Evaluation of and Improvements for Procedures for Preoperative Body Wash to Prevent Surgical Site Infections

MALIN WESTER

ELIN NYGREN WÅHLIN
Evaluation of and Improvements for Procedures for Preoperative Body Wash to Prevent Surgical Site Infections

Utvärdering och förbättring av tillvägagångssätt för preoperativ helkroppstvätt för att förhindra postoperativa infektioner

Malin Wester
Elin Nygren Wåhlin

Degree project in Technology and Health
Second Cycle, 30 Credits
Supervisor at KTH: Björn-Erik Erlandsson
External supervisor: Mats Johnsson
Examiner: Sebastiaan Meijer
TRITA-CBH-GRU-2018:112

KTH Royal Institute of Technology
School of Engineering Sciences in Chemistry, Biotechnology and Health
Department of Biomedical Engineering and Health Systems
Abstract
This report examines preoperative body wash performed by the patients themselves at home and its potential to prevent surgical site infections. This was accomplished by studying current recommended protocols and active substances in Sweden in relation to a potential replacement product. Products identified and included in the report are Descutan, manufactured by Fresenius Kabi AB and Pronto-derm by B. Braun Medical AB, with the active substances of chlorhexidine and polyhexanide.

After comparisons, an experiment and evaluations, a new proposed protocol has been developed. The proposed protocol involves decolonization of bacteria, including multidrug resistant organisms. In that way, an alternative to handle the increased antibiotic resistance in the world is described. In addition, costs of the products have been compared and by avoiding surgical site infections, potential savings have been calculated.

From the review, ambiguous results were obtained regarding the effect of preoperative body wash on surgical site infections.

In summary, there are many benefits and a lot of money to save, with the new active substance and by avoiding surgical site infections. The conclusion is that Prontoderm is more expensive, but that the total cost of the product kit could be reduced by adjusting the size of the products after protocol and dosage. Further, it was decided that three washes are sufficient for a full preoperative body wash.

Keywords: surgical site infection, chlorhexidine, polyhexanide, decolonization, preoperative body wash, Prontoderm, Descutan, patient protocol, multidrug resistant organisms.
Sammanfattning

Denna rapport undersöker preoperativ helkroppstvätt utförd av patienterna själva i sin hemmiljö med möjlighet att förhindra postoperativa infektioner. Detta genom att ha studerat nuvarande rekommenderat protokoll och aktiva substans i Sverige i relation med en potentiell ersättande produkt. Produkter som identifierats och ingått i rapporten är Descutan, tillverkad av Fresenius Kabi AB, och Prontoderm av B. Braun Medical AB, med de aktiva substanserna klorhexidin respektive polyhexanid.


Från undersökningen erhålls tvetydiga resultat gällande den preoperativa tvättens betydelse för postoperativa infektioner.


Nyckelord: postoperativ infektion, klorhexidin, polyhexanid, dekolonisering, preoperativ helkroppstvätt, Prontoderm, Descutan, patientprotokoll, multiresistenta organismer.
Acknowledgements

First of all we would like to thank our supervisors Mats Johnsson and Björn-Erik Erlandsson for guidance, encouragement and support during the whole process. Not only helping us with the project, but also making sure that we succeed in our personal life and future careers. Overall, we would like to thank the employees at B. Braun Medical AB to always supporting us when asking for help.

A special thanks to our friends and family agreeing to contribute to the project with participation in our experiment.

Distribution of Work

This thesis has been produced by a collaboration between Malin Wester and Elin Nygren Wählin. The work has been distributed equally between the authors where both have had focus on data collection, data analyzing and report writing. Though some areas have obtained more focus from one of the authors and vice versa. A good dialog has been maintained throughout the whole process.
List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI</td>
<td>Biocompatibility Index</td>
</tr>
<tr>
<td>Ca</td>
<td>Circa</td>
</tr>
<tr>
<td>ESBL</td>
<td>Extended Spectrum Betalactamase</td>
</tr>
<tr>
<td>FDA</td>
<td>United States Federal Food and Drug Administration</td>
</tr>
<tr>
<td>HAI</td>
<td>Health care Associated Infections</td>
</tr>
<tr>
<td>KTH</td>
<td>Kungliga Tekniska högskolan, Royal Institute of Technology</td>
</tr>
<tr>
<td>MDRO</td>
<td>Multidrug Resistant Organisms</td>
</tr>
<tr>
<td>ml</td>
<td>Milliliter</td>
</tr>
<tr>
<td>MRSA</td>
<td>Methicillin-resistant Staphylococcus aureus</td>
</tr>
<tr>
<td>µg</td>
<td>Microgram</td>
</tr>
<tr>
<td>PHMB</td>
<td>Polyhexamethylene biguanide</td>
</tr>
<tr>
<td>SEK</td>
<td>Svenska Kronor, the swedish currency</td>
</tr>
<tr>
<td>SSI</td>
<td>Surgical Site Infection</td>
</tr>
<tr>
<td>VRE</td>
<td>Vancomycin-resistant Enterococci</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
# Contents

1 Introduction ........................................... 1
   1.1 Aims and Objectives ........................................... 2
   1.2 Delimitations ........................................... 2

2 Background ........................................... 3
   2.1 Health Care Associated Infections ........................................... 3
   2.2 Antibiotics and Multidrug Resistant Organisms ........................................... 3
      2.2.1 The Bacteria ........................................... 4
   2.3 Preoperative Body Wash ........................................... 4
      2.3.1 Active Substances ........................................... 5
      2.3.2 Biocompatibility Index ........................................... 5
      2.3.3 European Standards ........................................... 5

3 Method ........................................... 7
   3.1 Data Collection ........................................... 7
   3.2 Data Analyzing ........................................... 7
   3.3 Evaluation of Usability of Patient Protocols ........................................... 8
      3.3.1 Creating a Questionnaire ........................................... 8
      3.3.2 Evaluation of Questionnaire ........................................... 8
      3.3.3 Creating a Patient Protocol ........................................... 9
   3.4 Ethical Consideration ........................................... 9

4 Results ........................................... 11
   4.1 Preoperative Body Wash and Surgical Site Infections ........................................... 11
   4.2 Products for Preoperative Body Wash ........................................... 12
      4.2.1 Descutan ........................................... 12
      4.2.2 Prontoderm Pre-Kit ........................................... 13
   4.3 Comparison of Substances ........................................... 13
   4.4 Experiment ........................................... 15
   4.5 Trivial Cost Analysis ........................................... 17

5 Discussion ........................................... 19
   5.1 Choice of Method and Delimitations ........................................... 19
   5.2 Experiment Analysis and Creating of the Protocol ........................................... 19
   5.3 General Analysis ........................................... 21

6 Conclusion ........................................... 25

References ........................................... 27

A Protocols ........................................... A-1
   A.1 Descutan ........................................... A-1
   A.2 Prontoderm ........................................... A-2
   A.3 Constructed Protocol ........................................... A-3

B Instructions and Questionnaire ........................................... B-1
   B.1 Instructions ........................................... B-1
   B.2 Questionnaire ........................................... B-3

C Sammanställning Questionnaire ........................................... C-2
List of Figures

1 Percentage of total SSI isolates .................................................. 11
2 Distribution of age ................................................................. 15
3 Distribution of gender ............................................................. 15
4 Use of clean towel ................................................................. 16
5 Requesting another format ...................................................... 16
6 Protocol perceived easier ......................................................... 16
1 Introduction

Surgical site infection (SSI) is the second most common type of health care associated infection in Sweden \cite{1} and poses a difficult complication after surgery. Each infection negatively affects the patient and its health. Furthermore it has a substantial impact on the economy since an infection can double the length of time a patient is hospitalized and its subsequent costs \cite{2}.

A study shows that approximately 40-60 \% of all SSIs could be prevented \cite{3} and several studies have presented that body washing with an antimicrobial agent before surgery can reduce the incidence of SSIs after a surgery \cite{2, 4}. However, another study presents results showing that showering with antiseptic solutions reduce the skin flora of the patients but whether it has an effect on the SSIs remains inconclusive \cite{5}.

Bacteria exist on all healthy humans but can cause an infection if they enter into the body. The result of a multi resistant bacterium entering the body, for instance via a wound, could lead to an infection that usually would be treated with antibiotics. Undergoing surgery implies a high risk to receive an infection, involving multidrug resistant organisms, since the skin where many bacteria can appear is penetrated and thus provides an opportunity for the bacteria to enter. It is common that contamination of the surgical site is caused by the patient’s endogenous bacterial flora \cite{6}. One way to prevent this is by modern antiseptics \cite{7}.

Antibiotic resistance is a growing problem in health care and affects the public health negatively by mortality, morbidity and reduced living quality due to that ordinary infections become more difficult to treat \cite{8}. In recent years more cases of resistant bacteria have been reported. In Sweden the increase is from considerably lower levels compared to the rest of the world, but any sign of a reversing trend is missing \cite{9}. From a patient safety perspective, the occurrence and the increase of resistant bacteria pose a serious threat since it could lead to a future without effective antibiotics or antiseptics. Therefore, it is a challenge for health care to counteract the establishment and spread of such bacteria \cite{10}.

Products that clean and prepare the skin before surgery are one way to fight antimicrobial resistance and are available in various forms such as wipes, nasal gel, foam, shower gel and mouth rinse to provide a full body sanitation \cite{11}.

