All previously published papers were reproduced with permission from the publisher.

Published by Karolinska Institutet.

Cover design: WWW.MAJSTUDIO.SE

© Helene Andersson, 2012
Yes, there is goal and meaning in our path -
but it's the way that is the labour's worth?

(Karin Boye from the poem, I rörelse, translated into English
By David McDuff in “Karin Boye: Complete poems”)

To the memory of Hans Jörbeck and my mother
ABSTRACT

MRSA and other resistant bacteria- prevalence, patient and staff experiences, wounds and infection control

Antibiotic resistance has become a major and serious global problem in healthcare. Limited treatment options for infections caused by these organisms can lead to increased morbidity and mortality. Sweden has a low prevalence of antibiotic resistance compared to most other countries but this presents an increasing problem for society and healthcare even in Sweden. The overall aim of this thesis was to illuminate potential problems related to antibiotic resistance from different perspectives: assessing the prevalence of resistant bacteria methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant enterococci (VRE) or other resistant bacteria, and associated wound types, patient and health staff experiences when confronted with resistant bacteria infection, and the occurrence of such infections in the nursing home environment.

In the first study a total of 2172 patients admitted to hospital or as out-patient visit at a University hospital during one day were examined with the purpose to identify all wounds, wound types and wound characteristics, and to identify bacteria in all wounds, particularly MRSA, VRE and multi-resistant Gram-negative rods. Four hundred and eight (19%) patients had a total of 668 wounds. Of these, 248 wounds, from 216 patients were cultured. Two unknown MRSA-patients were identified. No patient with VRE was found and there was a low prevalence of other multi-resistant bacteria.

In the second study fifteen patients with MRSA infected wounds were interviewed. The aim was to ascertain and describe patients’ knowledge, perceptions and experiences of being MRSA-positive. The interviews were analyzed according to qualitative content analysis. From the analysis three categories and one overall theme were identified. Results showed that information about the MRSA diagnosis often caused a shock-like reaction. The patients’ perception of being MRSA-positive was that it was stigmatizing like the plague or leprosy; they felt dirty and a severe threat to their environment. Fears of infecting someone else and being rejected were commonly expressed. Knowledge and empathy from staff involved in their care was crucial to optimise patients’ experiences. Staff’s needs of education to meet patients’ demands for information, and to prevent spread of antibiotic contamination was essential.

In the third study eight nurses and seven assistant nurses from different hospital wards and nursing homes were interviewed regarding their experiences of caring for MRSA-positive patients. Qualitative content analysis was carried out when analysing the data and three themes were identified during the process. Stress and too high workload were factors which were described to cause concerns in the caring situation. A major concern was that nurses felt at risk of becoming infected themselves and then transmitting the infection to other patients and to family members. Knowledge and ignorance about MRSA affected the nurses’ caring; ignorance made them afraid and insecure while knowledge and understanding shaped confidence in their role as caregivers.

In the fourth study 560 residents in a total of 67 wards, in nine nursing homes were investigated for prevalence of MRSA, VRE and extended-spectrum β-lactamase (ESBL) - producing Enterobacteriaceae and if carriage of resistant bacteria was related to antibiotic treatment, other risk factors and/or staff’s adherence to guidelines for infection control. In all 296 staff members were interviewed and observed. No resident was positive for MRSA or VRE. Fifteen residents were found to be ESBL-positive. Usage of antibiotics was higher in wards where ESBL-positive residents were detected and there was an indication that there was transmission of ESBL between residents. Staff’s adherence to infection control guidelines sometimes revealed shortcomings but no significant difference regarding adherence to the guidelines could be found.

In conclusion: Prevalence of MRSA appears low in both hospitalized patients, out-patients and nursing home residents. Adherence to infection control guidelines among healthcare staff, however, needs further improvement. MRSA colonized patients experienced psychological pressure and stigmatization. Knowledge and empathy from staff involved in their care is crucial to optimise patients’ experiences. Staff education to meet patients’ demands for information and the prevention of contamination is essential.

Keywords: MRSA, VRE, ESBL, colonization, infection control, wound, patient experiences, staff experiences, nursing care, qualitative interview, qualitative content analysis

ISBN; 978-91-7457-823-2
LIST OF PUBLICATIONS

This thesis is based on the following papers, and references to the papers are made by their Roman numbers, I-IV:

PAPER I
Wounds scrutiny in a Swedish hospital: prevalence, nursing care and bacteriology, including MRSA
Lindholm C, Andersson H, Fossum B, Jörbeck H.
J Wound Care. 2005 Jul; 14(7): 313-9

PAPER II
MRSA-global threat and personal disaster: patients’ experiences
Andersson H, Lindholm C, Fossum B.

PAPER III
Emotional reactions when caring for MRSA-positive patients; Ignorance and fear versus knowledge and security
Andersson H, Andreasen S, Lindholm C, Fossum B.
Scand J Caring Sciences. Submitted

PAPER IV
Prevalence of antibiotic resistant bacteria in residents of nursing homes in a Swedish municipality: Healthcare staff knowledge of and adherence to principles of basic infection prevention
Scand J Inf Dis. 2012 Published: Early view online 10 Jun 2012
DOI: 10.3109/00365548.2012.671956
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction and background</td>
<td>6</td>
</tr>
<tr>
<td>Definitions of infection</td>
<td>6</td>
</tr>
<tr>
<td>History</td>
<td>7</td>
</tr>
<tr>
<td>Drug-resistance</td>
<td>12</td>
</tr>
<tr>
<td>Resistance mechanisms</td>
<td>12</td>
</tr>
<tr>
<td>Drug-resistant bacteria</td>
<td>12</td>
</tr>
<tr>
<td>Transmission</td>
<td>15</td>
</tr>
<tr>
<td>Patient and staff experiences of infectious diseases</td>
<td>17</td>
</tr>
<tr>
<td>Rationale</td>
<td>18</td>
</tr>
<tr>
<td>Aims of the thesis</td>
<td>19</td>
</tr>
<tr>
<td>Overall aims</td>
<td>19</td>
</tr>
<tr>
<td>Specific Aims</td>
<td>19</td>
</tr>
<tr>
<td>Methods and samples</td>
<td>20</td>
</tr>
<tr>
<td>Design</td>
<td>20</td>
</tr>
<tr>
<td>Paper I: Quantitative descriptive study</td>
<td>20</td>
</tr>
<tr>
<td>Paper II-III: Qualitative descriptive studies</td>
<td>21</td>
</tr>
<tr>
<td>Paper IV: Quantitative and qualitative approach</td>
<td>24</td>
</tr>
<tr>
<td>Ethical Considerations</td>
<td>25</td>
</tr>
<tr>
<td>Summary of results</td>
<td>27</td>
</tr>
<tr>
<td>Paper I</td>
<td>27</td>
</tr>
<tr>
<td>Paper II</td>
<td>28</td>
</tr>
<tr>
<td>Paper III</td>
<td>28</td>
</tr>
<tr>
<td>Paper IV</td>
<td>29</td>
</tr>
<tr>
<td>Discussion</td>
<td>31</td>
</tr>
<tr>
<td>Reflections on the findings</td>
<td>31</td>
</tr>
<tr>
<td>Methodological considerations</td>
<td>37</td>
</tr>
<tr>
<td>Conclusion and clinical implications</td>
<td>41</td>
</tr>
<tr>
<td>Future research</td>
<td>42</td>
</tr>
<tr>
<td>Sammanfattning på svenska</td>
<td>43</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>46</td>
</tr>
<tr>
<td>References</td>
<td>49</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIDS</td>
<td>Acquired immune deficiency syndrome</td>
</tr>
<tr>
<td>DRB</td>
<td>Drug-resistant bacteria</td>
</tr>
<tr>
<td>ESBL</td>
<td>Extended-spectrum β-lactamase</td>
</tr>
<tr>
<td>GP</td>
<td>General practitioner</td>
</tr>
<tr>
<td>HIV</td>
<td>Human immune deficiency virus</td>
</tr>
<tr>
<td>MRSA</td>
<td>Methicillin-resistant <em>Staphylococcus aureus</em></td>
</tr>
<tr>
<td>VRE</td>
<td>Vancomycin-resistant enterococci</td>
</tr>
</tbody>
</table>
PROLOGUE

The best aspect of the nursing profession has for me been all the encounters with the patients, hearing their life stories and all the confidences one is entrusted with. As a nurse in an infectious disease clinic you will come in contact with MRSA-positive patients. These patients’ stories and their hospital experiences have made an impression on me. It was the MRSA-positive patient’s situation that prompted me to embark on this research. I have worked as a nurse at an infectious disease clinic for over ten years in combination with a leadership role for clinical advancement of staff and the development of quality patient care at the clinic when my research journey started in 2002.

The majority of the MRSA-positive patients in Sweden around the turn of the century (year 2000) were infected with MRSA while in healthcare facilities being treated for other conditions. When I met these patients some of them told me that after being diagnosed with MRSA they felt that they did not receive the same care as before or as that received by other patients. Patients described that they felt that staff were afraid of them and did not want to take care of them and they felt inferior and segregated. When the opportunity arose to do research in this area it was important for me to be able to elucidate the MRSA-positive patients’ situation.

I wanted to examine what the MRSA-positive patients experienced during their contacts with healthcare. An obvious question was if the MRSA-positive patients felt that they were being segregated when they sought care, and if this was the case, was it due to lack of knowledge or was it fear among healthcare staff? I also wanted to learn about what the healthcare staff experienced. If we could capture the experiences and feelings of staff caring for MRSA-positive patients we could hopefully do something about it, with the positive outcome of better care for the MRSA-positive patients. Wounds and wound healing has been my passion and big interest since I started to work as a nurse and many of the MRSA-positive patients had wounds. Because of this it became natural to involve wound care in the research. Several questions needed to be addressed in this area: what was frequency of patients with wounds at a university hospital and how were these wounds treated? Were there carriers of resistant bacteria among the patients with wounds in hospitals and in nursing homes? Do staff adhere to guidelines for infection control? Based upon these questions studies were designed to form the basis for this thesis. Two other types of resistant bacteria as well as MRSA are highlighted in the thesis, VRE and ESBL-producing bacteria.
INTRODUCTION AND BACKGROUND


That we have antibiotics available in the pharmaceutical arsenal is second nature for us and the thought of a future without them readily available is a terrifying scenario (Cars, et al. 2008; Hogberg, et al. 2010).

Proof of the origin of infections and how they spread and cause disease came just 150 years ago. Prior to that the knowledge was based on practical experiences and observations and this was not considered scientific enough as proof of knowledge even with undisputable statistical evidence (Hays 2009).

As an introduction to the subject a brief section in this thesis provides background on how perception and knowledge of infection and transmission of infections has changed from historic to present times.

DEFINITIONS OF INFECTION

In The Medical and Pharmaceutical Dictionary the definition of infection is synonymous with contagion and; to infect, to give the infection to, or to taint. Someone or something could be infectious or contagious. There is also a focus on the infection and infection sources (Cressy 2005).

Definition according to the American Heritage Medical Dictionary:

Infection

1 Invasion by and multiplication of pathogenic microorganisms in a bodily part or tissue, which may produce subsequent tissue injury and progress to overt disease through a variety of cellular or toxic mechanisms.
2 An instance of being infected.
3 An agent or a contaminated substance responsible for one's becoming infected.
4 The pathological state resulting from having been infected.
5 An infectious disease.

Contagion

1 a Disease transmission by direct or indirect contact.
   b A disease that is or may be transmitted by direct or indirect contact; a contagious disease.
   c The direct cause, such as a bacterium or virus, of a communicable disease.
2 Psychology The spread of a behavior pattern, attitude, or emotion from person to person or group to group through suggestion, propaganda, rumor, or imitation.
A harmful, corrupting influence.
The tendency to spread, as of a doctrine, influence, or emotional state (American Heritage 2007). As one example on contagions of emotions is that one talk about infectious laughter.

