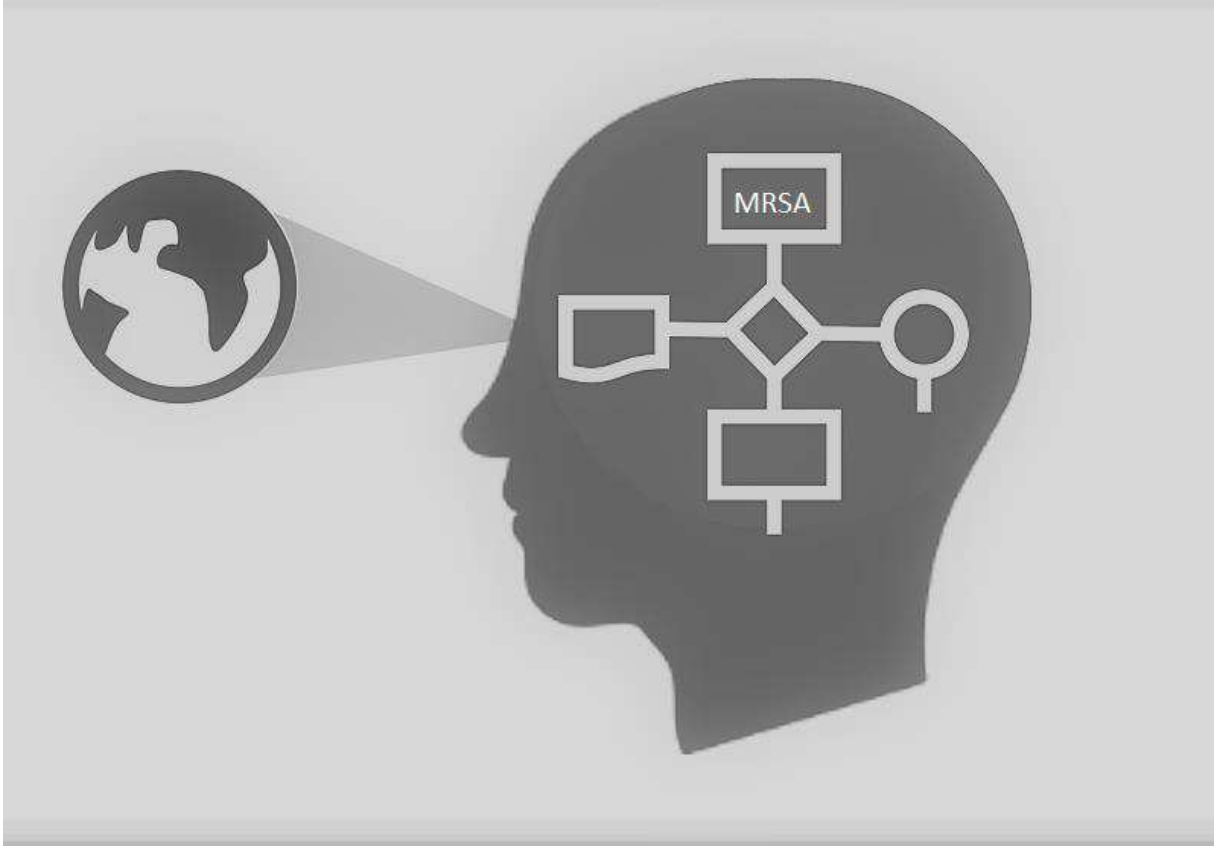
Improving MRSA risk communication towards the Dutch general public: A Mental Model Approach



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Abstract

Background: The amount of infection outbreaks is increasing significantly. This is due to high proportions of antibiotic resistance in bacteria. Antibiotic resistance happens when bacteria change when they are exposed to antibiotics. As a result, medicines become ineffective and infections persist in the body. Methicillin-resistant *Staphylococcus aureus* (MRSA) is a bacteria that is resistant to many antibiotics, and is ever more becoming a public health problem, due to its prevalence among animals, food and otherwise healthy people. MRSA is a common cause of severe infections (e.g. sepsis) in healthcare facilities; the community and the YOPI (Young, Old, Pregnant and Immunosuppressed) are at-risk for these infections. It is essential that risk communication promotes awareness of MRSA among the general public, and in particular among the YOPI-group, so they can adopt preventive health and infection control measures, especially in outbreaks.

Methods: Effective risk communication should be tailored to the public's relevant beliefs and knowledge ("mental models"), therefore the mental models of the Dutch general public concerning MRSA are identified by an electronic self-administered questionnaire (n=1590). A cross-sectional design was used. In addition, perceived vulnerability, MRSA risk perception, MRSA information seeking intention and resource use are explored. Furthermore, between group differences (at-risk / non-at risk for infection by MRSA) in combination with socio-demographics are explored.

Results: Although there were many correct beliefs, the public also possessed many misconceptions, in the general, route of infection, reservoir and consequences domain. Knowledge gaps were detected in the route of infection and reservoir domain. The majority of the general public does not know MRSA occurs in cattle, while it is very common in the livestock sector. Females, people aged around 47-48 and low educated people have the least knowledge of MRSA and are the hard-to-reach group. The large majority uses the internet when they search for information regarding MRSA.

Conclusions: Our findings highlight the need for the systematic analysis of the public's mental models prior to designing risk communication. Although the mental model approach (MMA) is very thorough and is time- and cost-intensive, it is worth the investment, since adequate risk communication will be effective on the long term. Future work should make use of the MMA to develop effective risk communication strategies for other possible (new) health threats. Especially countries where MRSA causing infections rates are high, should make use of the MMA to lower these rates.

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1. INTRODUCTION

Microorganisms that are resistant to the first selection-antibiotics or against multiple groups of antibiotics are called highly resistant microorganisms (HRMO; RIVM, 2016) or superbugs (WHO, 2016a). Antimicrobial resistance arises when microorganisms (such as bacteria, fungi, viruses, and parasites) change when they are exposed to antimicrobial drugs (such as antibiotics and antivirals; WHO, 2016a). As a result, the medicines become ineffective and infections persist in the body, increasing the risk of spread to others. The amount of infection outbreaks is increasing significantly; 800 outbreaks in the 1980's have increased to over 3000 outbreaks in 2010 (Smith et al., 2014). In addition, there are high proportions of antibiotic resistance in bacteria that cause common infections (e.g. urinary tract infections, pneumonia, sepsis) in all regions over the world (WHO, 2016). This has far-reaching consequences. Health care costs for patients with resistant infections are higher than costs for patients with non-resistant infections, due to longer duration of illness, additional tests and use of more expensive drugs, longer lengths of hospital stay, worse clinical outcomes and higher mortality rates (WHO, 2016a; WHO, 2016b; RIVM, 2016; Golkar, Bagasra & Pace, 2014).

1.1 MRSA

Staphylococcus aureus is a type of bacteria which is a common cause of severe infections in health care facilities and the community (WHO, 2016a). Resistance to first-line drugs to treat infections caused by *Staphylococcus aureus* is widespread (WHO, 2016a). People with the HRMO methicillin-resistant *Staphylococcus aureus* (MRSA) are estimated to be 64% more likely to die, than people with a non-resistant form of the infection (WHO, 2016a).

MRSA emerges in two ways: ''MRSA colonization'' and ''MRSA infection''. MRSA colonization (or MRSA carriage) means the bacterium is carried by a human or animal for a longer time and there are no signs of disease; there is no tissue invasion or damage (LCI-richtlijn MRSA, 2011; Boyce, 1998). MRSA colonization can serve as a reservoir for the spread of these microorganisms to others and can lead to infection in the host, but this does not necessarily need to occur (Stokowski, 2006; LCI-richtlijn MRSA, 2011). An MRSA infection is the entry and multiplication of microorganisms in the tissues of the host, leading to various signs of disease, such as a boil (furuncle), impetigo, folliculitis or cellulitis (Stokowski, 2006; LCI-richtlijn MRSA, 2011).

In the last decade, MRSA colonization has demonstrated to be prevalent among

animals, such as dogs, cats and pigs (David & Daum, 2010; Weese, 2010) and raw meat (David & Daum, 2010) and milk (Normanno et al., 2007) as well. Furthermore, while MRSA infections used to be largely found in hospitals, other health care environments and in patients visiting these facilities (called Hospital Acquired MRSA [HA-MRSA]), nowadays, MRSA infections are also common outside these facilities, known as community-associated MRSA (CA-MRSA; David & Daum, 2010). It is not always possible to determine the source of MRSA, but hand contact appears to be the main route of contamination (LCI-richtlijn MRSA, 2011; Noordaa, Sauerwein & Verbrugh, 2002). In addition, dissemination of staphylococci takes place via air (skin flakes, aerosols; Wooldridge, 2012), by secondary sources in the direct environment (clothing, bedding, toys, dust, inert materials; Van der Giessen, van de Giessen & Braks, 2010; Wooldridge, 2012) or by animals (Van der Giessen et al., 2010; Wooldridge 2012). The primary reservoir of MRSA is the nose (front nostrils), but other examples of body sites that serve as a reservoir are the respiratory tract, open wounds, hair and the axilla (Stokowski, 2006; LCI-richtlijn MRSA, 2011).

One of the larger problems of MRSA is there are many risk factors for getting colonized or infected, for instance a hospitalization in a foreign country (Kaiser, Schultz, Kruithof, Debets-Ossenkopp & Vandenbroucke-Grauls, 2005). MRSA spreads optimally between people who live close to each other as in health care institutions (crowding; LCI-richtlijn MRSA, 2011). In comparison to the Netherlands, which follows an intensive 'search and destroy MRSA policy', MRSA colonization and infection are more common in countries where a less intensive policy is applied (LCI-richtlijn MRSA, 2011). Therefore the rate of MRSA colorizations and infections among patients from most foreign hospitals is higher than the Netherlands and people who stayed in a foreign health care institution have a higher chance on MRSA contamination (LCI-richtlijn MRSA, 2011).

Specific for MRSA colonization, there is a high frequency (20-60%) among people working with pigs (Osadebe, Hanson, Smith & Heimer, 2013; Bisdorff et al., 2012; Van den Broek et al., 2009; Graveland, Wagenaar, Bergs, Heesterbeek & Heederik, 2011; Khanna, Friendship, Dewey & Weese, 2008; Van Cleef et al., 2014). A high frequency of MRSA colonization is also present within cattle cow farms (Vanderhaeghen, Cerpentier, Adriaensen, Vicca, Hermans & Butaye, 2006). In Belgium, nearly 10% of the Belgian cattle cow farms are affected by MRSA (Vanderhaegen et al., 2006). In Turkey, the prevalence is even 17,5% (Turutoglu, Ercelik & Ozturk, 2006). Having contact with living pigs or cows is recognized as a significant risk factor for MRSA colonization. Next to cattle cow and people working with pigs, an increased colonization rate has been found in horses, as well as dogs and cats (Van

Duijkeren et al., 2010; Leonard & Markey, 2008). Suspected transmission possibilities between humans and small animals or horses were reported several times in the past (Manian, 2003; van Duijkeren, Wolfhagen, Box, Heck, Wannet & Fluit, 2004; Weese et al., 2006a; Weese et al., 2006b). The study of Vincze et al. (2014) showed that pet animals, dogs and cats should be considered as potential sources for human MRSA colonization and, as such, having contact with a pet animal is mentioned as a risk factor for MRSA colonization. Other people who are at increased risk are adopted children and people who have contact or were recently near an MRSA patient, previously had MRSA, have skin conditions such as eczema, wounds, chickenpox and burns (Graffunder & Venezia, 2002).

Alongside MRSA colonization, there are risk factors which may cause an increased risk of contamination by MRSA and there are risk groups where infections by MRSA cause a serious clinical course. In the first place a risk group for MRSA infection is the so-called YOPI group: ‘’Young, Old, Pregnant and Immunosuppressed’’ (LCI-Richtlijn MRSA, 2011; Stinis & Lenderink, 2008). Individuals with an underlying medical problem or an impaired immune function not only get colonized, but also get infected with MRSA (Stinis and Lenderink, 2008). This enables wound infections, urinary tract infections and lung infections to arise and easier warrants hospitalization (Liu et al., 2011; Murray, 2005). Dialysis patients, patients with impaired immune systems (HIV-patients, patients undergoing chemotherapy), chronic diseases (COPD, diabetes) and with foreign bodies (catheters, pacemakers) are examples of immunosuppressed people within the YOPI group (LCI-richtlijn MRSA, 2011; Graffunder & Venezia, 2002; Narewski, Kim, Marchetti, Jacobs & Criner, 2015). In hospitals and nursing homes, MRSA infections are regularly seen by patients who had previous hospitalization (within the last 12 months) or previous surgery, use antibiotics, have skin disorders (eczema, psoriasis), open wounds and burns (LCI-richtlijn MRSA, 2011; Graffunder & Venezia, 2002; RIVM, 2014). In the community, direct skin contact in combination with acquiring lesions can epidemically cause skin infections, for example via contact sports (judo, rugby, football and wrestling; LCI-richtlijn MRSA, 2011).