Antimicrobial agents containing the active substance chlorhexidine is commonly used for decolonization of patients and is recommended by the World Health Organization \cite{12}. But recent studies have shown that it can cause serious allergic reactions and that resistance to the substance can occur \cite{12, 13}, which imply reduced effect against bacteria. An alternative substance is Polyhexamethylene biguanide (known as polyhexanide or PHMB) which will be evaluated in this report.
1.1 Aims and Objectives

The aim of this thesis is to document the results of a patient protocol that involves the use of, for Sweden, a different active substance for preoperative body wash. By preoperative body wash there are possibilities to constrain contamination of surgical wounds with multidrug resistant organisms and improve the care for patients, as well as reduce the economic losses due to surgical site infections. The research question is: Polyhexamethylene biguanide (PHMB) and its use compared to other conventional procedures for preoperative body wash. The objectives for the project are:

- To study the procedure for preoperative body wash including a chemical substance that differs from the one that is recommended today.
- To review what changes in the conventional procedures that may be performed in order for implementing the new procedure in Sweden, if potential benefits of the substance are identified.
- In addition, to superficially investigate and compare costs for the products.

1.2 Delimitations

Many factors can be related to causing SSIs, like preoperative hair removal, a large number of people in the operation room and factors related to the patient such as impaired immunity, etcetera. However the scope for this work is limited to solely investigating the preoperative body wash procedure performed by the patients themselves before the surgery.
2 Background

2.1 Health Care Associated Infections

Health care Associated Infections (HAIs) are one of the most common complications for patients in hospitals. HAIs are usually expressed as prevalence or incidence. Prevalence implicates the number of infections at a certain point in time divided by the number of individuals examined. It thereby expresses how much of the disease there is in a population at a certain time point. Incidence, on the other hand, implicates the number of new cases of infections in a defined time period in relation to the number of examined individuals during the same period of time. Thereby it expresses the occurrence of new infections. Since HAIs prolong hospitalization, the incidence rates are lower than the corresponding prevalence rates, unless patients are followed up after discharge [10].

Surgical Site Infections (SSIs) are common health care associated infections due to that microorganisms contaminates the wound where the invasive procedure took place. The SSI normally occurs within thirty days after surgery, though the number of days for follow up varies due to type of operation. For orthopedical operations with an implant the follow up carries out during ninety days [6, 14]. The World Health Organization (WHO) recently presented SSI to be the most common and surveyed type of health associated infections in low- and middle-income countries and the second most common in high-income countries [15].

The infection risk varies due to the type and amount of bacteria as well as factors related to the patient, health care setting, type of surgical intervention, aseptic technique and antibiotic prophylaxis. Risk factors related to the patient that increase the risk for infection are for instance impaired immunity, high or low age, obesity, smoking or skin lesions [16]. Receiving a SSI imply complications for the patient and the economy by prolonged illness and hospital stay, a higher risk of death and greater hospital costs. In fact, such an infection can redouble the time a patient is hospitalized and its subsequent costs [2]. Consequently, there are lots of benefits to obtain by preventing the infections. The amount of preventable infections are approximately 40-60 % of all SSIs [3], by optimal hygiene procedures for instance [10].

2.2 Antibiotics and Multidrug Resistant Organisms

Antibiotics are antimicrobial drugs that are used to treat and prevent bacterial infections in humans and animals. That bacteria become resistant to substances fighting them is a natural evolutionary process. However, the development of antibiotic resistant bacteria, by haphazard mutations in bacterial genes, have come to be more fast and extensive than it would have been, due to many years of excessive and improper use of antibiotics worldwide. With a more rational use of the drug, development of resistance could be inhibited, but not completely stopped [17].

When antibiotics are used, the resistant bacteria get an advantage. While the antibiotic-sensitive bacteria die, the resistant bacteria can propagate, as well as genetically transfer their resistance to new bacteria that can spread further. Resistance develops fastest in environments where bacteria often are exposed to antibiotics, such as in health care. Transmission of bacteria can occur by direct skin contact [17] from one individual to another or indirectly, for instance via the hands of the staff, transmitting bacteria from one patient to another [18]. Resistant bacteria are spread in the health care setting as a result of, among other things, lack of hygiene routines [17]. Factors that benefit colonization of multidrug resistant organism (MDRO) are for instance long visits at hospitals, therapy in intensive care units and surgical procedures [19]. Antibiotic resistance within health care is a major problem regarding HAIs and the amount of reported infections regarding MDRO have increased over the years.

Bacteria can develop resistance against several antibiotics and when a bacterium developed resistance to three or more antibiotics, multiresistance has evolved [17]. MDRO are not more aggressive than other bacterial strains of the same art, but when they cause an infection or colonization they are very difficult to treat. It can also be problematic to eliminate these strains from the health care setting [20]. The prevalence of resistant bacteria varies widely in different parts of the world, as well as data collection and follow-up systems. Antibiotic resistance is a growing global problem and there is an apparent connection
between the use of antibiotics and the prevalence of resistance [17]. The greater use of an antibioticum, the higher probability for bacteria to develop resistance [21]. For Sweden, the prevalence is more restricted, owing to many years of work to limit the use of antibiotics. However, Sweden is affected a lot by the situation in the rest of world [17]. The amount of resistant bacteria in Sweden has increased even if it is from considerably lower levels compared to most other countries [9]. An increase in reported cases is partly due to increased sample-taking of immigrants [22].

Yearly in the European Union, approximately 25 000 patients’ deaths are due to infections caused by resistant bacteria. In the whole world that amount could be up to 700 000. If present infection and resistance rates do not change we can expect millions of deaths annually at the year of 2050 [23] and thereby antimicrobial resistance has the possibility to cause more deaths than cancer. Furthermore it would include wide effects on the economy, with high costs regarding treatment and losses due to decreased productivity on the account of sickness. The World Bank alerts that multidrug resistant infections in the future could induce an economic damage equal to the financial crisis year 2008 [24].

2.2.1 The Bacteria
Clinical important types of MDRO are MRSA (Methicillin-resistant Staphylococcus Aureus), VRE (Vancomycin-resistant Enterococci) and ESBL (Extended Spectrum Betalactamase)-producing Enterobacteriaceae.

Staphylococcus aureus is a common bacterium that can colonize healthy humans, usually in the nose, but also on other mucus, in the throat and on the skin [25]. It can cause skin and wound infections, but also invasive infections [26]. MRSA is a form of the Staphylococcus aureus that is resistant to many antibiotics [27].

Enterococcus faecalis and Enterococcus faecium is a part of the human intestinal flora, but can colonize wounds and cause urinary tract infections [28]. The bacteria have become a more prominent cause of HAIs since they naturally are resistant to several common antibiotics and have the ability to develop resistance against all antibiotics known today. A particular problem is VRE, the enterococci that is resistant to vancomycin, since vancomycin is an important antibiotic, especially in the intensive care [29].

Enterobacteriaceae is a large family of bacteria that exists all over the world. It is one of the most common pathogenic bacteria, for instance they can cause urinary tract infections. These bacteria have increasingly acquired Extended Spectrum Betalactamase-enzymes (ESBL-enzymes) and are entitled by the collective term ESBL-producing Enterobacteriaceae. The ESBL-enzyme makes them resistant to several types of antibiotics [30, 31].

Health care acquired MRSA and ESBL-producing Enterobacteriaceae have increased worldwide, including Sweden in the last decade [10, 30]. ESBL is the form of resistance to antibiotics that is increasing fastest in Sweden [30]. The total amount of reported incidents with MRSA in Sweden has continuously grown over the years. Year 2016 there were 4402 cases reported, which is an increase with 13 % from 2015. From 2014 to 2015 the total amount of reported incidents increased with 33 % [26]. Year 2016 there were 10 659 ESBL-producing Enterobacteriaceae infections reported in Sweden which is an increase of 11 % compared to 2015. In the last 5-6 years the amount of reported cases have more than doubled [32]. Regarding VRE the amount of cases are low in comparison to the other two mentioned above. There were 165 reported incidents of VRE during 2016, compared to 157 during 2015 but the incidence is still at 1.7 cases per 100 000 inhabitants and year [33].

2.3 Preoperative Body Wash
Preoperative skin preparation is performed in order to reduce bacteria on the skin to decrease the probability of SSIs. There are several skin-preparation agents and methods available in different countries and the techniques used vary between hospitals and surgeons [34]. The patient is often requested before a planned operation to prepare the skin by performing a body wash at home [10].

Preoperative body wash has the potential to reduce the skin flora of the patient and brake down the
resident skin flora that normally grows in small colonies on the skin [10, 35]. The patients should them-
selves before planned operation in their homes wash the whole body with a skin cleanser, liquid soap or
shower gel. In cases where there is a high risk to obtain an infection the cleanser should have a disinfec-
tant effect [36]. Some products should be rinsed off while others serve as leave-on products [4, 37].
Today in Sweden the recommended product for preoperative body wash is an antiseptic solution with 4
% chlorhexidine [36]. It is desirable to have an antiseptic with a broad spectrum that acts fast and have
a prolonged effect without being toxic to the host tissue [38].

2.3.1 Active Substances

Chlorhexidine is an antiseptic agent used in many different preparations. Primarily chlorhexidine is used
as a disinfectant but it can also be used in cosmetics and pharmaceutical products [39]. The substance is
available in multiple forms such as diacetate and digluconate. In this report the term “chlorhexidine” is
going to be used when referring to chlorhexidine-containing solutions. Chlorhexidine is listed as an anti-
septic on the WHO Model List of Essential Medicines [40]. It acts fast and has a persistent antimicrobial
action that prevents regrowth of microorganisms [12]. When applied to skin the substance binds to
the surface of tissues and thereby providing a prolonged effect [41].

Polyhexamethylene biguanide, better known as polyhexanide or PHMB, is an antiseptic with antivi-
rual and antibacterial characteristics. It is used in different preparations such as swimming pool sanitizers
and contact lens disinfectants or in wound care dressings and cleansing products [42, 43]. Like chlorhexi-
dine, polyhexanide also binds to cellular surfaces after application and creates a prolonged effect for hours
[7] and the term “polyhexanide” refers to all polyhexamethylene biguanide-containing solutions in the
report henceforth. Polyhexanide is for instance used in Germany, United Kingdom, Poland, Denmark,
Belgium and Italy [44].