HISTORY

Traditional Greek medicine
If we go back to the fifth century B.C. and traditional Greek medicine, the leading theory on illness at that time was that it arose from an imbalance in one’s own body. It was believed that the human body contained four substances, blood, phlegm, yellow bile and black bile and that health depended on the strength, balance and quality of these substances, that they were in the correct proportions and well mixed. One also talked about the four elements, water, earth, air and fire and that these four elements entered into the body though food, drinks and the atmosphere (Hays 2009). The importance of the principles of sanitation were known already in 450 B.C. and there were health inspectors responsible for control of water and sewage and sanitation and food hygiene (Hays 2009).

The Bible
The Old Testament contains many references to diseases in general and particular infections connected to the wrath of God, a wrath brought on by human misbehaviour. The Bible, 2 Chronicles verses 26:20 (English Standard Version, 2001), describes when King Uzziah had done wrong: “When Azariah the high priest and all the other priests saw the leprosy, they rushed him out. And the king himself was eager to get out because the LORD had struck him”. The opinion that you suffer from illness because of a wrong doing or that you are evil and are being punished for that, continues to persist even in modern times.

The Bible also mentions associations between diseases and the “unclean”. Impurities are closely linked with skin disease and are described as marks of uncleanness. Leviticus (verse 13) covers the “Laws About Leprosy” and describes how to behave if leprosy is suspected: “The leprous person who has the disease shall wear torn clothes and let the hair of his head hang loose, and he shall cover his upper lip and cry out, “Unclean, unclean.” He shall remain unclean as long as he has the disease. He is unclean. He shall live alone. His dwelling shall be outside the camp”.

In the Middle Ages
During all times epidemics have come and gone and come back again when the opportunities for them have been propitious. Between the years 1000 and 1250 the European countries developed and grew rapidly and leprosy was the big issue at this time. The denser the population, the easier the infection could be spread. Leprosy began to decline between 1250 and 1350 when instead the great plague began its devastation (Hays 2009).

In Bergmark (1983) there is a description from the fourteenth century when the plague, also called the Black Death swept across the whole world and harvested lives everywhere. In Europe alone 25 million people, a quarter of the entire population
died. It is believed that the Black Death entered Europe by means of the home coming Crusaders’ ships. The ships harboured the black rats and black rats were carriers of the plague fleas which was earlier unknown of in Europe. The black rats first infected the European brown rats with plague, after which the infection spread to humans. When it was realized that a ship could come with diseases, quarantine provisions were imposed which assured that ships with their crews were forbidden to go ashore for up to 40 days, to assure that there was no infection onboard.

Besides ships and the Crusaders, infections were transported by human migration. Between 1349-1350 it is estimated that 1 200 000 persons had left their homes to go on a pilgrimage to Rome. Of these only 100 000 were believed to have survived. This migration brought the plague and other infections to different locations on the path of their migration process (Bergmark 1983).

Medical doctors had tried to protect themselves by wearing protective clothing, handkerchiefs and masks to escape the plague. This protective dressing was probably quite effective since we now know that the plague was caused by a bacterium that is transmitted between people through fleas, by the air and contact transmission from one person to another.

Figure 1. Antoine Barthelmy Clot-Bey, (1793-1868). De la peste observée en Égypte; Recherches et Considérations sur cette Maladie, Paris, Fortin, Masson, 1840. A lithograph plate that illustrates a plague doctor from 1720. Hagströmer Library, KI.

The eighteenth century
It was believed that beside God’s punishment and imbalance in the body fluid, illness could be caused by something in the environment, this something was circulating in the air, small invisible particles of “bad air” reached into the body via the eyes and nose, or by inhalation. This was sometimes called “the miasma” (Hays 2009).
Many doctors believed that the miasma was the cause of puerperal fever and that it was one of the “Genius epidemicus” - a kind of epidemic against which the doctors were not only powerless but also completely blameless.

During 1789-1792 a serious epidemic of puerperal fever was spread in Aberdeen. A physician, Dr. Alexander Gordon, ran a private practice in Aberdeen and his main interest was midwifery and obstetrics. Gordon had direct or indirect supervision of the victims of puerperal fever in Aberdeen and he carefully recorded his observations. He realized the similarity between patients with erysipelas and new birth mothers with puerperal fever, and was convinced that these diseases were transmissible between the patients. In 1795 Gordon published Treatise on the Epidemic Puerperal Fever of Aberdeen, (Gordon 1795). In the treatise he described that he himself, the nurses and his colleagues were responsible for the spread of the infection. “It is a disagreeable declaration for me to mention, that I myself was the means of carrying the infection to a great number of women”.

He also described how the infection should be prevented, for example; the rooms and beds where infected patients had been treated should be smoked and the patient’s night clothes burned. Doctors and nurses who had been exposed to infection should wash themselves thoroughly and all the clothes that been worn should be smoked. Gordon’s theory was received with loud protests by the medical profession. It would take fifty years before the theory would reemerge in a new light by Ignas Semmelweis (Nuland 2003).

During the eighteenth century smallpox ravaged and it is estimated that in Europe alone 60 million people died (Bergmark 1983). It was believed that the miasma spread the smallpox. In this case it is perhaps justified to say that because today we know that the smallpox could be both airborne and spread by contact contamination. There were rumours that milkmaids did not contract smallpox. The milkmaids came in contact with another closely related virus from the cows, cowpox. Cowpox gave the cows pustules on the udders and the milkmaids got pustules on their hands. The rumours said that the milkmaids that had got cowpox did not contract smallpox. This rumour led a farmer who was also a doctor, Edward Jenner, to do an experiment. In 1796 he vaccinated an eight year old boy with cowpox and after that exposed him to smallpox. The boy became immune against the smallpox and the first vaccine was discovered. Jenner described his results in a publication An inquiry into the causes and effects of the variolae vaccinae (Jenner 1798) and the word “vaccination” entered circulation (Hays 2009).
In the Nineteenth century, when general perceptions turned into proof
Evidence that microorganisms, or germs, caused infection became evident in the middle of the nineteenth century. Louis Pasteur was convinced that germs could cause and spread diseases. He was never able to prove it, but he showed that something he called a “microorganism” caused milk to sour and wine to ferment and by heating, the souring and fermenting processes ceased. Thus the term “pasteurization” (Nuland 2003; Hays 2009).

Pasteur’s theory on microorganism inspired others, e.g. Joseph Lister a British surgeon, to believe that wound infection or sepsis that followed after surgery might be caused by germs. He began experimenting with different techniques of “antisepsis” during operations. Lister used for example Carbolic acid in his attempt to create a sterile surgical environment (Nilsson & Peterson 1998).

There were others who were convinced that infections were spread by microorganisms and contaminated people and acted as contagions from one human to another. Ignas Semmelweis an obstetrician in Vienna, saw the connection between autopsies and death in new postpartum mothers and puerperal fever. He was responsible for two delivery departments at the hospital, one of them managed by doctors the other by midwives. In the department run by doctors the mortality rate in childbed fever was about 17% compared to the department run by the midwives where the death rate was only one tenth, i.e., 1.7%. The only difference between the departments was that the doctors started every morning with autopsies of the corpses of patients that had died during the night. After that they went to examine and deliver the women at the department. Semmelweis understood that it must be something that the doctors took with them from the corpses to the mothers. He introduced a new routine at the department which meant that no one was allowed to examine or deliver the women before they had cleaned their hands first with water and soap and then in Chlorine solution. In just a few weeks the death rate had fallen to the same level at both
departments. Despite these precise and specific references and convincing statistics his theory was seen as unproven speculations and Semmelweis had a likely tough task to convince his medical colleagues that the illness and death among the mothers was caused by themselves and that they passed illness between the patients as Gordon had theorized in the eighteenth century (Nuland 2003).

**Figure 3.** Midwifery washbasin, made 1833-1870. Used with permission from The Museum of Health Care at Kingston, Canada. http://artefact.museumofhealthcare.ca/

One who was not convinced that infections were spread by germs but understood how important hygiene was to health was Florence Nightingale. She came as a nurse to a Turkish hospital in Constantinople 1854 during the Crimean battle, with nourishing food, clean clothes and bed linen and combined with good hygienic routines and wound care she saved the lives of many soldiers that otherwise would have died of infections (Dossey 2000).

Even if theories and thoughts about what causes infections have been described throughout history by different people these were all guesses or based on clinical observations. But in 1876 Robert Koch provided proof when he traced the organism responsible for anthrax. In 1882 he isolated the first microorganism and proved that it caused diseases in humans, it was tuberculosis. And in 1884 he announced that the causative agent of cholera had been found. Despite obvious evidence, he also had difficulty convincing the world that these small microorganisms invisible to the eyes could cause sickness (Hays 2009).

**In the Twentieth century**

When the knowledge of bacteria and infectious agents increased, and bacteria could be isolated and grown, and the understanding that this particle could cause diseases, the research for countermeasures that could inhibit or kill these agents accelerated. In 1928 Alexander Fleming discovered that the mould *Pencillium notatum* had antibacterial qualities and could inhibit the growth of bacteria especially that of staphylococcus, pneumococcus and streptococcus (Fleming 1929). He had discovered the “Penicillin” and this product was then purified by Howard Florey and Ernst Chain (Chain,E, et al. 1940). However it was not until the Second World War, that penicillin was used clinically, as a drug (Hays 2009).
Today we know that infection can be spread by bacteria, viruses, fungi, parasites and prions. We have knowledge that infection can be transmitted and spread in many different ways, for example through the air we breathe, from something we eat or drink, from blood or other body fluids, from a vector for example a mosquito. We also know that infection can be spread from one person to another by hands or via clothes or other objects. How we relate to and manage this knowledge will be demonstrated and discussed later on in this thesis.

**DRUG-RESISTANCE**

It did not take long after the clinical introduction of penicillin before the first report about resistance against different preparations was presented. Chain and Abraham described in 1940 that a substance from *E.coli* could inactivate penicillin and in 1944 a report about occurrence of resistance by *Staphylococcus aureus* was presented (Kirby 1944).

**Resistance mechanisms**

Resistance means immunity in the sense of the ability to defend oneself and to survive. For example, people can get immunity against certain diseases after contracting an illness or by vaccination. Bacteria can become resistant to drugs and an invasion of resistant bacteria into the body can be difficult to treat and poses a big threat to human beings. Bacteria can acquire resistance in different ways. Their genetic material, the DNA can mutate, this can happen by chance, but it is also known that the more an antibiotic is used the greater the risk that the bacteria will develop resistance (Cars, et al. 2008). Development of resistance can also occur when the antibiotic resistant bacteria transfer their resistance to non-resistant bacteria. The three main mechanisms that describe the transfer of resistance between bacteria are, transformation, transduction and conjugation (Giedraitiene, et al. 2011). The overuse of antibiotics is a major problem and promotes this process (Cars, et al. 2008).

**Drug-resistant bacteria**

This thesis will comprise three different drug- resistant bacteria, with special focus on methicillin-resistant *Staphylococcus aureus* (MRSA), but also include vancomycin-resistant enterococci (VRE), extended-spectrum β-lactamase (ESBL) -producing *Enterobacteriaceae*.

**MRSA**

Methicillin was an antibiotic introduced around 1960 to treat gram-positive infections especially β-lactamase-producing bacteria such as *Staphylococcus aureus*. Within a year antibiotic resistance was observed by Jevons (1961) and since then the resistant bacteria began to spread and are now a considerable problem worldwide. Reports from Australia, USA, South Africa, Brazil, Japan, China and Europe indicate a threat to healthcare systems and individual patients (Tiemersma, et al. 2005; Perovic, et al. 2006; Izumida, et al. 2007; Klevens, et al. 2007; Coombs, et al. 2009; Wang, et al. 2009). In countries such as Russia, Jordan, Egypt and Cyprus, from 50 % and upward isolated
strains of Staphylococcus aureus have shown resistance to methicillin (Borg, et al. 2007; Baranovich, et al. 2009). Although Sweden has a low prevalence of MRSA (about 1%), it presents a serious problem for society and healthcare (Stenhem, et al. 2006; EARSS 2010). The prevalence of MRSA resistance in European is presented in Figure 4.

Figure 4. This report has been generated from data submitted to TESSy, The European Surveillance System on 2012-06-04. Page: 1 of 1. The report reflects the state of submissions in TESSy as of 2012-06-03 at 12:00.

