Bachelor Thesis

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Attitudes of Healthcare Workers with different Years of Work Experience towards Antimicrobial Resistance and Infection Prevention and Control (IPC)

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Abstract

Background: The problem of antimicrobial resistance (AMR) poses a threat to human health and is expected to further increase in the future. Current infection prevention and control (IPC) measures were found to be not sufficiently effective to counter these developments due to a non-compliance of healthcare workers to hygiene guidelines. Previous research revealed that undergraduate physicians hold incorrect beliefs about the importance of controlling AMR as well as the relevance of hygiene in this context. Therefore, this research aimed at investigating differences in attitudes and experiences regarding AMR and IPC of healthcare workers with short and long durations of work experience. In addition, recommendations about improvement processes in IPC and the control of AMR given by both groups were explored. **Methods:** A survey design was applied and by using two exploratory factor analyses, scales were identified from this questionnaire. Those scales were then used to analyse differences in attitudes and experiences regarding AMR and IPC of healthcare workers with short and long durations of work experience by applying Mann-Whitney U tests. Recommendations about improvement processes in IPC were explored by an inductive coding process. **Results:** Of the 638 healthcare workers from Dutch and German hospitals who responded to the questionnaire, 150 had short durations of work experience, whereas the other 488 had long durations. No significant differences in attitudes and experiences between both groups were found. Regarding improvement processes, both groups focused on hygiene as most important area. Healthcare workers with short durations of work experience were further found to focus on screening and isolation processes, whereas their colleagues with long durations of work experience focused on communication to control AMR. **Conclusion:** Compared to healthcare workers with short durations of work experience, those with long durations had more negative experiences with AMR as well as more positive attitudes and experiences regarding perceived received support, logistics and diagnostic processes in IPC. Improvements in hygiene were recommended by both groups to control AMR. However, healthcare workers with short durations of work experience then concentrated on ad-hoc measures and their colleagues with long durations focused on more reflective improvement processes. **Recommendations:** Further research in investigating differences in AMR and IPC related attitudes and experiences of different healthcare occupations in inpatient settings is recommended due to their different responsibilities and insights at work. Also, participants recommendations about improvement processes should be checked for possibilities of realization in order to provide new approaches to control AMR.

Introduction

In the middle of the 20th century, scientists made significant progress in the fight against microorganisms which cause diseases and infections. The development of antimicrobial drugs, especially antibiotics such as penicillin, enabled a decrease of mortality in humans (Tenover, 2006). However, the availability and increasing use of these antimicrobials revealed a serious downside and threat to human health as well. During the past decades the promising development was worldwide increasingly challenged due to a rising number of bacteria which established resistance against various antimicrobials, also called antimicrobial resistance (AMR) (Holmes et al., 2016; Tenover, 2006). In a medical context, AMR is defined and identified if a bacterial pathogen happens to be unaffected by an antimicrobial and therefore by a failure of this antimicrobial to cure a certain infection. However, putting AMR in the framework of the darwinian selection process, this turns out to be a natural and evolution-based reaction of bacteria to an exposure to high concentrations of antimicrobials. Therefore, AMR can be seen as a naturally occurring survival mechanism of the exposed microbes (Holmes et al., 2016).

Causes of increased cases of AMR over time include an increase in using antimicrobials in humans, animals, food processing technology, agriculture and environmental pollution (Acar & Rostel, 2001; Holmes et al., 2016). In inpatient-settings, especially the transmission of resistant microbes as well as the mis- and overuse of antibiotics is a significant part of the AMR problem. More specifically, in the U.S., 25% of healthcare workers were found to be carriers of resistant microbes and approximately 50% of antibiotic prescriptions were found to be unnecessary, incorrectly chosen, or given for prophylactic reasons, supporting the emergence of microbial resistance (Haddadin, Fappiano, & Lipsett, 2002; Harbarth, Samore, Lichtenberg, & Carmeli, 2000; Holmes et al., 2016; Lipsitch & Bergstrom, 2002). Due to the increasing ineffectiveness of widely used antibiotics, the treatment of several diseases became significantly more difficult within the past years (Acar & Rostel, 2001; Helms, Vastrup, Gerner-Smidt, & Mølbak, 2002; Tenover, 2006). Infections with resistant microbes in post-surgical patients are associated with increased mortality (1.3 fold higher; $p = .016$), morbidity as well as length of hospitalization (11 vs. 7 days) and healthcare costs (1.4 higher; $p=.017$) compared to patients without infections (Cosgrove, 2006).