2.3.2 Biocompatibility Index

Biocompatibility index (BI) is a way to classify antiseptic agents in relation of effectiveness and tissue
compatibility. The BI has been validated from in vitro experiments. The smaller the BI, the more
inconvenient the antibacterial effect in relation to the cytotoxicity, a BI < 1 indicates a toxicity that
exceeds the antiseptic effect [7].

2.3.3 European Standards

Below European standards are described that products can be tested according to.

EN 1040 - bactericidal activity
EN 1040 is a test conducted in vitro without interfering substance and referred to as Phase 1. In this test
a smaller number of, but representative, microorganisms are investigated [45]. The microbial reduction
for the product should be at least 10^5 times smaller for the test organisms Pseudomonas aeruginosa and
Staphylococcus aureus [46].

EN 1275 - fungicidal/yeasticidal activity
EN 1275 is also Phase 1. The microbial reduction for the product to fulfill should be at least 10^4 times
smaller. Aspergillus niger or Candida albicans is used as the test organism [47].

EN 13727 - bactericidal activity
EN 13727 is a Phase 2 test. In Phase 2, the tests are performed both with and without interfering sub-
stance. Also a larger number of representative microorganisms are investigated [45]. Handrub products
are tested under clean conditions and handwash products under dirty conditions [48]. The microbial
reduction should be at least 10^5 times smaller for handrub products and 10^3 times smaller for handwash
products. If the hygienic handwash and handrub fulfill the requirements of EN 13727 they reduce the
amount of Staphylococcus aureus, Pseudomonas aeruginosa, Escherichia coli and Enterococcus hirae. EN
13727 also requires the manufacturer to provide the recommended method of application [48], since it is
for products with an intended use (phase 2), compared to the other two which are phase 1 [45].
3 Method

3.1 Data Collection

Initially, an acquisition of relevant information for the subject was performed by research using the search engine Google Search; www.google.se. This was performed with the words mdro, ssi and preoperative body wash. Subsequently, additional terms and databases were identified. Databases utilized were:
- Primo via KTH, Royal Institute of Technology, Library
- ScienceDirect via KTH, Royal Institute of Technology, Library
- Pubmed via KTH, Royal Institute of Technology, Library
- Google Scholar

Other information was once again collected by research using Google Search. Identified words were; mrsa, methicillin resistant staphylococcus aureus, ure, vancomycin resistant enterococcus and esbl bacteria. These were all added with the term Sweden. The term mdro was extended to include multidrug resistant organisms, multi resistant bacteria and corresponding swedish term multiresistenta bakterier. Similarly, ssi was extended to include surgical site infection, postoperative infection and postoperativ infektion and preoperative body wash was replaced with preoperativ tvätt. The three initial terms and each of their variants were combined, sometimes in pairs and sometimes all together.

An investigation of the Swedish market was performed to find the conventional procedures that are used today by the patient regarding preoperative body wash. Two main products were identified whose active substance was chlorhexidine. The project was performed in collaboration with B. Braun Medical AB who manufactures polyhexanide-containing products for preoperative body wash. Although there are other substances available, polyhexanide was chosen as the potential substitute substance for comparison with chlorhexidine.

Other identified words were therefore different forms of the two substances. These consist of polihezanide, polyhexanide, polyhexamethylene biguanide, phmb, chlorhexidine and chlorhexidine gluconate which were searched for separately but also in combination with the term efficacy and in a word order of substance 1 added with the term comparison followed by substance 2. In addition, the term decolonization was combined with surgery and ssi with reduce.

The procurement of articles in databases were first performed in Primo and then proceeded to ScienceDirect, Pubmed and Google Scholar. Relevant articles from the year 2000 were chosen, with two exceptions, and initially reviewed by their abstract followed by their conclusion. Thereafter the whole article was read if more specific information was requested. All articles that were not available online were excluded. Further information about the substances and washing instructions was provided by the company, our external supervisor, the website www.fass.se and by a purchased Descutan home wash pack. Several similar protocols were identified but the protocol attached in the Descutan package, and for Prontoderm, the protocol confirmed to be utilized in Germany as a patient preoperative kit, was chosen for this project.

3.2 Data Analyzing

Data information collected from articles regarding chlorhexidine and polyhexanide were compared in regard to certain aspects that were identified during the phase for acquisition of information. If an aspect was identified for one of the substances, the same was then tried to be found for the other one, and thereafter compared with each other in order to describe similarities and differences.
Numbers of HAI and SSI rate were calculated from a prevalence study of HAI within institutional care that was performed in Sweden during week 12-13 of year 2017. The results were obtained using the following equations:

\[ \text{Percentage of SSIs} = \frac{\text{Number of SSIs} \times 100}{\text{Number of operations}} \]

\[ \text{Amount of HAI that are SSI} = \frac{\text{Number of SSIs} \times 100}{\text{Number of HAIs}} \]

Cost analysis was performed by a comparison for the different products, in relation to price and amount. Furthermore, saving potentials were estimated by reductions of HAIs.

\[ \text{Price per ml} = \frac{\text{Total price of product}}{\text{Amount of product in ml}} \]

3.3 Evaluation of Usability of Patient Protocols

To evaluate the new product protocol for possible implementation in Sweden, an experiment for comparison with one of the protocols for products containing chlorhexidine was conducted. The experiment involved twenty persons, eleven females and nine males, in the age range of 18-84. The participants included close relatives and friends in mixed ages and genders. These were chosen by the authors themselves in regard to include a wide range of ages and genders.

After agreeing to be involved in the experiment, detailed information, instructions and protocols were sent to the participants either via email or postal delivery (Appendix A and B). The instructions involved two different patient protocols for preoperative body wash with antiseptic agents, printed on ordinary paper. One from B. Braun Medical AB for “Prontoderm” and one from Fresenius Kabi AB for “Descutan”. The participants fulfilled one body wash with each instruction, in the order assigned to them. Ten participants used Prontoderm followed by Descutan and the other ten used the protocols in reversed order. All participants performed the body wash with their own products or water and no bacterial residue tests were performed. After each shower a questionnaire was answered anonymously online.

3.3.1 Creating a Questionnaire

The first part of the questionnaire considered the current performed protocol and the second part included concluding questions that were formulated to compare the two performed protocols and that solely were received if the participant had performed the second shower. Otherwise the questions were alike for both washes.

The questionnaire was developed in Google Forms by the authors with respect to user experience and assumed relations such as age, gender and previous washes (Appendix B). Receiving information regarding participants’ opinions was performed by involving questions about pictures, language, layout etcetera. This, without using questions that could affect their answer. Initially such questions were formulated with potential opinions in mind, that the authors believed people could have.

The first questions inquired age, gender and which protocol that was followed, formulated in mandatory multiple choice questions where solely one answer could be selected. Following questions referred to the design of the protocol and included “yes or no” questions followed by voluntary short answer questions allowing the participants to deliberate on certain aspects. The questions were formulated in regard to the information from the instructions. For instance, one question was asked to see whether they had followed the protocols correctly. This by asking for the condition of the towel since instructions of this were described in the protocols. The whole questionnaire was conducted in Swedish.

3.3.2 Evaluation of Questionnaire

Each answer to the associated question from each participant was registered in a document in Microsoft Excel (Appendix C). A question in the Excel sheet was represented by an own column with the respondents’ responses in the rows below. Hereafter, five questions, regarding age, gender, the towel’s condition,
desire of another format and the easiest perceived protocol, were illustrated by circle diagrams. These questions and comments for the rest of the questions were organized into themes for evaluation and thereafter calculated to percentage. The participants’ comments to the voluntary short answer questions were represented by own columns to obtain an overview and an estimation of potential changes. The comments were also analyzed in regard to whether the comment had a positive or negative opinion. Correlations in reference to earlier preoperative body washes and order were investigated.

3.3.3 Creating a Patient Protocol

When constructing the new protocol, all negative opinions from both protocols were tried to be avoided or improved in the new protocol and positive aspects were tried to be implemented. Furthermore, own opinions obtained during the process were taken into consideration for the construction. Photographs were taken of the products for the modified Prontoderm Pre-Kit and inserted in the protocol. Remaining pictures were produced in Adobe Photoshop.

3.4 Ethical Consideration

It was of importance that the participants understood the purpose and how the study ought to be performed. Informed consent was obtained, participants could withdraw at any time and all data were anonymous. The antiseptics assigned for the protocols were not used in the study since the participants’ safety could not be guaranteed with the actual products and adverse effects could occur.

When creating the questionnaire it was of importance to ensure that the questions were inclusive and did not violate any human rights. Focus was set to capture as many aspects of the protocols as possible and to avoid leading the participants to answer in a particular way.

Potential risks are to solely include results that are assumed to be of importance for the purpose of the study and that the outcomes will not be beneficial for other interests than the researchers and the company in collaboration (B. Braun Medical AB).
4 Results

4.1 Preoperative Body Wash and Surgical Site Infections

A prevalence study of HAIs presents a result of that 27.9% of all HAIs were due to surgery. Furthermore, approximately 8.8% of all surgeries cause a postoperative infection. This agrees with the numbers from 2016 [49]. In Sweden there is no national system for registering HAIs, and thereby not for SSIs either but different studies in countries equal to Sweden regarding socioeconomics and medical standards have been summed up by The National Board of Health and Welfare. The result shows that the occurrence of HAIs is similar between these kind of countries [10].

The surgical clinic at Östra sjukhuset in Gothenburg, Sweden, registered patients’ possible SSIs during 1984-1995 with a follow up of 30 days after discharge. This showed a result that 6% of the patients undergoing surgery got an infection (SSI) [10].