MRSA is a resistant variant of Staphylococcus aureus; a commensal found in the nose, throat, perineum and on the skin and can be carried by healthy humans without causing any symptoms of infection. Like other Staphylococcus strains, it can cause pneumonia, skin-, skeletal- and joint infections, septicaemia and is associated with a substantial mortality (Klevens, et al. 2007). The death rates increase and can almost double if MRSA is causing bacteraemia compared to if caused by antibiotic sensitive strains of Staphylococcus aureus (Cosgrove, et al. 2003; Filice, et al. 2010; Hanberger, et al. 2011). Older or debilitated patients and those with impaired immunity are more susceptible (Tacconelli, et al. 2006; Demling & Waterhouse 2007; Shurland, et al. 2007), and those with open wounds are particularly at risk of progressive infection (King, et al. 2006; Demling & Waterhouse 2007).
Contagious diseases are divided into four different groups in Sweden: notifiable, mandatory contact tracing, diseases dangerous to public health and diseases dangerous to society. In 2000, MRSA became a notifiable disease. The frequency of newly infected persons has increased yearly. From 325 newly infected persons in 2000 up to 1884 in 2011 (SMI 2012). Since 2004 MRSA is classified as a disease dangerous to public health, similarly as for example HIV/AIDS and hepatitis. Early on MRSA acquisition was associated with patient care in hospitals and nursing homes but nowadays community-acquired MRSA-infection is also a severe problem, and these patients could have acquired the infection without recent healthcare contacts (Klein, et al. 2009). The community acquired MRSA often presents with abscesses whereas hospital acquired infection often comprises patients with wounds or other risk factors such as a urinary catheter.

In Stockholm a new and comprehensive program was introduced with guidelines for the care of MRSA-positive patients in the Spring of 2002. These guidelines included for example that these patients on admission should be isolated in single rooms including hygiene facilities and if possible patients should be cared for at the infection clinic.

There was a lot of focus at this time on MRSA and courses were held for all hospital staff incorporating the new guidelines (Jorbeck & Parment 2002). There was also a lot of media hype about the dangers associated with the disease, its prevalence and the growing problem with antibiotic resistance in the world.

In Stockholm, where all the studies in this thesis were performed, MRSA-positive patients get initial information about MRSA infection from a physician, often the general practitioner (GP). Thereafter an infection control team meets the patient. They provide both verbal and written information on MRSA, activities of daily life, and how to reduce the risk of transferring the infection to others within their family or community. The MRSA-positive patients also receive a red card to be presented at all future contacts with healthcare, or for example a visit to the dentist or a pedicurist (Infectious Disease Control Unit 2012) and since MRSA is classified as a disease dangerous to public health, the patients have the obligation to inform others if there is a risk for transmission.

**VRE**

Enterococci are naturally present in the normal intestinal flora and because of that are often found on the skin around the anus and the urethra. Vancomycin is a useful antibiotic in the treatment of severe infections due to gram-positive bacteria, such as enterococci, staphylococci and streptococci. It is a very important antibiotic for intensive care units. Resistance against vancomycin was reported in Europe for the first time in 1988 (Leclercq, et al. 1988; Uttley, et al. 1988), and has become a big issue for many European countries (Werner, et al. 2008; EARSS 2010). VRE has caused hospital outbreaks worldwide (Willems, et al. 2005). Patients and healthcare staff can become asymptotically colonized with the bacteria. This carrier status may continue for anything from weeks to months. Enterococci often cause urinary tract infections but can also cause severe infection in the blood and colonization of foreign materials within the body, such as cardiac valves and artificial prostheses. VRE present in patients in hospitals can easily be spread if hygienic routines fail.
Fortunately prevalence of VRE is low in Sweden with 122 new cases in 2011 (SMI 2012).

**ESBL**

Intestinal bacteria can cause anything from urinary tract and abdominal infections to serious infection such as septicemia (Pitout & Laupland 2008). These infections are often treated with β-lactam antibiotics and Cephalosporins. Some intestinal bacteria can produce β-lactamases, which can break down antibiotics. Some of these bacteria have enzymes with mainly extended-spectrum of these β-lactamases, ESBL, consequently the infection may be difficult to treat. ESBL is found in both healthcare and social services such as nursing homes, but also in the community among healthy individuals who have never been in contact with health care. ESBL-infected persons are most often not sick and are usually unaware of it (Valverde, et al. 2004). Bacterial strains carrying ESBL are more common abroad, but since ESBL became a notifiable contagion in Sweden 2007 the number of newly detected cases has increased yearly. In 2007, 2098 new cases were identified and four years on, in 2011, there were 5666 new cases (SMI 2012). ESBL is currently a much bigger issue than MRSA and VRE. ESBL and VRE are mandatory contact tracing diseases and are registered from the laboratory, and the patients are informed about the infection and how to behave in order to not infect others but there are no restrictions to the patients or obligations to inform others as for MRSA (SMI 2012).

**Transmission**

Transmission of MRSA, ESBL and VRE can occur directly from one person to another, by direct skin contact. Contamination can also occur indirectly if for example, staff have not adhered to the principles of infection prevention thus transmitting the bacteria on their hands from one patient to another (WHO 2011). Furthermore transmission of the bacteria can also take place through contaminated food (Jorgensen, et al. 2002; Doi, et al. 2010; Calbo, et al. 2011; Pu, et al. 2011; Crago, et al. 2012).

A new patient safety law came into effect in Sweden in 2010 which stated: the employer shall ensure that adequate measures are taken to prevent suffering, bodily or mental harm or illness arising from patient contact with health services. The law also states that all health care staff are responsible for carrying out their duties in accordance with science and proven experience (SFS 2010).

Between 5-10% of all patients admitted to acute care hospitals in industrialized countries will receive a health care-associated infection and in developing countries the risk is even higher thus infection prevention is a necessity for patient safety and for the quality of care (Pittet, et al. 2008). The most common route of bacterial transmission in the health care environment is indirectly by contaminated hands of staff, but infectious agents can also be transmitted via clothes, objects and equipment (Duckro, et al. 2005; Henderson 2006; Pittet, et al. 2009; Sax, et al. 2009; Erichsen Andersson, et al. 2012; Ho, et al. 2012; Morgan, et al. 2012) and by insufficient disinfection of environment surfaces (Yamamoto & Marten 2008).

To prevent this spread of bacteria, Swedish guidelines state that principles of infection prevention should be practised during patient management at all times.
These principles include the use of alcohol-based hand disinfectants before and after direct patient contact and use of protective gloves and plastic aprons when there is a risk of contact with body fluids. Furthermore, working clothes should have short sleeves, to permit adequate hand and fore-arm disinfection prior to, and after patient contact, and hands and forearms must be free of watches and jewellery. Working clothes should be changed daily. Nails should be cut short and be free from nail polish.

Health care staff can be sporadically colonized with MRSA during a working pass, but the bacteria will just be found for a short time, (transient colonization). One can also be persistently colonized without symptoms, a carrier of the bacteria, for long time and without knowledge about it. It has been shown that both staff who are transiently or persistently colonized with MRSA have an increased risk to transfer the bacteria to patients (Vonberg, et al. 2006; Ben-David, et al. 2008).

The staff’s knowledge of how the infections are spread and infection prevention is essential (Harris, et al. 2000; Scheithauer, et al. 2010; Mamhidir, et al. 2011; McClean, et al. 2012). Fundamental lack of such knowledge is described regarding health care staff (Afif, et al. 2002; Easton, et al. 2007; Phillips, et al. 2010). Adherence to hygiene principles is extremely important. Studies have demonstrated that health care staff have low adherence to guidelines for hygiene principles (Harris, et al. 2000; Creedon 2005) and that they often rate their adherence higher than it proves to be when observed in their working situations (Jenner, et al. 2006; Boyce 2008). Adherence to hand hygiene guidelines has been found to vary from 17.5 % to 61.5 % (Kim, et al. 2003; Pan, et al. 2008; Eveillard, et al. 2011).

Both the compliance and adherence are used when discussing about how staff follow guidelines. There is no consensus regarding these concepts, one or the other is used and often meaning the same thing. Concordance is another descriptor. This concept is more common when patients’ compliance is in focus (Bissell, et al. 2004; Cushing & Metcalfe 2007). Compliance is a passive form, for example a patient gets a recommendation of a treatment from the health care and follows it. Adherence is a more active form: the patient gets the possibility to discuss the recommendation, and understands it, and the decision of treatment is taken together with the patient. Concordance means that the patient is the one that decides and here most of the responsibility and decision lie with the patient (Bell, et al. 2007).

The term adherence is used in the present thesis when referring to staff’s following of guidelines.

Isolation of patients
To prevent spread of resistant bacteria among hospital patients with MRSA, patients should be isolated in single rooms and if possible cared for at the infectious disease clinic when admitted to hospital. This with the aim to facilitate the close following of the infection control guidelines for the health care staff and to ensure that no bacteria are transmitted to other patients. The MRSA patient’s hospital room should also be cleaned daily with greater care than other patients’ rooms. If there is no available room at the infection clinic or if a patient’s condition so demands, he/she may be cared for on the ward which is most appropriate based on his/her medical needs. Patients with ESBL and VRE are also often nursed in single patient rooms with access to own toilet.
to prevent spread of the bacteria. However this does not mean that the patients are confined to their rooms throughout their hospital stay. In order to facilitate a certain degree of freedom of movement, the MRSA patient must comply with certain regulations, e.g. they should wear clean, recently changed clothes, and have newly changed wound dressings securely in place. In practice, however, this often results in this patient group being isolated in their rooms. Studies have shown that this isolation could be experienced as traumatic and that patients feel that they lack information and had few contacts with the staff, felt lonely and “shut-in” (Newton, et al. 2001; Criddle & Potter 2006; Skyman, et al. 2010). Skyman et. al (2010) showed that even if isolation was described as traumatic, the patients accepted it because they took responsibility for not spreading the infection.

When persons with MRSA, VRE or ESBL are cared for at nursing homes, there is another challenge, since the environment shall be both home-like and clinically adaptable. In Sweden, residents in nursing homes often have their own apartments, but are cared for by healthcare staff. There are often common areas such as dining and living rooms and the MRSA-carriers or ESBL and VRE-carriers must have the same right to activities and stimulation as other persons.

**Patient and staff experiences of infectious diseases**

Receiving information about a diagnosis that can be contagious to others can be dramatic. It is described that when patients with HIV infection were given their diagnosis they experienced feelings of devastation, shock and indignation (Stevens & Hildebrandt 2006). They felt dirty and ashamed and were afraid to tell anyone that they were HIV-positive because they did not know how they would be treated afterwards. It is also described as important that the one who gave the information about the diagnosis had knowledge about the disease and could answer questions. How the information was delivered was something they were influenced by for a long time (Stevens & Hildebrandt 2006). That health care staff’s knowledge of infectious diseases is of vital importance for staff’s willingness to care for patients with contagious diseases has been shown both in the matter of care for HIV-patients (Valimaki, et al. 2008), and for Hepatitis C patients (van de Mortel 2003). O’Sullivan, et al. (2000) showed that nurses’ willingness to care for AIDS-patients was based on their feeling of being prepared to care for people with AIDS, and on their anxiety and fears about contracting the disease from their patients. Also the health care staffs’ attitudes to, and agreement with guidelines have influences. In a study by Tzeng (2004) the findings showed that nurses’ levels of agreement with the general SARS infection control guidelines was related to the willingness to care for the SARS-infected patients.
RATIONALE

The actual prevalence of antibiotic resistant bacteria in the hospital environment in Sweden was an unknown, with the assumption that the hospitals had unrecorded cases. There were also gaps of knowledge of the prevalence of wounds of different types and the care of these wounds, which motivated Study I.

Little was known about the patient’s experiences and emotions when being infected with MRSA.
Studies have shown that communication between patients and physicians sometimes can be problematic because the patient has difficulty to understand the information given by the physician (Fossum & Arborelius 2004). The actual knowledge obtained from health care professionals might be reflected in the perception of dangers and restriction in life-style for the infected persons.
This makes it even more important to listen to how the MRSA-positive patients experience information given about their MRSA-infection and its impact upon daily life, hence Study II.

