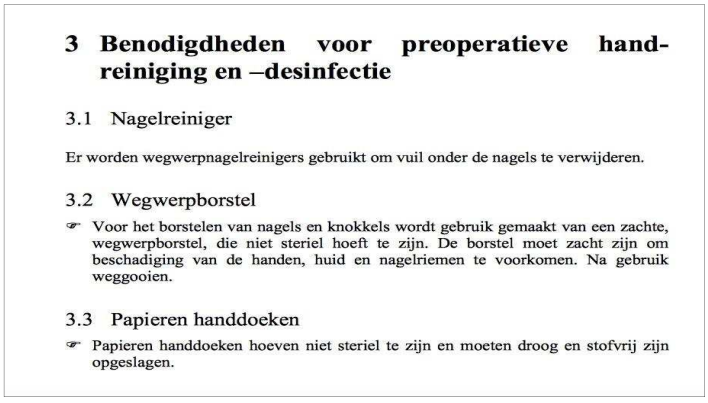
In der Nasenhöhle kommen wegen der erforderlichen Verträglichkeit für das Nasociliarepithel Polihexanid 0,1 % oder PVP-Iod 1,25 % [134] bzw. als Antibiotikum Mupirocin [135] in Betracht.

- Im Operationsraum erfolgt eine gründliche Antiseptik (Desinfektion) der Haut des Operationsgebietes (Kategorie IB). Die Haut muss während der erforderlichen (vom Hersteller entsprechend deklarierten) Einwirkzeit satt benetzt und feucht gehalten werden. Hierbei muss darauf geachtet werden, dass der Patient nicht in Flüssigkeitsansammlungen des Antiseptikums zu liegen kommt, da dies zu Hautschädigung (Nekrosen) oder Komplikationen durch Kriechströme beim Kauterisieren führen kann. Nach erfolgter Antiseptik wird die Umgebung des Operationsgebietes steril abgedeckt.

4.1.7 Perioperative Antibiotikaprophylaxe

Eine perioperative Antibiotikaprophylaxe ist in der Lage, das Risiko von postoperativen Infektionen im Wundgebiet zu

Figure 5. Example style German guideline



3 Benodigdheden voor preoperatieve handreiniging en –desinfectie

3.1 Nagelreiniger

Er worden wegwerpnagelreinigers gebruikt om vuil onder de nagels te verwijderen.

3.2 Wegwerpborstel

☞ Voor het borstelen van nagels en knokkels wordt gebruik gemaakt van een zachte, wegwerpborstel, die niet steriel hoeft te zijn. De borstel moet zacht zijn om beschadiging van de handen, huid en nagelriemen te voorkomen. Na gebruik weggooien.

3.3 Papieren handdoeken

☞ Papieren handdoeken hoeven niet steriel te zijn en moeten droog en stofvrij zijn opgeslagen.

Figure 6. Example style Dutch guidelines

Table 2. Comparison of the guidelines of Germany and the Netherlands - outward appearance

Compare on	**Germany**	**Netherlands**
form of representation	two documents: - one document with the guidelines itself of the G-Ba (policies without implementation): indicator lists with descriptions of the indicators and their goals - one document which is based on the G-Ba document and describes the implementation (by Robert-Koch institute)	three documents: - one general document of WIP (2011) - one especially for hand hygiene of WIP (2013) - one for antibiotic prophylaxis of SWAB (2017)
evidence	- guideline is based on recommendations of 'Centre for Disease Control and Prevention' from 1999 - scientific literature and studies	- general document (WIP, 2011): based on known facts of pathogenese and risk factors of SSIs - hand hygiene document (WIP, 2013): based on Europese norm 'NEN-EN12791', WHO guideline 'Handhygiene' and a Cochrane review over surgical hand antisepsis from 2008 - antibiotic prophylaxis document (SWAB, 2017): based on American Society of Health-System Pharmacists (ASHP), the Infectious Diseases Society of America (IDSA), the Surgical Infection Society (SIS) and the Society for Healthcare Epidemiology of America (SHEA) - all documents use scientific literature and studies
rule orientation	- instructive and declarative - practical-oriented	- instructive and declarative - practical-oriented - give step-by-step instructions
style	- fluent text with summaries in form of bullet-points - foreign words are described	- easy and reader-friendly language - short sentences - written in bullet-points

3.1.6. Content

One important point of comparison is the content of the guidelines (table 3). Because of the complexity and the fact that the main factors of both the German and the Dutch guidelines are hygiene, hand hygiene, hair removal, antibiotic prophylaxis, and normothermia, the comparison is confined to these five factors.

3.1.6.1 Hygiene

Hygiene in the surgery area is one very important and effective method of reducing the development of SSIs (Grauhan, Navasardyan, Tutkun, Hennig, Müller, Hummel, & Hetzer, 2014). The guidelines both in Germany and the Netherlands dictate that all members of the surgical team who are present during the surgery have to wear fluid-impermeable clothes, a mouthpiece, and special footwear which is clean of dirt and germs (Oldhafer et al., 2007; WIP 2011). If the clothes worn in the surgical theatre are dirty or damaged, they must be changed; when the surgery is finished, these clothes also must be changed. The Dutch guidelines advise to keep the number of staff during a surgery and the number of times leaving and entering the operating room during a surgery at a minimum (WIP, 2011). They recommend installing an electronic door movement counter, which registers the number of door movements per surgery. The German guidelines provide that the medical staff that is present in the surgery room take care that no pathogens can be transferred through their clothes when leaving the surgery area (Oldhafer et al., 2007).

3.1.6.2. Hand hygiene

The correct hand hygiene of all people who have contact with the operating room or materials which are used in the operating room is the most important method to prevent the development of SSIs. Concerning hand hygiene, both the German and the Dutch guidelines state that surgery staff who are in contact with the surgery room or materials used in the surgery room are not allowed to wear jewelry or artificial nails (Oldhafer et al., 2007; WIP, 2013). The German guidelines say that the staff must have round-cut nails and the skin of the hands has to be intact without any deflection or wounds (Oldhafer et al., 2007). Additionally, in both countries, the surgery staff are required to wash their hands before disinfection with soap, and the Dutch guidelines add that if necessary, the nails have to be cleaned with a special nail cleanser (Oldhafer et al., 2007; WIP, 2013). The guidelines of the two countries agree that after washing with water and soap, the hands have to be totally dry before disinfection with alcohol. The most significant difference concerning hand hygiene between

the German and Dutch guidelines is that Germany requires that the all skin up to the elbows must be disinfected before entering the surgery room (Oldhafer, et al., 2007). In contrast, in the Netherlands, it is not necessary to disinfect the fore arms, only the handy and the wrists, because the gloves are later worn over the surgery tunic (WIP, 2013). The guidelines of both countries agree that the hands must be totally dry and disinfection has to be wholly inducted before applying the surgery gloves.

3.1.6.3. Hair removal

The removal of hair is necessary for certain surgeries, although the risk of the development of lesions in the skin, which can lead to infections, is much higher. Concerning the removal of hair before surgery, both countries say that hair should only be removed if necessary for the surgery (Oldhafer et al., 2007; WIP, 2011). The guidelines of both countries agree that removing hair with a razor is not recommended because of the high risk of small skin lesions and thus higher infection risks. The German guidelines advise to employ a chemical method to remove hair, like a hair removal cream (Oldhafer et al., 2007). If such a cream is used, a skin tolerance test must be conducted no later than one day before surgery. If a hair removal cream cannot be used, the second method is hair removal with a hair cutter, thus the hair is merely shortened. This hair removal method with a hair cutter is the preferred method in the Netherlands (WIP, 2011). The Netherlands do not recommend hair removal creams because of the high risks of skin irritation (WIP, 2011). Shaving is absolutely not recommended because infection risks are two times higher than using a hair cutter. The preferred hair removal methods in Germany are chemical methods with hair removal creams or hair cutting. In the Netherlands, the only preferred method is hair cutting.

3.1.6.4. Antibiotic prophylaxis

Antibiotic prophylaxis before a surgery is a common method to reduce the risks of the development of infection during surgery. For this reason, is it important that the antibiotic which is used is suitable for the type of surgery and effective for the most common pathogens. The guidelines of both Germany and the Netherlands dictate this point as one of the most important factors for an effective antibiotic prophylaxis (Oldhafer et al., 2007; Bauer, van de Garde, van Kasteren, Prins, & Vos, 2017). The Dutch guidelines suggest designing an antibiotic protocol within the hospitals which is developed, implemented, and regularly updated by experts to maintain an overview of the administration of antibiotics (Bauer et al.,

2017). Moreover, they recommend the presence of an antibiotic professional, like an anesthetist, during the surgery, who controls the status, dose, and possible risk factors of the antibiotic prophylaxis. The German guidelines do not give any recommendations concerning a protocol or the presence of a professional. The German guidelines advise to administer the antibiotics 2 hours to 30 minutes before surgery, while the Dutch guidelines formulate that more precisely by setting the administration time to 60 minutes before the surgery (Oldhafer et al., 2007; Bauer et al., 2007). The guidelines of both countries say to provide a subsequent dose if the duration of the surgery is longer than normal (more than 3-4 hours). Finally, both countries do not recommend continuing the administration of antibiotics after the surgery because of side effects and the development of resistance.

3.1.6.5. Normothermia

Recent studies show that mild hypothermia, which means an undercooling of the patient, during a surgery is an independent risk factor for the development of SSIs (Oldhafer et al., 2007). Because of this, there are German and Dutch guidelines which focus on maintaining the state of normothermia, or the normal temperature state of the patient, which is between 36 and 38 degrees Celsius (WIP, 2011). Both countries recommend organizing an active warming of the patient before, during, and after surgeries with heating blankets and tempered surgery mattresses (Oldhafer et al., 2007; WIP, 2011). The Dutch guidelines have the supplemental instruction that these blankets and mattresses have to be disinfected before use and they should have an air heating system, where warm air is pumped through channels of the mattresses or a water heating system and warm water is pumped through the channels of the mattresses (WIP, 2011).

Table 3. Comparison of the guidelines of Germany and the Netherlands - content

guideline		Germany	Netherlands
hygiene	only surgery clothes in surgery area	x	x
	change clothes after surgery	x	x
	wear mouthpieces which cover hair and beard	x	x
	leaving and entering the surgery theatre is restricted to a minimum		x
	people inside the theatre are restricted to a minimum		x (can be achieved with a electronic door counter)
hand hygiene	no artificial nails	x	x
	no jewelry	x	x
	short, round cut nails	x	
	skin has to be intact	x	
	hand cleansing with water and soap before disinfection	x	x
	hand must be dry before disinfection	x	x
	entire skin until elbows must be disinfected	x	only until wrists
	disinfection duration: producer declaration	x	x
	special attention on fingertips, nail folds, finger spaces	x	
	hands must be dry before apply sterile gloves	x	x
hair removal	only if necessary for surgery	x	x
	removal with a cutter	x	x
	chemical removal with a hair removal creams	x	

	if shave is necessary: immediate before surgery	x	
antibiotic prophylaxis	type antibiotic is dependent on the most common pathogens	x	x
	antibiotic administration	2h to maximal 30 minutes before surgery	60 minutes before surgery
	antibiotics protocol which is developed, implemented and updated by professionals		x
	presence of a professional during surgery who is responsible for applying antibiotics		x
	if necessary: subsequent doses	x	x
	continuing antibiotic prophylaxis after surgery not recommended	x	x
normothermia	active, preoperative warming in connection with skin warming	x	x
	warming through tempered surgery mattresses or heating blankets	x	x (addition: Heating mattresses with air or water heating system; have to be disinfected before use)

3.2 Interventions to prevent the development of SSI through improved hand hygiene compliance

As previously described, this part of the research focuses only on interventions which reduce the development of SSIs by improving hand hygiene compliance. With the previously described search strategy, in total n=339 articles were found in Scopus, Web of Science, PsycInfo, and PubMed (figure 7). After removing the duplicates (n=73) followed by the title screening with the inclusion and exclusion criteria, there were n=118 articles remaining. After the abstract screening there were n=11 articles available for the full-text reading. During the abstract screening, 107 articles were removed because many of the interventions focused on hand hygiene compliance in the entire hospital setting, whereas this research only focuses on hand hygiene compliance in hospitals surgical settings.

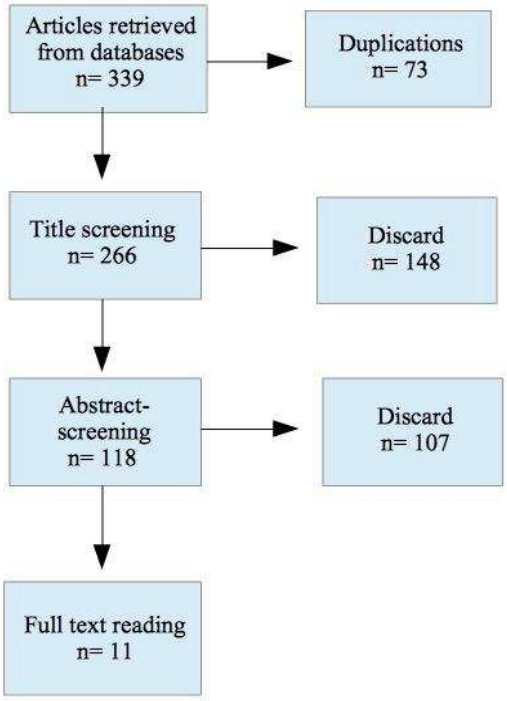


Figure 7. Article selection process including title screening, abstract screening and full text reading

3.2.1. Characteristics of the studies

First, the interventions can be compared by the characteristics of the studies (table 4). The publication years varied from 2005 to 2017, but most were very recent. Of the studied interventions, 8 of the 11 were published in between 2010 and 2017, and 5 interventions were released between 2015 to 2017. Six of the interventions used a quasi-experimental study design, and the design of the other five interventions was a randomized controlled trial. The sort of the outcomes which were measured by the studies were either behavioral (6 interventions), thus measured how the behavior of the participants concerning hand hygiene changed, or health-related (3 interventions), thus which effect the intervention had on SSI rates, or measured both (2 interventions).