A report from the Health Protection Agency summarizes data on SSIs, collected by National Health Service hospitals in England 2011/2012 and presents the distribution of the organisms causing SSIs in figure 1 [50]. MSSA mentioned in the diagram correspond to Methicillin Sensitive Staphylococcus Aureus.

![Figure 1: Percentage of total SSI isolates](image)

A Cochrane report reviewed evidence for preoperative body wash with antiseptics and its potential to prevent SSIs. The report included seven randomized controlled trials with a total of 10157 patients. When comparing washing with chlorhexidine and regular soap or placebo there was no statistically significant decrease in SSI, however comparing chlorhexidine with no wash at all showed a significantly statistical decrease in SSI when washing with chlorhexidine [5].

On the other hand, a study regarding SSIs following elective (planned) knee arthroplasties showed a reduction in the incidence of SSI when cleansing with antimicrobial cleansers the night and the morning.
before the planned operation. The study compared patients who followed a protocol for preoperative body cleansing with a leave-on product (2 % chlorhexidine impregnated cloths) the evening before and the morning of the operation, and patients that only had standard perioperative skin preparation in the hospital. A total of 912 patients were identified for the study, yet not all fulfilled the study. Overall, 136 completed the cleansing with protocol and 711 only had the perioperative skin preparation in hospital. Of the 711 patients, 21 acquired an SSI (3 %), while there were no SSIs among the 136 fulfilling the preoperative body cleansing protocol [4].

A report by the Swedish National Board of Health and Welfare regarding prevention of HAIs, give the recommendation that patients undergoing vascular surgery, orthopedic surgery, cardiac surgery or other surgery where skin bacteria can cause serious infections, should be prepared by showering with chlorhexidine at least two times before surgery. This recommendation is graded to category I, meaning that it either has a strong support from well-conducted and controlled clinical trials or is supported by a large majority of national and international expertise, and recommended in standard manuals. This recommendation is in the same grade as instructions for the health care professionals to disinfect their hands before each operation [10].

The same report presents that a preoperative body wash with regular soap reduces the amount of bacteria slightly but not even to a half. The soap also makes the bacteria spread more evenly throughout the skin area. If an antiseptic agent is used a substantial reduction occurs and such an agent is therefore preferable to use before a surgery from a microbiological perspective. Furthermore, multiple washes before the planned operation enhances the effect. One study presents a better effect after five days of performed washes compared to washes for two days but a similar study showed full effect after solely two days [10].

A sponge predosed with the solution is recommended due to that it ensures a body wash using a sufficient amount of the active substance [51]. In order to get a reduced amount of bacteria, cleansing by mechanical work, with a rubbing technique, has been proven effective in comparison to solely adding the antiseptic on the surface. The contact time is also of importance [52].

From the usage information of Descutan, containing chlorhexidine, it is stated that a significant reduction occur after three full body washes and additional washes only give a negligible effect [53].

### 4.2 Products for Preoperative Body Wash

Products for Preoperative Body Wash chosen for comparison were Descutan, manufactured by Fresenius Kabi AB, and Prontoderm, by B. Braun Medical AB. Patients who are known to be allergic to chlorhexidine are usually recommended a disinfectant based on alcohol.

#### 4.2.1 Descutan

The home wash kit for patients contains four sponges soaked with 15 ml cutaneous solution each and four bags with 10 ml of cutaneous soap solution each, which is enough for two washes. The sponges are meant to be used for body wash and the soap solution for hair wash.

Descutan is classified as a pharmaceutical and has been approved for the Swedish market since 05/02/1985 according to the Medical Products Agency (Läkemedelsverket) [53, 54].

**Active substance:** Chlorhexidinegluconate, 4 %.

On the prescribing information the protocol for washing is printed on the back.

**Price:** Ca 160 SEK.
4.2.2 Prontoderm Pre-Kit

The Prontoderm Pre-Kit contains Prontoderm Nasal Gel 30 ml, ProntOral 250 ml mouth rinse solution and Prontoderm Wipes 10 pieces x 5 packages. Each package of wipes contains 10 tissues, necessary for one full body wash. The amount of solution in every wipe is enough to ensure a sufficient cleansing of the whole body [55].

The products in the kit are classified as medical devices, type III [56], and tested according to European standards EN 1040, EN 1275 and EN 13727, described in the background. ProntOral and Prontoderm Nasal Gel are tested according to EN 1040 [57, 58]. Prontoderm wipes are tested according to EN 1275 and EN 13727 [59].

**Active substance:** Polyhexanide 0.10-0.15 %.

**Price:** Not yet available on the Swedish market, but sales prices in Europe are ca 244 SEK for the Prontoderm Pre-Kit.

Prontoderm Nasal Gel: Ca 44 SEK.

ProntOral: Ca 50 SEK.

Prontoderm Wipes: Ca 30 SEK × 5 [60].

4.3 Comparison of Substances

Both substances are antimicrobial agents with a broad spectrum [42]. One difference is that Staphylococcus aureus chlorhexidine has shown resistance to Staphylococcus aureus in clinical isolates [12] while polyhexanide has not shown resistance characteristics [7]. In addition, polyhexanide has a physicochemical action that prevents development of resistant bacterial strains [42] or finds it highly unlikely [7, 61]. Polyhexanide also has a faster antimicrobial activity than chlorhexidine after topical application [62].

Differences can also be seen regarding BI. Polyhexanide has a BI on 1.36 compared to 0.98 for chlorhexidine. Thereby polyhexanide has a better ratio of effectiveness and tissue compatibility than chlorhexidine. The effectiveness of polyhexanide is also confirmed by its better antimicrobial efficacy than chlorhexidine during both clean and dirty conditions [7].

The United States Federal Food and Drug Administration (FDA) informs that uncommon but severe allergic reactions have been identified from the use of skin antiseptics containing chlorhexidine. Due to this, FDA is requesting manufacturers to add a warning about the risk on the drug fact label for antiseptic products containing chlorhexidine that are sold over-the-counter [13]. Furthermore, chlorhexidine may cause hypersensitivity, eczema and anaphylactic reactions [7]. Rash and anaphylactic reactions are in fact well documented and make a concern, even if the number of cases are low [63].

Dermatitis or stomatitis caused by chlorhexidine-containing topical medicaments has been documented [39]. Large studies show that sensitization is a rather common issue in terms of relevance and that the reaction often is limited to the application site, though extended areas can also react. Work-related allergic cases have also been presented regarding the substance [63]. One study presents that allergic reactions can occur if chlorhexidine with concentrations over 4 % is used [37]. In contrast, polyhexanide is a rare allergen with a small allergic risk [7] even though cases of anaphylaxis have occurred [63]. For instance, severe anaphylaxis was reported for two patients where polyhexanide was applied in surgical wounds [64]. Though, all skin antispetics may cause side effects to the skin [63].

Polyhexanide is described to have good tolerability to skin, mucous and eyes and the cytotoxicity can be negligible [7, 65]. No known mutagenic, genotoxic or neurotoxic effects have been found in the United States Environmental Protection Agency Database [42]. From analyses it has been demonstrated that polyhexanide does not harm connective tissue. The substance even has a positive effect on some skin cells and contributes to the processes that increase the number of cells. Though this only applies to concentrations up to 2 μg/ml [66]. In addition, it has been found that polyhexanide inhibits bacterial
growth but not cell growth, owing to its beneficial value of BI [66]. However, chlorhexidine has been found to be cytotoxic to corneal and endothelial cells and neurotoxicity has been observed in animal models [37].

For higher concentrations of polyhexanide it may inhibit cell processes or be cytotoxic and cause fever and rashes. Information can also be found regarding that efficacy and cytotoxicity of polyhexanide are affected by additives that are used in order to reduce surface tension in a solution with polyhexanide as the active substance. This means that you must not use regular shampoo, soap, lotion, etcetera after application of polyhexanide since such solutions may inhibit the effect [7].

Different characteristics have been summarized with respect to the two substances with results regarding allergenicity and toxicity. The results show that polyhexanide has a very low allergenicity and toxicity while chlorhexidine has low allergenicity and moderate toxicity [42].

Both substances must not flow into the inner ear. For chlorhexidine it may cause permanent deafness [67]. Clinical records contain information on ear operations where decolonization before surgery was done with chlorhexidine that resulted in permanent hearing loss [68]. Both substances are also contraindicated for treatment of cartilage [42, 69].

Information from the usage information of Descutan describes how any remains of the product must not be disposed in the drain or household wastes. Residuals should be return to pharmacies [53]. For Prontoderm however, the products can safely be disposed down the drain [56]. Polyhexanide, as a substance, is not fully or partly biodegradable according to its definition but that does not mean that it does not decompose. Different studies have shown that polyhexanide during 28 days decompose to 13.5, 21 and 28 % [44] but the ecological database is still incomplete [42]. When the substance, after disposal, reach the sewage disposal plants, it decontaminates owing to other present substances [44]. No biodegradable rate has been found for chlorhexidine, more than it neither is fully or partly biodegradable. Though, it has been discovered that it decomposes to chloraniline which can be carcinogenic [70].

Chlorhexidine is considered to be the gold standard for antisepsis of oral cavity [71]. Though it might contribute to tooth staining and taste deviations [37]. Yet, in Europe, polyhexanide have been marketed to have an equal antimicrobial spectrum with less negative effects, toxicity and allergic reactions. Furthermore, a study presents polyhexanide when used as a mouth rinse solution to have equal efficacy in comparison with chlorhexidine. This also includes the substance when highly diluted. Chlorhexidine, on the other hand, has shown to loose efficacy when diluted to a concentration that is lower than 10 % of original concentration [37].

Both chlorhexidine and polyhexanide have prolonged effects after application [37]. Chlorhexidine may prevent regrowth of microorganisms for up to 6 hours [12] and for polyhexanide the antimicrobial barrier effect may last for up to 1 day [2, 7]. This effect is not impaired even with high loads of blood or albumin [7]. The full antiseptic effect occurs approximately 5 minutes after application with polyhexanide [2, 7].