There are special guidelines for how to care for MRSA-positive patients, including among other things stricter and enhanced hygiene practices.
It is a challenge for health care staff to care for MRSA-positive patients because there is a risk to be infected and to transfer the infection to other patients. Understanding experiences of staff caring for MRSA-positive patients was hitherto not known and the motivation for Study III.

Also little was known about the presence of antibiotic resistant bacteria in nursing homes. Potential spread between residents and its routes of spreading was unknown. Also any potential relationship between the adherence of healthcare staff to guidelines and principles of infection prevention and the presence of antibiotic resistant bacteria needed investigation (Study IV).

Together these four areas of research form the following thesis. From these varied perspectives, further elucidation of the problems and challenges of resistant bacteria in the healthcare and daily environments lay the groundwork for possible change in the handling of patients and prevention of spread of resistant bacteria and their sequelae.
AIMS OF THE THESIS

OVERALL AIMS

The overall aim of this thesis was to illuminate potential problems related to antibiotic resistance from different perspectives: prevalence of resistant bacteria and associated wound types, patient and health staff experiences when confronted with resistant bacteria infection, and the occurrence of such infections in the nursing home environment.

SPECIFIC AIMS

Study I To identify bacteria in wounds, with a special focus on MRSA, vancomycin-resistant Enterococcus (VRE) and multi-resistant Gram-negative rods
To identify all wounds, wound types and wound characteristics
To survey the nursing care of these wounds.

Study II To ascertain and describe patients’ knowledge, perceptions and experiences of being MRSA positive.

Study III To describe nursing staffs’ experiences of caring for methicillin-resistant Staphylococcus aureus (MRSA) positive patients.

Study IV To investigate the prevalence of 3 specific types of resistant bacteria, methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE) and extended-spectrum β-lactamase (ESBL) - producing Enterobacteriaceae, in residents living in nursing homes, and to determine whether carriage of resistant bacteria was related to antibiotic treatment or other risk factors, such as the presence of urinary catheters, open wounds, percutaneous enteral gastrostomies or tracheostomies.
To investigate any potential relationship between the adherence of healthcare staff to guidelines and principles of infection prevention and the presence of antibiotic-resistant bacteria.
METHODS AND SAMPLES

DESIGN

Table 1. An overview of methods in Paper I-IV

<table>
<thead>
<tr>
<th>Study</th>
<th>Paper I</th>
<th>Paper II</th>
<th>Paper III</th>
<th>Paper IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim</td>
<td>To identify bacteria in wounds, with a special focus on MRSA, VRE, and multi-resistant Gram-negative rods</td>
<td>To ascertain and describe patients’ knowledge, perception and experience of being MRSA positive.</td>
<td>To describe nursing staffs’ experiences of caring for meticillin-resistant Staphylococcus aureus (MRSA) positive patients.</td>
<td>To investigate the prevalence of 3 specific types of resistant bacteria, MRSA, VRE, and ESBL-producing Enterobacteriaceae, in residents living in nursing homes, and to determine whether carriage of resistant bacteria was related to antibiotic treatment or other risk factors, such as the presence of urinary catheters, open wounds, percutaneous enteral gastrostomies or tracheostomies (2)To investigate any potential relationship between the adherence of healthcare staff to guidelines and principles of infection prevention and the presence of antibiotic-resistant bacteria.</td>
</tr>
<tr>
<td>Method/Design</td>
<td>Prevalence study</td>
<td>Qualitative descriptive study</td>
<td>Qualitative descriptive study</td>
<td>Prevalence study, interviews, observation study</td>
</tr>
<tr>
<td>Data sources (n=)</td>
<td>408, patients with wounds</td>
<td>15 patients</td>
<td>8 nurses 7 assistant nurses</td>
<td>560 residents 296 staff members</td>
</tr>
<tr>
<td>Data collection</td>
<td>Data collection protocol, cultures, laboratory testing</td>
<td>Qualitative interviews</td>
<td>Qualitative interviews</td>
<td>Data collection protocol, cultures, laboratory testing</td>
</tr>
<tr>
<td>Data analysis</td>
<td>Descriptive statistics</td>
<td>Qualitative Content Analysis</td>
<td>Qualitative Content Analysis</td>
<td>Descriptive statistics, Fisher’s exact test</td>
</tr>
<tr>
<td>Status</td>
<td>Published</td>
<td>Published</td>
<td>Submitted</td>
<td>Published (online)</td>
</tr>
</tbody>
</table>

Paper I: Quantitative descriptive study

Design and procedure
Karolinska University Hospital in Stockholm Sweden is a major acute and trauma hospital and has all medical specialities apart from transplantation surgery. In 2002, there were approximately 800 beds, with another 1400 patients seeking care at the out-patients clinics each day. On the 14th of April, 2002 between 8 AM and 5 PM all patients admitted or attending the hospital’s out-patient clinics were questioned and examined for wounds, encompassing 2172 patients. If a wound was older than 24 hours, swabs for bacteriological analysis were taken with special focus on MRSA, VRE
and/or multi-resistant gram negative rods. We were also interested in any other bacteria colonizing these wounds, and the proportion of the wounds which were treated with antibiotics. Characteristics and treatment of these wounds was scrutinized. Informed consent was obtained from all medical managers of the hospital (n= 60) and from nurse managers of 93 units. Two staff members (nurses) per ward who would be on duty for the specified study day were appropriated and responsible for the data collection. These nurses had a two-hour education session (repeated on three occasions) by the researchers on how to fill in the forms and how to take bacteriological swabs from the wounds. These forms were designed for leg ulcers, pressure ulcers and for other wounds. All nurses were provided with a pressure ulcer card containing the Modified Norton Scale on one side and descriptive and photo classification of pressure ulcers on the other side. Validity of the questionnaires and the cards had been tested previously in a major 3-week wound-survey in Uppsala, Sweden (Lindholm, et al. 1999).

Bacteriology and laboratory investigations
Inclusion for swabbing: Wound with duration of ≥ 1 day.
Exclusion for swabbing: Dry wounds, fresh surgical wounds and pressure ulcers category I were excluded from swabbing.

After cleansing, swabs were taken with the help of a charcoal cotton tipped stick and put into a Stuart medium. Two swabs were taken from each wound, one for general culture and one for MRSA/VRE culture.

The swabs were analysed, typed or assessed for resistance according to current routines at the Laboratory of Microbiology at Karolinska Hospital.

Data analysis
Data was analysed using descriptive statistics in SPSS version 17.0 and presented as number and percent.

Paper II-III: Qualitative descriptive studies

Design
In paper II MRSA-positive patients’ experiences of living with MRSA and in paper III nurses’ experiences of caring for MRSA-positive patients was investigated. To broaden our knowledge qualitative interviews were chosen because this provides a framework within which respondents can express their own understanding in their own terms (Patton 2002). The purpose of interviewing is to allow the investigator to enter into the other person’s perspective. Interviews are aimed to find out what is in and on someone else’s mind, to gather their stories (Patton 2002). Patton also states that qualitative data describe and that qualitative designs are naturalistic to the extent that the research takes place in real-worlds settings and the researcher does not attempt to manipulate the phenomenon of interest.

Participants (paper II)
Fifteen persons, 7 male (21-90 years) and 8 female (22-83 years), were interviewed during June 2005 - February 2006.
A total of 19 patients were contacted, one patient failed to show up, one changed her mind, one was too ill, and one left Stockholm. The participants had to be aged
eighteen years or older, understand Swedish and live in Stockholm. All participants had been diagnosed with MRSA after a healthcare consultation for non-healing wounds between 2 and 14 months prior to the interview. Ten became infected during hospitalisation or other contacts with healthcare and five had a community acquired infection. MRSA-positive patients with wounds were selected by the researcher with help from the two MRSA-teams in Stockholm. Patients with wounds were selected because these patients have repeated contacts with healthcare and often visit community based clinics to have their dressings changed. At the time of the interview, thirteen of the fifteen participants had healed wounds. To obtain as wide and varied experience of the phenomenon as possible participants of different gender and age were chosen (Lincoln & Guba 1985; Patton 2002). Potential participants were contacted by telephone and the aim of the study was explained. If they agreed to participate, written information was sent, and a time and place for the interview arranged. Informed verbal consent was obtained before performing the interviews.

**Participants (Paper III)**

Fifteen persons, eight registered nurses (22-61 years) and seven assistant nurses (34-59 years), were interviewed during October 2007 - September 2008. The purpose was to capture the experience of caring for MRSA-positive patients from as broad perspective as possible (Patton 2002). Because of that we selected nurses that worked in different kinds of units such as surgical, medical, orthopaedic and rehabilitation wards in an urban area as well as in a geriatric hospital, and at different nursing homes in Stockholm. The registered nurses had worked between ten months and 34 years in their respective occupation and the assistant nurses had worked between seven to 22 years in the present occupation. The participants had all been involved in the care of MRSA patients but not on a regular basis. The number of MRSA-patients they had encountered varied from one to fifteen, with the exception of one nurse who had worked in England and had nursed over one hundred MRSA-positive patients. Participation in the study was approved by their managers. After receiving the potential participant’s names from their managers, they were contacted by phone and given information about the study. Informed consent was obtained, all agreed to participate, and a time and place for the interview was arranged.

**Data collection**

Kvale & Brinkmann (2009) have described the aspects of qualitative interviews in the following way: the interview seeks to interpret the meaning of central themes in the life world of the respondents. The interviewer registers and interprets the meaning of what was said as well as how it is said. Patton (2002) states that the interviewer seeks qualitative knowledge expressed in normal language, the interview does not aim at quantification and that the interview attempts to obtain open nuanced description of different aspects of the participants’ life world. Also the questions should be asked in a truly open-ended fashion so people can respond in their own word.

All interviews were tape-recorded with permission from the participants. A semi-structured interview guide was used (Kvale & Brinkmann 2009). Patton (2002) describes that the interview guide provides topics or subject areas within which the interviewer is free to explore, probe, and ask questions that will elucidate and illuminate that particular subject. An interview guide with open-ended questions both
allow the sequence and form of questions to change in order to follow up the answers given and the stories told (Kvale & Brinkmann 2009).

The participants (Paper II) were encouraged to speak freely about their experience of the MRSA-infection. In paper III staff’s experience of caring for MRSA infected patients was focused. Follow-up questions were asked when needed depending on the interview. The interviews started with small talk in order to create a relaxed and comfortable atmosphere. Again the aim of the study was stated as well as that the participant was free to terminate the interview whenever they wanted to and that they were assured of confidentiality.

To test the validity of the interview guide two pilot interviews were conducted (Kvale & Brinkmann 2009). Results showed that the format allowed relevant answers regarding the aim of the study. As the pilot interviews turned out well, they were included in the study (Trost 2010). Example of questions from the interview guide: “Can you describe your feelings when you were informed about the MRSA infection?” (Paper II). “Can you please tell me your experience when caring for MRSA-positive patients?” (Paper III). Three interviews in Paper II took place in the participant’s home, the others in a secluded and quiet place at a hospital in Stockholm and lasted between 13-55 minutes (mean 32 minutes). All the interviews in Paper III, were held in a quiet location in their respective working place, chosen by the participant and lasted between 15-53 minutes (mean 28 minutes).

Data analysis
All interviews were transcribed verbatim and analysed by qualitative content analysis. This method of data analysis was previously developed in order to handle large amounts of text data and was used as a quantitative method in mainly media research and theology. In its early stage content analysis often was used for quantitative description of a subject, and focus on manifest content (Berelson 1952). Content analysis has now become a common qualitative research methodology and among others Graneheim & Lundman (2004), and Patton (2002) have explained how to use the method. Textual information from interviews, focus groups, and open-ended survey questions are suited to be analyzed by content analysis. Patton (2002) states “Content analysis requires considerably more than just reading to see what’s there”. Today content analysis is also often used in a more interpreting form, and focuses on the latent content (underlying meaning) (Graneheim & Lundman 2004).