Knowledge and awareness among the general public would enable people to make a contribution to efforts to reduce MRSA colonization and infection incidence and spread. In addition, knowledge of levels of public awareness of MRSA would inform healthcare providers of educational needs of (potential) patients and, most importantly, those most vulnerable to MRSA infection. Duncan, Schaller & Park (2009) created a measure which assessed awareness by the extent to which individuals perceived themselves to be vulnerable to infectious diseases: ‘’perceived vulnerability to disease’’ (PVD). This measure assesses

individual differences in chronic concerns about the transmission of infectious diseases and consists of two constructs: Germ Aversion and Perceived Infectability. Germ Aversion measures the emotional discomfort towards disease-connoting situations and predicts responses rooted in intuitive appraisals of disease transmission risk. Perceived Infectability measures beliefs about personal susceptibility to the transmission of infectious diseases and predicts responses by more rational appraisals (Duncan et al., 2009). In addition, Perceived Infectability has proven to more strongly predict implicit negative associations with individuals who tend to be characterized by diminished immunocompetence (Duncan & Schaller, 2009). Within the YOPI group, the elderly and the immunosuppressed belong to the diminished immunocompetence group, they are most vulnerable to contamination by MRSA infections. Since the elderly and the immunosuppressed receive an invitation for a flu vaccination every year, they can be defined. The at-risk YOPI group obviously has different and more educational needs in comparison to the non-at risk group. When the YOPI group has worse beliefs about personal susceptibility to infectious diseases, they should be tailored different information than the non-at risk group. In addition, the non-at risk group should not unnecessary be frightened by receiving information not intended for them. As such, it will be interesting to explore if there is a difference in Perceived Infectability between the (invitation for a) flu vaccination group versus the non-flu vaccination group. The hypothesis is that the flu vaccination invitation group will have more strongly implicit negative associations and score higher on Perceived Infectability, than the non-flu vaccination invitation group.

Primary prevention is aimed at preventing MRSA infections. Good hygiene for the person and its environment is crucial, for example because of the risk of contamination by direct hand contact (LCI-richtlijn MRSA, 2011). In general, after physical contact with people with an MRSA colonization or MRSA infection, hands need to be washed or disinfected (LCI-richtlijn MRSA, 2011). Specific for the hospital environment, wearing gloves during wound care and wearing protective clothing (surgical mask, disposable gloves, short sleeve coat), strictly following cleaning and disinfection procedures and isolation at risk departments or outside these risk departments (out of precaution) are preventive measures that are important (LCI-richtlijn MRSA, 2011, WIP, 2012). Secondary prevention involves the early detection of the infection caused by MRSA in people who are ill or who are at increased risk of becoming ill. Pig farmers, for example, who have a higher chance on MRSA colonization, screening is mandatory whenever they or their family members are admitted to a hospital (Voss et al., 2005). Preventive measures include treating people with signs of an MRSA infection, giving work bans for patient-related work to infected employees at care

facilities, and strict isolation of infected patients (WIP, 2012). Tertiary prevention is the treatment of an MRSA infection (LCI-richtlijn, 2011). Fostering knowledge and awareness among the general public, and in particular the YOPI group, to prevent MRSA infections, are measures within the primary prevention domain.

1.2 Risk communication

In addition to primary prevention, adequate risk communication is an essential element to protect the general public from MRSA infections (Verhoeven, Karreman, Bosma, Hendrix & van Gemert, 2010).

The general public often has limited knowledge on how to manage risk in case of infections or outbreaks and therefore risk communication is necessary (Verhoeven et al., 2010). When there is an outbreak, the general public needs to know, when they are (or at risk of) getting MRSA colonized, what to do to avoid contact with the at-risk group for MRSA infections. And if there was contact, what to do next. Risk communication is any purposeful exchange of information about health or environmental risks between interested parties (Covello, von Winterfeldt & Slovic, 1986). It covers a wide range of activities, such as stimulating interest in health issues, increasing public knowledge, influencing attitudes and behavior of people, acting in situations of emergency or crisis and aiding in decision making (Boholm, 2008). Risk communication needs to be adjusted to the specific needs of the people, so that they are facilitated to judge their own risk situations and to make informed decisions according to preparedness and personal safety measures to mitigate the risk (Seeger et al, 2003; Seeger, 2006; Renn, 2009). The public typically makes decisions based on their perception of the risk, rather than the actual risk (Fischhoff, Bostrom & Quadrel, 2002). Public conceptions of risk are complex, and influenced by factors such as whether the risk involves possibly fatal consequences, is uncontrollable and unknown (Slovic, 1987). Thus, directed at MRSA, analyzing the risk perception, would provide necessary information for adjusting risk communication to the specific needs. In addition, it is necessary that the source of information is the same as the source the audience will use when they will search for information on the subject (the intention of information seeking use of resources). E-Health can be an added value in creating effective risk communication. E-Health is the use of emerging information and communication technology, especially the internet, to improve or enable health and health care (Eng, 2001). Directed at MRSA, exploring risk perception, information seeking intention and resource use (eHealth) will help to create effective risk communication. This will be especially useful for the risk groups, including the subgroup

receiving an invitation for the flu vaccination. The hypotheses will be that the flu vaccination invitation group has a higher level of risk perception than the non-flu vaccination invitation group and different information sources are used regarding MRSA.

A common problem of the design of risk communication is that they rely primarily on experts, instead of its intended users (Verhoeven et al., 2010). Members of the general public cannot always understand the information available, because in case of health issues, it is too medical for a lay-person to understand or because they have misconceptions about the subject (Verhoeven et al., 2010).

1.3 The mental model approach

The mental model approach fills this gap by focusing on understanding how the mental model of the recipient differs from that of the expert, in the belief that effective risk communication needs to better understand different ways people viewed risk (Morgan, Fischhof, Bostrom & Atman, 2002). Empirical evidence combining risk communication and mental models, suggests that risk communication messages which consider differences in mental models are more effective in achieving general education goals, as well as encouraging action (Maharik & Fischhoff 1992; Bostrom, Morgan, Fischhof & Read, 1994). From this perspective, interaction and dialogue with those who face the risks may shed light on their mental models, including how these people view risk and how these perceptions then relate to message targeting (Steelman & McCaffrey, 2013).

The mental model approach has proven to be fundamental in creating successful risk communication interventions. It can be applied in a variety in topics, such as identifying lay people's requirements regarding nuclear waste, to develop an essential online information system for the site selection of a nuclear waste repository in the United Kingdom (Skarlatidou, Cheng & Haklay, 2012). In the Netherlands it has been applied to MRSA, by using the mental model approach, a website on Methicillin-Resistant Staphylococcus Aureus, MRSA-net, was developed (in German and in Dutch), to promote awareness and recognition of MRSA, letting the general public adopt preventive health and infection control measures (Verhoeven et al., 2010) and has proven to be successful.

The mental model approach is a five-step method for creating and testing risk messages (Morgan et al., 2002). The main goal of the mental model approach is to find the knowledge gaps between experts and lay mental models in order to be able to close these gaps with communication, providing the specific missing information and replace misconceptions with correct information (Fischhoff, Downs & de Bruin, 1998). Knowledge gaps are the

discrepancies between the knowledge that people of varying socioeconomic levels attain when engaging mass media content and misconceptions are views or opinions that are incorrect, because they are based on faulty thinking or understanding (Hwang & Southwell, 2015). Mental models include relevant beliefs and knowledge, evoke associations, reveal misconceptions and are continuously subject to change as people gather more information which they use to construct and rebuild their mental models (Morgan et al., 2002). Beliefs are hereby defined as the probability dimensions of a concept (Fishbein, Martin, Raven & Bertram, 1962). The mental model approach distinguishes itself from other approaches because it attempts to cover both scientific and individual truths which are both crucial in developing successful risk communication strategies (Byram, Fischhoff, Embrey, de Bruin & Thorne, 2001). This method allows for the possibility that lay people hold information that the experts do not have, so gaps between expert and lay people knowledge can be identified, as can be misconceptions.

Step one in the mental model approach is creating an expert model (Morgan et al., 2002). Current scientific knowledge about the process that determine the nature and magnitude of the risk has to be reviewed. All this information has to be summarized, from the perspective of what can be done about the risk, allowing external review and analysis of relevance of information. The information will be transformed into an influence diagram, a directed network drawn from decision theory, which allows representing and interpreting the knowledge of experts from diverse disciplines. Once the expert model is created, it will be reviewed by technical experts with different perspectives in order to ensure balance and authoritativeness (Morgan et al., 2002). Step two in this process is conducting open-ended interviews, eliciting people's beliefs about the hazard, expressed in their own terms (Morgan et al., 2002). The interview protocol is based on the influence diagram, so that it covers all the potentially relevant topics. It allows the expression of both correct and incorrect beliefs. Responses are analyzed in terms of how well these mental models agree with the expert model, captured in the influence diagram (Morgan et al., 2002). Step three is to create a confirmatory questionnaire, consisting of items that fit with the beliefs expressed in the open-ended interviews and the expert model. Applying the questionnaire to large groups will estimate the population prevalence of these beliefs (Morgan et al., 2002). Step four in the mental models approach is using the results from the interviews and questionnaires, along with an analysis of the decisions that people face, to determine which incorrect beliefs need correcting and which knowledge gaps need to be filled (Morgan et al., 2002). The last part of this step is to define a way of communication, which also needs to be exposed to expert

review to ensure its accuracy (Morgan et al., 2002).

This study will take a first step in defining a way of risk communication, following the mental model approach, aiming at primary prevention to prevent the general public and especially the at-risk groups from getting MRSA infections, especially in case of outbreaks. This study will focus on step three by examining the knowledge and awareness by exploring correct beliefs, misconceptions and knowledge gaps in the different domains of the general public regarding MRSA. In addition, the subgroup with the most MRSA knowledge will be compared with the least knowledge subgroup on socio-demographic factors (age, gender, flu vaccination invitation, education level and urbanity). The hypothesis will be only education level will differ on knowledge level, where a lower education level means less MRSA knowledge. Finally, this study will give recommendations for the subsequent steps of the mental model approach.

The research questions that will be explored include:

1. What are the correct beliefs, misconceptions and knowledge gaps in the different domains of the general public regarding MRSA?

1a. To what extent does the general public have the correct beliefs per MRSA domain?

1b. To what extent does the general public have misconceptions per MRSA domain?

1c. To what extent does the general public have knowledge gaps per MRSA domain?

1d. What are the socio-demographic factors of the subgroup with the most MRSA knowledge versus the subgroup with least knowledge?

2. What is the Perceived Vulnerability towards disease of the general public?

2a. What is the Germ Aversion towards disease of the general public?

2b. What is the Perceived Infectability towards disease of the general public?

2c. Is there a difference in Perceived Infectability towards disease between the flu vaccination invitation group and the non-flu vaccination invitation group?

3. What is the risk perception, information-seeking intention and resource use of the general public regarding MRSA?

3a. What is the risk perception of the general public regarding MRSA?

3b. Is there a difference in risk perception between the flu vaccination invitation group and the non-flu vaccination invitation group regarding MRSA?

3c. What is the information seeking intention and resource use of the general public regarding

MRSA?

3d. Is there a difference in information seeking intention and resource use between the flu vaccination invitation group and the non-flu vaccination invitation group regarding MRSA?

2. METHODS

2.1 Research design

The goal of the study was to analyze the beliefs, knowledge gaps, misconceptions, perceived vulnerability, risk perception, information seeking intention and resource use of a representative sample of the Dutch general public regarding MRSA. Aiming at primary prevention to prevent the general public and especially the at-risk groups from getting MRSA infections, especially in case of outbreaks. A cross-sectional design was used.

2.2 Procedure

The questionnaire consists of 112 questions, subdivided into five domains: Knowledge, beliefs and misconceptions regarding MRSA (n=66), specific questions about animals (n=4), a socio-demographic factor (n=1), the Perceived Vulnerability to Disease questionnaire (PVDQ; n=15) and the Framework of Risk Information Seeking (FRIS; n=22) model.

2.2.1 Mental model approach

The questionnaire was created using the mental model approach. The expert model of Verhoeven et al. (2010) was used as a starting point. By reviewing current scientific knowledge about the processes which determine the nature and magnitude of the risks related to MRSA, and in cooperation with experts, a new improved expert model was created (see Appendix A). Concepts of the expert model include source, route of infection, reservoir, prevention, risk factors, type of infection, consequences and treatment. Subsequently, students of the University of Twente (n=14) conducted open-ended interviews based on the expert model, eliciting people's (in)correct beliefs about MRSA.

By using the expert model and the beliefs expressed in the open-ended interviews, a self-administered questionnaire was constructed, with the aim to make the correct beliefs, misconceptions and knowledge gaps of the general public regarding MRSA explicit. In addition to the concepts of the expert model, general questions regarding MRSA were added to the questionnaire exploring the general beliefs about MRSA (which were not covered by the expert-model).