Although cases of antimicrobial resistance in Europe, and more specific in the Netherlands and Germany are low in number compared to developing countries, the threat of AMR is expected to increase in the future (Cookson, 2005). Also, since the rate of newly developed antimicrobials have found to be stagnating, there are no expected short-term

solutions regarding factors outside the behaviour of healthcare workers, to control the threat of AMR (Cars et al., 2008). This increases the urgency of improving factors within the control of healthcare workers, such as Infection Prevention and Control (IPC) including identifying AMR in patients (diagnostics), the implementation of suitable hygiene measures as cleaning and hand washing, organizational aspects as isolation rooms (logistics), and actions and responsibilities during an outbreak (outbreak management) in order to provide guidelines and training for healthcare workers to control the emergence and transmission of AMR effectively (Cookson, 2005). Although, in certain settings the rate of antimicrobial prescriptions has decreased within the past decade, the reduction in AMR cases was modest (Holmes et al., 2016). One explanation might be that a high number of AMR infections are not newly developed in an individual by mis- or overuse of antibiotics but evolve by transmission within inpatient settings. These findings lead to the relevance of focusing on transmission processes of AMR to identify factors responsible for the inefficiency of current IPC measures in order to improve these (Holmes et al., 2016).

Previous studies have investigated reasons for the limited effectiveness of IPC. A research on the transmittance of methicillin-resistant Staphylococcus aureus (MRSA) in intensive care units has found that related hospital-acquired infections could be controlled by an increase in hand hygiene compliance of healthcare workers to guidelines published by the World Health Organization (WHO) (Lee, Cho, Jeong, & Lee, 2013). Compliance to hand hygiene and IPC guidelines however, is challenged by a common misbelief hold by healthcare workers that AMR is a widely national problem, but less relevant to the clinician's own institution and patients (Giblin et al., 2004). The low rate of compliance was found to be based on complex attitudes and beliefs, which have to be altered in order to effectively change behaviour related to AMR prevention. The success of measures such as IPC depend on the individuals executing them, in this case, on the individual actions and behaviours of healthcare workers in inpatient settings. Due to this fact, this research will focus on healthcare workers attitudes towards and experience with AMR and IPC measures in order to find reasons for their non-compliance towards provided guidelines.

In the context of work attitudes and beliefs it can be stated that these are significantly shaped by prior work experience (Loughlin & Barling, 2001). This relation also was found in the context of AMR- and IPC-related attitudes of healthcare workers (Pulcini, Williams, Molinari, Davey, & Nathwani, 2011). Studies have found that 37% of junior doctors, i.e. doctors qualified from medical school and in their first six years of non-specialized training, do not perceive AMR as a relevant topic in their daily practice. Also, regarding factors causing

AMR, insufficient hand hygiene practices were rarely included in their perception (Pulcini et al., 2011). These findings could get confirmed by another research, which stated that 24% of final-year medical student respondents perceived that hand hygiene practices are not at all relevant to the context of AMR (Dyar et al., 2013). However, the authors did neither study AMR-related experiences or attitudes of graduated physicians or other healthcare workers with more work experience, nor regarding IPC. Due to their daily experience with AMR as well as with the application of hospital guidelines in IPC, it can be assumed that healthcare workers with longer durations of work experience hold more serious-taking attitudes towards AMR and the importance of IPC as means to control AMR. Combining the two findings of low compliance to hygiene guidelines as well as AMR- and IPC-experience and attitudes of healthcare workers with different amounts of work experience, this leads to the relevance of investigating underlying attitudes of these two groups of healthcare workers regarding mechanisms of the transmission of AMR within inpatient settings as well as their experience with AMR and IPC.

Due to healthcare workers everyday contact with work related processes regarding AMR, including experience with conducting existing guidelines and techniques of AMR control, they have a unique insight, which might also include potential lacks of efficiency in controlling AMR. Therefore, the relevance arises to investigate healthcare workers attitudes about current improvement processes in their work and related processes facilitating the control of AMR.

On a concluding basis, this research will focus on the experience and attitudes regarding AMR and IPC of healthcare workers with different years of work experience. Therefore, the overall research question of this study is *Are there differences in AMR and IPC related attitudes and experience between healthcare workers with different years of work experience*? In this regard, the first sub-question is *Are there differences in AMR and IPC related attitudes and experience of healthcare workers with short compared to long durations of work experience?* Based on findings of previous research by Dyar et al. (2013) and Pulcini et al. (2011) it is hypothesized that there is a significant difference between attitudes of healthcare workers with long durations of work experience (graduated physicians) which are expected to be more negative regarding AMR as well as more positive regarding the importance of IPC as means to control AMR compared to healthcare workers with short durations of work experience (non-graduated physicians).

The second focus of this research will lie on healthcare workers attitudes about current work-related improvement processes regarding IPC and controlling AMR. However, in order

to answer the overall research question, the different improvement processes of healthcare workers with long durations compared to those with short durations of work experience will get explored. The second sub-question is therefore *What different improvement processes regarding IPC and the control of AMR are recommended by healthcare workers with long compared to short durations of work experience?*

Methods

Design and Pilot Study

Regarding the setup of the research, a survey design was employed. In order to improve information quality and efficiency as well as to identify unclear wording or other limitations in advance, the study was preceded by a pilot study. This pilot study was conducted with one physician and one nurse and resulted in minor changes in wording to enhance clarity. Also, the information was added that some questions might not be directly related to the healthcare workers daily work tasks, however, should be answered by participants as best as they can based on their attitude and experience.