Graneheim & Lundman (2004) describe that both manifest and latent content deal with interpretation but the interpretation varies in depth and level of abstraction.

The researcher listened to and read all of the transcribed interviews several times to obtain an impression and to grasp the overall content of the entire material and to check that nothing had changed or left out during the transcribing procedure. The interviews were then read sentence by sentence. Meaning units that answered the questions of issue were marked. Meaning units are words, sentences or paragraphs containing aspects related to each other through their content and context. Thereafter, the meaning units were condensed and abstracted and labelled with a code.

In paper II from these codes preliminary categories and sub-categories were created according to the procedure which constitutes the manifest content recommended by Graneheim & Lundman (2004). One co-author independently read half of the
interviews, and then the authors together discussed the codes, sub-categories and categories until agreement was reached. Finally, the underlying meaning (the latent content) of the categories was formulated into a theme. The difference between categories and themes is that themes are on a more interpretative level.

In Paper III, from the codes, preliminary themes were identified. One co-author independently read all the interviews and another co-author read a third of the interviews. The authors discussed the preliminary themes during several meetings. This process continued until a consensus was reached in order to achieve credibility (Graneheim & Lundman 2004). The discussion resulted finally in formulation of three themes which summarized the underlying content of the interviews. Finally all the interviews were re-read again to ensure that nothing valuable was omitted and to select verbatim excerpts to illustrate the findings.

**Paper IV: Quantitative and qualitative approach**

*Design and procedure*

The study was conducted in a municipality of Stockholm County during four weeks in October and November, 2008. The municipality has nine nursing homes with a total of 67 wards and each home participated during one week. Residents found to be colonized with resistant bacteria were followed up with repeated cultures for up to 24 months. During the same time all healthcare staff were interviewed and observed regarding adherence to guidelines and principles for infection control.

Before the start of the study all staff were informed in both written and oral form about the aim of the study and how it would be undertaken. A nurse at each nursing home was selected by the nursing home manager as responsible for the study locally and was specially trained to assist colleagues regarding bacterial sampling. Ten volunteer nursing students from a university college were also trained in order to help with sampling and to assist with the observations.

*Residents*

The study involved 573 residents who lived in the nine nursing homes. Five hundred and sixty (98%) agreed to participate in the study, 420 females and 140 males.

Nurses in charge registered the resident’s name, social security number, room number and presence of urinary catheters, open wounds and percutaneous enteral gastrostomies or tracheostomies. All residents had their own rooms, with a toilet and shower, except sixteen who shared toilet and shower facilities in pairs. All toilets were equipped with soap and disinfection dispensers. There were also hand basins and disinfection dispensers in the sluice rooms, laundry rooms and other strategic locations on the wards.

The medical records of residents who were found to carry resistant bacteria were scrutinized regarding the presence of urinary incontinence, need for assistance with personal hygiene, wheel-chair use and dementia.

*Sampling*

In residents who agreed to participate, swabs were taken from the nasal and pharyngeal areas to identify any presence of MRSA. MRSA cultures were also performed using swabs taken from open wounds, percutaneous enteral gastrostomies and tracheostomies.
whenever present, and urine if the patient had a urinary catheter. Faecal samples were examined for ESBL and VRE, one sample for each test. Antibiotic treatment during the previous 6 months was registered. Residents with a positive culture were followed up with further swab cultures for up to 24 months, every three months during the first year and every six months during the second year.

The swabs were analysed, typed or assessed for resistance according to current routines at the Laboratory of Microbiology at Karolinska Hospital.

**Staff**

During one pre-set day for each nursing home, which was not announced beforehand, all healthcare staff working morning or afternoon shift were questioned about their age, job title, years in the profession, frequency of changing working clothes, and were observed regarding adherence to guidelines and principles for infection control. Two hundred and ninety-six (95%) of a total of 310 staff participated. None of them declined to participate, but some were excluded for miscellaneous reasons, such as being out of office or that the working situation did not permit it. The healthcare staff were observed during interviews with regard to how they were dressed, if they were wearing rings, watches or bracelets. It was also observed if long hair was put up or if the staff had long, cosmically adorned or polished nails. The protocol used for interviews and observations has previously been used in another Swedish study report (Lindholm, et al. 2006). Observations regarding adherence to infection control guidelines were also performed when possible and when it seemed natural in connection with nursing tasks. These observations were written down and discussed between the investigator and the nursing students after the end of the day.

In five of the nine nursing homes, staff were observed and/or interviewed regarding potential situations where use of protective aprons and hand cleansing/disinfection was relevant.

**Data analysis**

Statistical analyses were performed using SPSS version 19.0. Descriptive statistics were used and are presented as numbers and percent and Fisher’s exact test (2-tailed), was used to test the differences in proportions in two independent groups.

**ETHICAL CONSIDERATIONS**

The Swedish Research Council states that it is the researchers own responsibility to see to that the research is of good quality and is morally acceptable (CODEX 2011). Ethical considerations for inclusion of participants in the studies in this thesis follow the principles of the World Medical Association Declaration of Helsinki (WMA 2008) and the International Council of Nurses Codes of Ethics for Nurses (ICN 2006).

For the study in Paper I the local ethics committee approval was sought and granted. On the study day a notice was posted at every unit to inform that the study would be performed at the hospital that day. Every patient at every ward and out-patient clinic was asked about the presence of wounds. If the patient had any wound they received
written information about the study and that participation was voluntary. If they gave their informed consent to participate in the study their wound/wounds were registrated by study specific protocols, the wound/wounds were examined, and if the inclusion criteria were fulfilled the wound/wounds were cultured. The patients were informed of results from the culture by their treating physician.

All participants in Paper II and III were informed verbally and in writing about the study and that participation was voluntary, that they could withdraw at any time and that all data were confidential. The MRSA-positive participants were assured that non-participation would not affect their future care. Staff were assured that no personal information would be passed on to their employer. They were assured that the recorded interviews would only be identifiable by the researcher.

During the interview there were MRSA-positive participants who asked questions about the MRSA-infections or guidelines. The researcher did not answer their questions during the interview but allowed them to ask their questions after the interview. Perhaps this is not ethically correct, but it had been more unethical to leave them with a lot of unanswered questions. If the researcher was not able to answer the questions or if the questions were of a medical nature the patients were recommended to contact the MRSA-teams.

Interviews are interventions and they affect people. Neither the interviewer nor the interviewee could know, in advance, what impact an interview would have or has had (Patton 2002).

In Paper IV nearly half of the participants had a diagnosis of dementia. All participants were informed verbally and in writing about the study but it was not always easy to assure that they had understood the information and to obtain their informed consent. A notification of the study was posted in good time prior to the study start at strategic places at the nursing homes so that relatives could take part of the information. Phone numbers were available to the responsible researchers, if questions should arise. Some of the nursing home managers sent the written information home to the next of kin. During the study information and training of the staff and the nursing students, it was emphasized that no residents should under any circumstances feel forced to take part in the sampling or agonized should they not wish to take part in the study. There was one next of kin who phoned and asked about the study and after that gave the informed consent to participation of their relative. Also one of the participants called before the study start, just to confirm his willingness to participate in the study.

For the studies in Paper II, III and IV, ethical approvals were obtained from the Regional Ethics Committee in Stockholm.

The studies in the thesis rest on the principles of the good clinical practice. Findings were aimed to improve patient safety and nursing care.
SUMMARY OF RESULTS

PAPER I

Wounds scrutiny in a Swedish hospital: prevalence, nursing care and bacteriology, including MRSA

The aims of this study were to investigate prevalence of wounds at a University hospital, to access characteristics of these wounds and how these wounds were treated and furthermore how many wounds were colonized or infected with MRSA, VRE and/or multi-resistant Gram negative rods.

Between 8 AM and 5 PM on a single day, a total of 2172 patients were admitted to the hospital or visited the out-patient clinics (n=93) at the Karolinska University Hospital, Solna in Stockholm. Of these, 408 (19%) had a total of 668 wounds. Thirty-seven patients had pressure ulcers, 83 had leg and foot ulcers and 288 patients had other types of wounds. Bacteriological swabs were taken from 216 patients, in 248 of these wounds.

MRSA was identified in two patients: An 81-year-old male treated for pneumonia had a superficial wound (3 x 4cm) on one elbow. The wound duration was three weeks. The surrounding skin was normal. He had acquired this wound during the hospital stay.

The other patient was a 61-year-old woman with multiple sclerosis. She was treated for erysipelas in the left leg, and had wounds over the right heel and right dorsal foot, as well as a grade IV pressure ulcer in the sacral area. MRSA was identified in all of these wounds.

She had been cultured for MRSA when admitted to the hospital but was at that time negative.

None of the patients had any clinical signs of infection and both were cared for in multiple-patient rooms.

No patient was identified with VRE, but eight patients were found to have growth of multi-resistant Enterobacteriaceae and Pseudomonas aeruginosa in their wounds.

Nursing care varied according to wound type and ward. Cleansing was performed with saline for 58% of the wounds. Fifty-eight different types of wound dressings were used, the mean frequency of dressing changes was once daily.

Wounds were painful in 40 % of the cases where pain was registered, with predominance of leg and foot ulcers (53%). Sixteen percent (24/150) of patients with wound pain did not receive analgesia.
PAPER II
MRSA - Global threat and personal disaster: patients’ experiences

The aim of this study was to capture and bring to light the MRSA-positive patients’ experiences and feelings of being diagnosed with MRSA and to let them describe their life situation as MRSA-positive.

Based on the fifteen interviews and as a result of the analysis the findings are described in three categories; Understanding and emotional reactions, Treatment by the healthcare professionals and Consequences and expectations. One overall theme emerged summarizing the three categories; Being exposed to others’ shortcomings and being a threat to others’ health.

Upon the initial information about the MRSA diagnosis, emotional reactions varied from indifference to shock. For many participants this was a traumatic experience and caused a shock-like psychological trauma. The participants compared it to having the plague or leprosy, expressing that they felt dirty and had become infected because they had not washed properly.

Amongst numerous other worries, the fear of infecting others dominated. Participants felt that they were a threat to their environment and were afraid of infecting someone else. The feeling of being a danger to their children, grandchildren, friends or colleagues at work was described as traumatic and causing anxiety. Participants were concerned that they would be rejected by friends, co-workers and others.

The participants observed a lack of knowledge by the staff in terms of MRSA infection, how it is spread, how to protect oneself, also about principles for infection control and of existing guidelines. Staff’s behaviour and how they express themselves affect the participants’ experiences of their infection. The participants sometimes felt better informed about the infection and the guidelines than the healthcare staff. The infection had in many cases influenced their life and stopped them from doing things they liked to do.

PAPER III
Emotional reactions when caring for MRSA-positive patients; Ignorance and fear versus knowledge and security

The aim of this study was to describe experiences about caring for MRSA-positive patients from the perspective of nursing staff who were not regularly caring for MRSA patients.

Based on the underlying content of the fifteen interviews and the analysis three themes were identified: Ignorance leading to fear and insecurity, Knowledge and experience leading to security and Thoughts and feelings on workload.

Both nurses and assistant nurses are presented as nurses. Insecurity about how to care for the MRSA-patient initiated strong emotional reactions among the nurses. Nursing an MRSA-patient was sometimes described as a terrifying experience and the patients could be regarded as a real threat. The nurses were not only afraid of acquiring MRSA themselves but also of spreading the infection to others.
other patients and to family members. Insecurity and fear among the nurses also had pronounced impact on nursing care. It was described that because of the objections to caring for the MRSA-patients the nurses just went into the patient’s room if they really needed to and that no one wanted to touch the patient without rubber gloves. Conflicts arose because no one wanted to care for the patients or even enter the patients rooms. The nurses expressed that they thought the patients felt that they did not receive proper information about their condition or prognosis and that the patients were ignored and disregarded.

However some of the nurses thought that caring for MRSA-patients was not more complicated than caring for other patients. They expressed that they had good knowledge about MRSA, how it is spread and how to care for MRSA-patients.