2.2.2 Pilot test

The questionnaire was developed using Qualtrics (www.qualtrics.com). Qualtrics is a software program that can upload and store questionnaires on the internet. The questionnaire was pilot-tested within a group of 11 respondents, by letting them fill out the self-administered questionnaire and by interviewing them afterwards. The goals were A) to explore if the respondents understood the questions and did not feel uncomfortable by the questions, B) to get feedback on the lay out of the questionnaire and C) to see if the respondents could fill in the questionnaire within 20 minutes. After the pilot tests, the feedback was discussed within a group of researchers of the University of Twente, leading to some minor adjustments to the questionnaire. Questions (n=4) were adjusted, because they were too difficult to comprehend, questions (n =6) were adjusted to make a clear distinction between MRSA carriage and MRSA infection, and questions (n=6) were deleted, because they were too much alike and choices needed to be made, making sure the respondents would stay within the time limit. Furthermore, changes were made in lay-out, by making intro texts and questions clearer by adjusting size and color.

2.3 Respondents and sampling

The goal was to reach a representative sample of 1500 Dutch respondents. Data collection took place between October 18th and November 5th 2016. Before starting the questionnaire, the respondents had to give informed consent in which they agreed that their data was going to be used anonymously for research purposes. At the beginning of the questionnaire, the respondents were told the questionnaire is part of a study by the University of Twente, investigating the ideas of the Dutch population regarding "MRSA" and they could also join if they knew nothing about the subject. ‘’Force Response’’ was added in the survey, therefore answering the question was mandatory in order to reduce the number of incomplete surveys. After completing the questionnaire, the respondents got a link to the MRSA net website (www.-mrsa-net.nl) in case they wanted more information on MRSA and to eliminate unnecessary fear that the questionnaire has possibly evoked.

2.3.1 Motivaction

The URL to the Qualtrics survey was send to a professional agency (Motivaction). Motivaction sent the survey by e-mail to a representative selection of their 65.000 panel members. By using data of the basic attitude of the panelists (Mentality), an representative sample was realized on age, gender, education and region, but also socio-cultural orientations

and values. Motivaction hereby uses the propensity method, in the following manner:
- Using profile information (socio-demographic characteristics and socio-cultural orientation) to retrieve a sample as representative as possible, before any correction by means of weighing will take place.
- The socio-demographics were weighted according to the Golden Standard of CBS (Centraal Bureau voor Statistiek).
- Socio-cultural orientations were weighed, calibrated on an offline sample itself without self-registration. The calibration file used is the annual Mentality-measurement of Motivaction. This data is collected using questionnaires given by face-to-face interviewers among a representative sample of respondents aging 15 to 80 years.
- By using a sophisticated weighting technique, weighing was possible on a large number of variables. Also the interaction effects between variables, such as the age distribution within an education level are included.

Motivaction was commissioned to deliver at least 1500 respondents. The survey was linked to the system of Motivaction, so Motivaction could attach socio-demographics when the survey closed. The weighing factor was also linked by Motivaction, a weighting factor higher than 1 meaning someone was underrepresented and their scores weigh more heavily and a weighting factor lower than 1 meaning someone was underrepresented and their scores weigh less heavily.

2.3.2 Inclusion- and exclusion criteria

The participant needed to have a thorough command of the Dutch language, had to be 18 years or older, and needed to have sufficient knowledge of working with the internet on a computer, tablet or phone.

2.4 Measurement

2.4.1 Beliefs general public MRSA

The main questionnaire consists of 66 statements which were subdivided into general statements (4 items) and 7 expert-model domains: ‘’Source’’ (6 items), ‘’route of infection’’ (12 items), ‘’ reservoir’’ (2 items), ‘’risk factors’’ (20 items), ‘’consequences’’ (4 items), ‘’prevention’’ (12 items) and ‘’treatment’’ (6 items). The expert-model domain: ‘’type of infection’’ is included in the items of other domains by asking specific questions about the two types of infection: MRSA carriage and MRSA infection. Items were all answered on a 5-

point scale comprised of "certainly true", "probably true", "don't know", "probably not true", and "not true". Examples of statements are: ''MRSA is a disease'' or ''When an animal licks me (like a dog/cat) I decrease the risk of MRSA carriage''. The main questionnaire was validated by two microbiologists (Dr. Ron Hendrix and Prof. Dr. Bhanu Sinha) on correctness and usefulness.

2.4.2 Socio-demographic and human-animal contact

Additional to the main questionnaire, the general public was questioned whether they received an invitation for flu vaccination (''yes'' or ''no''). Respondents receiving an invitation for flu vaccination are the elderly and immunosuppressed and belong to the at-risk group for MRSA (colonization and infection).

Items measuring human-animal contact were also added to the main questionnaire, being an important factor within MRSA transmission. Human-animal contact was examined by 2 identical multiple choice questions: ''Do you have close contact with the following animals every week (multiple answers possible)?'' With different answering options: ''cow'', ''pig'', ''poultry'', ''horse'' and: ''No, I don't have close contact with these animals every week''. The other question had the following endpoints: ''dog'', ''cat'', ''rabbit'' and: ''No, I don't have close contact with these animals every week. Additional to these items, another question was asked after each question: ''Do you wash your hands after contact with any of these animals?'', using a 5 point Likert scale with endpoints labelled from: ''always'', ''often'', ''regularly'', ''sometimes'', ''never''.

2.4.3 Perceived Vulnerability

The Perceived Vulnerability to Disease self-report questionnaire (PVDQ) is included in the survey to assess individual differences in chronic concerns about the transmission of infectious diseases and consists of two constructs: Germ Aversion and Perceived Infectability. Germ Aversion measures the emotional discomfort towards disease-connoting situations and predicts responses rooted in intuitive appraisals of disease transmission risk. Perceived Infectability measures beliefs about personal susceptibility to the transmission of infectious diseases and predicts responses by more rational appraisals.

The Perceived Vulnerability to Disease Questionnaire is originally a English questionnaire. It was translated forward-backward from English to Dutch, including the response options and instructions, following the guidelines of Beaton, Bombardier, Guillemin & Ferraz (2000). The first translation from English to Dutch was made by two native Dutch

speakers with an excellent mastery of the English language. One of the translators had an idea of the concepts and the other did not (naive translator). Together the two translators and an observer came to one consensus translation. This consensus translation was translated back separately by two native English speakers. These translators were hired from translation agency: ‘’Perfect’’ in Enschede (the Netherlands). Both translators had no idea about the relevant concepts of the questionnaire. After their translation, an expert committee (consisting of two researchers and a master student at the University of Twente) compared the two consensus translations and reached a final consensus translation.

The PVDQ is a 15-item self-report questionnaire with a 7-point scale response, with endpoints labelled from: ‘’1 = strongly disagree’’, ‘’2 = disagree‘’, ‘’3 = somewhat disagree’’, 4 = ‘’neither agree, nor disagree’’, ‘’5 = somewhat agree’’, ‘’6 = agree’’, ‘’7 = strongly agree’’. Six of the questions were reverse scored, meaning that the numerical scoring scale runs in the opposite direction. So, strongly disagree would attract a score of 7, disagree would be 6, somewhat disagree 5, neither agree, nor disagree stays 4, somewhat agree becomes 3, agree becomes 2 and strongly agree = 1. The variables were reverse scored using SPSS. The PVDQ measured two conceptually distinct factors: Perceived Infectability (7 items, original questionnaire $\alpha = .87$) and Germ Aversion (8 items, original questionnaire $\alpha = .74$). Examples of statements are: ‘’If an illness is ‘going around’, I will get it’’ (Germ Aversion) and ‘’ If an illness is 'going around', I will get it’’ (Perceived Infectability). Higher scores on Germ Aversion refer to more emotional discomfort towards disease-connoting situations. Higher scores on Perceived Infectability refer to more beliefs about personal susceptibility to the transmission of infectious diseases. Higher scores on the total score of the 2 subscales combined indicate greater perceived vulnerability to disease.

The Cronbach’s Alpha regarding Perceived Infectability to disease of the general public (current study) was .87. The subscale is very reliable, because the Cronbach’s Alpha is higher than .8. The Cronbach’s Alpha regarding Germ Aversion to disease of the general public was .67. The subscale is not very reliable, because the Cronbach’s Alpha is lower than .7. Removing one of the questions did not improve the reliability by either subscale.

2.4.4 MRSA risk perception

A sub-scale of the questionnaire is created, based on the FRIS-model of ter Huurne (2008). This model helps to better understand the determinants that start the process of information seeking behavior. The FRIS model is a starting point for communication professionals in the design and implementation of receiver oriented risk communication.

Concepts of the FRIS-model include risk perception, self-efficacy, involvement, affective responses, information sufficiency and information seeking intention (and resource use). Because the original questionnaire (ter Huurne, 2008) was about industrial risk, questions have been converted to (the risk of infection by) MRSA (see Appendix B). The concept of risk perception was measured by 3 questions and 3 statements about the risks and consequences of MRSA. An example of a question is: ‘’How big will the consequences of an MRSA outbreak be, according to the patients in a hospital?’’. An example for an statement is: ‘’The chance of a MRSA outbreak causing deaths is…’’. A Likert scale was used for the statements as well as the questions, with endpoints labelled: ‘’1 = very small’’, ‘’2 = fairly small’’, ‘’3 = not small/not big’’, ‘’4 = fairly large’’ and ‘’5 = very large’’.

The Cronbach’s Alpha regarding MRSA risk perception was .77 (n=6) and removing 1 question did only improve the α to .79, so it was not removed. The subscale is reliable, because it is between 7 and 8.

2.4.5 MRSA information seeking intention and resource use

The concept of MRSA information seeking intention, also based on the FRIS-model of ter Huurne (2008), was added to measure if and where the respondent will look for information when he hears something about MRSA. Endpoints were labeled: ‘’Newspapers’’, ‘’internet’’, ‘’general practitioner’’, ‘’GGD’’, ‘’RIVM’’, ‘’Other, namely…’’ and ‘’I’m not looking for information’’. The question is: ’If I see, read or hear something about MRSA, I’m looking for information on the following sources…’’.

2.5 Statistical analysis

Statistical analyses have been performed with SPSS 24. Regarding research question 1: ‘’ What are the correct beliefs, misconceptions and knowledge gaps in the different domains of the general public regarding MRSA?’’, descriptive analyses were performed to examine MRSA correct beliefs, misconceptions and knowledge gaps on individual and domain level of the general public. First, commonly held correct beliefs were examined, defined as items on which 50% or more endorsement of the correct answer (‘’certainly true’’ and ‘’probably true’’) was recorded. Next, commonly held knowledge gaps and commonly held misconceptions were examined by analyzing the items that were answered incorrectly or attracted “don’t know” responses to identify MRSA knowledge that may be considered relatively poorly understood. Items attracting 50% or more of “don’t know” responses were identified and classified as “commonly held knowledge gaps”. Items attracting 25% or more

incorrect (‘’probably not true’’ and ‘’not true’’, but not ‘’don’t know’’) answers were classified as ‘’commonly held misconceptions’’. The cut-off point for identifying misconceptions was based on that used in previous studies (Smith, Lang, Sullivan, & Warren, 2004). The higher the percentage for each (in)correct or don’t know answer for each question or statement the larger the correct belief, misconception or knowledge gap. For each domain the percentage of beliefs, misconceptions and knowledge gaps within the domain were described. Questions and statements which were answered correctly by less than 20% of the respondents were examined by dividing the general public into subgroups with most knowledge (having the correct belief) versus least knowledge (don’t know and not having the correct belief) by these questions and statements. The Chi-Square test for independence was used to compare the subgroups on gender and receiving an invitation for an flu vaccination. The independent samples T-test was used to compare the subgroups on mean (SD) scores on age. The one-way analysis of variance (ANOVA) was used to compare the subgroups on education level and urbanity. If there is a significant difference, an Tukey honest significance difference (HSD) test will be performed to find out which conditions are significantly different from each other.

Regarding research question 2: ‘’What is the Perceived Vulnerability towards disease of the general public?’’, descriptive analyses were used calculating the means (SD) on the subscales Germ Aversion towards disease and Perceived Infectability towards disease. To examine the difference in Perceived Infectability towards disease between the flu vaccination invitation group and the non-flu vaccination invitation group, the Kolmogorov-Smirnov test was performed to conclude if mean difference between the two groups is normally distributed. Levene’s test for equality of variance was used to test if the variances were equal. If both conditions are met, an independent samples T-test is performed to compare mean scores and conclude if there is a difference between the flu vaccination invitation group and the non-flu vaccination invitation group. If the data is not normally distributed, the median will be calculated and an Mann-Whitney U test will be performed.