Table 4. Study design of interventions to improve the hand hygiene compliance in surgical settings

Title	Authors	Country	Year	Study design	Sort outcome
1.) Patient hand hygiene practices in surgical patients	Ardizzone, Smolowitz, Kline, Thom ,& Larson	United States of America	2013	quasi-experimental study	behavioral
2.) A single standardized practical training for surgical scrubbing according to EN1500: effect quantification, value of the standardized method and comparison with clinical reference groups	Fichtner, Haupt, Karwath, Wullenk, Pohlmann, & Jatzwauk	Germany	2013	randomized controlled trial	behavioral
3.) Effect of music on surgical hand disinfection: a video-based intervention study	Gautschi, Marschall, Candinas, & Banz	Switzerland	2017	randomized controlled trial	behavioral
4.) Practice of skin protection and skin care among German surgeons and influence on the efficacy of surgical hand disinfection and surgical glove perforation	Harnoss, Brune, Ansorg, Heidecke, Assadian, & Kramer	Germany	2014	randomized controlled trial	health
5.) Compliance of surgical hand washing before surgery: Role of remote video surveillance	Khan & Nausheen	Pakistan	2017	quasi-experimental study	behavioral
6.) Surgical site infections, occurrence, and risk factors, before and after an alcohol-based hand rub intervention in a general surgical	Lindsjo, Sharma, Mahadik, Sharma, Lundborg, & Pathak	Sweden/ India	2015	quasi-experimental study	health

department in a rural hospital					
7.) Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina	Rosenthal, Guzman, & Safdar	Argentina	2005	quasi-experimental study	behavioral, health
8.) Usage of Ultraviolet Test Method for Monitoring the Efficacy of Surgical Hand Rub Technique Among Medical Students	Vanyolos, Peto, Viszlai, Miko, Furka, Nemet, & Orosi	Hungary	2015	quasi-experimental study	behavioral
9.) Video-based instructions for surgical hand disinfection as a replacement for conventional tuition? A randomized, blind comparative study	Weber, Constantinescu, Woermann, Schmitz, & Schnabe	Switzerland	2016	randomized controlled trial	behavioral
10.) A simple effective clean practice protocol significantly improves hand decontamination and infection control measures in the acute surgical setting	Howard, Williams, Sen, Shah, Daurka, Bird, Loh, & Howard	United Kingdom	2009	quasi-experimental study	behavioral, health
11.) Reduction in surgical site infections in neurosurgical patients associated with a bedside hand hygiene program in Vietnam	Le, Dibley, Vo, Archibald, Jarvis, & Sohn	Vietnam	2007	randomized controlled trial	health

3.2.2. Characteristics of the interventions

The content, implementation, and results of the interventions are summarized in table 4. In the majority of the interventions, healthcare staff of surgical units was the target group. Two interventions focused on both medical staff and patients, while two interventions focused only on patients of the surgical unit. In total, there were three interventions which had medical students as their target group. The focus of these interventions was the prevention of SSIs from the start, thus the underlying goal was to directly teach students how to correctly perform surgical hand hygiene.

Concerning the phase of surgical procedure in which hand hygiene compliance is influenced by the interventions, half of the interventions were implemented before surgery (pre-operative) and the second half were implemented after surgery (post-operative). None of the interventions focused on the improvement of hand hygiene compliance during surgery (peri-operative).

Another point on which the interventions can be compared is the component of the TPB with which they work. Aside from one intervention, all others were influenced by the component of perceived behavior control. Four of these interventions additionally concerned attitude and three also focused on the subjective norm of the target group. One intervention tried to influence only subjective norms. Additionally, there was one intervention which included all three of the components in the intervention.

There were in total five different forms of modality of the interventions. These were presentations, practical trainings, feedback, posters or brochures, and interventions which were implemented as experiments. The modality which was used most is practical training, which was implemented in 6 of the 11 interventions.

The following features were used during the interventions: information, education, communication with healthcare professionals, communication with colleagues, skills training, feedback, and awareness. The majority of the interventions made use of information, education, and skills training.

The goals of the interventions varied. There were three interventions which had the goal to improve medical staff's hand hygiene through an educational program (Fichtner, Haupt, Karwath, Wullenk, Pohlmann, & Jatzwauk, 2013; Rosenthal, Guzman, & Safdar, 2005; Vanyolos, Peto, Viszlai, Miko, Furka, Nemet, & Orosi, 2015). Two of the interventions aimed to improve the hand hygiene of healthcare workers through a distribution of hand sanitizers in

combination with informing staff how to correctly use them (Lindsjo, Sharma, Mahadik, Sharma, Lundborg, & Pathak, 2015; Le, Dibley, Vo, Archibald, Jarvis, & Sohn, 2007). There were also interventions which focused improving the hand hygiene of the patients (Ardizzone, Smolowitz, Kline, Thom ,& Larson, 2013), the effect of music during the hand rub (Gautschi, Marschall, Candinas, & Banz, 2017), the usage of skincare products on hand hygiene (Harnoss, Brune, Ansorg, Heidecke, Assadian, & Kramer, 2014), the role of a remote video auditing system during hand hygiene (Khan & Nausheen, 2017), video versus conventional instruction (Weber, Constantinescu, Woermann, Schmitz, & Schnabel, 2016), and the use of clean practice protocols to observe staff's hand hygiene performance (Howard, Williams, Sen, Shah, Daurka, Bird, Loh, & Howard, 2009). In total, 9 of the 11 interventions had a significantly positive effect. The other three interventions showed small improvements, but these were not significant.

Table 5. Interventions to improve the hand hygiene compliance in surgical settings

Intervention	Target group, partici-pants	Goal	Phase	TPB	Modality	Features	Implementation (incl. duration, process)	Function mechanism	Main effects	Conclusions
1.) Ardizzone, Smolowitz, Kline, Thom ,& Larson, 2013	surgical patients and nurses	promoting nurses assistance with patient hand hygiene	post-operative	perceived behavior control	presentation given by a professional	information, education, communication with health-care professionals	4-6 months, Pre-intervention: observation and survey of surgical nurses, intervention: presentation about hand hygiene of surgical patients and ways of how to support them, post-intervention phase: observation of nursing staff	giving nurses the information and skills about patients hand hygiene so they can support patients with that	pre-intervention phase: in 17.3 % nurses helped patients with hand washing, after intervention: 44,6%	This intervention had a positive effect on hand hygiene compliance of patients
2.) Fichtner, Haupt, Karwath, Wullenk, Pohlmann, & Jatzwauk, 2013	Medical students, 8th semester	improve surgical hand disinfection EN1500	pre-operative	perceived behavior control	Practical training implemented by a tutor	Information, education, skills training, communication with colleagues	6 months, Skills-Lab training, (1) checking of pre skills (2) control group: SHD without training, intervention group: training, peer-teaching on SHD with health care professionals, then SHD was performed (3) hands were photographed under ultraviolet lamp	helping students to develop skills under supervision of professionals and peers	intervention group less disinfection gaps than the control group, the intervention group performed better than the reference group which represent the clinical standard of the learning objective	peer-teaching skills lab training of surgical hand disinfection according to EN1500 can be considered an appropriate method for the standardized teaching of medical students in clinical-practical skills

3.) Gautschi, Marschall, Candinas, & Banz, 2017	surgeons, surgeons in training, medical students and scrub nurses	the effect of music on the duration of SHD	pre-operative	perceived behavior control	experiment		(1) SHD was observed without background music: control group (2) SHD while listening to music: intervention group	music may have an relaxing effect and staff begins to enjoy SHD because of the music	no significant difference between control and intervention group, but the proportion participants who scrubbed for a short time was reduced from 17% to 9% in the intervention group	listening to music do not result to longer scrub times
4.) Harnoss, Brune, Ansorg, Heidecke, Assadian, & Kramer, 2014	surgical staff	usage of SP/SC skin care products by surgical staff	pre-operative	perceived behavior control	experiment		(1) questionnaire send to surgeons (2) intervention: group A started 8 days before experimental day using SP and SC products 3 times per day, group B no usage (3) experimental day 1 measurement of efficacy of SHR for both groups (4) group B started next day usage of SP/SC products, group A no usage (5) experimental day 2 efficacy of SHD was measured for both groups	Skin protection and skin care products (skin care products) care for the skin so they are less dry and chapped and SHD is more effective	The measured skin moisture was significant higher after SP/SC usage. After application of SP/SC during 8 consecutive days, the bacterial reduction factors (log10) were 1.98 ± 1.83 (IE) and 1.84 ± 1.41 (SE)	In the study, the combination of selected SP/SC products and one alcohol-based hand rub formulation did not show a negative interaction
5.) Khan & Nausheen, 2017	All surgeons, surgical assistants and operating room technicians of Aga Khan hospital	study and support compliance of hand scrub with a remote video auditing system and feedback	pre-operative	subjective norm	in the hospital, results of video recording are presented on whiteboards in de hospital	feedback, awareness	(1) video auditing system installation in scrub area (2) 4 week-period: hand hygiene was measured without feedback (3) 12 week-period: weekly feedback in form of presentation of results of the recordings on notice boards	feedback of professionals and the visual representation of this feedback should make staff aware of their actual hand wash performance and show them there is space for improvement	pre-feedback period: 14.67% hand scrub time compliance, post-feedback period: 80.7% hand scrub time compliance	Video monitoring combined with real-time feedback of HCW hand hygiene rates produced a significant and sustained improvement in hand hygiene compliance

6.) Lindsjo, Sharma, Mahadik, Sharma, Lundborg, & Pathak, 2015	all patients admitted to the departme nt of surgery at the CRGH	occurrence and risk factors of SSI before and after a ABHR intervention	post-operative	perceived behavior control	posters and education sessions	information, education	(1) pre-intervention period (2) intervention period: distribution of alcohol-based hand rub (ABHR) and information posters showing the correct use of them, monthly training sessions for surgical staff about ABHR	training of the correct use of ABHR and information posters should improve the ability of patients to use them, which increases the use and result in better hand hygiene	pre-intervention period: SSI incidence 5%, intervention period: 6,5%, not significant, use of ABHR was between 1.14 and 4.95L per 1,000 patient days per month in pre-intervention period and increased to 7.17-20.98L per 1,000 patient days per month after intervention	The results of this study so far imply that the chain of contamination of microorganism s was not affected by the introduction of ABHR in the setting
7.) Rosenthal, Guzman, & Safdar, 2005	health care staff (on surgical intensive care unit)	supporting hand hygiene compliance with an educational program	post-operative	subjective norm, perceived behavior control	meetings, educational classes	information, education, skill training, communication with health-care professionals, feedback	(1) monthly meeting at which visual displays of hand washing rates were presented (also posted monthly on the 2 ICU) (2) educational classes 1 hour group sessions every day for 1 week with infection control manuals and the APIC hand hygiene guideline as an educational tool, attendance voluntary, theoretic and practical indications for the use of hand hygiene were reviewed (3) infection control review classes to provide an opportunity for infection control questions (4) frequent feedback: reports to the ICU manager, graphic presentations in meetings, feedback data was posted in the ICUs	training in classes, review sessions and posters improve the ability of staff to correctly wash their hands, feedback shows them results and through open presentation of the results staff is motivated to improve performance	compliance improved from 23.1% to 64.5%, nosocomial infections in both ICUs decreased from 47.55 per 1000 patient-days to 27.93 per 1000 patient-days	42% relative reduction in nosocomial infection rates by emphasizing compliance with hand hygiene

8.) Vanyolos, Peto, Viszlai, Miko, Furka, Nemet, & Orosi, 2015	third year medical students	improving hand hygiene compliance by use of an educational program	pre-operative	perceived behavior control, attitude	educational program in a teaching hospital	information, education, skills training	(1) survey 1 (2) intervention implemented during required course, 5 weeks, 1 lecture and 2 practicals per week, in fourth week: 45-minute lecture about the review of antisepsis, scrub solutions for SHR, behavior rules in the operating room (3) in same week: practical training in small groups where students are trained and afterwards required to perform process under control and supervision, students were asked to perform surgical hand rub (5-minute protocol was used), at the end alcohol-based fluorescent solution was applied for visualization of areas missed during the procedure under ultraviolet light (4) hand were paced into a box with 3 ultraviolet lamps, photographs were taken (5) survey 2	theoretical in combination with practical training under supervision should teach staff skills to correctly perform SHR, afterwards students can check results under UV lamp which made them aware of their actual performance and motivate them to improve performance	number of students with unsatisfactory surgical hand disinfection was significantly lower in survey 2 compared with survey 1, detection of minimum 1 missed spot in survey 1 occurred in 123 students (48.6%), in survey 2 in 65 students (25.7%)	The main advantage of the applied method was the ability to face the students promptly with the outcome of their hand rub procedure, the mistakes, and its localization. Identifying failures provided an opportunity to enhance their efforts