The results showed that the more information nurses received, and the more they learned about MRSA the more positively they could care for the MRSA-patients. The premise for the care of patients with MRSA-infection requires knowledge of the guidelines and the special hygiene precautions that prevail in the care of MRSA-patients. Correct information about the infection and how it is spread was crucial for nurses to feel secure in caring for MRSA-patients. Furthermore, it was also important that the information came from specialists in this area. Guidelines, memos and adequate information were believed to be of central importance. The nurses described that they often had to update themselves on the guidelines when they cared for a patient with a MRSA-infection. They felt safe if they knew about the guidelines and how to easily locate them.

That the workload was affected when an MRSA-patient was admitted was described by all the nurses. The caring procedures took longer time due to more stringent hygiene routines and more strict cleaning procedures, compared to ordinary work. Both stress and too high workload were factors which were described to cause worries. There was an anxiety about the risk of transmission of MRSA between the patients. The working situation could sometimes be very stressful and arduous so that the hygiene routines were overlooked and mistakes could be made, which worried the nurses. Especially during the summer, the work situation could be extreme. It was described that when no rooms were available the patients had to be cared for in the corridor, in the shower and even on the balcony.

**PAPER IV**

**Prevalence of antibiotic-resistant bacteria in residents of nursing homes in a Swedish municipality: Healthcare staff knowledge of and adherence to principles of basic infection prevention**

The aim of this study was to investigate the prevalence of three specific types of resistant bacteria, MRSA, VRE and ESBL-producing *Enterobacteriaceae* in residents living in nursing homes, and whether carriage of these resistant bacteria was related to antibiotic treatment or other risk factors such as the presence of urinary catheters, open wounds, percutaneous enteral gastrostomies or tracheostomies. Also if there was any
potential relationship between the adherence of healthcare staff to guidelines and principles of infection prevention and the presence of antibiotic resistant bacteria.

From nine nursing homes, with 67 wards, 560 and sixty (98%) of the 573 residents living at the nursing homes agreed to participate in the study. MRSA swabs were taken from 542 residents, involving more than one thousand cultures from different sites, but none was positive. Faecal samples were obtained from 495 (88.3%) residents. None of them was positive for VRE. Fifteen ESBL-positive residents (3%) were identified in 10 wards, in seven of the nine nursing homes.

The majority of the ESBL-positive isolates were identified as Escherichia coli (14/15). In three of the nursing homes the isolates, were found to be closely related in the residents who were living in adjacent rooms, which indicated transmission between residents. ESBL-infection was not known by staff for any of the cases before the study start.

In two homes antibiotic treatment was not recorded for all residents, but from the other seven homes antibiotic usage could be compared between residents at wards. Faecal samples were obtained from 86/92 (93%) residents in wards with ESBL-positive residents at these homes, and 36 (42%) of these had received antibiotics during the previous six months, compared to 84/296 (28%) of the residents in wards where no ESBL-positive residents were found (p=0.02). No other risk factors showed any significant differences between wards with ESBL-positive and wards with no ESBL-positive residents. After two years follow up, four residents were still ESBL-positive, while four were negative.

Of the 310 staff members who were on duty during the study day in the respective homes, 296 (95%) were observed and interviewed concerning adherence to the guidelines and principles of infection prevention. According to interviews, staff revealed generally good knowledge about the infection prevention guidelines but observation demonstrated numerous deviations from these guidelines in clinical practice.

Among other things observations were made of 13 staff members during changes of wound dressings. Two nurses did not use gloves at all, one of whom did not disinfect their hands afterwards, and two did not use aprons. One nurse removed gloves during the procedure and did not disinfect hands before or after the dressing change. Four nurses did not disinfect their hands before and six did not disinfect their hands after dressing changes.

Shortage of time was sometimes mentioned to explain the deviation from infection prevention principles. Poor quality of the gloves, often breaking when being used, was mentioned as being a problem in most nursing homes, the staff had to wash their hands with soap and water before disinfection, despite awareness of that this could lead to more skin problems, with dryness and eczema, than using alcohol-based hand disinfection alone. In general staff knew that they should use both aprons and gloves when they performed “dirty” procedures, but they admitted that aprons were not always put on. There was no significant difference regarding adherence to the guidelines between staff from wards with ESBL-positive residents and those where all residents were ESBL-negative.
DISCUSSION

REFLECTIONS ON THE FINDINGS

Wounds and wound care
In the study from 2002 (Paper I) the prevalence of patients with wounds was 19 % (408/2172), of these 37 (9%) had a pressure ulcer. A recently published Swedish national pressure ulcer prevalence survey by Gunningberg, et al. (2012) showed that 15.5 % of patients admitted to hospitals had pressure ulcers. This provides evidence that wounds are rather common in healthcare settings in Sweden. Cleansing was performed in study I, with saline solution for 58% of the wounds. In a review of eleven studies, comparing tap water cleansing of different wound types with saline and other cleansing methods, the results showed that there were no differences in infection rates or healing process between the cleansing methods and the conclusion was that money could probably be saved if tap water was used (Fernandez & Griffiths 2012).

Of the residents where the method of wound cleansing was recorded in paper IV, only one was cleaned with saline solution.

Results from the 13 observations of the staff during dressing changing procedures in the same study, only on three of these occasions were the procedures performed according to infection control guidelines, stating the use of hand disinfectants before and after the procedure and the use of aprons and gloves (The National Board of Health and Welfare 2007).

The knowledge and fear for MRSA-infection
Many of the interviewed MRSA-positive participants (Paper II) described that the diagnosis caused a shock-like reaction. Previous knowledge and understanding of a disease may influence reaction to a diagnosis. Studies have shown that the most common sources of information about MRSA for the public were newspapers and television (Gill, et al. 2006; Easton, et al. 2009; Rohde & Ross-Gordon 2012). Washer & Joffe (2006) describe that the mass media’s portrayal of MRSA acts as a bridge between medical and public understanding of the phenomenon. The authors analysed four British newspaper coverage of MRSA over a 10-year period, 1995-2005 describing MRSA as lethal, a killer or potentially fatal “superbugs” and as a major threat to public health (Washer & Joffe 2006). In a study by Criddle & Potter (2006) a patient described the feeling of shock when given the MRSA-diagnosis just because televised news and documentaries had shown MRSA as “superbugs” that could kill people. Previous research has shown that there is a lot of ignorance about MRSA and how it is spread, many people are unaware of what antibiotic resistance is and how it arises and are not aware of the connection with the use of antibiotics, especially not one’s own use of antibiotics (Brooks, et al. 2008). These perceptions support an interview study which indicated that the public neither saw or felt that they have a personal role in either the problem with resistant bacteria or its solution (Hawkings, et al. 2007).

Healthcare staff must be attentive to the fact that a patient’s knowledge and views about MRSA are often coloured by what has been reported via mass media, negatively affecting their response to the MRSA diagnosis.
Feelings of dirtiness, shame and guilt
Washer et al. (2008) interviewed 60 people about what they associated with the term MRSA. The interviewed persons named dirty and poorly managed hospitals and even “bad air” in hospitals based on the germ spreading theory of folklore such as the old times miasma theory (Washer, et al. 2008). The MRSA-positive participants in paper II compared MRSA with having the plague or leprosy, expressing that they felt dirty and had become infected because they had not washed properly. The participants also talked about their feelings of shame. In another study MRSA-infected participants not only mentioned feelings of guilt and shame but also stated that they understood how human immunodeficiency virus (HIV) positive people must have felt (Lindberg, et al. 2009). It is confirmed that HIV-infected persons had these kind of reactions when receiving their diagnosis (Stevens & Hildebrandt 2006). The fear of talking about the diseases with others was common as was the fear of being rejected. Some of the MRSA-positive participants had not told anyone about their infection. The participants also expressed thoughts that they perhaps had done something wrong and that it was their own fault that this had happen to them. This brings back to mind the Bible and the description that it is God’s punishment for wrong doing that causes them to be inflicted. This is hard to contemplate, since the majority of the MRSA participants were infected during healthcare contacts.

To be a threat to other people if you do things wrong
A major concern for the MRSA-positive patients was to infect someone else with MRSA and that they were a threat to other people. The participants (Paper II) described that they were extremely careful with their hand hygiene, always used paper instead of cloth towels if not at home and were extremely careful with any wounds, ensuring that they were covered at all times. Others have described that they would disinfect the bathroom when expecting visitors (Lindberg, et al. 2009). The fear of contaminating others became so strong for some that they did not dare to hug their children or grandchildren. Similar feelings were expressed by some of the nurses (Paper III) and used as an explanation as to why they worried about caring for the MRSA-positive patients. The nurses felt that they risked becoming infected themselves and then passing the infection to own family members.

Both stress and too extreme workload were factors that also worried the nurses (Paper III). There was an anxiety of being the cause of a transmission between the patients. It is known that the most common transmission of MRSA is from the healthcare workers’ hands and clothes (Pittet, et al. 2006; Pittet, et al. 2009). Sometimes the working situation could be very stressful and arduous which led to hygiene routines being overlooked and mistakes could be made which worried the nurses. Especially during the summer, the working situation in hospitals could be extremely stressful and heavy because of holidays and shortage of staff. Under these circumstances when the nurses had a heavy workload and were exhausted, it could lead to routines being stretched and to losing focus on hygienic needs. Previously it has been shown that if a unit is disorganized and the staff feel overwhelmed with work, the likelihood of prevention practices being compromised was greater (Sinkowitz-Cochran, et al. 2012). It was expressed that what looks easy in theory is quite different in practice.
Healthcare staff in nursing homes (Paper IV) also mentioned shortage of time as an explanation for deviating from infection prevention guidelines. Also poor quality of the gloves was considered to be a problem in most of the nursing homes. Following the damage to gloves most of the staff washed their hands with soap and water before disinfection, despite awareness that this could lead to skin problems (Kampf & Löffler 2007; Souweine, et al. 2009). Difficulties in obtaining approval to purchase necessary equipment is described from other nursing home staff (Wolf, et al. 2008; McClean, et al. 2012). The participants in study IV describe the limited availability of clean working clothes. A study that evaluated the contamination of staffs clothing in three nursing homes shows a high level of MRSA-contamination, up to 80% after a half day working shift, which indicates the importance of changing working clothes daily (Gaspard, et al. 2009).

Importance of knowledge for care giving
Insecurity and lack of knowledge can influence the level of care given. MRSA-positive participants (Paper II) described that they sometimes felt that the staff did not have enough knowledge about MRSA particularly with regard to existing guidelines and how MRSA is spread, and that they in some cases felt better informed than the staff. That this perception was right was confirmed during the interview with the nurses in paper III, where some of the nurses felt that they did not have adequate knowledge to care for these patients. The study showed that ignorance regarding potentially contagious diseases made the nurses afraid and insecure. That the healthcare staff have adequate competence for their duties is the responsibility of the head of each unit as stated by The National Board of Health and Welfare and the responsible should be the one who initiates, plans and carries out the education (SOSFS 2005:12). Brannigan, et al. (2009) state that hospital management must regard infection control as a core aspect of patient safety.

How can adherence to principles and guidelines be improved?
Both in the interviews with MRSA-positive participants (Paper II) and with the healthcare staff in paper III+IV it became clear that the staff category that had poorest adherence to hand hygiene practice was the physicians, this is also confirmed in other studies (Lee, et al. 2011; Scheithauer, et al. 2011).
An interview study (Erasmus, et al. 2009) with nurses, medical students and physicians, showed that nurses and medical students expressed the importance of hand hygiene for preventing cross-infection among patients and themselves. They further reported that hand hygiene is most often performed after tasks that they perceived to be dirty, and personal protection appeared to be more important for adherence than for patient safety. Physicians expressed the importance of hand hygiene for self-protection, but they perceived that there is a lack of evidence that hand washing is effective in preventing cross-infection. It was stated that personal beliefs about the efficacy of hand hygiene and examples and norms provided by senior hospital staff are of major importance for hand hygiene adherence. Medical students explicitly mentioned that they copy the behaviour of their superiors, which often leads to non-adherence during clinical practice. Physicians mentioned that their non-adherence arises from their belief that the evidence supporting the effectiveness of hand hygiene for prevention of hospital-acquired infections was not strong (Erasmus, et al. 2009).
That healthcare worker hand-hygiene compliance is influenced significantly by the behaviour of other healthcare workers are also shown by Lankford, et al. (2003). The importance of good role models is shown also by Barrett and Randles (2008), through interviews with nursing students about factors influencing hand hygiene practice. The results indicated that time and the importance of “fitting in” to the nursing team, were the major factors for non-adherence from the students’ perspective (Barrett & Randle 2008).