Research question 3: ‘’What is the risk perception and information-seeking intention of the general public regarding MRSA?’’, was answered calculating the mean (SD) on MRSA risk perception. The difference in MRSA risk perception between the flu vaccination invitation group and the non-flu vaccination invitation group, was examined by executing the Kolmogorov-Smirnov test to conclude if mean difference between the two groups is normally distributed. Levene’s test for equality of variance was used to test if the variances were equal. If both conditions are met, an independent samples T-test is performed to compare the means

and conclude if there is a difference between the flu vaccination invitation group and the non-flu vaccination invitation group on risk perception. If the data is not normally distributed, the median will be calculated and an Mann-Whitney U test will be performed. To explore where the general public intends to search for information when they hear about MRSA, descriptive analysis was performed by describing if they use information sources and which sources they use. Next, the Chi-Square test for independence was used to compare the subgroups (flu vs non-flu vaccination invitation) on intention of use of different information sources.

3. RESULTS

3.1 General Public

In Table 1 the general public's socio-demographic characteristics are described. A total of 1590 Dutch respondents participated in the study. Age ranged between 18 and 80 years old, with a mean age of 47 years, consisting of 49,4% males and 50,6% females.

Characteristic	n	%	M(SD)
Gender			
Male	786	49,4	
Female	804	50,6	
Age			47 (16.03)
18 till 24	176	11,1	
25 till 34	254	16	
35 till 44	289	18,2	
45 till 54	318	20	
55 till 64	274	17,3	
65 till 80	279	17,4	
Education			
Low educated	390	24,5	
Middle educated	793	49,9	
High educated	407	25,6	
Urbanity			
Not urbanized	180	11,3	
Low urbanized	338	21,2	
Moderate urbanized	305	19,2	
Highly urbanized	442	27,8	
Very highly urbanized	324	20,4	
Missing values	2	0,1	
Invitation flu vaccination 2016			
Yes	654	41,1	
No	936	58,9	
Germ Aversion	1590		3.74 (.86)
Perceived Infectability	1590		3.22 (1.04)
Risk Perception	1590		2.69 (.59)

Note. M = Mean, SD = Standard Deviation, R = Range.

3.2 Correct beliefs, misconceptions and knowledge gaps

In total there were 23 correct beliefs (34,8%), 21 misconceptions (31,8%) and 14 knowledge gaps (21,2%) within the 66 items (see Table 2 till Table 10). The sum of ‘’probably false’’ and ‘’false’’ scores and ‘’probably true’’ and ‘’true’’ scores, are respectively commonly held misconceptions (higher than 25%; red frame) or commonly held correct beliefs (higher than 50%; green frame), depending on the right answer to the statement. The right answer to the statement is highlighted in bold green. In the ‘’don’t know’’ column, the commonly held knowledge gaps are highlighted when they are higher than 50% (blue frame). In every table the negative items are described first and the positive items second.

3.2.1 Correct beliefs, misconceptions and knowledge gaps within domains

In the general domain (see Table 2) there were 3 misconceptions within the 4 questions and there was 1 correct belief. The majority (60%) correctly believed MRSA is a bacterium and the majority (71%) believed MRSA is a contagious disease or did not know it is a contagious disease. A substantial group of the respondents believed MRSA is both a bacterium and a contagious disease (n=359, 23%). There were no knowledge gaps in the general domain.

Table 2
General: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don’t know	Probably/not true
General			
MRSA is a contagious disease.	**41%**	30%	**29%**
MRSA is a disease.	**37%**	27%	**36%**
MRSA is a virus.	**26%**	34%	**39%**
MRSA is a bacterium.	**60%**	31%	9%

In the source domain (see Table 3), there was 1 misconception within the 6 questions and there were 2 correct beliefs. There was 1 knowledge gap regarding the statement: ‘’MRSA

occurs in cattle, such as pigs, chickens and calves''. In total 75% did not know this or thought MRSA did not occur in cattle. The minority, but still a large group (42%), did not know or thought MRSA did not occur in nursing homes.

Table 3
Source: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Source			
MRSA only occurs in hospitals.	**34%**	29%	**37%**
MRSA occurs in nursing homes.	**58%**	35%	7%
MRSA occurs among the population.	**54%**	33%	13%
In some hospitals, MRSA is always present.	**32%**	49%	19%
MRSA occurs in schools.	**29%**	49%	22%
MRSA occurs in cattle, such as pigs, chickens and calves.	**25%**	**57%**	19%

In the route of infection domain (see Table 4), the majority of the 12 questions were misconceptions (n = 7) and there were 2 correct beliefs. The majority (51%) does know MRSA spreads via air and does not spread via insect bites (54%). Regarding misconceptions, a small group (6%) knows MRSA can spread via dogs and cats, this means 94% does not know or does not believe MRSA can spread via these animals. Next, the majority (78%) does not know or does not believe MRSA can spread from animals to humans. Half of the questions (n=6) were knowledge gaps and by each possible route of infection, at least 39% of the general public does not know if it is indeed a route of infection of MRSA. The majority did not know if MRSA spreads via rats and mice (56%), resulting in the largest knowledge gap in this domain.

Table 4
Route of infection: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Route of infection			
MRSA spreads by insect bites.	4%	42%	**54%**
MRSA spreads via rats and mice.	8%	**56%**	**37%**
MRSA spreads via air.	**51%**	39%	10%
MRSA spreads by direct skin to skin contact.	**35%**	43%	22%
MRSA spreads via saliva.	**36%**	48%	16%
MRSA spreads via clothing and bedding.	**27%**	47%	**25%**
MRSA spreads via blood.	**26%**	49%	**25%**
MRSA spreads from animals to humans.	**23%**	**50%**	**27%**
MRSA spreads via pigs and cows.	**20%**	**50%**	**30%**
MRSA spreads via feces of animals.	**15%**	**53%**	**32%**
MRSA spreads via imported animals.	**12%**	**53%**	**35%**
MRSA spreads via dogs and cats.	**6%**	**53%**	**41%**

In the reservoir domain (see Table 5), there was 1 misconception within the 2 questions and there were 2 knowledge gaps. The large majority (92%) did not know MRSA spreads via hair or believed MRSA does not spread via hair, this was both a misconception and a knowledge

gap. There were no correct beliefs.

Table 5
Reservoir: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Reservoir			
MRSA occurs in the intestines and nose and pharynx.	**36%**	**55%**	9%
MRSA spreads via hair.	**8%**	**54%**	**38%**

In the risk factors domain (see Table 6 and Table 7), there were 6 misconceptions within the 20 questions and there were 9 correct beliefs. The large majority did not know or thinks having a chronic disease does not increase the chance to be an MRSA carrier, which is wrong (72%). Almost all of the general public does not know or incorrectly thinks that petting dogs does not improve the chance to be an MRSA carrier (96%) and antibiotic use does not improve the chance to get an MRSA infection (76%), which both is wrong. There were many correct beliefs, for example, the majority of the general public knows poor immunity is a risk factor for MRSA infection (81%), not only old people can become MRSA carrier (71%) and treatment or hospitalization increases the chance to be an MRSA carrier (67%). There were no knowledge gaps within the risk factors domain.

Table 6
MRSA Carriage Risk Factors: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
MRSA Carriage Risk Factors			
Healthy people never become MRSA carrier.	6%	27%	**67%**
Only old people can become MRSA carrier.	3%	26%	**71%**

Table 6
MRSA Carriage Risk Factors: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
MRSA Carriage Risk Factors			
The chance to be MRSA carrier, is increased by:			
An unhealthy lifestyle (such as little exercise and smoking)	**33%**	37%	**30%**
Overloading your muscles.	6%	44%	**50%**
Treatment or hospitalization.	**67%**	27%	6%
A recent foreign hospitalization	**60%**	33%	8%
Many people who are close to each other.	**50%**	35%	15%
Not washing your hands properly	**47%**	34%	20%
Flu (influenza)	**41%**	41%	18%
Skin conditions such as eczema, wounds, open wounds and burns.	**35%**	44%	22%
Having a chronic disease (rheumatoid arthritis, asthma, diabetes, renal failure and liver failure).	**28%**	44%	**28%**
Contact with living pigs, chickens and veal calves.	**24%**	45%	**31%**
Contact sports (like Judo).	**18%**	44%	**38%**

Table 6
MRSA Carriage Risk Factors: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
MRSA Carriage Risk Factors			
The chance to be MRSA carrier, is increased by:			
Petting dogs	**4%**	47%	**51%**

Table 7
MRSA Infection Risk Factors: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
MRSA Infection Risk Factors			
The probability of an MRSA infection is increased by:			
Poor immunity.	**81%**	17%	2%
Having direct contact with a patient with an MRSA infection.	**71%**	24%	5%
An surgical operation.	**65%**	28%	6%
A stay in a nursing home.	**56%**	35%	9%
Having an infusion or urinary catheter	**30%**	48%	22%
Antibiotic use.	**24%**	45%	**31%**

In the consequences domain (see Table 8), there were 2 misconceptions within the 4 questions, there was 1 correct belief and 1 knowledge gap. Almost all of the general public thinks an MRSA infection begins with a high fever or does not know what is right (93%), this

is both a knowledge gap and a misconception. The majority thinks a person may only leave the hospital if he/she is no MRSA carrier anymore (76%).

Table 8
Consequences: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Consequences			
A person may only leave the hospital if he / she is no MRSA carrier any more.	**38%**	38%	**24%**
An MRSA infection begins with a high fever, like flu.	**33%**	**61%**	**7%**
A person may die from a MRSA infection.	**51%**	41%	8%
Someone who is a MRSA carrier, needs to stay longer in the hospital than usual.	**45%**	40%	15%

In the prevention domain (see Table 9), there was 1 misconception within the 12 questions and there were 6 correct beliefs. The majority knows much about the domain prevention, for example that someone with an MRSA infection needs to be nursed in isolation (63%). The large majority does not know if cleaning your home properly reduces the chance to be an MRSA carrier or wrongly beliefs it reduces the chance (70%). And a smaller majority does not know or doesn't think washing your clothes properly can prevent MRSA carriage (62%). There were 2 knowledge gaps, regarding if an vaccination can prevent a MRSA infection (55%) or MRSA-carriage (55%).

Table 9

Prevention: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Prevention			
By cleaning your home properly, you reduce the chance to be an MRSA carrier.	**25%**	45%	**30%**
A vaccination can prevent a MRSA infection.	12%	**55%**	**33%**
A vaccination can prevent MRSA-carriage.	8%	**55%**	**37%**
When an animal licks me (like a dog/cat) I decrease the risk of MRSA carriage.	4%	46%	**50%**
Someone with a MRSA infection, needs to be nursed in isolation.	**63%**	31%	6%
When you visit someone in the hospital who is an MRSA carrier, you can prevent yourself from MRSA carriage by wearing self-protective clothing (such as disposable gloves, face mask).	**57%**	33%	10%
You can prevent MRSA carriage by wearing (disposable) gloves by wound care.	**56%**	32%	12%
You can prevent MRSA carriage by washing your hands.	**52%**	32%	16%

Table 9
Prevention: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Prevention			
You can prevent MRSA carriage by wearing self-protective clothing (such as disposable gloves, face mask).	**51%**	34%	15%
A recent foreign hospitalization is a reason to nurse someone in isolation.	**47%**	39%	15%
Someone who is a MRSA carrier, needs to be nursed in isolation.	**42%**	38%	20%
You can prevent MRSA carriage by washing your clothing.	**38%**	40%	22%

In the treatment domain (see Table 10), there were no misconceptions within the 6 questions and there were 2 correct beliefs. There were 2 knowledge gaps (33,3%). The majority does not know if most antibiotics are not working against MRSA, while a large group of the general public knows this is indeed true (42%) and only a few gave the incorrect answer (6%). The majority does not know or doesn't think that once you are a MRSA carrier, you'll ever lose it (75%) and does not know or doesn't think you can be treated when you are a MRSA carrier (60%).

Table 10
Treatment: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Treatment			
Once you are a MRSA carrier, you'll never lose it.	23%	**53%**	**25%**

Table 10
Treatment: Correct beliefs, misconceptions and knowledge gaps

Concept from the expert model	Probably/certainly true	Don't know	Probably/not true
Treatment			
By good hygiene (such as washing hands frequently) you can get rid of MRSA carriage.	17%	48%	**35%**
When someone has an MRSA infection, he/she can be treated for it.	**66%**	30%	5%
With proper treatment of an MRSA infection, the mortality rate is low.	**56%**	40%	3%
Most antibiotics do not work against MRSA.	**42%**	**53%**	6%
When someone is an MRSA carrier, he/she can be treated for it.	**41%**	44%	15%

Comparing the different domains (see Table 2-10), the general domain has in terms of percentage most misconceptions (75%). Route of infection (n=7) has most misconceptions in total and most knowledge gaps (n=6). In percentage terms, the reservoir domain has the most knowledge gaps (100%). The most correct beliefs in terms of percentage were in prevention (50%). The MRSA risk factor domain has most correct beliefs (n=9) and many misconceptions (n=6) as well.