Polyhexanide has been described to have very low risk of adverse environmental effects [72]. In contrast, chlorhexidine may be very toxic to aquatic organisms and induce long term adverse effects in such environments. Its adsorptive capacity to soil and sewage sludge are very high but it does not undergo bioaccumulation in organisms [73]. The concentrations of the active substances in the different products differ. Descutan contains 4 % chlorhexidine [53] while Prontoderm contains 0.10-0.15 % polyhexanide.

Chlorhexidine has shown to be effective against MDRO, including MRSA and VRE [74, 75] and Prontoderm, containing polyhexanide, has shown to be effective against MRSA, ESBL and VRE [2].
4.4 Experiment

The involved protocols, instructions, questionnaire and answers can be found in Appendix A, B and C.

Participation of the respondents amounted to 100%. The distribution of age and gender are presented in figure 2 and 3. Among the different age intervals the largest one was comprised by the range of 25-44. The number of persons divided into genders corresponded to nine men and eleven women. Any answers specific for a special age or gender were not identified.

Four answers of the total forty described that they were not able to perform the wash by themselves. However, all of them had the possibility to get assisted by a relative or friend. Three out of these four performed a wash including Prontoderm and solely one used Descutan.

The protocols were clear according to 80%. Of the remaining 20% it was evenly distributed between the two protocols. The participants described ambiguities considering instructions for performing the procedure twice and the washing of plastic objects. In addition, it was for Descutan suggested to use subsections for description of the body wash. Three persons answered “no” considering an appropriate order of the instructions, whereof two followed the Prontoderm protocol. Though, three of them that answered “yes” also added comments whereof all of them desired information regarding a clean towel to be presented earlier, all following Descutan.

Three of forty answered that the instructions did not come in the right order, one corresponding to Descutan and two corresponding to Prontoderm. Regarding Prontoderm the numbered picture created confusion in that it was presented after the instructions about drying of the body. In addition, it was for Descutan suggested to use subsections for description of the body wash. Three persons answered “no” considering an appropriate order of the instructions, whereof two followed the Prontoderm protocol. Though, three of them that answered “yes” also added comments whereof all of them desired information regarding a clean towel to be presented earlier, all following Descutan.

As for the use of appropriate pictures, six answered “no”, five persons following Descutan and one person following Prontoderm. For Prontoderm, illustrations were desired instead of pictures of an actual human being. Regarding Descutan the participants wanted more relevant pictures. The same distribution was obtained regarding clear pictures. Comments for Prontoderm described difficulties in finding the correct order for the wash with wipes. Furthermore, a higher resolution of the pictures were requested. Regarding Descutan the participants wanted more relevant and clear pictures. There were also some uncertainties considering which steps they belonged to. A numbered picture to summarize the steps were requested, as well as more pictures.

Two persons did not think that the language was sufficiently understandable, one considering Prontoderm, one considering Descutan. For Prontoderm there were uncertainties concerning the gargle of solution and the grammar. For Descutan it was the formulation concerning rinsing of the body and hair.

Four out of forty answers thought the layouts were not sufficiently clear whereof three belonging to Prontoderm. Bigger and clearer numbers were requested and someone commented the font to be too
“school-like”. For Descutan a summary was requested in the beginning. Further comments regarding Descutan described that it was good to have the instructions on one page and that the numbers were clear.

Figure 4: Use of clean towel

Figure 5: Requesting another format

In the instructions for Descutan it was specified that the towel should be clean, despite this 20% answered that their towel was used. Overall, drying with a used towel was common, shown in figure 4. One person commented that no clean towel was used for Prontoderm since it was solely an experiment, though he described that it may be used before a surgery even though it was not included in the instructions. Another person commented that it ought to be a clean towel in Prontoderm as well. One participant reported that it was a coincidence that the towel was clean when following Descutan and that he otherwise might have missed it since focus is on the wash of the body.

Figure 6: Protocol perceived easier

Considering instructions in a different format, 37.5% answered “yes”, shown in figure 5. The requests that came up were formats such as waterproof material and digitally by mail or as a pdf-file. One person suggested a voice assistant feature able to recite the instructions and also have a voice feedback.

Participants’ own adding comments about the washes stated that check boxes were desired, as well as a clear marking of fundamental information to clarify instructions not included in the actual wash procedure but still important for the decolonization, for instance by an information box. There were also questions about what other preparations that may be avoided in order to not remove the disinfectant effect after the wash, as for general hand antiseptics for instance. It was encouraged to not use vague words, to remind of areas, easy to forget and to use bold type of important information. Regarding Descutan, comments described that most focus was set to the wash itself and the occurrence of freshly washed bed linen was solely a coincidence. Difficulties to get an overview with Descutan was also described again.

After performing the second shower, a final section with questions was presented. One person filled in that he/she performed the first shower both times and did thereby not obtain the last questions. Another mistake that was identified was that a participant filled in that he/she performed the Prontoderm shower twice.

Regarding the easiest perceived protocol, 57.9% answered Descutan, one answered neither of them, while
the others answered Prontoderm, presented in figure 6. That one person reported that it may depend on if one prefer text or pictures for understanding and that a combination of both probably would be the best option. Same question presented that 12/19 chose the first performed protocol as the easier one. Furthermore, 3/11 answers preferring Descutan had undergone a preoperative body wash with Descutan before the experiment. One participant commented that the thought of Descutan as the easier body wash may depend on that such a wash already been performed.

The new protocol created by the authors after the experiment, based on the participants’ answers and comments, can be found in Appendix A.3.

4.5 Trivial Cost Analysis

By avoiding HAIs, the amount of care days could decrease with 300 000 days per year which responds to ca 3 billions SEK/year, costs due to possible sick leave are not included [76].

Previous acquired results show that 27.9 % of all HAIs are due to SSIs [49]. This corresponds to ca 837 millions SEK/year.

Previously mentioned study suggests that approximately 40-60 % of all SSIs could be prevented [3] which corresponds to ca 335-502 millions SEK/year. Information about the amount of SSIs correlated to imperfect preoperative body wash has not been obtained, neither the reduction of SSIs and subsequent costs, owing to the investigated product.

The average prolongation of the number of care days for a SSI is ca seven days. To calculate the total costs for an infection after surgery is complicated since a lot of variables must be taken into account. Important variables include doctor visits, treatments, loss of income, sickness compensation etcetera [10].

Descutan (ca 160 SEK) is less expensive than Prontoderm Pre-Kit (ca 244 SEK).

Price per ml:
Descutan: = 1.6 SEK/ml.
Prontoderm Nasal Gel: 1.47 SEK/ml.
ProntOral: 0.2 SEK/ml.
Prontoderm Wipes: Not confirmed.

Potential reduction of costs for proposed Pre-Kit and protocol: 40 %. This implicates a total price of 146 SEK. If only the reduction of two packages Prontoderm Wipes is taken into account the cost for the Pre-Kit decrease to 184 SEK.

If only reducing the Pre-kit with two packages of Prontoderm wipes (184 SEK), the pre-kit is 15 % more expensive than Descutan (160 SEK).
5 Discussion

5.1 Choice of Method and Delimitations

Research was initially performed in Google Search to receive general information within the area and thereafter expanded to scientific databases to get more specific and immersed knowledge. The research was performed in both English and Swedish to be able to get knowledge specific for the situation in Sweden. Information from companies’ websites may be biased, but important for the purpose of our work to investigate the applicability of a product for preoperative body wash. During the process more articles have been discovered for chlorhexidine and not so many for polyhexanide. Information sometimes had to be searched for in terms of the product itself instead of the substance and relying on articles specific for a product might be biased, as mentioned above.

Utilized information focused on newer resources to avoid acquisition of facts that is out of date. Exceptions were made for two articles since they included information assumed to be important for our work. In addition, only online articles were chosen owing to its easy access from databases provided by KTH.

Delimitations for the project were decided in agreement with our supervisors. The collaborating company presented an area of interest, due to an assumed problem of MDRO in the future, that we chose to investigate further. Focus was set on the company’s already existing products containing polyhexanide to investigate the applicability for preoperative body wash in Sweden which thereby reduced the amount of potential substances. The research question regarding conventional procedures was constrained by identifying the most commonly used agent in Sweden. Two main products were distinguished, Descutan and HiBiScrub, but focus was set to Descutan since it involved an instruction similar to Prontoderm’s.

When developing the experiment it was of importance to ensure that it was ethically correct. Only persons over eighteen were asked to participate since they are individuals of legal age of majority. In order to get a more randomized experiment and exclude variables that may affect the results, half of the participants were assigned the protocols in a specific order and the other half in reversed order. The aim of the experiment was to collect user experience regarding design of the protocols, to check for ambiguities and if one was perceived easier to follow.

5.2 Experiment Analysis and Creating of the Protocol

As stated in the results, section 4.4, mistakes, when filling in the questionnaires, occurred for two participants. Regarding the participant that filled in the wrong followed protocol, it was evident that it belonged to the other protocol, according to corresponding answers. This assumption has also been confirmed by the participant afterwards and thereafter corrected before summarizing the data.

Most of the participants were in the range of 25-44 due to that many of the participants are friends of the authors, and themselves are included in that interval.

According to the result and its subsequent comments regarding the need for help during the washes we probably think are due to the difficulty to use wipes on the back by oneself. An additional reason may be that the participants could not bring the instruction in to the shower since it might get wet, and instead let someone outside recite the instructions for them. This also agrees with latter comments regarding difficulties to use wipes on the back and the desire of a water resistant protocol.