9.) Weber, Constantinescu, Woermann, Schmitz, & Schnabel, 2016	first year medical students	the effect of video instruction on surgical hand disinfection	pre-operative	perceived behavior control, attitude	presentation	information, education	(1) two groups: VI and CI, Video instruction group was shown a two minute video sequence as an introduction to surgical hand disinfection; the conventional instruction group was taught the introduction to surgical hand disinfection by a nurse within two minutes (2) individual practical test where the students have to perform surgical hand disinfection (3) checking quality of hand disinfection under a ultraviolet lamp, added to that they were observed by health care staff by use of an check list (4) students attended the instruction of the other group (5) questionnaire about the two learning methods	teaching staff in SHD by a video instruction is more attractive and checking results under ultraviolet lamp makes performance for the students visible	in the preparation phase there was no significant difference between the two groups, in the practical phase (SHD) the VI group performed significantly better than the CI group, in quality there was no significant difference between both groups questionnaire results: 60.4% prefer video instruction, 39.6% prefer conventional instruction	question if video instruction can be as effective as conventional instruction in surgical hand disinfection can be positively answered

10.) Howard, Williams, Sen, Shah, Daurka, Bird, Loh, & Howard, 2009	surgeons, nurses and health care professionals, patients	influence of a simplified evidence-based 'Clean practice protocol' to improve hand decontamination	post-operative	subjective norm, perceived behavior control, attitude	Education program on surgical unit	information, education, skills training, communication with health-care professionals, awareness	(1) First audit: Clean Practice Protocols were used to assess surgeons, nurses and health-care professionals compliance with hand decontamination and infection control during surgical ward-rounds, clean practice activities are recorded and scored (2) results of these protocols were presented to the surgical teams (3) simple education and awareness program outlining the CPP was implemented, incl. distribution of posters in the theaters and surgical wards for 3 months (4) Second audit	protocols were used to collect data and feedback for staff, through presentation of results to the surgical teams they are aware of their actual performance and get to know where is space for improvement, to support them in this improvement staff gets training and posters to teach them skills and knowledge about hand disinfection to improve ability and compliance	Based on the data of the repeat audit, hand decontamination had improved significantly across all surgical specialities from 28% to 87%, correct usage of gloves and aprons improved from 2% to 50%. The overall 'clean' practice score also improved significantly from 63% to 89%	the introduction of an evidence-based clean practice protocol significantly improved clinical compliance of hand decontamination, correct usage of gloves and aprons, and overall infection control in a large teaching hospital
11.) Le, Dibley, Vo, Archibald, Jarvis, & Sohn, 2007	patients admitted to the neurosurgical wards who had undergone an surgery during the study periods	the effect of bedside hand sanitizer and education in surgical units on the development of SSI	post-operative	perceived behavior control, attitude	posters, training, brochures	information, education, skills training	(1) bedside units hand sanitizer were installed in ward A (intervention) and used for all patients for 1 year, hand sanitizer made of ethyl alcohol and chlorhexidine gluconate, staff were trained in using the hand sanitizer, educational brochures are distributed about the importance of hand hygiene and how to clean hand with hand sanitizers, poster to encourage hand hygiene was placed in the nursing station (2) no hand sanitizers and educational training was implemented in ward B (control)	through the availability and the easy reach of the hand sanitizer in combination with teaching staff about the use of them so they can support patients and the distribution of posters with tips make patients able to use them adequately. Posters also show why it is important to use them what influences attitude	After intervention incidence of SSI on ward A dropped from 8.3% to 3.8%, incidence in ward B from 7.2% to 9.2%. Before intervention: no difference in SSI incidence between the wards, after the intervention: SSI incidence on ward A was significantly lower than that on ward B	this study demonstrates that introduction of bedside dispensers of alcohol-based hand sanitizer in con- junction with an educational program was an effective strategy for controlling SSI in Vietnam

4. Discussion

4.1 Comparison of the German and the Dutch guidelines

The benefits of a collaboration between Germany and the Netherlands in the field of infection prevention were noticed several years ago with the EurSafety Health-net project, which focused on the prevention of infections in the EUREGIO. While infection numbers in Europe increased during the last 10 years according to the European Centre for Disease Prevention and Control (2013), this project achieved progress in the prevention of infections in the EUREGIO through a significant decrease of nosocomial MRSA rates (Jurke, Kock, Becker, Thole, Hendrix, Rossen, & Friedrich, 2013). Because this success resulted from a cooperation between German and Dutch healthcare organizations and the goal is to expand this success in the future, a harmonization between the German and the Dutch SSI guidelines is desirable. This harmonization would simplify the building of a prevention network and designing of interventions against SSIs which fit both German and Dutch hospitals. To this end, this research studied on which points the guidelines of both countries are similar and on which points they differ through an unsystematic review where the outward appearance and the content of the guidelines of both countries were compared.

The content and the outward appearance of the guidelines of both countries showed great differences. The two most important differences concerning the content were, first, that in Germany, hands and arms have to be disinfected up to the elbows, whereas in the Netherlands, this procedure is only necessary to the wrists. The second difference between the guidelines is that in Germany, the first choice to remove hair before surgery is a hair removal cream (Oldhafer et al., 2007). If the patient suffers skin irritation because of these creams, the use of a hair cutter is recommended. In the Netherlands, it is advised to use a hair cutter in the first place. Hair removal creams are not recommended in the Netherlands because of the risk of skin irritation (WIP, 2011). One possible explanation for this difference can be that the guidelines are based on different references concerning the removal of hair, and one study found that hair removal creams are not risky for skin irritations, whereas the other study found the opposite. There are only a small number of differences concerning the content of the guidelines, but these discrepancies are significant. This could be a problem when designing technology to prevent SSIs in Germany and the Netherlands, which, for example, could focus on the correct hair removal before surgery, since hair removal cream is strongly recommended in Germany but strongly not recommended in the Netherlands because of skin irritations.

The German and Dutch guidelines differ still more significantly in their outward

appearance. The most obvious difference is that the German guidelines orient mainly on references and, based on that, give very detailed recommendations in fluent text for practical applications. In contrast, the Dutch guidelines are constructed more independently of references by first providing their recommendations in short bullet points and then offering motivations based on scientific literature. One possible reason for this could be that in Germany, the legislation in the infection protection law is arranged in such a way that there is an increased liability risk when hygiene guidelines are contravened (Jäkel, 2017). According to the infection protection law, the compliance with the hygiene standards is fulfilled when the recommendations of the Robert Koch institute are considered. The German standards are thus more detailed and more based on scientific literature than the Dutch ones. This is because the German regulations have a law-like status and thus have to be extensively described and proven.

Because of the assumption that these guidelines can be harmonized and cooperation between Germany and the Netherlands in the prevention of SSIs could be more attainable, it would be beneficial to base both sets of guidelines on the same foundation. Such a foundation could be the "Global guidelines for the prevention of surgical site infections," published by the WHO in 2016 with the goal to offer a worldwide equal standard concerning the prevention of SSIs. These include, among others, the five factors which are part of the German and the Dutch guidelines, and this report bases every recommendation on recent literature in the form of systematic reviews. With this document as a base for Germany and the Netherlands, or even for all countries, worldwide cooperation between hospitals to design interventions and build a worldwide network against the development of SSIs would be a huge advantage and a possibility to stop the rise of SSIs.

When designing technology to prevent the development of surgical site infections in Germany and the Netherlands, it is recommended to base this technology on the similarities of the guidelines and not on the differences. The latter would result in complications and misconceptions and could impede the success of such a technology.

4.2 Hand hygiene interventions

The second research question regards which hand hygiene interventions exist to prevent the development of surgical site infections. Eleven interventions were found through the use of a systematic review. It is evident that a significant majority (9 of the 11 interventions) had a positive (short-time) effect on the reduction of SSIs, which means that hand hygiene is a factor which can be successfully improved. As previously described, the TPB can be adapted to hand hygiene compliance, which is why it was decided to analyze which component of the TPB was used in the

interventions to influence the behavior of the participants (White et al., 2015). One result of this systematic review was that the component which was used most was perceived behavior control. This result could be expected because there was a study in 2002 by Jenner, Watson, Miller, Jones, and Scott who tested the adaptability of the TPB model on hand hygiene. The most important result of this study was that attitude and personal responsibility are strong predictors for intention, which again is a strong predictor for behavior. In this study, perceived behavior control had no significant effect on intention but was a direct predictor for behavior (figure 8). Because of that, this factor is easy to influence, and it is expected that this factor has direct consequences on actual behaviors. This study also found that the time that medical staff has to conduct hand hygiene and the availability of sinks both influence perceived behavior control. This means that medical staff first need to have the skills to conduct proper hand hygiene, but also that the circumstances must allow for these skills to be applied in practice.

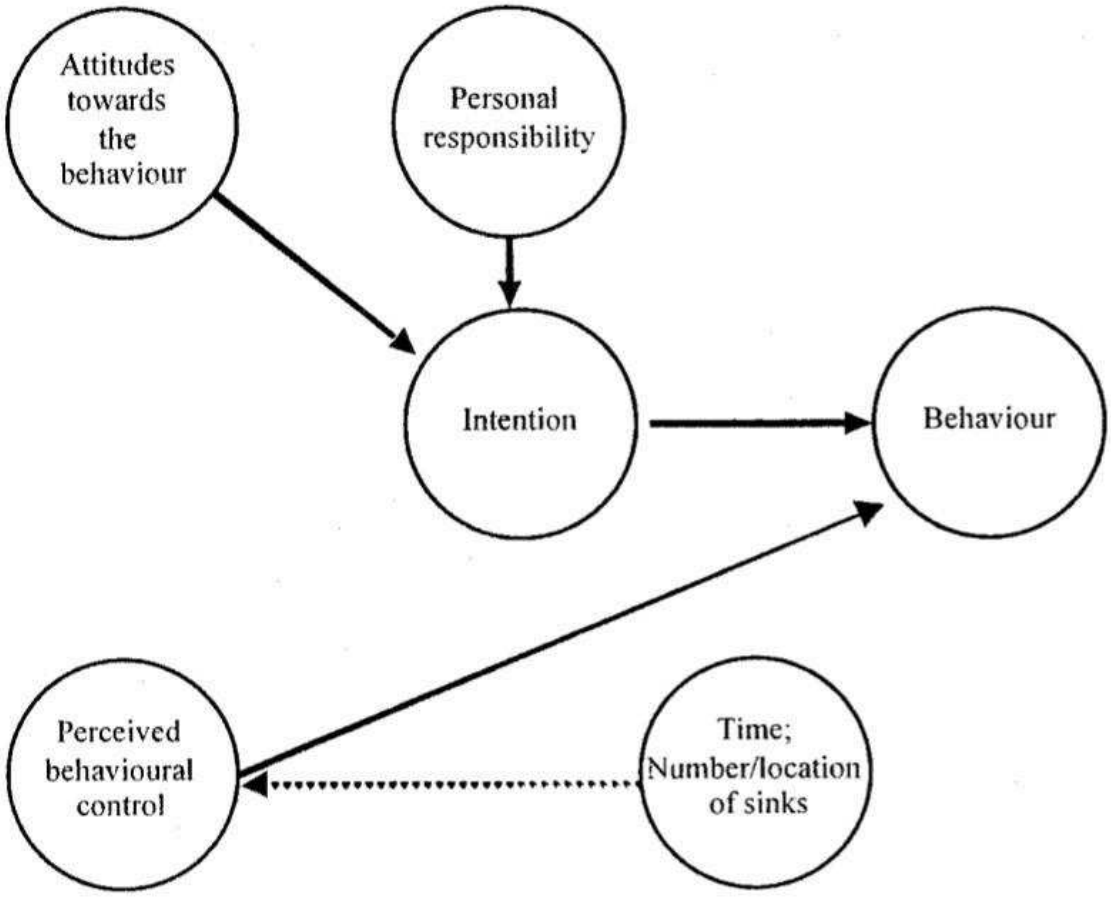


Figure 8. Hand hygiene TPB, reprinted from: Jenner, E. A., Watson, P. W. B., Miller, L., Jones, F., & Scott, G. M. (2002). Explaining hand hygiene practice: An extended application of the Theory of Planned Behaviour. Psychology, Health and Medicine, 7(3), 311-326. doi:10.1080/13548500220139412

When taking a deeper look at the results, they show that 6 of the 11 interventions worked with a combination of components of the TPB, and all of these interventions had greatly successful outcomes. However, there is no evidence in the literature that a combination of the components of the TPB in one intervention is more successful than influencing only one factor. This is an area which calls for further research.

An e-health intervention which was designed by Bertrand, Babu, Gupta, Polgreen and Segre (2011) made use of a virtual reality (VR)-simulation with virtual agents to train healthcare workers about hand hygiene skills, thus influencing their perceived behavior control. During this VR-simulation, the trainee is a healthcare inspector who monitors the hand hygiene performance of the characters who work in the animated hospital setting simulation (figure 9). First, the trainee receives

training from a virtual trainer about correct hand hygiene according to the WHO recommendations. After that, the trainee assesses the hand hygiene performance of healthcare staff that works in the hospital setting and receives feedback on that. In this way, this technology made use of the perceived behavior control aspect of the TPB. When taking a step further and integrating another factor of the TPB to this existing VR-technology, in this case the notion of attitude, a scenario could be presented every time the animated healthcare worker does not follow the correct hand hygiene rules in which possible consequences of this non-compliance are demonstrated, like a deep SSI. With this, the trainee can experience which consequences can result from non-compliance and how important it is to perform correct hand hygiene.