3.3 Socio-demographic factors most knowledge versus least knowledge

In total, there were 8 statements and no questions which were answered correctly by less than 20% of the respondents (see Table 2-10).

3.3.1 Gender

Chi-square results show a statistically significant difference in knowledge level of: ‘’MRSA spreads via hair’’ and: ‘’The chance to be MRSA carrier, is increased by contact

sports (like Judo)'' among gender (see Table 11). Males appear to have more knowledge regarding these statements. There was no significant difference on the other 6 statements or questions.

Table 11
Results of Chi-Square Test of knowledge and gender

Statement	Correct belief n (%)	Don't know and misconception n (%)	χ^2	*p*
MRSA spreads via hair.				
Male	72 (9,2%)	714 (90,8%)	5.346	.021
Female	49 (6,1%)	756 (93,9%)		
The chance to be MRSA carrier, is increased by contact sports (like Judo).				
Male	160 (20,4%)	625 (79,6%)	8.547	.003
Female	119 (14,8%)	685 (85,2%)		

Note. Differentiation (df) = 1. Numbers in parentheses indicate column percentages.

3.3.2 Flu invitation vaccination

Chi-square results show a statistically significant difference in knowledge level of: ''MRSA spreads via pigs and cows'' and: ''The chance to be MRSA carrier, is increased by contact sports (like Judo)'' among flu vaccination invitation (see Table 12). These results suggest that the invitation flu vaccination group has more knowledge on: ''MRSA spreads via pigs and cows'' and less knowledge regarding: ''the chance to be MRSA carriers, is increased by contact sports (like Judo)''. There was no significant difference on the other 6 statements.

Table 12
Results of Chi-Square Test of knowledge and flu vaccination invitation

Statement	Correct belief n (%)	Don't know and misconception n (%)	χ^2	*p*
MRSA spreads via pigs and cows				
Flu vaccination invitation	144 (22%)	510 (78%)	4.500	.034
Non-Flu vaccination invitation	166 (17,7%)	770 (82,3%)		
The chance to be MRSA carrier, is increased by contact sports (like Judo).				

Flu vaccination invitation	96 (14,7%)	558 (85,3%)	6.579	.01
Non-Flu vaccination invitation	184 (19,7%)	752 (80,3%)		

Note. Differentiation (df) = 1. Numbers in parentheses indicate column percentages.

3.3.3 Age

An independent-samples t-test was conducted to compare age in knowledge level (see Table 13). These results suggest that age really does have an effect on knowledge level and a clear direction is seen. Specifically, our results suggest for all 4 statements that the older someone gets, the knowledge level lessens. There was no significant difference on the other 4 statements.

Table 13
Independent Samples T-test of knowledge level and age

Statement	**Correct belief n (%)**	**Age M (SD)**	**Don't know and misconception n (%)**	**Age M (SD)**	***p***
MRSA spreads via dogs and cats	91	40.22 (15.66)	1499	47.30 (15.97)	.000
MRSA spreads via imported animals	195	43.89 (16.46)	1395	47.32 (15.93)	.005
The chance to be MRSA carrier, is increased by petting dogs	71	38.27 (15.23)	1519	47.30 (15.96)	.000
The chance to be MRSA carrier, is increased by contact sports (like Judo)	280	43.02 (15.73)	1310	47.73 (15.98)	.000

Note. M = Mean; SD = Standard Deviation

3.3.4 Education level

A one-way between subjects ANOVA was conducted to compare the effect of knowledge level on education level in low, middle and high education level conditions. There was a significant effect of knowledge level for the three conditions on 6 of 8 statements (see Table 14). Only the statements: ‘’MRSA spreads via feces of animals’’ and: ‘’ An MRSA infection begins with a high fever, like flu’’, did not significantly differ on low, middle and high educated conditions. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the high educated condition was significantly higher than the low educated

condition on 6 of the 8 statements (see Table 14). Our results suggest if someone is high educated, it possesses more MRSA knowledge than someone who is low educated.

Table 14
One-Way Analysis of Variance and Tukey's HSD procedure of the three education levels and knowledge level.

Comparisons	**E low**	**E middle**	**E high**	***F*-ratio**	**Tukey's HSD**
MRSA spreads via pigs and cows					
Mean	1.15	1.20	1.23	3.69*	E high > E low*
SD	0.36	0.40	0.42		
MRSA spreads via dogs and cats					
Mean	1.03	1.06	1.09	6.37**	E high > E low***
SD	0.16	0.23	0.28		
MRSA spreads via imported animals					
Mean	1.08	1.13	1.14	4.91**	E high, E middle >
SD	0.27	0.34	0.35		E low*
MRSA spreads via hair					
Mean	1.03	1.08	1.10	7.27***	E high > E low***
SD	0.18	0.28	0.30		E middle > E low*
The chance to be MRSA carrier, is increased by petting dogs					
Mean	1.03	1.04	1.07	3.62*	E high > E low*
SD	0.17	0.20	0.25		
The chance to be MRSA carrier, is increased by contact sports (like Judo)					
Mean	1.11	1.17	1.24	10.29***	E high > E low***
SD	0.32	0.38	0.43		E high > E middle**
					E middle > E low**

Note. E = educational level; SD = Standard Deviation; degrees of freedom (df) *F*-ratio = 2, 1586; * $p<.05$; ** $p<.01$; *** $p\leq.001$

3.3.5 Urbanity

A one-way between subjects ANOVA was conducted to compare the effect of knowledge level on urbanity in not urbanized, low urbanized, moderate urbanized, highly urbanized and very highly urbanized conditions. There was a significant effect of urbanity on correct knowledge of: ‘’MRSA spreads via pigs and cows’’ at the p<.05 level for the five conditions [F(4, 1583) = 3.14, p = 0.014]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the very highly urbanized was significantly different than the not urbanized condition (MD = -.10630). However, the other conditions (low urbanized, moderate urbanized and highly urbanized) did not differ. There were no significant effects regarding urbanity on the other statements. These results suggest there are no clear differences in knowledge level regarding urbanity.

3.4 Germ Aversion

The general public had a mean (SD) score of 3.74 (.86) on Germ Aversion towards disease, this means the general public shows moderate emotional discomfort towards disease-connoting situations.

3.5 Perceived Infectability

The general public had a mean (SD) score of 3.22 (1.04) on Perceived Infectability Towards disease, this means the general public shows moderate beliefs about personal susceptibility and thus feel moderate susceptible to the transmission of infectious diseases.

The flu vaccination invitation group (n=654) had a mean (SD) score of 3.38 (1.1) and the non-flu vaccination invitation group (n=936) had a mean (SD) score of 3.11 (.97). A Kolmogorov-Smirnov test clarified no normal distribution in mean difference on Perceived Infectability between the flu vaccination invitation group (D= .074, p = .000) and the non-flu vaccination invitation group (D = .078, p = .000). A Mann-Whitney test indicated that the flu vaccination invitation group with a Median (IQR) of 3.28 (1.57) has stronger beliefs about personal infectability and thus feels more susceptible to the transmission of infectious diseases than the non-flu vaccination invitation group with a Median (IQR) of 3(1), U = 335628.5, p = .000.

3.6 MRSA risk perception

The general public had a mean (SD) score of 2.69 (.59) on risk perception regarding MRSA. Thus, the general public beliefs the risks and the consequences of MRSA in their

living environment are between fairly small and not small/not big.

The flu vaccination invitation group (n=654) had a mean (SD) score of 2.69 (.63) and the non-flu vaccination group (n=936) had a mean (SD) score of 2.68 (.57). A Kolmogorov-Smirnov test clarified no normal distribution in mean difference on risk perception between the flu vaccination invitation group (D= .111, p = .000) and the non-flu vaccination invitation group (D = .172, p = .000). A Mann-Whitney test indicated that there is no significant difference on risk perception between the flu vaccination invitation group with a Median (IQR) of 2.83 (.67) and the non-flu vaccination invitation group with a Median (IQR) of 2.83 (.67), U = 379111,5; p = .849.

3.7 MRSA information seeking intention and resource use

The large majority (n=1086; 68%) intends to search for information when they see, read or hear something about MRSA (see Table 15). A large group will not search for information (n=504). The majority (61%; n=965) of the general public uses at least the internet as a resource when they see, read or hear something about MRSA. This is by far the resource most used by the general public (89%).

Table 15

Sources of information general public

Sources of information	n (%)	Percentage of total using resources
Internet	965 (61%)	89%
General practitioner	315 (20%)	29%
Newspapers	173 (11%)	16%
GGD	136 (9%)	13%
RIVM	101 (6%)	9%
Will not search for information	504 (32%)	

The flu vaccination invitation group makes significantly more use of the general practitioner (see table 16; $\chi(1) = 8.229$, p = .004) and the newspaper ($\chi(1) = 38.120$, p = .00) as a source of information in contrast to the non-flu vaccination invitation group. There are no significant differences for the other sources.

Table 16

Sources of information flu vaccination invitation group versus non-flu vaccination invitation group

Sources of information	**Flu vaccination invitation n (%)**	**Non-flu vaccination invitation n (%)**	***p***
Internet	403 (25%)	562 (35%)	.551
General practitioner	152 (10%)	163 (10%)	**.004***
Newspapers	109 (7%)	64 (4%)	**.00***
GGD	56 (4%)	79 (5%)	.931
RIVM	50 (3%)	51 (3%)	.077
Will not search for information	191 (12%)	313 (20%)	.064

4. DISCUSSION

This study has been conducted to systematically determine the Dutch general public's beliefs, misconceptions and knowledge gaps; together with risk perception, information seeking intention and resource use concerning MRSA, and perceived vulnerability towards disease in general, all on a large scale following the mental model approach, in order to develop effective risk communication strategies to prevent the general public and in particular the at-risk groups from getting infections by MRSA in case of outbreaks.

Our data revealed that the Dutch general public has many commonly held correct beliefs regarding MRSA, in particular for risk factors and prevention measures. This might be due to MRSA risk factors and prevention measures also holding for general health threats. Interestingly there was only one commonly held correct belief with over 80% of the general public having this correct belief, showing a lack of knowledge and ignorance. The study of Verhoeven et al. (2010) was similar to the current study, by using the mental models approach and applying it to the subject of MRSA, but differs by asking quite a few different and more questions and is limited by including a small number of respondents, mainly consisting of highly educated young people and thus not having a representative sample of the Dutch population. Despite these limitations, the study of Verhoeven et al. (2010) showed surprisingly similar results, with most commonly held correct beliefs in the risk factors and prevention measures domain as well. In addition, the Dutch general public has many misconceptions, mostly in the general, route of infection, reservoir and consequences domain. Verhoeven et al. (2010) had the most misconceptions in the general and consequences domain as well, but had no route of infection domain because of an different expert-model and had no misconceptions in reservoir, probably due to different items used.

To a lesser extent, commonly held knowledge gaps are present, especially regarding the domains route of infection and reservoir. Unfortunately Verhoeven et al. (2010) did not describe their knowledge gaps. Since the correct beliefs and misconceptions are very alike, we can assume there are no big differences regarding knowledge gaps. Generally the correct beliefs and misconceptions of the Dutch general public of the study of Verhoeven et al. (2010) have sustained into present time, this can be explained because there have been no interventions in the meantime. The quantities of misconceptions and knowledge gaps prove risk communication strategies are needed, focusing on the above domains and starting with the general domain, by explaining what MRSA exactly is.

By looking at statements where a very high percentage of the general public has misconceptions and knowledge gaps and therefore possesses no (or false) knowledge, the

domain route of infection is most present, followed by risk factors, consequences and reservoir. Zooming in on socio-demographics, males seem to have slightly more knowledge than females. Regarding age, people aged around 47-48 seem to have significant less knowledge than people aged around 38-44. Furthermore, high educated people have far more knowledge of MRSA than low educated people. Although there was no significant difference on most statements, there were no differences between the at-risk YOPI group and the non-at risk group and only one small difference on urbanity. In developing risk communication, low educated people and to a lesser extent females and people aging around 47-48, are the hard-to-reach group, and require special attention by giving them other and more information, especially in the domains route of infection, risk factors, consequences and reservoir.

Studies investigating the general public's awareness are scarce. Only a few other studies could be identified that particularly investigated the general public's awareness (Brinsley-Rainisch, Cochran, Busch-Knapp & Pearson, 2007; Easton et al., 2008; De Giusti et al. 2011). The study of Brinsley-Rainisch et al. (2007) was qualitative and directed at regular S. aureus infections, rather than MRSA in particular and thus to limited to base effective risk communication upon (Brinsley-Rainisch et al. 2007). Easton et al. (2008) used a shorter survey with different questions, which are not compatible with the current study. De Giusti et al. (2011) examined knowledge, attitude and behavior in relation to MRSA skin infections of Italian medical and public health technician students and their family members, cohabitants and friend groups were seen as the general population, which was too small and too biased to base hard evidence up on.