The chosen pictures for our constructed protocol are adapted due to the comments about a desire of more relevant and clear pictures. There is also an agreement by the authors themselves together with one participant, regarding that illustrations are more appropriate than pictures of a real human being. The low resolution that was criticized is partly due to copying of images from an existing protocol instead of using original images. Language ambiguities may depend on translation from an existing protocol in German to Swedish without adding own interpretations or clarifications.
Clearer and bigger numbers regarding a summarized picture have been taken into consideration for the construction. The font for Prontoderm was decided to remain since only one participant had comments about that. In addition, it is a font frequently used by the company manufacturing the product. To present the instructions as a folded brochure instead of one page, was decided since the authors themselves preferred that format since the wash procedure is presented on one page and subsequent nasal and oral wash, intended to be performed outside the shower, is presented on the back. However, the new protocol was constructed with the appreciated clear numbers of Descutan in mind.

In the constructed protocol there are instructions added about using a clean towel. This was done since we assumed importance of not contaminating the body unnecessarily by drying with a used towel. This was agreed upon by both of our supervisors and some of the participants in the experiment. We also went through instructions specifically for the Prontoderm Wipes where it was stated that the towel should be clean. Regarding that 20% did not use a clean towel even though it was stated in the instructions, could have several reasons. They may not have read the instructions properly, there may be too much information in the protocol, the information may be too small or badly placed etcetera. Since this information was missed out for some of the participants, they also might have excluded other parts and thereby not performed the body wash properly.

To offer the protocol in an electronic form is a simple solution, which already is available for Descutan where the patients can download the instructions from a website. This is an addition that we will recommend for the Prontoderm Pre-Kit. An instructional film is also available for Descutan, which can generate easier understanding for the instructions. Otherwise, the instructions ought to be printed on a more water resistant material.

The suggestions about check boxes and information boxes were applied to the new protocol since they were considered as appropriate changes. The addition regarding check boxes was decided to be an inserted attachment for the brochure that can be removed to be filled in after each wash. In that way it is possible to avoid that too much information, that does not belong to the actual cleansing procedure, is presented in the shower while the patient is performing the wash. The decision was also taken regarding to not change the original instructions too much. With check boxes the patient can get an easy overview of what is done and what is left of the body wash. In addition, it was found that check boxes were used for a similar protocol of Prontoderm and could therefore easily be implemented to the new one. Furthermore, it was chosen to also apply the information about freshly washed clothes, bed linen and other cautionary information in the information box. Bold type was also decided to be utilized. To enhance the overview of the whole procedure the washing scheme was decided to remain but with modifications of an easier illustration together with fewer and bigger numbers. We also added a picture for the shower to emphasize important areas for decolonization.

More than half (12/19) of the participants perceived the first performed shower easier. This seems to describe a relation that may depend on the enthusiasm to begin an experiment and immerse oneself into that protocol and therefore also read the instructions more carefully. After performing one shower, unwillingness to learn a new one may emerge. The persons can also have created an opinion about the protocol and analyzed which parts they liked and be biased in the comparison towards the second one. Also, three of the eleven persons that answered Descutan to be easier, had performed a preoperative body wash with Descutan earlier which could affect their opinion by already knowing the steps of the procedure. If these answers are excluded from the comparison, the results are modified by eight persons perceiving Descutan to be easier compared to seven for Prontoderm. Still there is more people preferring Descutan and that can be explained by a more extensive body wash for Prontoderm. Furthermore, the protocol of Descutan is more similar a normal shower while nasal and oral cleansing may be more foreign.

Requests for clear and relevant pictures came up several times during the questionnaires and have had a great impact for the construction of a new protocol. The same applies to summarizing of the steps and information not connected to the washing steps.

The experiment involved twenty persons which might be too small to draw any certain conclusions,
but it can be used as a guideline for future work.

5.3 General Analysis

Since antibiotic resistance is a growing problem and Sweden is affected by the situation from other countries, we think that a preoperative body wash that handles bacteria, including resistant ones, is of great importance to avoid infections difficult to treat. It is also significant with a new substance since the present one has shown resistance characteristics and other adverse effects. Through a carefully performed wash of the whole body it is also possible to eradicate bacteria that can colonize the body internally, as intestinal bacteria for instance, that can end up on the skin surface and in worst case cause an infection including MDRO.

The resistance characteristics also describes a difference of importance between the two active substances, chlorhexidine and polyhexanide, since organisms have generated resistance against the former one. In addition, polyhexanide has a physicochemical action that prevents development of resistant bacterial strains. Thereby, polyhexanide is a better alternative in the fight against MDRO. Though, the resistance that has occurred against chlorhexidine might be due to the widespread use of products containing the substance and we can not be certain that the same will not happen for polyhexanide even though research today argues that it is highly unlikely.

According to our documented result regarding the distribution of organisms causing SSIs, Staphylococcus aureus correspond to a large amount, even the resistant form MRSA. Since that particular bacterium has shown resistance to chlorhexidine there seems to be a good reason to use a different agent that handles these bacteria and also has a low possibility to develop resistance, as for our investigated product Prontoderm. In addition it may avoid the tendency of the resistant bacteria to genetically transfer the resistance to new bacteria.

During this project we found that patients undergoing elective surgery are recommended to perform preoperative body wash, even though some studies say that there is no clear evidence on that it would prevent infections. Yet, this recommendation is well established among health care professionals and in handbooks. After receiving exhaustive knowledge in the area we therefore believe that a preoperative body wash would have an impact on the reduction of SSI rate as a result of a good decolonization. However, bacteria might always colonize a wound during operation by other reasons, as from the environment or the clothes of the health care professionals. But with preoperative cleansing there are possibilities to minimize the probability.

We argue that there are deficiencies in follow-up regarding if patients perform the preoperative body wash properly and the fact that Sweden does not have a surveillance system for following the infections makes it difficult to ensure if the preoperative body wash prevents SSIs. Since it is a complex system, difficulties to identify correlations occur and a deficient follow up system does not make it easier.

A study taken into account concluded that the use of leave-on chlorhexidine impregnated cloths appeared to decrease SSI rates. With respect to this, the protocol for preoperative body wash with Prontoderm products could be beneficial since it includes leave-on wipes as the final step. But more research needs to be performed to establish that leave-on products is the winning concept.

Even if high doses of polyhexanide, like chlorhexidine, might cause skin eruption, the considered products containing polyhexanide is in a much lower concentration. Also, in comparison with chlorhexidine, the investigated substance seem to have an advantageous feature regarding the BI and its tissue compatibility which makes the risk-benefit ratio superior to the compared substance.

Regarding the number of washes to fulfill a sufficient decolonization of the skin, a decision of three full body washes were chosen to be implemented in the constructed protocol. This due to that we advocate fewer but more accurate cleansing than more numerous and careless cleanings. By several washes it is possible to assure that the patient, by “mistake”, cleanses all areas on the body and in that way
obtain a complete decolonization. On the other hand we do not believe that this is something to be left by chance, the instructions should encourage patients to wash accurately. Studies have shown that two washing cycles are sufficient, thereby three ought to be enough.

Both Descutan and Prontoderm involve cleansing by mechanical work, Descutan by its sponge and Prontoderm with its wipes which both include a rubbing technique. Since this mechanical work has a great impact for reducing the amount of bacteria, we believe that it is of importance to include and ensure that the instructions considering this are clear. The mechanical work has such importance that a reduction of bacteria would occur even if the wash was performed solely with water, as long as the rubbing technique is involved. Though, it would not eradicate as much bacteria as when combined with an antiseptic agent.

B. Braun also manufactures a foam and a solution for body wash which have the potential to replace the wipes. In that way, usage of disposable materials could be decreased which might be beneficial for the environment. Though that would exclude the mechanical work unless a sponge is manufactured for this. Additionally, the wipes are predosed with an amount solution that is esteemed to yield a full body wash so the patients themselves do not need to be concerned about the dosage. As mentioned earlier, the wipes include leave-on products which is advantageous since the contact time is of importance in order to get a sufficient reduction of bacteria.

The fact that usage information state not to dispose the remains of Descutan down the drain might seem odd since it should be used in the shower. A possible reason for this may be that there is a desire for minimizing waste. This might also be something that is standardized for pharmaceuticals and thereby not actually connected with the substance.

Apparent modifications from the conventional procedures implemented in the new constructed protocol are the procedures regarding oral and nasal wash. Since many bacteria, especially resistant ones, often colonize these areas we believe it is of great importance to include these steps in the preoperative body wash in order to avoid infections with MDRO. At the same time it was chosen to emphasize important areas for skin cleansing where many of the bacteria often appear.

Even in acute surgical interventions where no preoperative body wash has been performed at home there is still an argument to use polyhexanide-containing products, owing to its fast antimicrobial effect that is of importance during a surgery.

We believe that if surgeries are performed properly following all hygiene routines etcetera, the cleansing with Prontoderm ought to reduce the number of SSIs. In addition to that polyhexanide is effective as preoperative cleansing, the same products can also be used for MDRO decolonization and wound healing. The products are also a potential replacement to antibiotic treatment with its broad antimicrobial spectrum, low toxicity and great tissue compatibility.

Since no specific numbers have been obtained regarding the reduction of SSIs by preoperative body wash, neither by using this new product or protocol, it is difficult to estimate the cost saving potential. Overall there are huge possibilities to save money for health care by reducing HAIs, SSIs included. Additionally, an infection may cause suffering and anxiety for the patient which not are included in the calculated costs. Regarding that 40-60 % of all SSIs can be avoided, a large amount of money could be saved but it may not solely depend on preoperative body wash. As stated it can depend on many factors related to the patient or environment. Though, we believe that a proportion of the preventable SSIs correspond to an accurately performed preoperative cleansing of the skin.