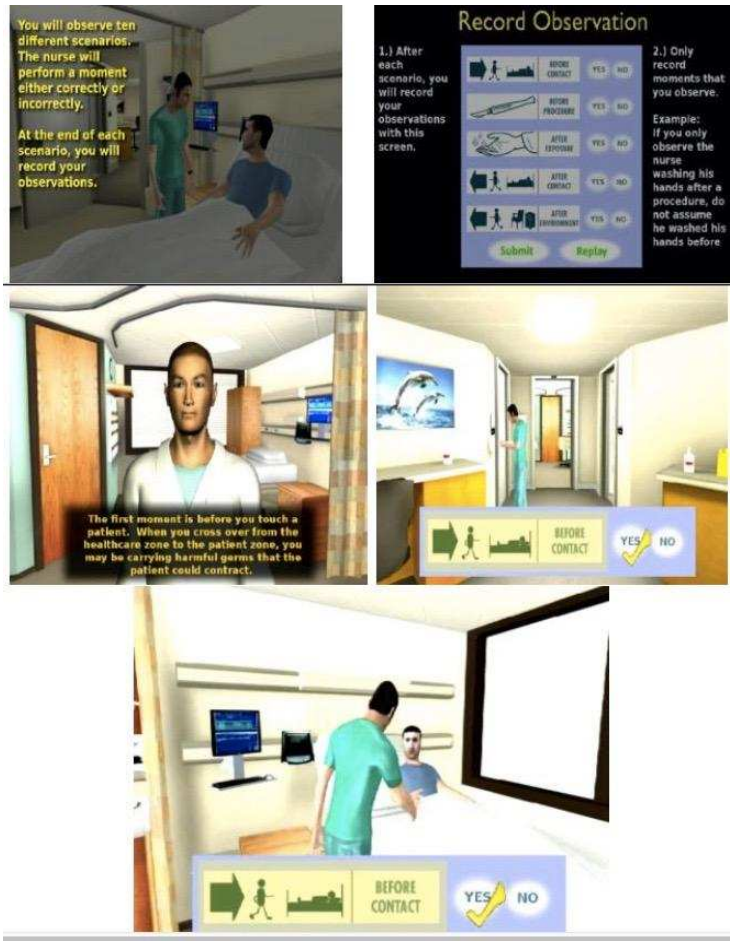


Figure 9. VR-technology 'Blender', retrieved from: Bertrand, J., Babu, S.V., Gupta, M., Segre, A.M., & Polgreen, P.M. (2011). A 3D Virtual Reality Hand Hygiene Compliance Training Simulator. 21st Annual Scientific Meeting of the Society for Healthcare Epidemiology of America

It was also noticeable that many of the interventions that offered feedback on hand hygiene performance were successful and had positive outcomes. This implies that regular feedback on how hand hygiene is performed and identifying space for improvement has a positive effect on hand

hygiene compliance. This has also been proven by many studies which are not part of this systematic review because they focused on hand hygiene in normal hospital settings rather than in surgical units. Most of these interventions delivered feedback though the presentation of graphs and statistics of hand hygiene performance inside the hospitals (Conway, Riley, Saiman, Cohen, Alper, & Larson, 2014; McGuckin, Waterman, & Govednik, 2009). There are also several studies which found that immediate feedback is the most effective way to deliver feedback. One of these studies offered real-time feedback through wireless technology (Marra, Sampaio Camargo, Magnus, Blaya, Dos Santos, Guastelli, Rodrigues, Prado, Victor, Bogossian, Monte, Dos Santos, Oyama, & Edmond, 2014). In that study, which was implemented in a normal hospital unit, the wireless technology was applied in front of every patient room next to the alcohol-based hand rub dispenser. Before entering the patient room, this technology noticed if the healthcare worker had performed proper hand disinfection. A red light flashed above the patient's bed if hand disinfection was not performed or performed insufficiently. A green light appeared if hand rub was performed correctly. Through this technology, healthcare workers received real-time feedback which significantly increased hand hygiene compliance. The same effect was found by a study with a very similar design and implementation (Storey, FitzGerald, Moore, Knights, Atkinson, Smith, Freeman, Cryer, & Wilson, 2014). They also found that immediate real-time feedback is more effective than retrospective feedback because it is closer to the situation and the behavior which was performed. All of these studies show that feedback, especially when given immediately, seems to be an important factor and opportunity to positively influence hand hygiene compliance. Many interventions which were collected through the systematic review worked with ultraviolet lamps to evaluate the effects of their interventions. These ultraviolet lamps could also be used to offer medical staff real-time feedback. To determine if such feedback method is effective, there could be a study with an experiment in the scrub area. Boxes with ultraviolet lamps could be placed next to the hand scrub area in surgical wards, and surgical staff would be required to check their performance immediately after completing the hand rub.

Another result of this systematic review was that the interventions which are addressed are generally very recent. This implies that the prevention of the development of surgical site infections is an increasingly more important topic. One possible explanation for this is that SSI prevalence rose the last 10 years in Europe, thus a further increase of SSI numbers may occur (European Centre for Disease Prevention and Control, 2013). This shows that the development of SSI research in the next 10 years will be a common and important topic, even though the high number of recent interventions shows that the risks of these infections and the need for action are already known.

4.3 Limitations

This research had some limitations. First, there was no evidence found that the documents used for the comparison of the German and Dutch guidelines are the official documents which are used in all hospitals in Germany or the Netherlands. In the Netherlands, for example, there is also a document of the Veiligheidsmanagementsysteem (VMS) which offers guidelines to prevent the development of SSIs in hospitals. The documents used for this narrative review seem to be the most common and official documents used in Germany and the Netherlands, but there is no evidence that these guidelines are implemented and known in all hospitals. It was decided to use the German document from the Robert Koch institute because the compliance to these recommendations is advised by the infection protection law of Germany (Jäkel, 2017). The choices for the Dutch documents of the WIP and the SWAB were made because many other documents, like the one by the VMS, use the WIP and SWAB documents as references and are primarily based on them (VMS, 2009).

A second limitation is that this systematic review was conducted by only one researcher. The data collection including the evaluation and assessment of the articles with the inclusion and exclusion criteria was not examined or verified by a second researcher. Because of that, there is the probability that researcher bias is present in this study.

4.4 Recommendations for further research

One important result of this study is that perceived behavior control when performing hand hygiene plays an important role in the improvement of surgical hand hygiene compliance. Literature shows that attitude and values of healthcare staff also strongly influence the compliance of hand hygiene protocol. A recommendation for further research is to study which factor is the most important for why hand hygiene compliance is still a challenge in hospitals and healthcare settings. This can be accomplished by arranging focus groups consisting of healthcare staff. During these focus groups, the difficulties which the staff actually experience concerning hand hygiene compliance in practice and their needs concerning hand hygiene interventions can be detected. These focus groups can be repeated during the design process of an intervention or technology to constantly address the needs of the users and make implementation in practice easier (participatory design).

4.5 Conclusion

Recently, SSIs and their prevention have become an increasingly more important topic, and many interventions already exist to cease their spread and development. Educational training to improve perceived behavior control, awareness training to influence attitudes, and feedback and supervision of leaders to stimulate the subjective norms of surgical staff are significant points address when building intervention against the development of SSIs. The differences between the German and Dutch guidelines could complicate cooperation between Germany and the Netherlands concerning the prevention of SSIs, and there is the need for a similar foundation of the relevant documents.

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Appendix

Appendix A: Comparison German and Dutch guideline

content		Germany	Netherlands
	hygiene	OP-Bereichskleidung wird ausschließlich in der OP-Funktionseinheit getragen Vor jeder neuen Operation muss die sterile OP-Kleidung gewechselt wer- den Vor Betreten des Operationsraumes soll ein Mund-Nasen-Schutz angelegt werden, sofern im OP-Saal die sterilen Instrumente bereits gerichtet sind, ei- ne OP demnächst beginnen wird oder eine OP durchgeführt wird (Katego- rie IB). Der MNS wird während der gesamten Operation getragen (Katego- rie IB). Er muss ausreichend groß sein, Mund und Nase bedecken und eng am Gesicht anliegen (Kategorie IB). Bart- haare müssen (ggf. in Kombination mit der OP-Haube) vollständig abgedeckt sein Vor Betreten des Operationsraumes muss ein Haarschutz getragen werden, der das Haupthaar (sowie ggf. in Kombination mit dem Mund-Nasen-Schutz auch das Barthaar) vollständig bedeckt Das OP-Team muss einen sterilen OP- Mantel mit definierter Barrierefunkti- on und sterile OP-Handschuhe tragen Beim Wechsel von Personal zwischen Aufwachraum und OP-Raum muss (ggf. durch einen Schutzkittel) Sorge getragen werden, dass die Bereichs- kleidung nicht mit Krankheitserregern kontaminiert wird source: Oldhafer et al., 2007	In het operatiekamercomplex wordt operatiekamerkleding gedragen Na het langer dan 30 minuten verlaten van het operatiekamercomplex dient bij terugkomst schone operatiekamerkleding te worden aangetrokken Tijdens de operatie dragen allen die in de operatiekamer aanwezig zijn een chirurgisch mondneusmasker Tijdens verblijf in zone A en B van het operatiecomplex dient men het hoofdhaar geheel bedekt te hebben. Dit geldt ook voor een baard Het aantal aanwezigen bij een operatie dient altijd tot een minimum te worden beperkt Het in- en uitlopen tijdens een operatie dient tot een minimum te worden beperkt. source: WIP, 2011

hand hygiene

- Die Mitglieder des OP-Teams müssen kurze und rund geschnittene Finger- nägel haben und dürfen keine künst- lichen Fingernägel tragen
- Die Haut muss intakt (frei von infizierten Läsionen) und regelmäßig gepflegt sein
- Schmuck behindert die sachgerechte Desinfektion. An Händen und Unter- armen dürfen daher keine Schmuck- stücke, Uhren oder Ringe getragen werden
- Hände und Fingernägel der Mitarbeiter sollen bei Betreten des OP-Trakts sauber sein
- Da die Hand insbesondere zu Dienstbeginn, allerdings mit Bakteriensporen kontaminiert sein kann [163], Alkohole aber nicht sporozid wirken [164], sollten die Hände zu Dienst- beginn, spätestens aber vor Anlegen der OP-Bereichskleidung in der OP-Schleu- se, einmal gewaschen und abgetrocknet werden
- Die Zeitspanne zwischen der Händewaschung und der Einschleusung gewährleistet eine ausreichende Abtrock- nung der Restfeuchte der Haut bis zur alkoholischen Händedesinfektion, sodass die Wirkung der Desinfektion nicht mehr beeinträchtigt wird [163].
- Bei der Händedesinfektion müssen alle Hautareale bis zum Ellenbogen für die vom Hersteller deklarierte Mindest- einwirkzeit benetzt werden. Unter prak- tischen Gesichtspunkten werden daher zunächst Unterarme und Hände mit dem alkoholischen Präparat benetzt. In der sich anschließenden Händedesinfekti- onsphase hat sich das Einreibeverfahren nach EN 12791 bewährt, das bei korrekter Umsetzung Benetzungslücken verhindert [165]. Das Hauptaugenmerk beim Einrei- ben soll auf die Fingerkuppen, Nagelfalze und Fingerzwischenräume gelegt werden
- Die Anforderung an die Wirksamkeit der chirurgischen Händewaschung mit mi- krobiziden Waschpräparaten unterschei- det sich nicht von der mit alkoholischen Einreibepräparaten
- Die Hände sollen aus folgenden Gründen luftgetrocknet sein, bevor die OP-Handschuhe angelegt wer-
- De voorwaarden voor het toepassen van goede persoonlijke hygiëne en handhygiëne, onder andere het verbod op ringen en kunstnagels, staan beschreven in de WIP- richtlijnen: Persoonlijke hygiëne medewerkers en Handhygiëne
- De handen en polsen worden gereinigd met water en zeep
- Na het reinigen moeten de handen en polsen, voorafgaand aan het inwrijven met een handdesinfectans, goed worden gedroogd, waarbij gebruik wordt gemaakt van papieren handdoeken.
- Als de handen en polsen droog zijn, worden ze met een dusdanige hoeveelheid handdesinfectans ingewreven, dat de handen en polsen gedurende de door de fabrikant voorgeschreven periode nat blijven. Blijf de handen blijven wrijven totdat het desinfectans opgedroogd is.
- De hoeveelheid handdesinfectans en het aantal keren dat opnieuw hand- desinfectans vanuit de dispenser genomen wordt, varieert dus per individu en per preparaat. Hierbij is van belang dat de door de producent van het handdesinfectans voorgeschreven contacttijd, wordt aangehouden
- Steriele handschoenen worden pas aangetrokken als de handen en polsen droog zijn
- source: WIP, 2013