The Dutch general public has moderate Perceived Vulnerability to disease, they show moderate emotional discomfort towards disease-connoting situations (Germ Aversion) and moderate personal susceptibility to the transmission of infectious diseases (Perceived Infectability). There is no need for direct action to lessen the emotional discomfort and personal susceptibility, while they are healthy and being in line with the original study of Duncan et al. (2009), where a smaller, younger and higher educated sample of the Dutch population (recruited at Groningen University) had moderate Perceived Vulnerability as well. Díaz, Soriano and Beleña (2016) state season of the year and disease prevalence in the environment should be taken into account in any study concerning Perceived Vulnerability to disease, because any change in these variables could lead to different results. When disease prevalence in the Netherlands rises, future research can use the results of the current study to determine if there is an disproportionate increase in Perceived Vulnerability and thus a call to action to provide adequate information for other infectious diseases.

Comparing the at-risk YOPI group for getting infected by MRSA with the non-at risk group on Perceived Infectability, confirmed the hypotheses; the at-risk group feels more susceptible to the transmission of infectious diseases than the non-at risk group. Demonstrating there is a need for more and different risk communication for the at-risk group in comparison to the non-at risk group, who should not be unnecessarily frightened by receiving information not intended for them. However, the general public beliefs the risks and consequences of MRSA are small and there is no difference in MRSA risk perception between the groups, meaning the at-risk YOPI group feels more susceptible to infectious diseases in general, but does not see MRSA as a cause for infectious diseases. Combined with many misconceptions, knowledge gaps and small MRSA risk perception, it enforces the underestimation of the risks and consequences of MRSA by the general public, with the at-risk group in particular, and the need for risk communication strategies to focus on providing information and raising awareness.

The large majority will search for information by using at least the internet and future risk communication strategies should definitely make use of this resource. The at-risk YOPI group makes significantly more use of the newspaper and the general practitioner as resources in comparison to the non-at risk group. This can be helpful in designing risk communication, by making (non-) use of these sources for information provision, depending upon the target group chosen.

Earlier the study of Verhoeven et al. (2010) was mentioned as being not representative, because of lacking a representative sample of the Dutch population. This study counteracted these limitations by using a professional agency (Motivaction), making use of their 65.000 panel members in combination with their propensity method, to retrieve a representative selection of at least 1500 people of the Dutch general public.

To our knowledge, this study is first to examine the socio-demographics of the general public possessing least knowledge of MRSA, giving us valuable insights into the hard-to-reach group.

Using the Mental Model Approach to systematically determine the Dutch general public's beliefs by combining the expert-model with people's (in)correct beliefs about MRSA, benefited the public to a large extend. Without using the expert-model, not all domains (and topics) of MRSA would be covered. And without using the interviews with people to discover their (in)correct beliefs of MRSA, many misconceptions and knowledge gaps would not be discovered by the survey, which would result in risk communication

strategies only covering a small area of the needs of the public and lead to an ineffective intervention.

Our study has a few limitations. The cut-off points of commonly held correct beliefs, misconceptions and knowledge gaps are somewhat arbitrary, but have proven to be clear and useful in earlier studies (Smith et al., 2004). Despite thorough investigation and reviewing experts, some of the questions could be arguable, like: ‘’MRSA *only* occurs in hospitals’’. This is a catch-question, because MRSA is also called: ‘’the hospital bacteria’’ and *often* occurs in hospitals and this can be confusing for the respondents. Next, the questions and statements in the questionnaire are not divided equally between the domains, with the smallest domain: ‘’reservoir’’ possessing only 2 questions and the largest domain: ‘’risk factors’’ having 20 questions, making comparisons between some of the domains difficult. The difference in proportion is caused by the need to provide meaningful questions and statements, independently at which domain they belong and choices needed to be made between quality and quantity. In addition, the experts were not asked what would be most important information for the general public, especially precautions and prevention measures to avoid MRSA colonization and/or infection. Although this might be unfortunate, as in accordance to the Mental Model Approach (MMA), the experts need to be involved in designing the risk communication strategies and this step can easily be added in the process.

To our knowledge, this is the first study to examine risk perception on the level of the general public and also the first study to investigate the information seeking intention and resource use of the general public regarding MRSA. Earlier, risk perception regarding MRSA was only studied on the patient/healthcare personnel level (Gill, Kumar, Todd, Wiskin, 2006; Kouabenan, Dubois, Gaudemaris, Scarnato & Mallaret, 2007).

In the current situation many misconceptions and knowledge gaps in the general public are not a serious threat in preventing infections by MRSA. It only is a threat for MRSA colonized people who are unaware of their increased risk of MRSA causing infections in the YOPI-group. It is frightening the majority of the general public does not know or thinks MRSA does not occur in cattle, people working or living in the livestock sector aren’t aware they pose a risk to others. For example, people working at cattle cow farms or working with pigs have a high chance of MRSA colonization and probably aren’t aware they should wash their hands regularly and not hug their grandma who received total hip replacement surgery. Besides giving these groups special attention in creating risk communication strategies, future research can be directed at people working in the livestock sector and the YOPI group, to

explore if they are aware of their vulnerable position by explicitly investigating their mental models, for example in situations where there is a risk of contamination.

In the case of an outbreak, the misconceptions and knowledge gaps can transform immediately into a very serious threat by fear of the unknown. Fear of SARS (Severe Acute Respiratory Syndrome) arose from the underlying anxiety about a disease with an unknown cause and possible fatal outcome with print media, television and the internet reporting dramatic stories and increasing fear (Person, 2004). Fear of Ebola caused people who had contact with infected persons to escape from the surveillance system, relatives to hide symptomatic family members or take them to traditional healers, and patients to flee treatment centers. Studies have shown that during serious disease outbreaks, when the general public requires immediate information, a subgroup of the population that is at potentially greater risk of experiencing fear, stigmatization, and discrimination will need special attention from public health professionals (Markel, 1997; McClain, 1994). Within the current study, the YOPI-group could be this subgroup and require special attention in case of an outbreak.

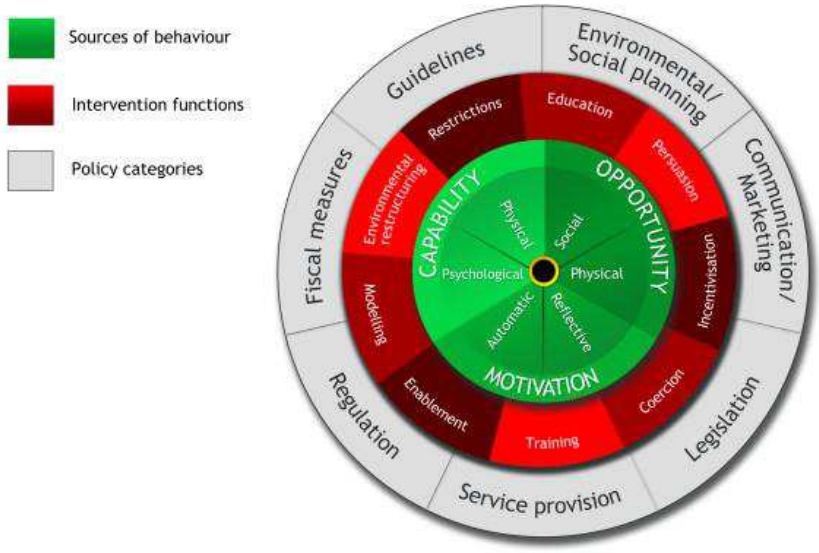
A number of recommendations based on the findings in this study can be made in developing risk communication strategies. The Dutch general public uses internet as a main source of MRSA information. This is very useful information, by making sure the risk communication strategies are accessible by the internet and using eHealth would be a perfect fit. By using eHealth, engineers applying a technology-driven approach in the creation of design requirements is a common problem (Van Velsen, Wentzel & Van Gemert-Pijnen, 2013). EHealth technology can only be effectively used when it is developed by a multi-disciplinary team who apply a human-centered approach that takes the specifics of the context (both organizational and that of the individual user) in which the technology is to be used into account (Pagliari, 2007). An human-centered approach includes user-involvement from as early as possible (Van Velsen et al., 2013). Participatory development of eHealth technologies is used to maximize the fit between the technology, its intended users and other stakeholders like payers, providers, decision-makers and the environmental context in which the technology is used and is necessary to make effective use of eHealth (Yusof, Papazafeiropoulou, Paul & Stergioulas, 2008).

The CeHRes (Center for eHealth Research) Roadmap (Van Gemert-Pijnen et al., 2011) is an holistic framework, has an human-centered approach and can be used to help plan, coordinate and execute the participatory development process of eHealth and serve as a platform for developing risk communication strategies. Using the Roadmap is meaningful, because without the holistic approach, eHealth technologies run the risk of being ineffective

to support healthy behavior (Van Gemert-Pijnen, 2013). Using the input from prospective end-users and involving them in the design process leads to better user performance in health care environments, enhances user satisfaction and usage, and improves system acceptance (Nijland & Verhoeven, 2013). The Roadmap makes uses of ‘’Personas’’; hypothetical ‘’archetypes’’ of end-users (van Gemert-Pijnen et al., 2011). Personas are a brief summary of end-users, presented by the biography of a person and can be created by carrying out open-ended interviews. Because they are at higher risk, it will be necessary to interview the livestock sector, the at-risk YOPI group and, because they are hard to reach, low educated people regarding MRSA and create Personas for them. Further following the Roadmap, the output of the open-ended interviews will be translated into user requirements (Van Velsen et al., 2013). User requirements of the design can be the at-risk group for MRSA colonization (e.g. cattle farmers) being aware they are a risk for the YOPI group and the YOPI group themselves being aware they are at risk. Furthermore, the need of these groups for information about prevention measures (e.g. washing hands, wash clothing) and the need of the general public for unfrightening information during an MRSA outbreak are probably user requirements. Experts should be involved to determine which misconceptions and knowledge gaps are most important and need to be influenced for the general public in case of an outbreak and in the current situation for the livestock sector and the YOPI group. Creating a website or maybe enhancing the website of www.mrsa-net.nl would be an easy way to start the eHealth design process. Future research should see this as a possibility, but above all keep the options wide open, depending on the participatory development and human-centred design process.

Improving the implementation of evidence-based practice and public health depends on behavior change (Michie, van Stralen and West, 2011). Effectively implementing risk communication strategies needs behavioral change methods, to fill up the most important knowledge gaps and change misconceptions. Simply giving the right information will not work. Michie et al. (2011) developed the Behaviour Change Wheel (BCW) from various frameworks of behavioral change identified in a systematic literature review and the BCW has been found to be a robust starting point for designing interventions and planning policy (Michie, Atkins & West, 2014). It consists of three components (see figure 1).

Figure 1: Behaviour Change Wheel (Michie, van Stralen & West, 2011)



The hub identifies the sources of the behavior that could prove effective targets for the intervention by using the COM-B (Capability, Opportunity, Motivation and Behavior) model. The COM-B model recognizes behavior is part of an interacting system involving all these components (Michie et al., 2011). Capability is a person's possession of physical and psychological skills to perform the new behavior. Opportunity refers to the capability of the physical and social environment to make the person feel able to undertake the new behavior. Motivation are the person's conscious and automatic processes which underline the performance of any behavior. Interventions need to change one or more of these components to positively change they system and put it into a new configuration (Michie et al., 2011). By using the Mental Model Approach, the current study mainly focused on the ''Capability'' component by exploring if the general public possesses the necessary knowledge (psychological skills) as an indicator to perform the new behavior in the current situation and in case of an outbreak. The FRIS-model showed some insights in the ''Motivation'' component, for example by MRSA risk perception, but was too limited to base conclusions upon. Future research should make use of all three components to explore what conditions internal to the individual and in their social and physical environment need to be in place for the at-risk group for MRSA colonized people and the YOPI-group to carry out the correct preventive measures in the current situation and for the whole general public in case of an outbreak. An extended version of the FRIS-model direct at MRSA and open-ended interviews could be valuable methods to use here.

Surrounding the hub of the BCW is a layer of nine intervention functions to choose from based on the COM-B analysis (Michie et al., 2011). Although further research is necessary for the analysis, in the context of the current study: ‘’Education’’, ‘’Persuasion’’ and ‘’ Environmental restructuring’’ could be affective intervention functions. Education can be effective in increasing the knowledge of the general public by imparting knowledge and developing understanding. It is meaningful to make an distinction on education level within the use of eHealth technology, while low educated people know far less of MRSA in comparison to middle and high educated people. With the general public having a lack of knowledge and small MRSA risk perception, Persuasion, using communication to induce positive or negative feelings or stimulate action, can be an intervention function to reach an adequate knowledge level of MRSA, so estimate the MRSA risk perception better, by showing the at-risk group what the consequences are if they get into close contact with people with MRSA colonization. Environmental restructuring, changing the physical or social context, can be a valuable addition for the at-risk group and cattle cow farmers in the current situation. The general practitioner (GP), second most important resource of MRSA information, can be provided with on-screen prompts to provide information of prevention measures in case someone visits who had surgery and is within the at-risk group for infection.