Even if the Prontoderm Pre-Kit in total is more expensive than Descutan, according to the price setting established in other countries, the price per ml is lower. However, no amount in ml has been found for Prontoderm Wipes, which corresponds to the largest cost. On the contrary, our constructed protocol solely include three washes which implies that less of the products can be used. If we perform calculations with the same proportion of the product, but with the decision of three instead of five washes, the amount
of required solution is decreased by 40%. According to the instructions of the products regarding dosage, there will be excess product that can be valuable if further cleansing must be performed or if inaccurate and too large amounts have been used. This has also been included in our calculations, though according to us, the intended excess might be too large. This also means that the costs for the product could be decreased even further if the excess also decreases, though it may not be a linear relation between the price and the amount in ml since manufacturing of bottles could imply major costs. The cost for wipes could directly be reduced since they are portioned into packages meant for one full body wash. If we neglect the idea that the nasal gel and mouth rinse solution could decrease in bottle size and only look at potential reduction of wipes, it still represents a price that approaches Descutan (15 % more expensive).

The Prontoderm Pre-Kit with 3 packages of wipes is more expensive than Descutan. Thereby it ought to be at least 15 % more effective than Descutan to make it economically sufficient to place on the market. This only considers direct costs and does not take other advantages with Prontoderm into account. No studies are yet available with results corresponding to the efficacy of Prontoderm, making it difficult to draw any further conclusions about the implementation on the Swedish market.
6 Conclusion

The aim of this report has been accomplished by our own constructed protocol. An insight of the present procedure and its involved substance has been obtained, also in relation to the investigated product. An economical estimation of costs for the products as well as a cost saving potential have been developed.

From what is desired by an antiseptic agent it was concluded that our investigated substance fulfilled all criteria. There are advantages for both products and their involved substances but more benefits are obtained from Prontoderm owing to its fast action, environmentally friendly substance, no resistance characteristics, good tissue compatibility, low concentration and broad spectrum.

If the infection rate can be decreased it is also possible to reduce antibiotic use. Thereby there are also possibilities to reduce resistant bacteria from propagating to other bacteria and spread even further and in that way inhibit antibiotic resistance. Furthermore it may reduce long visits at hospitals, that otherwise also is beneficial for colonization of MDRO.

The results of performed preoperative body washes are ambiguous since there is no consensus regarding their reduction of SSI rates. Studies describe different outcomes regarding this, although it is strongly recommended by health care professionals. From the results it was concluded that three full body washes are sufficient to fulfill a full decolonization.

From the analysis of the performed experiment with protocols for preoperative body wash it was also concluded that clear and relevant pictures are important for understanding as well as placement of text and appropriate language. The existing price of Prontoderm Pre-Kit is more expensive than Descutan, but potential reductions may be obtained. In regard to the cost analysis, sizes of the packages ought to be adapted to the protocol and its dosage. Prontoderm ought to be 15 % more effective than Descutan for implementing it on the Swedish market, if only taking the costs of the products into consideration.

By expanding the experiment to include a larger range of participants a more trust worthily and more reliable result could be obtained. This is something that can be executed in the future using this report as background. A further expansion could be to include patients undergoing elective surgery and performing the body wash with the actual products. In addition, the investigators may gather isolates from the participants’ skin flora, to ensure the efficacy. It would also be of interest to surveil possible subsequent SSIs. If it can be determined that the investigated product reduces the SSI rate together with an estimation of costs per SSI, it will also be possible to calculate the saving potential of the product.

Many improvements can be obtained for patients, personnel and surroundings. Patients may perceive an easier protocol and generate a more accurate preoperative body wash, personnel may avoid work related infections and hospitals may inhibit transmission of bacteria. The benefits to obtain with the new product and protocol will probably overcome the negative aspects and costs.
References


[51] R.-M. Carlsson. “Routine: Care Hygiene - Preoperative Full Body Disinfection” (In Swedish). Internet: [https://alfresco.vgregion.se/alfresco/service/vgr/storage/node/content/19256/V\unhbox\voidb@x\bgroup\let\unhbox\voidb@x\setbox\@tempboxa\hbox{a\global\mathchardef\accent@spacefactor\spacefactor\accent23\a\group\spacefactor\accent23\spacefactor\accent20\%20Preoperativ\%20helkroppsdesinfektion.pdf?a=false&guest=true, Mar. 4, 2013 [Dec. 4, 2017].


A Protocols
A.1 Descutan

Tvättinstriktion för Descutan

1. Ta av klocka, ringar och andra smycken.
2. Duscha hela kroppen inklusive håret med vatten. Stäng av duschen.
3. Tvätta håret med tvålösningen i påsen.
4. Öppna svampförpackningen och fyll på med vatten för att fukta svampen. Tvätta kroppen med svampen enligt nedanstående punkter.
5. Tvätta ansiktet. Var noga kring näsan.
6. Tvätta överkroppen, var särskilt noga med armhålor och navel.
7. Tvätta underkroppen, benen och fötterna. Var särskilt noga med könsorgan och ljumskar.
8. Skölj av hela kroppen med vatten. Stäng av duschen.
9. Tag ny svamp och tvålösning och upprepa hela hållningen från steg 3 till 8 ytterligare en gång.

OBS! Använd inte Descutan i hörselgången, fetvadd kan rekommenderas. Undvik kontakt med ögonen.

FRESENIUS KABI
RISIKOREDUCTION FÖRE OPERATION

För en optimal förberedelse av din kommande operation rekommenderar vi en förebyggande helkroppstvätt med Prontoderm för att minska bakterierfloran på huden. Denna procedur kan minimeras risken för eventuella sårinfektioner.

Påbörja behandling:
5 dagar före den planerade operationen.

Vänligen genomför tvättet enligt instruktionerna i 5 dagar. Tvättcykeln avslutas på sjukhuset, så vi ber dig att ta med produkterna till operationen. Resterande produkter kan återanvändas efter operationen.

Observera att du inte ska raka dig i operationsområdet före operationen. Om du inte kan göra följande steg själv, fråga personal eller anhörig om hjälp.

A.2 Prontoderm

2. Nästvätt:
• Rengör näsan 3 gånger om dagen med en bomullspinne (ta bort eventuellt torkat snor).
• Applicera sedan Prontoderm Nasal Gel i näsborsarna och tryck på näsvingen flera gånger.

3. Muntvätt:
• 3 gånger om dagen efter borstning av tänderna. 10 ml ProntOral gurglas och skölj munnen (1 min) eller gnugga med en indränktnuvårdspinne.

Alla andra föremål såsom glasögon, smycken, proteser etc. kan tvättas av med Prontoderm Wipes.
Plastobjekt ska sköljas med dricksvatten efter en kontakttid på ca 5 minuter.

Prontoderm
För bakteriereducerande tvätt

INSTRUKTIONER
FÖR PRONTODERM PRE-KIT

1. Kroppstvätt:
• Utför kropp inklusive hårtvätt med samma duschgel/schampo.
• Efter torkning, gnid förutsiktigt hela kroppen med Prontoderm Wipes (vätservetter) enligt diagrammet nedan och lät det torka.

Använd en Prontoderm Wipe per nummer på schemat.
A.3 Constructed Protocol

2. Nästvätt, 3 gånger/dag
- Rengör näsan med en bomullspinne (ta bort eventuellt torkat snor).
- Applicera sedan Prontoderm Nasal Gel, i storleken av en ärta, i näsborrarna och tryck på näsvingarna flera gånger.

3. Muntvätt, 3 gånger/dag
- Efter borstning av tänderna, gurgla och skölj runt 10 ml ProntOral i munnen under 1 min, eller gnugga med en indränkta munvårdspinne.

Eventuella plastobjekt bör sköljas av med kranvatten ca 5 min efter rengöring.

Föremål såsom glasögon, smycken, proteser etc. kan rengöras med Prontoderm Wipes.

RISKREDUKTION FÖRE OPERATION

För en optimal förberedelse av din kommande operation rekommenderar vi en förebyggande helkroppstvätt med Prontoderm för att minska bakteriefördel på huden. Denna procedur kan minimera risken för eventuella sårinfektioner.

Påbörja behandlingen: 2 dagar före den planerade operationen, den sista tvätten görs på morgonen före operation.

Vänligen genomför tvätten enligt instruktionerna i 3 dagar. Tvättsystem avslutas på sjukhuset, så vi bor ditt att ta med produkterna till operationen. Resterande produkter kan återanvändas efter operationen.

Observera att du inte ska raka dig i operationsområdet före operationen.

Om du inte kan göra följande steg själv, fråga personal eller anhörig om hjälp.

Viktigt att tänka på:
- Använd en ren handduk.
- Ta av klocka, ringar och andra smycken innan påbörjad tvätt.
- Använd inte Prontoderm i hörselgången.
- Rena kläder och sängkläder för att undvika kontaminering.

1. Kroppstvätt 1 gång/dag
- Torka kroppen med en ren handduk och använd därefter Prontoderm Wipes (våtservetter) på hela kroppen. Använd en våtservett per nummer enligt figuren och låt det torka.

OBS! Använd inte hudkräm eller andra produkter efter utförd kroppstvätt.
Personligt protokoll för preoperativ tvätt

<table>
<thead>
<tr>
<th>2 dagar före operation</th>
<th>1 dag före operation</th>
<th>Morgonen före operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kropp</td>
<td>Kropp</td>
<td>Kropp</td>
</tr>
<tr>
<td>Hår</td>
<td>Hår</td>
<td>Hår</td>
</tr>
<tr>
<td>Näsa x 3</td>
<td>Näsa x 3</td>
<td>Näsa x 1</td>
</tr>
<tr>
<td>Mun x 3</td>
<td>Mun x 3</td>
<td>Mun x 1</td>
</tr>
</tbody>
</table>

Fyll i protokollet efter genomförande av moment.
B Instructions and Questionnaire

B.1 Instructions

Informationsblad och samtycke

Hej och tack för att du angivit dig till att delta som försöksperson i vårt examensarbete.