It is shown that behavioural changes and improvement of hand hygiene adherence could be achieved with hand hygiene practice training and positive feedback (Won, et al. 2004; Doron, et al. 2011; Mathai, et al. 2011; Mayer, et al. 2011). Observation studies have shown that different kinds of reminders such as blinking lights and signs also can lead to improvement in hand hygiene adherence (Camins & Fraser 2005; Lederer, et al. 2009; Nevo, et al. 2010; Helder, et al. 2012).

Morse (1997) described the differences between qualitative and quantitative research (between theory and the real word) and development of theories is illustrated in a figure, see Figure 4.
The Morse model in Figure 4 could maybe also be associated with and translated into the practice of healthcare, taking adherence to infection control guidelines as an example. Each and every ward, health centre, nursing home etc. has different conditions and dimensions which leads to different work conditions. If the guidelines for infection control are to be followed in practice one must examine the environment, the ”real world” for example where the sluice room and the kitchen are placed in relation to where the patients’ rooms or the examination rooms are located. Where will an assistant nurse put the tray with dirty dishes when she comes out from a MRSA-positive patient room? They should be put directly into the dishwasher, but if the dishwasher is already running what does she/he do? Where shall a consulting doctor put her/his doctor’s coat during the examination of a patient? Are there coat hooks in the patient’s room for this purpose, or does the doctor have to hang it outside the room unattended? The pocket can contain records from other patients, telephones, pagers for
example. These small practical things may be looked upon as niceties, but they are the real world in healthcare and it is when these niceties do not work out that infection is spread.

For the healthcare staff guidelines need to be put into practice in the work environment. The guidelines must be built upon the real world, the staffs’ own reality, otherwise it is a risk that it just remains a theory.

**Patient and staff security**

The healthcare staff have to, and have the right to, feel safe in their role as caregivers, both for their own sake and the safety of the patients.

One can discuss who is to blame if the working situation is so extreme and stressful to the healthcare staff that they don’t have time to think about the infection control practice with the result that a patient becomes infected. Is it the individual who tries to work quickly to keep up with their duties when they have to care for patients in the corridor or shower? Of course everyone has a personal responsibility but is this not a working environment issue? What responsibility has the manager, the employer and the politicians? Sinkowitz-Cochran, et al. (2012) showed that healthcare staff who felt more engaged, who had a good leadership structure, and perceived being supported by leadership were more likely to have better MRSA prevention practices.

**Changes in the MRSA situation in Sweden since 2002**

Since starting work on this thesis in 2002, the actual situation around MRSA-infection and the care of MRSA-positive patients has changed.

Previously in Sweden, each county had different rules and procedures for how MRSA-positive patients should be treated. In a survey by Andersson, et al. (2009) it was found that about half of Sweden’s 21 counties gave MRSA carriers a clean bill of health if they had several consecutive negative swabs, whereas in the remaining counties they were regarded as lifetime carriers. In 14 of the counties MRSA-positive patients received a carrier-card when informed about their infection which they were obliged to present when in contact with any form of medical care including dentist visits, massage and chiropody treatment. In six counties no carrier-cards were issued and in one county it was optional, the patient was issued with a card if they requested one. In 2010 The National Board of Health and Welfare published recommendations for the assessment of carrier status and risk of infections so the management of the MRSA-positive patients would be uniform across the country. One of the recommendations was if a MRSA-positive patient had repeated negative MRSA-cultures during a 12 month period, and fulfilled certain other criteria they would be declared free from MRSA (The National Board of Health and Welfare 2010).

In 2002 over 40% of the patients with MRSA became infected during contact with healthcare (SWEDRES 2002). Nowadays the contamination often happens in connection with a stay abroad or community acquired infection. In 2010 only two percent were established to be a hospital acquired infection (SWEDRES 2011). Also in settings for nursing home care the frequency of transmission between residents has decreased, as with the results from our study (Paper IV) which found no residents to be MRSA-carriers in the nine studied nursing homes. Results from other Swedish surveys at nursing homes show similar results (Jonsson, et al. 2011; Olofsson, et al. 2012).
Perhaps the finding of low prevalence of MRSA reflects that the spread of MRSA in Swedish healthcare has decreased because staff now have become better in preventing MRSA transmission.

Even if the frequency of new cases of MRSA overall shows a small increase every year, Sweden still has a low prevalence of MRSA (Hanberger, et al. 2007; SWEDRES 2011) with a frequency of less than 1% compared to other countries (Molstad, et al. 2008; Brugnaro, et al. 2009). A new issue for the healthcare settings today is the ESBL-producing bacteria. ESBL has become a very serious problem in many countries (Valverde, et al. 2004; Paterson & Bonomo 2005; Livermore, et al. 2007; Peirano & Pitout 2010). We found 15 (3%) residents (Paper IV), who were positive for ESBL in the nursing homes. It is known that recent antibiotic treatment is a risk factor for ESBL-infection (Shah, et al. 2004; Rodriguez-Bano, et al. 2008; Tacconelli, et al. 2008; Song, et al. 2009). We compared wards where ESBL-positive residents were found with wards where no ESBL-positive were found, and significantly more residents had been treated with antibiotics during the 6 months preceding the sampling in wards where ESBL-positive residents were identified.

Very worrying is that ESBL, with even more extended spectrum, has begun to spread and is nearly totally resistant to all antibiotics and very difficult to treat (Samuelsen, et al. 2009; Kumarasamy, et al. 2010). It is not known for how long carriage of ESBL may be, as some of the bacterial species producing these enzymes may also have other resistance mechanisms. In our study four residents still had faecal carriage of ESBL-producing Enterobacteriaceae two years from the first sample. This is in accordance with another Swedish study; after an outbreak with ESBL-producing E. coli in a hospital ward and a related long-term care facility, the carriage time among the 27 cases was up to 59 months (Alsterlund, et al. 2009; Alsterlund, et al. 2011). Of the 15 ESBL-positive residents in our study, seven had adjacent rooms which could indicate transmission between residents. This highlights again the importance of staff’s adherence to infection control guidelines.

METHODOLOGICAL CONSIDERATIONS

To illuminate problems related to antibiotic resistance from different perspectives both quantitative and qualitative methods have been used in this thesis, which we consider as a strength. As Patton (2002) stated, different kinds of data may yield somewhat different results because different types of inquiry are sensitive to different real-world nuance. Patton also states that to mix methods offers opportunities for deeper insight into the relationship between inquiry approach and the phenomenon under study.

PAPER I

This study was performed during one day at a major university hospital. Impressive participation of 100% of the units indicates a good coverage of the hospital and is a strength of this study. The large number of units that participated (n=93), with the consequent large number of local investigators, might have influenced the results.
All investigators were trained both in the classification of wounds, in the swabbing technique and on how to fill in the referral documents, and written instructions were provided, together with a prefilled-in example of the referral document. However, there might have been flaws in the swabbing methodology in some cases, a factor that cannot be controlled for in such a big study. For patients with more than one wound, the instruction was that all wounds should be cultured if they were not located side by side. But there were patients with several wounds and all their wounds were not cultured. It can also be difficult to assess complete microbiology in the laboratory. But as one of the study objectives was to look for resistant bacteria, accuracy in regard of that can be assumed. So the main study objective to identify antibiotic resistant microorganism was most likely achieved.

PAPER II-III
For reporting and ensuring trustworthiness in study II and III we use the terms credibility, dependability and transferability as is recommended by, e.g. Graneheim and Lundman (2003).

Credibility
To achieve credibility in Paper II, and to enlighten the phenomena from different perspectives we tried to have a rich variation of age, gender and the participant should have had their MRSA-carriage during different lengths of periods of time. Patients with wounds were selected because these patients have repeated contacts with healthcare and often visit community based clinics to have their dressings change. In Paper III, our ambition was to capture the experiences from staff with close physical contact with the MRSA-positive patients, thus nurses and assistant nurses were chosen as informants. They worked in different specialties, had varied work experience and had cared for different numbers of MRSA- patients.

The dominance of women could perhaps have influenced the result, but since the majority of nurses and assistant nurses are female, this is likely a representative sample. A limitation was that the head nurse at each unit was the one who selected the nurses and assistant nurses for the interviews. There could be a risk that the most positive and well informed person was chosen. The results from all the interviews were discussed between the co-authors until agreement was reached that the data from the interviews were sorted in categories and themes that covered all the aspects of the data and that nothing important had been excluded. Suitable and representative quotations from the text were included, and this adds strength to the studies.

Dependability
The purpose of interviewing is to allow us to enter into the other person’s perspective. We interview to find out what is in and on someone else’s mind, to gather their stories (Patton 2002).

A semi-structured interview guide was used in both paper II and III. The interviews started with open-ended questions and follow-up questions were used if needed. This allowed the participants to describe their experiences in their own words (Kvale & Brinkmann 2009) and it allowed the interviewer to follow-up the answers given and stories told with new questions (Graneheim & Lundman 2004). It also meant that all
participants highlighted the same areas but also gave an opportunity to broaden the view for the interviewer. It can be discussed if fifteen participants is considered enough. Patton (2002) states that there are no rules for sample size in qualitative studies. But sample size depends on what you want to know, the purpose of the inquiry, what’s at stake, what will be useful, what will have credibility, and what can be done with available time and resources. The interviews varied by amount of time needed and the volume of information gathered. In one case, the interview lasted for only 13 minutes as the interviewee was very uncommunicative. The participant told that he had not wanted to come himself but his mother thought it was good for him to go for the interview. However, the interviews all together gave a rich and broad insight both in breadth and depth of the areas that was the intention of the study.

Was it a limitation or a strength that the participants knew that the researcher besides being an interviewer was a clinical nurse at the infection clinic? It was a little surprising that only one patient expressed complaints against the healthcare system, when ten of the MRSA-positive participants had become infected during hospitalisation or other contact with healthcare. Perhaps the participants’ knowledge that the interviewer was a nurse, made them hesitant to complain or to be critical about staff and the healthcare delivery. However the knowledge of the interviewer also allowed them to talk more freely about their problem because they knew that the interviewer had knowledge about the MRSA-infection, the guidelines and principles of infection prevention and could understand their situation. Many of the MRSA-positive participants reported after the interview that they were very glad that they had got the chance to speak out their voice of how the life-situation was as MRSA-positive and that they hoped that it would lead to improvement and changes in the care for MRSA-positive patients in the future. They also expressed that it was a relief to come and talk to someone who understood their problems.

The interviewed staff also knew that the interviewer was a nurse attached to an infection clinic. One participant reported that she had read the guideline before the interview so as to not appear as being ignorant. As a preventive measure, prior to the start of the interview it was stated that the interviewer had not come to assesses their knowledge about MRSA, but was there to gain insight in their experiences of caring for MRSA-positive patients. During these interviews it felt to be an advantage that the participants knew that the interviewer was a nurse working at an infection clinic, because they knew that their data was treated confidentially and could speak freely about their experience and that the interviewer well understood their concern.