	den: verringerte Perforationsgefahr der Handschuhe [167], geringeres Irritations- risiko und signifikante Wirkungsverbes- serung der alkoholischen Händedesinfek- tion bei 1 min Lufttrocknung □ source: Oldhafer et al., 2007	
hair removal	□ Präoperative Haarentfernung nur bei operationstechnischer Notwendigkeit, bevorzugt mittels Kürzen der Haare bzw. chemischer Enthaarung □ Fällt die Entscheidung auf die mechanische Entfernung, muss sie unmit- telbar vor der Operation erfolgen. □ source: Oldhafer et al., 2007	□ Alleen om chirurgisch technische redenen wordt bepaald of lichaamshaar in het operatiegebied moet worden verwijderd. □ Wanneer lichaamshaar in het operatiegebied preoperatief wordt verwijderd, gebeurt dit met een tondeuse. □ source: WIP, 2011
antibiotic prophylaxis	□ Perioperative Antibiotikaprophyla- xe nur bei gesicherter Indikation. Die Auswahl des Antibiotikums richtet sich nach der Wirksamkeit gegen die häufigsten Wundinfektionserreger für die jeweilige Operationsart □ Damit ergibt sich die Notwendigkeit der Ver- abreichung in einem Zeitintervall von 2 h bis spätestens 30 min vor OP-Beginn □ Überschreitet die OP-Dauer 3–4 h, empfiehlt sich eine erneute Applikation □ Eine längere Anwendung von Antibiotika erbringt in der Regel keine besseren Ergebnisse im Sinne der Prophylaxe □ source: Oldhafer et al., 2007	□ De SWAB adviseert daarom voor volwassenen: het eerste generatie cefalosporine cefazoline i.v. (1 tot 2 gram 30-60 minuten voor incisie), gecombineerd met metronidazol iv (500mg) wanneer een anaëroob spectrum nodig is □ Hospitals should establish a multidisciplinary AM team (including surgeons, anesthesiologists, nurses, pharmacists, infection control specialists and clinical microbiologists) who should develop and implement a protocol of appropriate PAP □ to ensure appropriate timing, antibiotic prophylaxis before and during surgery should be the responsibility of anesthesiologists □ PAP should be administered within 60 minutes before incision, ideally at the time of anesthetic induction □ although a single dose of PAP is preferred, subsequent doses should be given depending on the duration of the procedure and the half-life of the antibiotic □ continuing antibiotic prophylaxis after the end of surgery is not recommended □ source: Bauer et al., 2017
Normothermia	□ Perioperativ soll der Zustand der Nor- mothermie aufrechterhalten wer- den, sofern nicht aus therapeutischen Gründen eine Hypothermie erforder- lich ist □ Als die wirksamste Maßnahme zum Schutz vor Hypothermie wird die (aktive) präoperative Erwärmung eingeschätzt [219], selbstverständlich in Verbindung mit intraoperativer Hauter- wärmung. □ Zum Schutz des Patienten vor Ausküh- lung eignen sich temperierte OP-Tischauf- lagen und eine Wärme speichernde bzw. Wärme freisetzende Abdeckung □ source: Oldhafer et al., 2007	□ Actieve opwarming van de lichaamstemperatuur van de patiënt is mogelijk met een warmtedeken/warmtematras voorzien van luchtkanalen waardoor hete lucht wordt geperst (hete luchtverwarming) of waardoor heet water wordt rondgepompt (waterverwarming) □ Houdt de lichaamstemperatuur van de patiënt tussen de 36 en 38 graden Celsius twee uur voor de inductie van anesthesie, gedurende de ingreep en gedurende het verblijf in de verkoeverkamer. □ source: WIP, 2011

Appendix B: Extraction forms

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 15 may 2017

2. Study Identification

2.1 Title: Patient hand hygiene practices in surgical patients
2.2 Authors: Laura L. Ardizzone, Janice Smolowitz, Nancy Kline, Bridgette Thom, Elaine L. Larson
2.3 Affiliation:
2.4 Country:
2.5 Year of publication: 2013
2.6 Journal: American Journal of Infection Control, Vol 41 Issue 6
2.7 SJR-ranking:

3. Abstract

Background

Little is known about the hand hygiene practices of surgical patients. Most of the research has been directed at the health care worker, and this may discount the role that hand hygiene of the surgical patient might play in surgical site infections.Methods A quasiexperimental, pretest/post-test study was conducted in which patients (n = 72) and nurses (n = 42) were interviewed to examine perceptions and knowledge about patient hand hygiene. Concurrently, observations were conducted to determine whether surgical patients were offered assistance by the nursing staff. Following an initial observation period, nursing staff received an educational session regarding general hand hygiene information and observation results. One month after the education session, patient/nurse dyads were observed for an additional 6 weeks to determine the impact of the educational intervention. Results Eighty observations, 72 patient interviews, and 42 nurse interviews were completed preintervention, and 83 observations were completed postintervention. In response to the survey, more than half of patients (n = 41, 55%) reported that they were not offered the opportunity to clean their hands, but a majority of the nursing staff reported (n = 25, 60%) that they offered patients the opportunity to clean their hands. Prior to the educational intervention, nursing staff assisted patients in 14 of 81 hand hygiene opportunities. Following the intervention, nursing staff assisted patients 37 out of 83 opportunities (17.3% vs 44.6%, respectively, [$\chi 21 = 13.008$, P = .0003]).Conclusion This study suggests that efforts to increase hand hygiene should be directed toward patients as well as health care workers.

4. The intervention

4.2 What is the target group of this intervention? surgical patients and nurses

4.3 Goals of the intervention:
(1) explore nurses' and patients' perceptions of patient hand hygiene and (2) determine the effectiveness of an educational intervention directed at the nursing staff about patient hand hygiene

4.4. What is the focus of this intervention? Promoting that nurses assist patients with surgical hand washing

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research? yes

4.6 Features
Which are the features of the intervention?
- Information x
- Education x
- Skill training
- Exercises

- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals x
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention? no

4.9 Intended usage
What is the time strip of this intervention? 4-6 months

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
presentation

4.11 Process
How is the intervention implemented? Preintervention phase: survery and observation of patients and nurses, 2 months later: presentation of health care professionals, 1 month later: observation for 6 weeks
Where is the intervention implemented? 434-bed medical centre in an urban environment
By who is the intervention implemented? 3 volunteers for datacollection (nurses), presentation ws given by a primary investigator (PI)
When is the intervention implemented?

5. Study design
5.1 Design type
What is the design of the intervention? Pre and postintervention phase, preintervention phase: nures and patients participated in a survey, assistance of patient handwashing was ovserved, after pre intervention phase, the nursing staff participated in an educational initiative: 30-minute presentation about HAIs, handwashing efforts and aggregate audit results of the first intervention phase. Opportunity for questions, electronic version was available for team members who werent there.

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected x
- Forced

5.3 Reach
Participants: (1) Surgical patients: 71 (2) professional nursing staff: 42
How many people participated in this intervention? 71 patients and 42 nurses
How many people were recruited? 75 patients, 42 nurses

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? only surgical patients, who had some level of dependency on nursing staff, over 18 years old, willing to participate

5.5 Randomization
If there are different groups: How were they spitted in different groups? no different groups, pre and post test study

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: 4-6 months

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? effect of the intervention, comparison pre and postintervention phase
When are the outcomes measured? after the postintervention phase

6.2 Effects
What are main effects of the intervention? preintervention phase: in 17.3 % nurses helped patients with handwashing, after intervention: 44,6%
Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects?

6.4 Other findings

7. Discussion
What are shortcomings of the intervention named by the authors?

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: A single standardized practical training for surgical scrubbing according to EN1500: effect quantification, value of the standardized method and comparison with clinical reference groups
2.2 Authors: Fichtner, A., Haupt, E., Karwath, T., Wullenk, K., Pohlmann, C., Jatzwauk, L.
2.3 Affiliation: Universitatsklinikum Halle
2.4 Country: Germany
2.5 Year of publication: 2013
2.6 Journal: GMS Zeitschrift für medizinische Ausbildung
2.7 SJR-ranking:

3. Abstract
The standardized training of practical competences in skills labs is relatively new among German Medical Faculties. The broad acceptance and outstanding evaluation results do not provide objective data on the efficiency and cost-efficiency of these trainings. This study aims on the quantification of the teaching effect of the surgical scrubbing technique EN1500 and its comparison with clinical references of OR personnel. METHODS: 161 4(th) year medical students were randomized into intervention and control group. The intervention group received a 45 minute standardized peer-teaching training of practical competences necessary in the OR including the scrubbing according to EN1500. Fluorescence dye was mixed in the disinfectant solution. After hand disinfection, standardized fotographs and semi-automated digital processing resulted in quantification of the insufficiently covered hand area. These results were compared with the control group that received the training after the test. In order to provide information on the achieved clinical competence level, the results were compared with the two clinical reference groups. RESULTS: The intervention group remained with 4,99% (SD 2,34) insufficiently covered hand area after the training compared to the control group 7,33% (SD 3,91), p<0,01. There was no significant difference between control group and reference groups: surgeons 9,32% (SD 4,97), scrub nurses 8,46% (SD 4,66). The student intervention group showed results that were significantly better than the clinical references. The methodic mistake remained negligible. In the sub-group analysis, the students with low or medium experience in surgical scrubbing and hand disinfection derived highest benefit from the training, whereas students with no or high experience did benefit less. All participants showed better results on hand palms compared to back of hand areas. DISCUSSION: A single standardized peer-teaching of surgical scrubbing and hand disinfection according to EN1500 is sufficient to improve the measurable coverage of hand area and reduce the disinfection gap by 1/3. In absolute measures, the competence level of experienced surgeons and scrub nurses is achieved or even exceeded

4. The intervention

: Universitair medical centre Halle, Germany

4.2 What is the target group of this intervention? Medical students, 8th semester

4.3 Goals of the intervention:
1. How can training effects in surgical scrubbing and hand disinfection be measured in a standardized manner? How can the quality of surgical hand disin- fection and possible disinfection gaps be precisely quantified?
2. How well are 4th year medical students able to learn the procedure of surgical hand disinfection after having completed a single standardized practical training (see Figure 1)? Are these skills sufficient for a safe application in the daily routine? Are there additional effects of the standardized surgical scrubbing technique in terms of efficient hand disinfection without disinfection gaps?

3. How good are the skills of the medical students after a single standardized practical training in direct comparison with the reference groups OR personnel and surgeons?

4.4. What is the focus of this intervention? surgical hand disinfection (EN1500)

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research?

4.6 Features
Which are the features of the intervention?
- Information x
- Education x
- Skill training x
- Exercises
- Monitoring
- setting goals
- Communication with colleagues x
- Communication with healthcare professionals
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? 6 months

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
Practical training implemented by a tutor

4.11 Process
How is the intervention implemented? intervention and control group + reference group for comparison, intervention group received training concerning surgical hand disinfection, control group did not, both groups had to perform surgical hand disinfection, after that hand where photographed under a UV-lamp
Where is the intervention implemented? Medical centre Halle
By who is the intervention implemented?
When is the intervention implemented?

5. Study design

5.1 Design type
What is the design of the intervention? Skills-Lab training, (1) questionaire about pre skills in surgical hand disinfection (2) control group: disinfection of the hands with Sterilium incl. the farbstoff Visirub (3) intervention group: standardized training in the skills-lab, peer-teaching method with a tutor who was trained in surgical hand disinfection, training in groups of 4 students, multiple times per day (content: behavior in the surgical theatre, transfer to the OR, surgical hand disinfection, dressing/ undressing of sterile gloves) (4) the Sterilium which was used to disinfect the hands was mixed with a colorant (Visirub) , after 3 minutes time of exposure the hands were photographed under a UV-Lamp, after that the photographs were analysed

5.2 Recruitment of the participants of the intervention:
- Free x (students)

- Convenience
- Selected x (reference group)
- Forced

5.3 Reach
Participants: medical students, 8th semester: splitted in intervention and control group, reference group: 21 OR nurses and 16 surgeons
How many people participated in this intervention? 161 students
How many people were recruited? 161 students and 21 + 16 members of the reference group

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? not mentioned

5.5 Randomization
If there are different groups: How were they spitted in different groups? random

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1 intervention group		practical training + hand disinfection
2 control group		no training + hand disinfection

5.7 Duration of the intervention
Time span of the intervention: 6 months

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? Effect of the training on surgical hand disinfection
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? measuring method was suitable, intervention group less disinfection gaps than the control group, the intervention group performed better than the reference group which represent the clinical standard of the learning objective, control group showed also better results than the reference group
Was there a difference between intervention group and control group? yes
Is the outcome significant? yes

6.3 Conclusions
What are conclusions based on the variables and effects? peer-teaching skills lab training of surgical hand disinfection according to EN1500 can be considered an appropriate method for the stand- ardized teaching of medical students in clinical-practical skills

6.4 Other findings
A single standardized training of surgical hand disinfection according to EN1500 can be so efficient that the results of the clinical reference groups are out- matched

7. Discussion

What are shortcomings of the intervention named by the authors?
As a shortcoming it has to be mentioned that the pilot study was conducted with small group sizes. Reference group I comprised a total of 21 qualified OR nurses, whereas in reference group II only 16 surgeons could be included.

Data Extraction Form

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Usage of Ultraviolet Test Method for Monitoring the Efficacy of Surgical Hand Rub Technique Among Medical Students
2.2 Authors: Erzsebet Vanyolos MSc, Katalin Peto PhD, Aida Viszlai, Iren Miko PhD, Istvan Furka PhD, Norbert Nemeth PhD, Pirodka Orosi PhD
2.3 Affiliation: Department of Operative Techniques and Surgical Research, Faculty of Medicine, University of Debrecen, Nagyerdeikrt. 98, Debrecen, Hungary
Department of Hygiene and Infection Control, Faculty of Public Health, University of Debrecen, Debrecen, Hungary
2.4 Country: Hungary
2.5 Year of publication: 2015
2.6 Journal: Journal of Surgical Education Vol 72
2.7 SJR-ranking:

3. Abstract

Background Adequate hand movements are essential in surgical hand rub, so it is important for medical students to learn it correctly. To assess its efficacy, we aimed to use ultraviolet (UV) light test after applying fluorescent solution. Methods Digital images of the hands of 253 medical students were analyzed during “Basic Surgical Techniques” course on the 10th (Survey 1) and 14th (Survey 2) week of the curriculum to check the process and the skills development. The last step of the surgical hand rub was performed with a fluorescent solution, and then the hands were placed under UV light. Photographs were taken and analyzed. Every uncovered area was considered an error. Number and the localization of missed spots and its extent was determined. For evaluation, palmar (P) and dorsal (D) sides of the hands were divided into regions of interest (1—distal phalanxes, 2—thumb and first metacarpus, 3—second to fifth fingers, and 4—second to fifth metacarpals). Results Various magnitude and number of failure occurred in 123 (48.61%) students in survey 1 and in 65 (25.69%) in survey 2. The most frequent sites of the missed spots were D/2 and P/4 region in survey 1 and D/1 and P/4 in survey 2. There was an improvement seen in survey 2, as shown by a decrease in the number and extent of missed spots. Right-handed students made fewer mistakes on their nondominant hands than left-handed students (n = 23) did. Discussion The method was suitable to monitor the efficacy of surgical hand rub technique and identify the mistakes and the critical sites. The main advantage of the UV test was the immediate feedback, which resulted in a distinct improvement. Conclusion Applying the UV test to the medical education and training may contribute to improvement in the compliance and the efficacy of the technique of surgical hand rub among the students.