Vi genomför vårt examensarbete på civilingenjörsprogrammet i Medicinsk teknik vid KTH där vi granskar produkter och instruktioner för preoperativ tvätt. Inför en operation kan patienten bli ordinerad att hemma, innan operationen, tvätta hela kroppen med ett desinficerande medel. Detta för att minska bakteriefloran på kroppen och på så vis kunna förhindra att en infektion uppstår i samband med operation.

Studien involverar två separata helkroppstvättar samt ifyllande av frågeformulär efter respektive dusch. Helkroppstvätten går att genomföra vid valfritt tillfälle, så det går utmärkt att kombinera med din normala dusch, bara att du vid dessa två tillfällen ska följa instruktioner för hur tvätten ska gå till.

Då vi i detta experiment inte har etiska tillstånd att testa de olika produkterna kommer ni genomföra duschen med er egna tvål och schampo eller vatten, för att därefter svara på ett frågeformulär online. Detta formulär skickas till er via mail.

Svaren från formulären kommer vara anonyma och enbart kopplas till ålder och kön som du uppger under frågeformuläret.

Deltagande i denna studie är helt frivilligt och du kan när som helst välja att avbryta ditt deltagande utan att motivera varför.

Vid frågor är du välkommen att kontakta Elin eller Malin.

Samtycke

Jag har tagit del av ovanstående information och getts möjlighet att ställa frågor om studien.

Genom utförande av dusch och ifyllnad av frågeformulär ger du ditt samtycke till deltagande.
Grundläggande instruktioner för helkroppstvätt

- Var uppmärksam på att tvättinstruktionerna kommer vara numrerade med 1 respektive 2. Börja med den som är märkt med 1.

- Du kommer att genomföra enbart en helkroppstvätt med varje instruktion, även om det i instruktionerna för själva produkterna står att det ska göras i flera dagar.

- Det blir totalt två olika tvättar med olika instruktioner att följa d.v.s. en för Descutan och en för Prontoderm.

- Tvätten kan genomföras i samband med din vanliga dusch. De båda tvättarna och formulären önskas vara slutförda senast 2017-12-01.

- Inför och under tvättarna kommer ni behöva använda er fantasi då vi inte kan dela ut de faktiska produktarna eller liknande eftersom vi inte kan garantera att exempelvis en allergisk reaktion inte uppstår.

- Denna undersökning syftar inte till att utvärdera själva produkten, utan till att granska hur instruktionsbladet fungerar.

- Frågeformulären fylls i online och nås via en länk som skickas till er mail.
Frågor efter genomförande av helkroppstvätt

Vi ber dig svara ärligt och tänka efter angående din upplevelse av instruktionen för helkroppstvätten. Inga svar är rätt eller fel.

*Obligatorisk

Personlig information

1. Hur gammal är du? *
   Markera endast en oval.
   - 18-24
   - 25-44
   - 45-64
   - 65-84
   - 85 eller äldre

2. Vad har du för könstillhörighet? *
   Markera endast en oval.
   - Kvinna
   - Man
   - Vill ej uppga
   - Övrigt: __________

Utformning

3. Vilken instruktion följde du? *
   Markera endast en oval.
   - Descutan - Fresenius Kabi
   - Prontoderm - B. Braun

4. Kunde du utföra tvätten själv? *
   Markera endast en oval.
   - Ja
   - Nej
5. Om "nej" på föregående fråga, skulle du ha möjlighet att ta hjälp av någon anhörig?


6. Var instruktionerna tydliga? *
Markera endast en oval.

☐ Ja
☐ Nej

7. Om "nej" på föregående fråga, varför?


8. Kom instruktionerna i lämplig ordning? *
Markera endast en oval.

☐ Ja
☐ Nej

9. Om "nej" på föregående fråga, vad vill du ändra på?


10. Var bilderna som användes lämpliga? *
Markera endast en oval.

☐ Ja
☐ Nej
11. Om "nej" på föregående fråga, varför?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

12. Varbilderna tillräckligt tydliga? *
   Markera endast en oval.
   
   ☐ Ja
   ☐ Nej

13. Om "nej" på föregående fråga, varför?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

14. Var språket förståeligt? *
   Markera endast en oval.
   
   ☐ Ja
   ☐ Nej

15. Om "nej" på föregående fråga, varför?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

16. Var instruktionernas layouter tillräckligt tydliga med avseende på typosnitt, teckenstorlek, färger m.m.? *
   Markera endast en oval.
   
   ☐ Ja
   ☐ Nej
17. Om ”nej” på föregående fråga, var upplevde du att det fanns brister?

__________________________
__________________________
__________________________

18. Handduken var: *
  Markera endast en oval.
  ☐ Nytvättad
  ☐ Använd

19. Hade du velat få instruktionen i en annan form än på papper? *
  Markera endast en oval.
  ☐ Ja
  ☐ Nej

20. Om ”ja” på föregående fråga, hur hade den instruktionen sett ut?

__________________________
__________________________
__________________________

21. Har du något själv att tillägga?

__________________________
__________________________
__________________________

Tvätt nr:

22. Vilken tvätt var det du genomförde? *
  Markera endast en oval.
  ☐ Första  Sluta fylla i det här formuläret.
  ☐ Andra
Avslutande frågor
Här följer några avslutande frågor efter din andra genomförda tvätt.

23. Med undantag från denna undersökning, har du genomfört en preoperativ tvätt tidigare? *
  Markera endast en oval.
  
  [ ] Ja  
  [ ] Nej  
  [ ] Vet ej

24. Om "ja" på föregående fråga, minns du vilken produkt som användes då?

25. Vilken av instruktionerna upplevdes enklast? *
  Markera endast en oval.
  
  [ ] Descutan - Fresenius Kabi  
  [ ] Prontoderm - B. Braun  
  [ ] Övrigt:

26. Om någon upplevdes enklare, varför?

27. Var det någon del som upplevdes otydlig?
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>19-20</td>
<td>Alice</td>
<td>手持記</td>
<td>ja</td>
<td><strong>Questions</strong></td>
<td>ja</td>
<td>ja</td>
<td><em>Ble to see if the person was</em>*</td>
<td><em>Ble to see if the person was</em></td>
<td><em>Ble to see if the person was</em></td>
</tr>
<tr>
<td>21-22</td>
<td>Kriss</td>
<td>手持記</td>
<td>ja</td>
<td><strong>Questions</strong></td>
<td>ja</td>
<td>ja</td>
<td><em>Ble to see if the person was</em>*</td>
<td><em>Ble to see if the person was</em></td>
<td><em>Ble to see if the person was</em></td>
</tr>
<tr>
<td>23-24</td>
<td>Kriss</td>
<td>手持記</td>
<td>ja</td>
<td><strong>Questions</strong></td>
<td>ja</td>
<td>ja</td>
<td><em>Ble to see if the person was</em>*</td>
<td><em>Ble to see if the person was</em></td>
<td><em>Ble to see if the person was</em></td>
</tr>
<tr>
<td>25-26</td>
<td>Alice</td>
<td>手持記</td>
<td>ja</td>
<td><strong>Questions</strong></td>
<td>ja</td>
<td>ja</td>
<td><em>Ble to see if the person was</em>*</td>
<td><em>Ble to see if the person was</em></td>
<td><em>Ble to see if the person was</em></td>
</tr>
<tr>
<td>27-28</td>
<td>Kriss</td>
<td>手持記</td>
<td>ja</td>
<td><strong>Questions</strong></td>
<td>ja</td>
<td>ja</td>
<td><em>Ble to see if the person was</em>*</td>
<td><em>Ble to see if the person was</em></td>
<td><em>Ble to see if the person was</em></td>
</tr>
</tbody>
</table>

---

**C Sammanställning Questionnaire**
<table>
<thead>
<tr>
<th>Avstand: annen</th>
<th>Åpen kommentar</th>
<th>Belte</th>
<th>Vetringsfaktor</th>
<th>Anvendt</th>
<th>Anvendt</th>
<th>Anvendt</th>
<th>Anvendt</th>
<th>Anvendt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,5 cm fornt.</td>
<td>til 6 cm fornt.</td>
<td>til 8 cm fornt.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 cm fornt.</td>
<td>til 5 cm fornt.</td>
<td>til 6 cm fornt.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,5 cm fornt.</td>
<td>til 5 cm fornt.</td>
<td>til 6 cm fornt.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 cm fornt.</td>
<td>til 5 cm fornt.</td>
<td>til 6 cm fornt.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,5 cm fornt.</td>
<td>til 5 cm fornt.</td>
<td>til 6 cm fornt.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hendelse:**

- **Beregnet belte lengde i cm:**
  - Belte 1: 2 cm
  - Belte 2: 2 cm

**Kommunikasjon:**

- **Til**:
  - Belte 1: 2 cm
  - Belte 2: 2 cm

**Avstand:**

- **Belte 1:**
  - 1,5 cm fornt.
  - 2 cm fornt.
  - 2,5 cm fornt.
  - 3 cm fornt.
  - 3,5 cm fornt.

**Anvendt til:**

- Belte 1: til 6 cm fornt.
- Belte 2: til 6 cm fornt.

**Vetringsfaktor:**

- Belte 1: til 8 cm fornt.
- Belte 2: til 8 cm fornt.

**Anvendt:**

- Belte 1: 1
- Belte 2: 1

**Kunne bestå i:**

- Belte 1: 1
- Belte 2: 1

**Avvik til:**

- Belte 1: 1
- Belte 2: 1

**Kommentar:**

- Belte 1: til 6 cm fornt.
- Belte 2: til 6 cm fornt.

**Beregnet belte lengde i cm:**

- Belte 1: 2 cm
- Belte 2: 2 cm