Transferability
The findings provide a broader understanding of the situation of persons living with MRSA, and healthcare staffs’ view of MRSA-positive patients and their combined perception and experiences. Perhaps this insight might improve our understanding of other patients and staff in similar situations. According to Graneheim & Lundman (2004), a rich and vigorous presentation of the findings together with appropriate quotations can enhance transferability.
PAPER IV
The study was conducted in a municipality of Stockholm County, with nine nursing homes, and a total of 67 wards. Perhaps the result would be different if we had chosen another municipality in Stockholm or in a different part of Sweden. Even if every nursing home had a nurse responsible to conduct the study locally who was specially trained to assist her colleagues regarding bacterial sampling, the large number of wards with the consequent large number of local investigators, might have influenced the results. According to interviews, the staff revealed generally good knowledge about the infection prevention guidelines but observation demonstrated numerous deviations from these guidelines in clinical practice.
Unfortunately there was not enough time for continuous observation of the daily work of the staff. Furthermore, information concerning the frequency of incontinence, being wheel chair-bound and dementia of the residents was given by the nurse medically responsible for all nursing homes as a whole. For the residents who were found to carry ESBL-producing *Enterobacteriaceae*, we had the data per person but not for those who were ESBL-negative, adequate comparisons of these potential risk factors were thus impossible.
We investigated prevalence of wounds, wound types and wound characteristics and also the nursing care of these wounds, but we have chosen not to publish these data because it was not fully reported from every nursing home. Twelve percent of the residents did not have a faeces culture and thus were not analyzed for VRE and ESBL which could have affected the result. The reason for the drop outs were the large number of residents with the diagnosis of dementia (48%) and the practical problems to get faeces samples. We are hence content with the fact that so many of the residents with dementia could be sampled, and for this we must give thanks to the staff that did a fantastic job.
CONCLUSION AND CLINICAL IMPLICATIONS

The four studies presented in this thesis highlight some possible improvement potentials for healthcare and it can be concluded that:

- Wounds are common in healthcare. Every fifth patient in an acute care hospital has a wound. Almost all wounds are colonized with bacteria. Resistant bacteria can exist in a wound even in the absence of signs of infection.

- Cost cutting can be achieved if proper local wound-care principles with documented cleansing methods are introduced.

- Both for patients and healthcare staff MRSA colonization represents a threat.

- Lack of knowledge and improper and misleading information both by staff and patients can have consequences for the patients and their family members and cause fear and isolation. Nurses have a central role in the education of staff, patients and family members.

- Knowledge and ignorance of MRSA affect the nurses’ caring role; ignorance made them afraid and insecure while knowledge and understanding shaped confidence in their role as caregivers.

- Observation of the adherence of healthcare staff to infection control guidelines revealed shortcomings and continued work is needed for further improvement.

- MRSA seems not to be common neither in hospital nor in nursing homes in Sweden despite increasing numbers of general MRSA-infections reported annually.

- Previously unidentified cases of ESBL could be found in nursing homes and were more common on wards where antibiotic treatment was more frequent.

Clinical implications

It is a responsibility of all healthcare workers to obtain knowledge regarding principles of infection control in order to prevent the spread of MRSA and other potentially pathogenic microorganisms. The manager also needs to take their responsibility for infection control.

- More education regarding guidelines for healthcare staff caring for patients with antibiotic resistant bacteria is needed. The existent guidelines may have to be presented in new and different ways to get better adherence from healthcare staff. The importance of positive role-models cannot be overemphasized. Both MRSA-colonized patients and healthcare staff caring for these patients need more support to prevent fear and anxiety.
FUTURE RESEARCH

Even if guidelines for infection control are well known to most healthcare staff, which was shown in this thesis, awareness and knowledge did not generally lead to adherence. Factors of importance for non-compliance to these fundamental rules might for example include leadership, time constraints, stress, and unexpected events. An investigation to identify mechanisms leading to non-compliance might lead to increased awareness and quality improvement of patient care.
SAMMANFATTNING PÅ SVENSKA

Det övergripande syftet med denna avhandling var att utifrån olika perspektiv belysa problemen med resistenta bakterier. Att få kunskap om patienters upplevelser av att vara bärare av MRSA-bakterier och att förstå personals upplevelser av att vårda dessa patienter utifrån risken att själva bli smittade och att överföra infektionen till andra. Även att undersöka epidemiologin av resistens problem vid ett universitets sjukhus och att undersöka om bärare finns av resistenta bakterier på sjukhem, samt eventuell relation mellan detta bärarskap och sår, antibiotikabehandling och andra riskfaktorer samt vårdpersonals följsamhet till basala hygien rutiner.

Studie I
Syftet var att undersöka förekomst av sår hos alla patienter som var inneliggande eller besökte mottagningar på ett stort Universitetssjukhus under en dag. Att identifiera alla sår, sårtyper och sårkarakteristika, samt att undersöka behandlingen av dessa sår. Vidare att identifiera bakterier i dessa sår, med ett speciellt focus på MRSA, VRE och andra multi-resistenta gram negativa bakterier. Även i vilken proportion sår som hade antibiotikabehandlats undersöktes. Studien genomfördes under en dag mellan kl. 8-17, alla sökande och inneliggande patienter undersöktes angående sårförekomst. Såren registrerades i tre olika formulär, trycksår, ben- och fotsår samt övriga sår. Registrering av sårstorlek, sårsmärta, smärtstillande behandling, omläggningsfrekvens, omläggnings teknik m.m. registrerades. Sårdlingar togs från sår äldre än 24- timmar. Resultaten visade att 2172 patienter fanns på sjukhuset den aktuella dagen och 19 % hade sår på kroppen. Femton procent av patienterna med ben- och fotsår upplevde antingen kontinuerlig smärta eller smärta vid förbandsbyte. Femton procent av patienternas sår rengjordes med NaCl. Kranvatten anses som ”golden standard” enligt riktlinjer vid sårtvätt utom under särskilda omständigheter. Sårtvätt med kranvatten vid svårhänta sår skulle kunna ge möjlighet till kostnadsbesparing. Två personer med växt av MRSA i såren identifierades. Ingen av dessa hade känd MRSA-infektion. Ingen patient med VRE identifierades men åtta patienterna med växt av andra multi-resistenta bakterier i sin sår. En av MRSA-patienterna hade odlats vid inskrivningen, var då negativ, den andra patientens sår hade uppstått under vårdtiden. Ingen av de två MRSA-positiva patienterna hade synliga symtom på infektion i såren och låg på fler-patientsalar tillsammans med andra patienter. Detta ger oss kunskapen att vi inte vet med säkerhet om en patient har MRSA i såren utan måste handlägga alla patienter med sår med största hygieniska noggrannhet.

Studie II

Studie III
Syftet var att beskriva vårdpersonals upplevelser av att vårda MRSA-positiva patienter. Sju undersköterskor och åtta sjuksköterskor från olika specialiteter, med, kir, ort, rehab och geriatriska avdelningar samt sjukhem intervjuades om sina upplevelser från vård av MRSA-positiva patienter. Intervjuerna analyserades genom kvalitativ innehållsanalys. Resultaten från analysen sorteredes under tre teman.


Studie IV
Syftet var att undersöka bärarskap av MRSA, VRE samt ESBL hos alla boende på sjukhem i en kommun i Sverige och om bärarskapet var relaterat till antibiotikabehandling, andra riskfaktorer och eller vårdpersonalens följsamhet till basala hygienrutiner. Femhundrastio boende från nio sjukhem på 67 avdelningar, deltog i studien. Faeces prover tog från 495 boende (88,3%). Två hundrannio personal intervjuades och observerades. Ingen boende var positiv för MRSA eller VRE. Femton boende var positiva för ESBL. Dessa personer följes under två år med regelbunda odlingar. Boende på avdelningar med ESBL-positiva personer antibiotika behandlades i större utsträckning (42%) än boende på avdelningar utan ESBL-positiva personer (28%; p=0.02). ESBL-positiva personer med samma ESBL-stam, på tre olika hem, värddes i intill liggande rum vilket indikerar att smitta kan ha skett mellan dessa boende. Dessa personer var beroende av personal för sin personliga hygien och var rullstolsburna, vilket kan leda till misstankar om att smitta kan ha överförts via
personalen. Personalens följsamhet till basala hygienrutiner var ibland bristfällig men några specifika skillnader mellan avdelningarna kunde inte konstateras.
ACKNOWLEDGEMENTS

This thesis would not have been possible without the help and encouragement from many people. I would like to express my sincere gratitude to all who have supported me during my study time and to all who have been involved in making this thesis possible. To all participants that have given time and generously shared with me their experience and all helpful and engaged healthcare staff that took part in the studies, I am extremely thankful.

There are some people I particularly want to thank:

Bjöörn Fossum, my supervisor, my real mainstay, you have shared your great experience in qualitative methodology with me. Thank you for your tireless support and all the time and care you have given to me. You have guided me all the way, I am so deeply grateful to you for everything.

Christina Lindholm, my co-supervisor, my great guru in life, you are so fantastically knowledgeable not only in the subject of wound care that you yourself received your PhD in, but you also have an incredible broad and deep knowledge of so many other things which you in such a fine and unselfish way share with others. I am so very grateful for everything you have done for me.

Mats Kalin, my co-supervisor, you have been there all the time and come up with wise insights, the big thoughts, calm and stable, thank you so much.

Hans Jörbeck, my co-supervisor, one of the most humble persons I have ever met, died so sadly in 2006. I miss him very much and his always encouraging words and the great support he always gave me.

JanÅke Lindgren, for providing excellent research facilities and for your support and believing in my research.

Maria Kumlin, thank you for sharing your knowledge and valuable experience and for all help you have given me.

Ingela Rädestad, thank you for that you so kindly have shared your great and broad experience with me.

Anne-Maj Hansson, thanks for your kind support of my research.

Åke Örtqvist, who first was my mentor, but then due to our collaboration on one of my studies was not allowed to continue in that role. Thank you so much for your support and your help.

Susanne Stierstedt, who became my new mentor. Thank you for the nice meetings and dinners and coffee times, you have been a big support and help.
Sissel Andreassen, you have contributed with so much knowledge and work with the analysis and writing, thank you so much it has been invaluable.

Ami Lexmark, for your great help with transcriptions and for your friendship. I also want to thank The MRSA-teams, for your great help and engagement. Former colleagues and friends in the International Group of Infection Diseases, especially Ann-Sofi Åsander.

Roisin Petrini, for all you support and help with my English spelling, you are the one to always trust in, a real friend, thank you so much.

Jane Anderberg, for your never ending support and encouraging me, and I also what to thank Jessica Stackell, for your strong support, thank you both so much you have meant so much to me. Ewa Granström, for your friendship, always encouraging words, and interest in my research. Thanks also to all colleagues and friends at Danderyd Hospital.

Christian Giske, and Aina Iversen, we planned study IV and wrote the article together. Thank you for nice meetings and a job well done, you have been so helpful and I have you to thank for so much. Also thanks to Marie Andersson, who did all the laboratory investigations for the study. Annette Arnkil, medically responsible nurse, for your great support and engagement in the study, it had not been done without your help. Also thanks to the ten nursing students, from Sophiahemmet University College that took part in the study, you did a splendid job and you will become good nurses.

Susan Andersson, for your excellent language review and for your consideration.

At Sophiahemmet University College I also want to thank colleagues and staff for kind support and for in different ways contributing to the work with this thesis. I want to give my special thanks to my friends, former or present doctoral students, Lena Axelsson, Caroline Löfvenmark, Louise Egberg, Eila Sterner, Nina Asplin, Bodil Samuelsson and Karin Bergkvist, without your help and encouragement this thesis had not been finished. It has meant so much for me to have your support.

To my friends, thank you for being my friends, soon I will have more time, I promise. In particular Madeleine, Ulrika, Lisa and Kristina, thanks for all help and support you have given me.

A special thanks I want to give to my aunt Anne-Maj, you have been my extra mother and my personal mentor all my life, all interest you have given me in my research, it is my good luck that I have you. To all my other relatives. To my father, sister, brother and your families, for your interest in me and my research and that I know that you always are there for me. Also thanks to Robban, for everything and all support during all the years.
My thoughts also go to my mother. I have so much to thank her for. She died when I just started my research carrier, 2002, 63 years old. I loved her so much, she meant so much to me and I miss her every day.

Lastly I want to thank my beloved children Daniel, and Alexandra, and Jimmy, my son-in-law that you have stood out with me who was always in a hurry and in my books, and to my grandchild Samantha, you are my sunshine in life, I love you all so much.

This research was supported by a grant from Strama, (the Swedish strategic programme against antibiotic resistance) and by research resources from Sophiahemmet Foundation.
REFERENCES


van de Mortel, T. F. (2003). Registered and enrolled nurses’ knowledge of hepatitis C and attitudes towards patients with hepatitis C. *Contemp Nurse* 16 (1-2), 133-144.