4. The intervention

4.2 What is the target group of this intervention? medical students

4.3 Goals of the intervention:
1. apply Ultraviolet light test after SHD

4.4. What is the focus of this intervention? using Ultraviolet lights to assess students SHD and improve compliance

4.5 Development
Is the intervention based on previous research? yes

4.6 Features
Which are the features of the intervention?
- Information x
- Education x
- Skill training x
- Exercises
- Monitoring x
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.9 Intended usage
What is the time strip of this intervention? 5 weeks

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
Educational program in the hospital

4.11 Process
How is the intervention implemented? Digital images of the hands of 253 medical students were analyzed during “Basic Surgical Techniques” course on the 10th (Survey 1) and 14th (Survey 2) week of the curriculum to check the process and the skills development. The last step of the surgical hand rub was performed with a fluorescent solution, and then the hands were placed under UV light. Photographs were taken and analyzed. Every uncovered area was considered an error. Number and the localization of missed spots and its extent was determined. For evaluation, palmar (P) and dorsal (D) sides of the hands were divided into regions of interest (1—distal phalanxes, 2—thumb and first metacarpus, 3—second to fifth fingers, and 4—second to fifth metacarpals
Where is the intervention implemented? teaching hospital
By who is the intervention implemented?
When is the intervention implemented?

5. Study design

5.1 Design type
What is the design of the intervention? survey 1 - intervention - survey 2

5.2 Recruitment of the participants of the intervention:
- Free
- Convenience
- Selected x
- Forced

5.3 Reach
Participants: Third year medical students
How many people participated in this intervention? 253
How many people were recruited? 285
How many participated actually? 253

5.4 Are there inclusion and exclusion criteria for the participation in the intervention? no
If yes, which?

5.5 Randomization
If there are different groups: How were they spitted in different groups?

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: 5 weeks

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? behavioral
When are the outcomes measured? survey 2

6.2 Effects
What are main effects of the intervention? Various magnitude and number of failure occurred in 123 (48.61%) students in survey 1 and in 65 (25.69%) in survey 2. The most frequent sites of the missed spots were D/2 and P/4 region in survey 1 and D/1 and P/4 in survey 2. There was an improvement seen in survey 2, as shown by a decrease in the number and extent of missed spots. Right-handed students made fewer mistakes on their nondominant hands than left-handed students (n = 23) did.
Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? The main advantage of the UV test was the immediate feedback, which resulted in a distinct improvement

6.4 Other findings

7. Discussion

What are shortcomings of the intervention named by the authors?

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Effect of music on surgical hand disinfection: a video-based intervention study
2.2 Authors: Gautschi, N., Marschall, J., Candinas, D., Banz, V. M.
2.3 Affiliation: Department of Visceral Surgery and Medicine, Inselspital, University Hospital Bern and Bern University, Bern, Switzerland and Department of Infectious Diseases, Inselspital, University Hospital Bern and Bern University, Bern, Switzerland
2.4 Country: Switzerland
2.5 Year of publication: 2017
2.6 Journal: Journal of Hospital Infection 95 (2017) 352e354
2.7 SJR-ranking:

3. Abstract

Surgical hand disinfection (SHD) is likely to be influenced by various factors. The aim of this study was to evaluate the effect of listening to music on the duration of SHD. In total, 236 SHD procedures were recorded on video. The duration of SHD exceeded 2 min in both the intervention group and the control group, with background music unable to achieve an increase in the time spent scrubbing. However, listening to music reduced the proportion of very short scrub times (<90 s) from 17% to 9% ($P = 0.07$). The following four factors increased mean scrub time significantly: female sex; lower staff seniority; scrubbing hands in groups; and use of a stopwatch. Although the improvement observed did not reach significance, it is suggested that background music may be useful for the 10% of healthcare workers who perform very short scrubs.

4. The intervention

4.2 What is the target group of this intervention? Surgical staff

4.3 Goals of the intervention:
1. to evaluate whether listening to background music while scrubbing influenced the duration of SHD

4.4. What is the focus of this intervention? The effect of music on SHD

4.5 Development
Is the intervention based on a theory or model?
Is the intervention based on previous research?

4.6 Features
Which are the features of the intervention?
- Information
- Education
- Skill training
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects?

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? 2 weeks

4.10 Certification
Is the intervention certified?

4.11 How is the intervention offered? (technology? on which platform? Campaign?)

4.11 Process
How is the intervention implemented? first week SHD was observed without background music (control group), second week the staff washed hands while listening to music (intervention group), music: charts from Switzerland, 236 pre operative procedures were available for analysis
Where is the intervention implemented? University Hospital Bern, Switzerland
By who is the intervention implemented?
When is the intervention implemented? between april and may 2015

5. Study design

5.1 Design type
What is the design of the intervention? before and after intervention study, first week SHD was observed without background music (control group), second week the staff washed hands while listening to music (intervention group), music: charts from Switzerland

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected x
- Forced

5.3 Reach
Participants: board-certified surgeons, surgeons in training, medical students and scrub nurses
How many people participated in this intervention? control group: 101, intervention group: 135
How many people were recruited? first week: 101, second week: 135

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? Only observations in which SHD was performed using alcohol-based products where included

5.5 Randomization
If there are different groups: How were they spitted in different groups? not mentioned

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1 control group	week 1	no background music while SHD
2 intervention group	week 2	listening to background music while SHD

5.7 Duration of the intervention
Time span of the intervention: 2 weeks

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical) educational
Which outcomes are measured? effect of music on SHD
When are the outcomes measured? during week 2

6.2 Effects
What are main effects of the intervention? no significant difference between control and intervention group, but: the proportion of participants who scrubbed for a very short time was reduced from 17% to 9% in the intervention group, board certified surgoens scrubbed shorter than other participants, female staff scrubbed longer than male staff
Was there a difference between intervention group and control group? no
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? listening to music do not result to longer scrub times (but: scrub times were before the intervention already fairly long, this could explain why no further improvement was documented)

6.4 Other findings
wearing a stopwatch significantly increased the overall mean scrub time from 129.5s to 160.5 s

7. Discussion

What are shortcomings of the intervention named by the authors?
study population nor randomized, Data were not collected regarding the microbiological colonization of HCWs' hands, or SSIs that developed after surgeries conducted during the two weeks of study, study took part in a single instituation, data analysis was not blinding

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Practice of skin protection and skin care among German surgeons and influence on the efficacy of surgical hand disinfection and surgical glove perforation
2.2 Authors: Julian C Harnoss1, Laura Brune2, Jörg Ansorg3, Claus-Dieter Heidecke4, Ojan Assadian5* and Axel Kramer2
2.3 Affiliation:
2.4 Country: Germany
2.5 Year of publication: 2014
2.6 Journal: BMC Infectious Diseases , Bandnummer:14 , Ausgabe:1
2.7 SJR-ranking:

3. Abstract
Background: Surgical hand rub and healthy skin are basic requirements to prevent surgical site infections. Nevertheless, there is little knowledge about the current practice of skin protection and/or skin care products (SP/SC) using among surgeons as well as a lack of data pertaining to the influence of SP/SC on the antimicrobial efficacy of surgical hand rub. Methods: A 10 weeks-survey among German surgeons as well as an experimental crossover study involving 26 participants were conducted. The immediate and sustainable efficacy (IE/SE) of surgical hand rub and participants' hand moisture were measured after an 8-day usage of SP/SC, as well as the influence on micro-perforations on surgical gloves. Results: The questionnaire was available to 16,000 German surgeons. Thereof, 1,771 surgeons accessed the questionnaire, representing a total participation rate of 11%. As 19% (n = 338) of questionnaires were incomplete, a total of 1,433 completed questionnaires were available for further analysis. More than 75% of the participants stated not to use any SP/SC, yet, almost 50% suffered from skin irritation or discomfort. Only 5% used SP/SC at the beginning of their shift. 10% refused to use SP/SC because of concerns that SP/SC may reduce the antimicrobial efficacy of surgical hand rub. After usage of SP/SC over 8-days, skin moisture was significantly higher ($P < 0.001$), whereas no significant influence on the antimicrobial efficacy of surgical hand rub was observed (IE: $P = 0.135$; SP: $P = 0.681$). Micro-perforations were detected in 8/52 surgical gloves (15%), with no statistical significant difference between SP/SC users (n = 2/26; 8%) and non-users (n = 6/26; 23%; $P = 0.249$). Conclusions: Following the results of this largest questionnaire base survey among German surgeons on skin care, there is a need to educate and inform surgeons on the correct application and the concept of SP/SC strategies. In the present study, the combination of selected SP/SC products and one alcohol-based hand rub formulation did not show a negative interaction with surgical hand rub or surgical glove perforation. However, it is advisable to ascertain the compatibility of SP/SC products with the used hand disinfectant prior to purchase.

Keywords: Hand disinfection, Surgical hand rub, Skin protection, Skin care, Compliance surgeon, Interaction, Alcohol-based hand rub, Micro-perforation, Surgical glove

4. The intervention

4.2 What is the target group of this intervention? surgical staff

4.3 Goals of the intervention:
1. evaluate the frequency and modality of usage of SP/SC products among surgeons and to investigate the efficacy of hand disinfection under regularly application of SP/SC usage in a longitudinal experimental setting

4.4. What is the focus of this intervention? usage of SP/SC by surgical staff

4.5 Development
Is the intervention based on a theory or model?
Is the intervention based on previous research? Yes : "In a previously published prospective questionnaire based survey [14] it was demonstrated that the know- ledge on this topic among medical and surgical nurses in a German university medical center was insufficient, leading to wrong behavior at work and inadequate use of SP and SC products.

"

4.6 Features
Which are the features of the intervention?
- Information
- Education
- Skill training
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other: usage of certain products x

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention? no
Which?

4.9 Intended usage
What is the time strip of this intervention? questionaire: 10 weeks, intervention: 16 days

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
experiment

4.11 Process
How is the intervention implemented? (1) questionnaire was send to 16,000 registered surgeons in Germany (2) cross-over study: two groups, group A started 8 days before experimental day and used SP cream and SC products three times per day and used SP cream 1 hour before SHR, group B did not use any SP/SC products, at experimental day 1 the efficacy of SHR using an alcohol-based hand rub was determined for all participants, then, the following day Group B used SP/SC products for 8 days, group A did not, at experimental day 2 again the efficacy of SHR was determined. At each ED, the skin moisture at three standardized measure points at the back of both hands was measured using a calibrated corneometer

Where is the intervention implemented?
By who is the intervention implemented?
When is the intervention implemented?

5. Study design

5.1 Design type
What is the design of the intervention?
2 part study: first questionnaire, then cross-over study

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected
- Forced

5.3 Reach
Participants: adult surgical staff
How many people participated in this intervention? 26
How many people were recruited? 26

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? no

5.5 Randomization
If there are different groups: How were they spitted in different groups? not mentioned

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1	A	First 8 days usage of SP/SC products, then 8 days no usage
2	B	First no usage, then 8 days usage of SP/SC products

5.7 Duration of the intervention
Time span of the intervention: 16 days

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical) health
Which outcomes are measured?
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? The measured skin moisture was significant higher after SP/SC usage. Without using any SP/SC products, the immediate (IE) and sustained (SE) bacterial reduction factors (log10) were 2.8 ± 1.49 (IE) and 1.57 ± 2.4 (SE), respectively. After application of SP/SC during 8 consecutive days, the bacterial reduction factors (log10) were 1.98 ± 1.83 (IE) and 1.84 ± 1.41 (SE), respectively, the frequency of micro- glove perforation was higher in participants without usage of SP/SC products, the difference in micro-perforation within the SP/SC group (2/26, 7.7%) and non-SP/SC group (6/26, 23.1%) was statistically not significant

Was there a difference between intervention group and control group? yes
Is the outcome significant? no

6.3 Conclusions
What are conclusions based on the variables and effects? In the present study, the combination of selected SP/SC products and one alcohol-based hand rub formulation did not show a negative interaction

7. Discussion

What are shortcomings of the intervention named by the authors?

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Compliance of surgical hand washing before surgery: Role of remote video surveillance
2.2 Authors: Ambreen Khan, Sidrah Nausheen
2.3 Affiliation: Aga Khan University, Karachi, Pakistan
2.4 Country: Pakistan
2.5 Year of publication: 2017
2.6 Journal: Journal of Pakistan Medical Association
2.7 SJR-ranking:

3. Abstract

Objective: To evaluate and increase the compliance of surgical hand scrubbing with periodic feedback. **Methods:** This study was conducted at the Aga Khan Hospital for Women and Children, Karachi, Pakistan, from April to July 2014. A remote video auditing system consisting of human auditors was used for visualising surgical hand wash compliance of the surgical team. The equipment, which used motion sensor, was installed in the scrub area wall, visualising the scrub sink only. A clock was displayed for the healthcare professionals to aid in ensuring two-minute hand washing. All surgeons, technicians and surgical assistants were included in the study. Surgical scrubbing was measured during a 4-week period by remote video auditing without feedback and a 12-week period with feedback. SPSS 19 was used for data analysis. **Results:** Of the 534 observations, 150(28%) were made during the pre-feedback period and 384(71.9%) during the post-feedback period. During the first 4 weeks, the overall compliance was 22(14.6%). The rate of compliance increased to 310(80.7%) during the 12-week post-feedback period. **Conclusion:** Video surveillance with feedback for hand washing was found to be an effective tool for measuring hand hygiene and improving compliance.