The outer layer of the BCW identifies seven policy categories which support the delivery of the intervention functions (Michie et al., 2011). Future research should certainly make use of the policy: ‘’Communication/marketing’’ by using the internet. For example an mass media campaign can be used, creating awareness within the at-risk groups for colonization and infection. Other policies should be taken into consideration, depending on the COM-B analysis.

The intervention functions Education and Persuasion already show a distinction in approach in filling up knowledge gaps (Education) and changing misconceptions (Persuasion). Where knowledge gaps can be filled up by presenting the unknown information, misconceptions need to be corrected (Vasilyeva, De Bra, Pechenizkiy & Puuronen, S., 2008). Specific tailoring is mainly used to solve misconceptions (Rimer et al., 1994). Oinas-Kukkonen and Harjumaa (2009) created a framework for Persuasive Systems Design (PSD) for developing and evaluating persuasive systems by making use of eHealth, as well as describing what kind of content and software functionality may be found in the final product (Oinas-Kukkonen & Harjumaa, 2009). It benefits in persuading end users to increase their interest in health issues, increase their knowledge, change their attitudes and behavior. The PSD model makes use of design principles, which are the system requirements to induce

behavioral change (Oinas-Kukkonen & Harjumaa, 2009). Tailoring is one of those principles, consisting of information provided by the system being more persuasive if it is tailored to the potential needs, interests, personality and other factors relevant to the user group. Therefore, distinctions in tailoring need to be made between low educated people and the middle and high educated people. Differences on age and gender are too small, so there is no need to make distinctions here. Furthermore the at-risk YOPI-group and the livestock sector do require more information, for example regarding prevention measures, and the non-at risk groups less; in order to not unnecessary frighten the non-at risk group. This can be done by for example an website where you fill in your socio-demographic data and the website gives you specific tailored information. Where low educated people receive more pictures and videos in comparison to high educated people. Future research can explore other socio-demographics in differences of MRSA knowledge level, for instance family size and religion, to see if they require different information provision.

In addition, when there is an MRSA outbreak, the general public needs a source which gives them correct and trustworthy information to protect them from incorrect information, like: ‘’Facebook’’ (Wise, Alhabash & Park, 2010). The design principle ‘’trustworthiness’’ provides this, by creating a system that is viewed as trustworthy, to possess increased powers of persuasion (Oinas-Kukkonen & Harjumaa, 2009). The system should provide truthful, fair and unbiased information, this can be done by showing on screen the Ministry of Health Care and/or a microbiologist is the source of the information. In addition, making the general practitioner aware of the eHealth technology and recommend them to the Dutch general public, can improve trustworthiness. The PSD-model contains various other design principles, which can be used in creating the risk communication strategies, depending on the findings of the COM-B analysis.

Overall, our findings made the Dutch general public’s mental models, perceived vulnerability, risk perception, information seeking intention and resource use, explicit. These results are an important step towards a safer and healthier society by showing us where the knowledge gaps and misconceptions are and where the focus needs to be in preventing the general public and the at-risk groups from getting infections by MRSA, especially in case of outbreaks. To reach this aim, eHealth technology should be used and there should be user-involvement from as early as possible in the design of risk communication strategies to ensure a fit between users and the eHealth technology (Nijland & Verhoeven, 2013; Van Velsen et al., 2013). The CeHRes Roadmap can be used to design the technology and the BCW framework can be used to change incorrect mental models, meaning filling up the knowledge

gaps and changing the misconceptions, of the Dutch general public. In addition, the PSD model is necessary to effectively fill up the knowledge gaps and change the misconceptions by giving special attention to the at-risk groups for colonization and infection and the hard to reach group (low educated people).

5. CONCLUSION

Overall, our findings highlight the need for the systematic analysis of the public's mental models prior to designing risk communication. We could not have foreseen the misconceptions that respondents came up with, which are in several cases supported by the majority of the Dutch general public. Furthermore, the correct beliefs and knowledge gaps gave insights in where the focus should be in risk communication. The general public made clear they underestimate the risks of MRSA and we need to wake them up by using eHealth technology, provide them with information and raise awareness. The results of this study can be used to fill up the knowledge gaps and solve the misconceptions by using eHealth and designing risk communication strategies using the CeHRes Roadmap. In a participatory process, which is user-based, it is more likely that the stakeholders develop a shared understanding of concept and language used by each other. The subgroups of low educated people, the people at-risk for getting MRSA infections (YOPI-group) and MRSA colonization (e.g. cattle cow farmers) need to be involved in the design process. An website seems like an easy platform for an intervention, but other types of interventions should be taken into consideration while the design process is in its infancy. The Behaviour Change Wheel (BCW) should be used as a framework to effectively implement risk communication strategies by using behavioral change methods to fill up the most important knowledge gaps and solve the misconceptions. The BCW has been found to be a robust starting point for designing interventions and planning policy and makes sure important elements will not be forgotten in the designing process. Open-ended interviews need to be done with the Dutch general public, and especially the low educated and the at-risk groups for MRSA infections and colonization, executing the COM-B (Capability, Opportunity, Motivation and Behavior) analysis. Specific tailoring for knowledge gaps and especially misconceptions is important and the PSD (Persuasive System Design) model can be used in this context. Future work should also make use of other design principles of the PSD model.

When disease prevalence in the Netherlands rises, future research can use the results of the current study to determine if there is an disproportionate increase in Perceived Vulnerability and thus a call to action to provide risk communication strategies for prevention measures and infection control of infectious diseases.

Future research should make use of the mental model approach to develop effective

risk communication strategies for other emerging zoonosis or possible (new) health threats. Although the mental model approach is very thorough and is time- and cost-intensive, it is worth the investment, since adequate risk communication will be effective on the long term. Unfortunately, the results of the current study are only representative for the Dutch general public, for example because of cultural differences and different policies between countries. The search-and-destroy policy is not common in most foreign countries, which immediately results in different expert-models because of different prevention measures. Despite these differences, countries like Romania, Brazil and the United States (where MRSA infection rates are high) should make use of the mental model approach to lower these rates.

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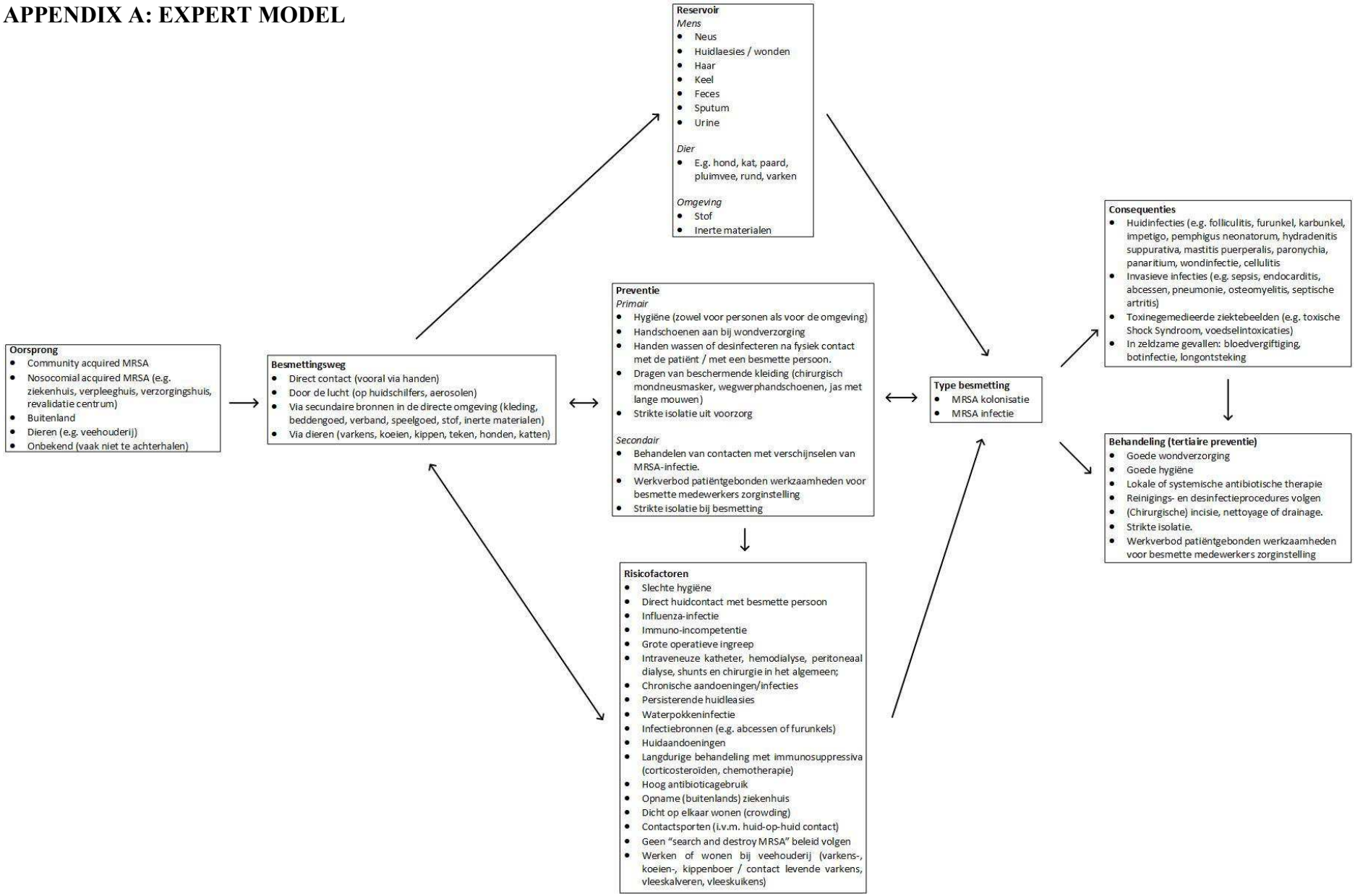
APPENDIX A: EXPERT MODEL



APPENDIX B: MRSA SURVEY

Deze vragenlijst is onderdeel van een onderzoek van de Universiteit Twente naar de ideeën van de Nederlandse bevolking over "MRSA". Ook als u helemaal niets weet over dit onderwerp, kunt u meedoen.

Het is de bedoeling dat u bij iedere vraag aangeeft of u het wel of niet eens bent met de gegeven stelling. Er zijn in deze vragenlijst geen foute antwoorden mogelijk. Alle informatie is belangrijk en nuttig voor ons onderzoek.

Uw antwoorden zullen anoniem blijven. U hoeft in deze vragenlijst nergens uw naam in te vullen.

Het is belangrijk de vragenlijst pagina voor pagina te doorlopen. U kunt daarom tussendoor niet terug bladeren naar eerder gegeven antwoorden.

De vragenlijst bestaat uit 10 onderdelen. Het invullen kost ongeveer 20 minuten.

Leest u alstublieft de instructies voorafgaand aan de vragen goed door.

ALVAST HARTELIJK DANK VOOR UW MEDEWERKING!

Ik weet dat meedoen aan dit onderzoek helemaal vrijwillig is. Ik weet dat ik op ieder moment kan beslissen toch niet mee te doen, zonder daarvoor een reden op te geven.

Ik geef hierbij toestemming dat mijn gegevens anoniem mogen worden gebruikt voor onderzoeksdoeleinden.

Ja, ga verder naar de vragenlijst.

Onderstaande stellingen gaan over hoe kwetsbaar u zich voelt voor ziektes. Geef voor de volgende stellingen aan in hoeverre u het eens bent met de stelling. Klik op het antwoord van uw keuze (Perceived Vulnerability towards Disease Questionnaire Duncan, Schaller & Park, 2009).

1. Het stoort me wanneer mensen niezen zonder hun mond te bedekken.
2. Als een ziekte heerst, krijg ik het ook.
3. Ik vind het prima om een waterflesje te delen met een vriend(in). (R)
4. Ik houd er niet van om met een potlood te schrijven waar iemand anders op heeft gekauwd.
5. Uit ervaring weet ik dat ik niet snel ziek word, zelfs als mijn vrienden ziek zijn. (R)
6. Ik ben altijd vatbaar geweest voor infectieziekten.
7. Na het schudden van iemands hand, was ik graag mijn handen.
8. Over het algemeen ben ik erg vatbaar voor verkoudheden, griep, en andere infectieziekten.
9. Ik houd er niet van om tweedehands kleding te dragen, omdat je niet weet wie het daarvoor droeg.
10. Ik heb meer kans dat ik een infectieziekte oploop, dan de mensen om mij heen.
11. Mijn handen voelen niet vies na het aanraken van geld. (R)
12. Het is onwaarschijnlijk dat ik een verkoudheid, griep, of andere ziekte krijg, zelfs als het heerst. (R)
13. Het maakt me niet angstig wanneer ik me tussen zieke mensen begeef. (R.)
14. Mijn immuunsysteem beschermt me tegen de meeste ziekten die andere mensen krijgen. (R)
15. Ik vermijd het gebruik van andermans telefoon of tablet, omdat ik iets zou kunnen oplopen van de vorige gebruiker.