Keywords: Hand hygiene, Surgical scrub compliance, Camera. (JPMA 67: 92; 2017)

4. The intervention

: Aga Khan University

4.2 What is the target group of this intervention? All surgeons, surgical assistants and operating room technicians

4.3 Goals of the intervention:

1. monitor surgical hand hygiene practices through the eye of the lens and ensure compliance to at least two-minute surgical scrubbing by the surgical team prior to surgery

4.4. What is the focus of this intervention? Study and support compliance of hand scrub with a remote video auditing system and feedback

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research? yes (Nishimura et al & Brown et al.)

4.6 Features
Which are the features of the intervention?

- Information
- Education
- Skill training
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other: feedback, making behavior visible x

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention? no
Which?

4.9 Intended usage
What is the time strip of this intervention? 4 months

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
in the hospital, results of video recording are presented on whiteboards in de hospital

4.11 Process
How is the intervention implemented? (1) remote video auditing system was installed in the scrub area, camera with a motion sensor, a clock was displayed in the scrub area (2) 4 week-period: hand hygiene was measured without feedback (3) 12 week-period: weekly feedback was given, the results and the performance feedback of the 4 week-period of measurement were presented on notice boards in the hospital and was communicated to departmental supervisors
All participants were informed of the video monitoring, in the feedback periods no participant was identified by name, an auditor (member of an infection control committee who has proper knowledge about hand hygiene procedures, techniques and guidelines) was responsible for recording and analyzing the data
Where is the intervention implemented? Aga Khan Hospital for Women and Children located at Kharadar
By who is the intervention implemented? Aga Khan hospital
When is the intervention implemented? from April 1, 2014 to July 31, 2014

5. Study design

5.1 Design type
What is the design of the intervention? Pre-feedback period without intervention to measure hand hygiene compliance followed by a post-feedback period with intervention (feedback) were also hand hygiene compliance is measured every 4 weeks

5.2 Recruitment of the participants of the intervention:

- Free

- Convenience
- Selected
- Forced x

5.3 Reach
Participants: all surgeons, surgical assistants and operating room technicians of the Aga Khan hospital
How many people participated in this intervention? not mentioned
How many people were recruited? not mentioned

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? only staff which is involved in surgical procedure of patients

5.5 Randomization
If there are different groups: How were they spitted in different groups? no

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: 4 months

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical) behavioral
Which outcomes are measured? hand hygiene compliance without feedback vs. with weekly feedback
When are the outcomes measured? during the 12 week post-feedback period

6.2 Effects
What are main effects of the intervention? 4 week pre-feedback period: 150 recodings, 22 showed compliance with 2-minute hand scrub time (14.67%); 12 week post-feedback period: in the first 4 weeks 147 recordings with a compliance rate of 88 (59.86%), in the middle 4 weeks 118 recordings with a compliance rate of 110 (93.22%) and in the last 4 weeks 119 recordings with a compliance rate of 113 (94.96%). In total 14.67% compliance in the pre-feedback period vs. 80.7% compliance in the post-feedback period
Was there a difference between intervention group and control group?
Is the outcome significant?
pre-feedback period: 14.67% hand scrub time compliance, post-feedback period: 80.7% hand scrub time compliance
6.3 Conclusions
What are conclusions based on the variables and effects? Video monitoring combined with real-time feedback of HCW hand hygiene rates produced a significant and sustained improvement in hand hygiene compliance. This technique has the potential to improve the quality of patient care

7. Discussion

What are shortcomings of the intervention named by the authors? fewer number of observations, shorter duration of the study

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Surgical site infections, occurrence, and risk factors, before and after an alcohol-based handrub intervention in a general surgical department in a rural hospital in Ujjain, India
2.2 Authors: Lindsjo, C., Sharma, M., Mahadik, V. K., Sharma, S., Lundborg, C. S., Pathak, A.
2.3 Affiliation:
2.4 Country: India
2.5 Year of publication: 2015
2.6 Journal: American Journal of Infection Control, Vol. 43, Issue 11

2.7 SJR-ranking:

3. Abstract

Background

This study set out to determine occurrence of and risk factors for surgical site infections (SSIs) before and after implementation of an alcohol-based handrub (ABHR) intervention in general surgery wards in a rural, tertiary care hospital in India. Methods Patients who underwent surgery between October 2010 and August 2011 (preintervention period) or September 2011 and August 2013 (intervention period) in the department of surgery were included. ABHR was introduced in September 2011. SSI was defined as per the Centers for Disease Control and Prevention guidelines. Comparison of SSI rate between the 2 periods was performed using analysis of variance. Risk factors were determined using multiple logistic regression models. Results Incidence of SSI was 5% (36/720) and 6.5% (103/1,581) respectively, showing nonsignificant difference (P = .5735). The risk factor common for SSI in both periods was the duration of surgery (OR = 2.6 vs OR = 1.96, pre- and intervention periods, respectively). Risk factors in the intervention period were being a woman (OR = 2.18), renal disease (OR = 3.61), diabetes (OR = 4.43), smoking (OR = 2.14), preoperative hospitalization (<3 vs >15 days; OR = 3.22), and previous hospitalization (OR = 3.5). Compared with other studies, the amount of ABHR used in our study was low. Conclusion The amount of ABHR used might not be sufficient to interrupt the chain of contamination of microorganisms; therefore, continuation of the intervention and surveillance is recommended.

4. The intervention

4.2 What is the target group of this intervention? All patients admitted to the department of surgery at the CRGH

4.3 Goals of the intervention:

1.to determine the occurrence of and risk factors for SSI after the implementation of a hand hygiene intervention in a general surgery department in a rural hospital in India and to compare the situation before the implementation of the intervention

4.4. What is the focus of this intervention? Occurrence and risk factors of SSI before and after a ABHR intervention

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research?

4.6 Features
Which are the features of the intervention?

- Information x
- Education x
- Skill training
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? October 2010-August 2013

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
posters, education sessions

4.11 Process
How is the intervention implemented? preintervention period. October 2010-august 2011, intervention period: september 2011-august 2013: distribution of ABHR with posters containing reminders for hand hygiene, education sessions for Health care workers. ABHR dispensers were placed in the wards, posters displaying instructions on the correct method of use of the ABHR (prepared according to the formula of the WHO) were placed at the wall closed to the dispensers. Monthly training sessions for nurses, nursing students, surgeons, residents-postgraduate registrars and cleaning staff, least about 2 hours and contained training and information on correct use of ABHR (WHO)

Where is the intervention implemented? Department of surgery in the Chandrikaben Rashmikant Gardi Hospital, India; in the surgical wards
By who is the intervention implemented?
When is the intervention implemented? October 2010-August 2013

5. Study design

5.1 Design type
What is the design of the intervention? pretest posttest design/ preintervention postintervention

5.2 Recruitment of the participants of the intervention:
- Free
- Convenience
- Selected
- Forced

5.3 Reach
Participants: All patients admitted to the department of surgery at the CRGH and Health care workers of this department
How many people participated in this intervention? number of patients: 1581, health care workers: 36 nurses, 6 nursing students, 4 surgeons, 10 residents-postgraduate registrars, 4 cleaning staff
How many people were recruited? not mentioned

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which?

5.5 Randomization
If there are different groups: How were they spitted in different groups?

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: October 2010-August 2013

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured?
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? SSI preintervention period: 5%, intervention period: 6,5% --> not significant, the incidence of SSI per year was 6.1, 6.2, 6.5, and 5.3 in 2010, 2011, 2012, and 2013 --> no statistical significant difference, The use of ABHR was between 1.14 and 4.95 L per 1,000 patient days per month from September 2011-March 2013. In April 2013, the use of ABHR increased to 7.17-20.98 L per 1,000 patient days per month
Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? The results of this study so far imply that the chain of contamination of microorganisms was not affected by the introduction of ABHR in the setting

6.4 Other findings
risk factor common for SSI in both periods: duration of surgery

7. Discussion

What are shortcomings of the intervention named by the authors? did not measured the compliance of hand hygiene among health care workers, other interventions occurring simultaneously could have influenced this intervention

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Reduction in nosocomial infection with improved hand hygiene in intensive care units of a tertiary care hospital in Argentina
2.2 Authors: Rosenthal, V. D., Guzman, S., Safdar, N.
2.3 Affiliation:
2.4 Country: Argentinia
2.5 Year of publication: 2005
2.6 Journal: American Journal of Infection Control, Vol. 33, Issue 7
2.7 SJR-ranking:

3. Abstract

Background Hand hygiene is a fundamental measure for the control of nosocomial infection. However, sustained compliance with hand hygiene in health care workers is poor. We attempted to enhance compliance with hand hygiene by implementing education, training, and performance feedback. We measured nosocomial infections in parallel. Methods We monitored the overall compliance with hand hygiene during routine patient care in intensive care units (ICUs); 1 medical surgical ICU and 1 coronary ICU, of 1 hospital in Buenos Aires, Argentina, before and during implementation of a hand hygiene education, training, and performance feedback program. Observational surveys were done twice a week from September 2000 to May 2002. Nosocomial infections in the ICUs were identified using the National Nosocomial Infections Surveillance (NNIS) criteria, with prospective surveillance. Results We observed 4347 opportunities for hand hygiene in both ICUs. Compliance improved progressively (handwashing adherence, 23.1% (268/1160) to 64.5% (2056/3187) (RR, 2.79; 95% CI: 2.46-3.17; P < .0001). During the same period, overall nosocomial infection in both ICUs decreased from 47.55 per 1000 patient-days (104/2187) to 27.93 per 1000 patient days (207/7409) RR, 0.59; 95% CI: 0.46-0.74, P < .0001).

4. The intervention

4.2 What is the target group of this intervention? health care staff (on surgical intensive care unit)

4.4. What is the focus of this intervention? supporting hand hygiene compliance with a educational program

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research? yes

4.6 Features
Which are the features of the intervention?

- Information x
- Education x
- Skill training x
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals x
- other: feedback x

4.7 Connections
Is this intervention connected with other interventions/ projects?

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? September 2000 - May 2002

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
meetings, educational classes

4.11 Process
How is the intervention implemented? (1) monthly meeting at which visual displays of handwashing rates were presented (also posted monthly on the 2 ICU) (2) educational classes 1 hour group sessions every day for 1 week with infection control manuals and the APIC hand hygiene guideline as an educational tool, attendance voluntary, theoretic and practical indications for the use of hand hygiene were reviewed (3) infection control review classes to provide an opportunity for infection control questions (4) frequent feedback: reports to the ICU manager, graphic presentations in meetings, feedback data was posted in the ICUs.
During intervention staff was informed that they are observed concerning their hand hygiene, but did not know when. Based on these observations bar charts of handwashing rates were displayed as feedback at monthly meetings.
Where is the intervention implemented? 2 ICUs of a private, 180-bed tertiary care teaching hospital situated in the city of Buenos Aires, 1 medical surgical intensive care unit (12 beds) and 1 coronary intensive care unit
By who is the intervention implemented?
When is the intervention implemented?

5. Study design

5.1 Design type
What is the design of the intervention? phase 1: baseline handwashing compliance (4 months), phase 2: intervention period (17 months)

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected
- Forced

5.3 Reach
Participants: ICU staff
How many people participated in this intervention? not mentiones
How many people were recruited? not mentioned

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which?

5.5 Randomization
If there are different groups: How were they spitted in different groups?

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: september 2000 - may 2002

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? behavioral
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? compliance improved from 23.1% to 64.5%, nosocomial infections in both ICUs decreased from 47.55 per 1000 patient-days to 27.93 per 1000 patient-days
Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? 42% relative reduction in nosocomial infection rates by emphasizing compliance with hand hygiene

7. Discussion

What are shortcomings of the intervention named by the authors? no randomization of hand hygiene vs. no hand hygiene because of ethical reasons, Hawthorne effect, other interventions which were implemented simultaneously may have impact on the hand hygiene program

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Usage of Ultraviolet Test Method for Monitoring the Efficacy of Surgical Hand Rub Technique Among Medical Students
2.2 Authors: Erzsebet Vanyolos MSc, Katalin Peto PhD, Aida Viszlai, Iren Miko PhD, Istvan Furka PhD, Norbert Nemeth PhD, Pirodka Orosi PhD
2.3 Affiliation: Department of Operative Techniques and Surgical Research, Faculty of Medicine, University of Debrecen, Nagyerdeikrt. 98, Debrecen, Hungary
Department of Hygiene and Infection Control, Faculty of Public Health, University of Debrecen, Debrecen, Hungary
2.4 Country: Hungary
2.5 Year of publication: 2015
2.6 Journal: Journal of Surgical Education Vol 72
2.7 SJR-ranking:

3. Abstract

Background Adequate hand movements are essential in surgical hand rub, so it is important for medical students to learn it correctly. To assess its efficacy, we aimed to use ultraviolet (UV) light test after applying fluorescent solution. Methods Digital images of the hands of 253 medical students were analyzed during “Basic Surgical Techniques” course on the 10th (Survey 1) and 14th (Survey 2) week of the curriculum to check the process and the skills development. The last step of the surgical hand rub was performed with a fluorescent solution, and then the hands were placed under UV light. Photographs were taken and analyzed. Every uncovered area was considered an error. Number and the localization of missed spots and its extent was determined. For evaluation, palmar (P) and dorsal (D) sides of the hands were divided into regions of interest (1—distal phalanxes, 2—thumb and first metacarpus, 3—second to fifth fingers, and 4—second to fifth metacarpals). Results Various magnitude and number of failure occurred in 123 (48.61%) students in survey 1 and in 65 (25.69%) in survey 2. The most frequent sites of the missed spots were D/2 and P/4 region in survey 1 and D/1 and P/4 in survey 2. There was an improvement seen in survey 2, as shown by a decrease in the number and extent of missed spots. Right-handed students made fewer mistakes on their nondominant hands than left-handed students (n = 23) did. Discussion The method was suitable to monitor the efficacy of surgical hand rub technique and identify the mistakes and the critical sites. The main advantage of the UV test was the immediate feedback, which resulted in a distinct improvement. Conclusion Applying the UV test to the medical education and training may contribute to improvement in the compliance and the efficacy of the technique of surgical hand rub among the students.