Antwoordmodel: 1 = sterk mee oneens … 7 = sterk mee eens

(R) = omgekeerde score

Subschaal 1 (Waargenomen Infecteerbaarheid): Items 2, 5, 6, 8, 10, 12, 14

Subschaal 2 (Ziektekiem Aversie): Items 1, 3, 4, 7, 9, 11, 13, 15

Domeinen verspreiding MRSA

Voor deze vragenlijst worden stellingen voorgelegd, geef vervolgens voor de volgende stellingen aan in hoeverre u denkt dat deze waar zijn. Klik op het antwoord van uw keuze. We willen weten wat u denkt, u kunt het niet verkeerd doen.

ANTWOORDMOGELIJKHEDEN

1 Niet waar
2 Waarschijnlijk niet waar.
3 Geen idee.
4 Waarschijnlijk waar.
5 Waar

1. Algemeen

	NIET WAAR				WAAR
1.1 MRSA is een ziekte.	1	2	3	4	5
1.2 MRSA is een besmettelijke ziekte.	1	2	3	4	5
1.3 MRSA is een virus.	1	2	3	4	5
1.4 MRSA is een bacterie.	1	2	3	4	5

2. Oorsprong

	NIET WAAR				WAAR
2.1 MRSA komt voor onder de bevolking.	1	2	3	4	5
2.2 MRSA komt alleen voor in ziekenhuizen.	1	2	3	4	5
2.3 MRSA komt voor in scholen.	1	2	3	4	5
2.4 MRSA komt voor in verpleeghuizen.	1	2	3	4	5
2.5 MRSA komt voor bij vee, zoals varkens, kippen en kalveren.	1	2	3	4	5
2.6 In sommige ziekenhuizen komt MRSA altijd voor.	1	2	3	4	5

3. Besmettingsweg

	NIET WAAR				WAAR
3.1 MRSA verspreidt zich door insectenbeten.	1	2	3	4	5
3.2 MRSA verspreidt zich door direct huid-op-huid contact.	1	2	3	4	5
3.3 MRSA verspreidt zich via de lucht.	1	2	3	4	5
3.4 MRSA verspreidt zich van dier op mens.	1	2	3	4	5
3.5 MRSA verspreidt zich door ratten en muizen.	1	2	3	4	5
3.6 MRSA verspreidt zich door varkens en koeien.	1	2	3	4	5
3.7 MRSA verspreidt zich door honden en katten.	1	2	3	4	5
3.8 MRSA verspreidt zich door kleding en beddengoed.	1	2	3	4	5
3.9 MRSA verspreidt zich door geïmporteerde dieren.	1	2	3	4	5
3.10 MRSA verspreidt zich via bloed.	1	2	3	4	5
3.11 MRSA verspreidt zich via uitwerpselen van dieren.	1	2	3	4	5
3.12 MRSA verspreidt zich via speeksel.	1	2	3	4	5

4. Reservoir

	NIET WAAR				WAAR
4.1 MRSA komt voor in de darmen en de neus- en keelholte.	1	2	3	4	5
4.2 MRSA verspreidt zich via het haar.	1	2	3	4	5

De normale plek waar een MRSA bacterie bij mensen woont is in de neus, dit noemen we MRSA-dragerschap en veroorzaakt geen klachten. Bij een MRSA-infectie daarentegen, heeft iemand wel klachten.

5. Risicofactoren

	NIET WAAR				WAAR
5.1 Gezonde mensen worden nooit MRSA-drager.	1	2	3	4	5
5.2 Alleen oude mensen kunnen MRSA-drager worden.	1	2	3	4	5

5.3 De kans om MRSA-drager te worden, wordt groter door:	NIET WAAR				WAAR
- Overbelasting van je spieren.	1	2	3	4	5
- Een ongezonde levensstijl (zoals weinig bewegen en roken).	1	2	3	4	5
- Een recente buitenlandse ziekenhuisopname.	1	2	3	4	5
- Veel mensen die dicht bij elkaar zijn.	1	2	3	4	5
- Het aaien van honden.	1	2	3	4	5
- Huidaandoeningen, zoals eczeem, verwondingen, open wonden en brandwonden.	1	2	3	4	5
- Behandeling of opname in een ziekenhuis.	1	2	3	4	5
- Griep (Influenza)	1	2	3	4	5
- Contactsporten (zoals judo).	1	2	3	4	5
- Niet goed je handen wassen.	1	2	3	4	5
- Het hebben van een chronische aandoening (reuma, astma, diabetes, nierfalen en leverfalen).	1	2	3	4	5
- Het contact met levende varkens, kippen of vleeskalveren.	1	2	3	4	5

5.4 De kans op een MRSA-infectie wordt groter door:	NIET WAAR				WAAR
- Een zwakke weerstand.	1	2	3	4	5
- Een operatie.	1	2	3	4	5
- Een verblijf in een verpleeghuis.	1	2	3	4	5
- Antibiotica gebruik.	1	2	3	4	5
- Het hebben van een infuus of urinewegkatheter.	1	2	3	4	5
- Direct contact hebben met een patiënt met een MRSA-infectie.	1	2	3	4	5

6. Consequenties

	NIET WAAR				WAAR
6.1 Een MRSA-infectie begint met hoge koorts, net als griep.	1	2	3	4	5
6.2 Iemand die MRSA-drager is, moet langer in het ziekenhuis blijven dan normaal.	1	2	3	4	5
6.3. Iemand mag pas het ziekenhuis verlaten als hij/zij geen MRSA-drager meer is.	1	2	3	4	5
6.4 Van een MRSA-infectie kan iemand doodgaan.	1	2	3	4	5

7. Preventie

	NIET WAAAR				WAAR
7.1 Iemand die MRSA-drager is, moet geïsoleerd worden verpleegd.	1	2	3	4	5
7.2 Iemand die een MRSA-infectie heeft, moet geïsoleerd worden verpleegd.	1	2	3	4	5
7.3 Een recente buitenlandse ziekenhuisopname is een reden om iemand geïsoleerd te verplegen.	1	2	3	4	5
7.4 Een inenting kan MRSA-dragerschap voorkomen.	1	2	3	4	5
7.5 Een inenting kan een MRSA-infectie voorkomen.	1	2	3	4	5
7.6 Je kunt MRSA-dragerschap voorkomen, door zelf beschermende kleding te dragen (zoals wegwerphandschoenen, mondkapje).	1	2	3	4	5
7.7 Je kunt MRSA-dragerschap voorkomen, door je handen te wassen.	1	2	3	4	5
7.8 Je kunt MRSA-dragerschap voorkomen, door je kleding te wassen.	1	2	3	4	5
7.9 Je kunt MRSA-dragerschap voorkomen, door (wegwerp) handschoenen te dragen bij wondverzorging.	1	2	3	4	5
7.10 Wanneer je in het ziekenhuis iemand bezoekt die MRSA-drager is, kun je MRSA-dragerschap bij jezelf voorkomen door zelf beschermende kleding te dragen (zoals wegwerphandschoenen, mondkapje).	1	2	3	4	5

7.11 Door je huis goed schoon te maken verlaag je de kans om MRSA-drager te worden. 1 2 3 4 5
7.12 Wanneer een dier mij likt (zoals een hond/kat) verlaag ik de kans op MRSA-dragerschap. 1 2 3 4 5

8. Behandeling

	NIET WAAR				WAAR
8.1 Wanneer je eenmaal MRSA-drager bent, kom je er nooit meer vanaf.	1	2	3	4	5
8.2 Door een goede hygiëne (zoals regelmatig handen wassen) kun je van MRSA-dragerschap afkomen.	1	2	3	4	5
8.3 Wanneer iemand MRSA-drager is, kan hij/zij daarvoor behandeld worden.	1	2	3	4	5
8.4 Wanneer iemand een MRSA-infectie heeft, kan hij/zij daarvoor behandeld worden.	1	2	3	4	5
8.5 De meeste antibiotica werken niet tegen MRSA.	1	2	3	4	5
8.6 Bij een goede behandeling van een MRSA-infectie, is de sterftekans laag.	1	2	3	4	5

9. FRIS MODEL

9.1. Risk perception

9.1.1 Hoeveel mensen denkt u dat er met MRSA besmet zijn (zowel dragerschap als infectie) in Nederland?
1%
15%
35%
60%

Hoe denkt u over de risico's van MRSA?
Heel klein, Redelijk klein, Niet klein/ niet groot, redelijk groot, Heel groot

9.1.2 Hoe groot is volgens u de kans dat u besmet raakt met MRSA?
9.1.3 Hoe groot is volgens u de kans dat u een MRSA infectie krijgt als u in een ziekenhuis zou worden opgenomen?
9.1.4 Hoe groot zullen volgens u de gevolgen van een MRSA uitbraak zijn voor de patiënten in een ziekenhuis?

Hoe denkt u over de risico's en de gevolgen van MRSA in uw leef- en woonomgeving?
Heel klein, Redelijk klein, Niet klein/ niet groot, redelijk groot, Heel groot

9.1.5 De kans dat er in mijn woonomgeving MRSA uitbreekt is…
9.1.6 De kans dat er in mijn werkomgeving MRSA uitbreekt is…
9.1.7 De kans dat er door een MRSA uitbraak doden vallen is…

9.2 Involvement

Wat betekent het onderwerp 'MRSA' voor u in uw dagelijks leven?
Helemaal niet, Nauwelijks, Enigszins, Nogal, Heel erg

9.2.1 Ik zou graag meer willen weten over MRSA.
9.2.2 Ik vind het belangrijk om informatie te krijgen over de risico's van MRSA.
9.2.3 Als er iets over MRSA in de media staat, trekt dat mijn aandacht.
9.2.4 Ik ken iemand die ooit besmet is geweest met MRSA □ ja □ nee
9.2.5 Ik heb wel eens gehoord dat er MRSA aanwezig was in een ziekenhuis. □ ja □ nee

9.3. Affective responses

Hoe voelt u zich wanneer u denkt aan de mogelijkheid op MRSA-dragerschap door slechte hygiëne? Dan voel ik mij…
Helemaal niet, Nauwelijks, Enigszins, Nogal, Heel erg

9.3.6 Gespannen
9.3.7 Angstig
9.3.8 Nerveus
9.3.9 Bezorgd
9.3.10 Boos

9.4 Information Sufficiency

De volgende stellingen gaan over uw kennis over MRSA. Kunt u aangeven in hoeverre u het eens bent met deze stellingen?
Helemaal Nauwelijks Enigszins Nogal Heel erg Niet

9.4.1 Ik ben tevreden met de kennis die ik nu heb over de risico's van MRSA.
9.4.2 Ik heb het gevoel dat ik de juiste kennis heb om met deze risico's om te gaan in mijn dagelijks leven.

9.5 Self-efficacy

In hoeverre denkt u zelf om te kunnen gaan met risico's die verbonden zijn aan MRSA?
Ik heb er vertrouwen in dat ik…
Helemaal niet, Nauwelijks, Enigszins, Nogal, Heel erg

9.5.1 Dat ik weet wat ik moet doen als er ergens MRSA uitbreekt.
9.5.2 Dat ik weet wat ik moet doen als ik een MRSA-infectie heb.

9.6 Information seeking intention

Onderstaande uitspraak gaat over hoe u omgaat met informatie over MRSA.

9.6.1 Als ik iets zie, lees of hoor over MRSA dan ga ik op de volgende plekken naar informatie zoeken (meerdere antwoorden mogelijk):
- *Kranten*
- *Internet*
- *Huisarts*
- *GGD*
- *RIVM*
- *Overig, namelijk…*
- *Ik ga niet op zoek naar informatie.*

10. Specifieke vragen dieren & griepprik

10.1 Komt u wekelijks in nauw contact met de volgende dieren (meerdere antwoorden mogelijk)?
- ☐ Koe
- ☐ Varken
- ☐ Pluimvee
- ☐ Paard
- ☐ Nee, ik kom niet wekelijks in nauw contact met deze dieren.

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10.2 Wast u na het contact met één van bovenstaande dieren, uw handen? 1 2 3 4 5

10.3. Komt u wekelijks in nauw contact met de volgende dieren (meerdere antwoorden mogelijk)?

- ☐ Hond
- ☐ Kat
- ☐ Konijn
- ☐ Nee, ik kom niet wekelijks in nauw contact met deze dieren.

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10.4 Wast u na het contact met één van bovenstaande dieren, uw handen? 1 2 3 4 5

10.5 Krijgt u jaarlijks een uitnodiging voor de griepprik?

- ☐ Ja
- ☐ Nee