4. The intervention

4.2 What is the target group of this intervention? third year medical students

4.3 Goals of the intervention:

1. assess the efficacy of the UV test method during our education program among medical students

4.4. What is the focus of this intervention? improving hand hygiene compliance by use of an educational program

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research?

4.6 Features
Which are the features of the intervention?

- Information x
- Education x
- Skill training x
- Exercises x
- Monitoring

- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other: facing outcomes of behavior x

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which? no

4.9 Intended usage
What is the time strip of this intervention? 5 weeks

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
educational program in a teaching hospital

4.11 Process
How is the intervention implemented? (1) survey 1 (2) intervention was implemented during a required "Basic surgical techniques" course, 5 weeks, 1 lecture and 2 practicals per week, in fourth week: 45-minute lecture about the review of antisepsis, scrub solutions for SHR, behavior rules in the operating room (3) in same week: practical training in small groups (5-7 students) where students are trained and afterwards required to perfrom process under control and supervision, students were asked to perform surgical hand rub (5-minute protocol was used), 2 phases of handwashing according to the WHO guidelines were conducted, at the end of the 2 phases an alcohol-based fluorescent solution was applied for visualization of areas missed during the procedure under UV light (4) hand were paced into a box with 3 UV lamps, photographs were taken (5) survey 2
Where is the intervention implemented? Department of Operative Techniques and Surgical Research of the Medical Faculty of the University of Debrecen
By who is the intervention implemented?
When is the intervention implemented? during the 10th to 14th week of a required course

5. Study design

5.1 Design type
What is the design of the intervention? survey 1 - intervention - survey 2

5.2 Recruitment of the participants of the intervention:
- Free
- Convenience
- Selected
- Forced x

5.3 Reach
Participants: Third year medical students
How many people participated in this intervention? 253
How many people were recruited? 285
How many participated actually? 253

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which?

5.5 Randomization
If there are different groups: How were they spitted in different groups? no

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: 5 weeks

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? educational
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? number of students with unsatisfactory surgical hand disinfection was significantly lower in survey 2 compared with survey 1, detection of minimum 1 missed spot in survey 1 occurred in 123 students (48.6%), in survey 2 in 65 students (25.7%)
Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? The main advantage of the applied method was the ability to face the students promptly with the outcome of their hand rub procedure, the mistakes, and its localization. Identifying failures provided an opportunity to enhance their efforts.

7. Discussion

What are shortcomings of the intervention named by the authors?

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: A simple effective clean practice protocol significantly improves hand decontamination and infection control measures in the acute surgical setting
2.2 Authors: Howard, D. P., Williams, C., Sen, S., Shah, A., Daurka, J., Bird, R., Loh, A., Howard, A.
2.3 Affiliation:
2.4 Country:
2.5 Year of publication:
2.6 Journal:
2.7 SJR-ranking:

3. Abstract

Background: The Hand Hygiene Liaison Group and Epic Projects (Pratt et al., J Hosp Infect 47[Suppl A], 2001) have asked specifically for further trials of educational interven- tions to improve hand decontamination compliance and infection control in the hospital setting. This study investi- gates the efficacy of a ‘clean practice protocol’ (CPP), derived from international guidelines, to improve compliance of infection-control practices by surgical teams in a large UK teaching hospital. Methods: The key infection-control activities were sum- mated to form the CPP presented here. An undisclosed infection-control audit of consultant-led ward-rounds from breast, gastrointestinal, vascular, urological, and intensive- care departments was performed. The audit results were presented to the surgical teams, after which an education/ awareness program was implemented. A repeat undisclosed audit was performed 3 months later. In both audits, infec- tion-control activities were recorded together with consul- tation time and any patient infective complications. Results: The surgical teams performed as follows in the ini- tial audit: hand decontamination (28% of consultations), correct use of gloves (2%), instrument cleaning (0%), gar- ment contamination (49%), and notes contamination (34%). Introduction of the CPP education program significantly im- proved hand decontamination to 87% ($p < 0.0001$), the correct use of gloves/aprons to 50% ($p < 0.0001$), and overall infection-control practice from 63% to 89% ($p < 0.05$). Conclusions: The introduction of the CPP significantly im- proved compliance of hand decontamination, correct usage of gloves and aprons, and overall infection-control in a large teaching hospital. The CPP is a highly effective auditing and educational tool that can be readily adapted for use in hos- pitals globally to monitor and improve infection-control practices.

4. The intervention

4.2 What is the target group of this intervention? surgeons, nurses and health care professionals

4.3 Goals of the intervention:
1. Answer the following question: Can a simplified evidence-based 'clean practice protocol' improve awareness, education

and clinical practice of the surgical teams?

4.4. What is the focus of this intervention? A simplified evidence-based 'Clean practice protocol' to improve hand decontamination

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research? yes

4.6 Features
Which are the features of the intervention?
- Information x
- Education x
- Skill training x
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals x
- other: making behavior visible

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? 3 months

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
Education program on surgical unit

4.11 Process
How is the intervention implemented? (1) First audit: Clean Practice Protocols were used to assess surgeons, nurses and health-care professionals compliance with hand decontamination and infection control during surgical ward-rounds, clean practice activities are recorded and scored (2) results of these protocols were presented to the surgical teams (3) simple education and awareness program outlining the CPP was implemented, incl. distribution of posters in the theaters and surgical wards for 3 months (4) Second audit

5. Study design

5.1 Design type
What is the design of the intervention? audit 1 - intervention - audit 2

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected
- Forced

5.3 Reach
Participants: surgeons, nurses and health care professionals of the surgical unit, patients
How many people participated in this intervention? first audit: 85 patients, second audit; 74 patients
How many people were recruited?

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which? not mentioned

5.5 Randomization
If there are different groups: How were they spitted in different groups?

5.6 Study sample

(If different groups are used during the interventions)

Group	Description	Intervention
1		
2		

5.7 Duration of the intervention
Time span of the intervention: 3 months

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? educational, behavioral
When are the outcomes measured? during the second audit

6.2 Effects
What are main effects of the intervention? Based on the data of the repeat audit, hand decontami- nation had improved significantly across all surgical specialities from 28% to 87%, correct usage of gloves and aprons improved from 2% to 50%. The overall 'clean' practice score also improved significantly from 63% to 89%

Was there a difference between intervention group and control group?
Is the outcome significant?

6.3 Conclusions
What are conclusions based on the variables and effects? The introduction of an evidence-based clean practice protocol significantly improved clinical compliance of hand decontamination, correct usage of gloves and aprons, and overall infection control in a large teaching hospital

7. Discussion

What are shortcomings of the intervention named by the authors? short period between the two audits

Data Extraction Form research question 2

Research question: (2) Which interventions exist to prevent the development of surgical site effects based on the German and Dutch surgery guidelines? What are the effects of these interventions?

1.1 Reviewer: Jana Köning
1.2 Date: 9 may 2017

2. Study Identification

2.1 Title: Reduction in surgical site infections in neurosurgical patients associated with a bedside hand hygiene program in Vietnam
2.2 Authors: Le, T. A., Dibley, M. J., Vo, V. N., Archibald, L., Jarvis, W. R., Sohn, A. H.
2.3 Affiliation:
2.4 Country: Vietnam
2.5 Year of publication: 2007
2.6 Journal:
2.7 SJR-ranking:

3. Abstract

objective. We conducted an intervention study to assess the impact of the use of an alcohol-chlorhexidine–based hand sanitizer on surgical site infection (SSI) rates among neurosurgical patients in Ho Chi Minh City, Vietnam. design. A quasi-experimental study with an untreated control group and assessment of neurosurgical patients admitted to 2 neurosurgical wards at Cho Ray Hospital between July 11 and August 15, 2000 (before the intervention), and July 14 and August 18, 2001 (after the intervention). A hand sanitizer with 70% isopropyl alcohol and 0.5% chlorhexidine gluconate was introduced, and healthcare workers were trained in its use on ward A in September 2000. No intervention was made in ward B. Centers for Disease Control and Prevention definitions of SSI were used. Patient SSI data were collected on standardized forms and were analyzed using Stata software (Stata). results. A total of 786 patients were enrolled: 377 in the period before intervention (156 in ward A and 221 in ward B) and 409 in the period after intervention (159 in ward A and 250 in ward B). On ward A after the intervention, the SSI rate was reduced by 54% (from 8.3% to 3.8%; *P* p .09), and more than half of superficial SSIs were eliminated (7 of 13 vs 0 of 6 in ward B; *P* p .007). On ward B, the SSI rate increased by 22% (from 7.2% to 9.2%; *P* p .8). In patients without SSI, the median postoperative length of stay and the duration of antimicrobial use were reduced on ward A (both from 8 to 6 days; *P* ! .001) but not on ward B. conclusions. Our study demonstrates that introduction of a hand sanitizer can both reduce SSI rates in neurosurgical patients, with particular impact on superficial SSIs, and reduce the overall postoperative length of stay and the duration of antimicrobial use. Hand hygiene programs in developing countries are likely to reduce SSI rates and improve patient outcomes.

4. The intervention

4.2 What is the target group of this intervention? patients admitted to the neurosurgical wards who had undergone an surgery during the study periods

4.3 Goals of the intervention:
1. measuring the effect of hand sanitizers and education on SSIs

4.4. What is the focus of this intervention? the effect of bedside hand sanitizer and education in surgical units on the development of SSI

4.5 Development
Is the intervention based on a theory or model? no
Is the intervention based on previous research? yes

4.6 Features
Which are the features of the intervention?
- Information x
- Education x
- Skill training x
- Exercises
- Monitoring
- setting goals
- Communication with colleagues
- Communication with healthcare professionals
- other:

4.7 Connections
Is this intervention connected with other interventions/ projects? no

4.8 Motivational techniques
Are there any motivational techniques used to support the participation in the intervention?
Which?

4.9 Intended usage
What is the time strip of this intervention? 2 years

4.10 Certification
Is the intervention certified? no

4.11 How is the intervention offered? (technology? on which platform? Campaign?)
posters, training, brochures

4.11 Process
How is the intervention implemented? Ward A (intervention), Ward B (control) (1) bedside units hand sanitizer were installed and used for all patients for 1 year, hand sanitizer made of ethyl alcohol and chlorhexidine gluconate, staff were trained in using the hand sanitizer, edicational brochures are distributed about the importance of hand hygiene and how to clean hand with hand sanitizers, poster to encourage hand hygiene was placed in the nursing station (2) no hand sanitizers and educational training was implemented in ward B
Where is the intervention implemented? Cho Ray Hospital, Vietnam, neurosurgical department
By who is the intervention implemented?
When is the intervention implemented?

5. Study design

5.1 Design type
What is the design of the intervention? quasi-experimental study, with a control group and assessment before and after intervention

5.2 Recruitment of the participants of the intervention:
- Free x
- Convenience
- Selected
- Forced

5.3 Reach
Participants: patients admitted to the neurosurgical wards who had undergone an surgery during the study periods
How many people participated in this intervention? 786 (377 in period before intervention, 409 after intervention)
How many people were recruited? 786
How many participated actually?

5.4 Are there inclusion and exclusion criteria for the participation in the intervention?
If yes, which?

5.5 Randomization
If there are different groups: How were they spitted in different groups? random

5.6 Study sample
(If different groups are used during the interventions)

Group	Description	Intervention
1	Ward A	hand sanitizers, posters, training and brochures
2	Ward B	no hand sanitizers or education

5.7 Duration of the intervention
Time span of the intervention: 2 years

6. Measuring effects

6.1 Variables
Sort outcome: (Health, behavioral, educational, economical)
Which outcomes are measured? health
When are the outcomes measured?

6.2 Effects
What are main effects of the intervention? After intervention incidence of SSI on ward A dropped from 8.3% to 3.8%, incidence in

ward B from 7.2% to 9.2%. Before intervention: no difference in SSI incidence between the wards, after the intervention: SSI incidence on ward A was significantly lower than that on ward B, median postoperative LOS and the median duration of antibiotic use in ward A was shorter than ward B, but not statistically significant

Was there a difference between intervention group and control group? yes
Is the outcome significant? yes

6.3 Conclusions
What are conclusions based on the variables and effects? In conclusion, this study demonstrates that introduction of bedside dispensers of alcohol-based hand sanitizer in con- junction with an educational program was an effective strategy for controlling SSI in Vietnam

7. Discussion

What are shortcomings of the intervention? results are based on unmatched group comparison, there might be other factors which contribute to the difference between ward A and ward B