Materials & Measures

The questionnaire consisted of 29 closed-ended questions and one open-ended question (see Appendix A). All answers were anonymized. Since the questionnaire was newly developed, no validity or reliability of the questions were known in advance to the study.

Socio-demographics. Each questionnaire started with seven questions measuring socio-demographic information about the healthcare worker, including age, gender, the department of the hospital they are working in, function within this department, years of work experience in this certain function, years of work experience within the hospital, and if the individual has already carried out an active function within the domain of hospital hygiene.

Attitudes towards AMR. In the first part of the questionnaire, participants were asked to answer four closed-ended questions about their attitude towards AMR, including perceived leading causes of AMR and reasons for prescription of (broad-spectrum) antibiotics. An example question was 'I belief that antibiotics are prescribed at the request of patients.'. Participants were instructed to indicate their attitude based on a scale ranging from *I do not agree*, coded as a 1, to *I agree*, coded as a 5 on a five-point Likert scale.

Experience with AMR. Participants were asked to answer three closed-ended questions about their experience with AMR. For each question participants were instructed to indicate the level of which the given scale reflects their experience with AMR. An example

question was: 'I believe that I can contribute sufficiently to limit AMR'. The scale to answer on ranged from *I do not agree*, coded as a 1, to *I agree*, coded as a 5 on a five-point Likert scale. Also covered were the respondent's experience if they feel sufficiently informed about diagnostic policy as well as for which party AMR is a problem. These questions also belonged to the first part of the questionnaire.

Attitudes towards IPC. Next, in the second part of the questionnaire, four closed-ended questions were asked about participants attitudes towards IPC. These questions focused on four different domains of IPC, namely diagnostics, infection prevention, logistics, and outbreak management. Investigated were attitudes towards the role and importance of each domain in infection and transmission prevention of AMR. Firstly, the domain of diagnostics was defined as the process of finding out if a patient carries resistant bacteria including screening as well as taking and testing cultures. Secondly, the domain of infection prevention was defined as the implementation of suitable hygiene measures, e.g. hand hygiene, the use of personal protective clothing, the cleaning of equipment as well as rooms. Thirdly, the domain of logistics was defined as means as the use of isolation rooms and the transfer of AMR-patients to out- and inpatient institutions. And lastly, the domain of outbreak management was defined as actions and responsibilities during an outbreak of AMR. An example question for attitudes towards IPC was: How important do you think hygiene measures are to limit AMR?'. The answers ranged from *unimportant* coded as a 1, to *very important*, coded as a 5 on a five-point Likert scale.

Experience with IPC. Participants' experience with IPC were measured with 18 closed-ended questions, three for the diagnostics and five for each of the other three previously mentioned domains of IPC. With these questions, experience with the perceived contribution of participants to each domain, as well as the received support from colleagues from different hierarchical levels and domains of the hospital were investigated. An example question was 'Do you have sufficient knowledge for hygiene measures to limit AMR? The answers ranged from *insufficient* coded as a 1, to *sufficient*, coded as a 5 on a five-point Likert scale. These questions also belonged to the second part of the questionnaire.

Improvement processes. In the third part of the questionnaire, participants were instructed to answer one open-ended question by stating their attitude about current work-related improvement processes regarding the control of AMR.

Participants

A total of 638 individuals participated in this research (442 women (69%), 196 men (31%)). All respondents were healthcare workers in one of six hospitals in the north-east of the Netherlands or north-west of Germany. Two of them are large university hospitals with approximately 1300 - 1500 beds each, three of the others are smaller university hospitals with 400 - 800 beds each, and the sixth hospital is a smaller general hospital with approximately 700 beds. For participation in the study, the inclusion criterion was to be a healthcare worker working in hospital departments with relevant contact to AMR. Therefore, participants were selected in a purposive sampling selection. Participants were divided into two groups. The first group consisted of participants with less than five years of work experience identifying short durations of work experience, whereas the second group with five to ten years was identified for long durations of work experience. This process was based on the fact that the general medical training lasts six years of working and afterwards the specialization program starts, as previously explained (Pulcini et al., 2011).

Procedure

Three questionnaires, two of them in Dutch and one in German, were developed and administered using the website *Qualtrics*. The weblink to the respective questionnaire was sent via email or was personally communicated with contact persons of the participating hospitals, who then distributed it to all doctors and nurses of their respective AMR-relevant department. The distribution of each questionnaire depended on the country and hospital the healthcare workers were working in. Participants were informed that participation in this research takes approximately 15 minutes, is on a voluntary and confidential basis and that all data will be anonymized. Reminders for responding were sent twice via email to the contact persons, however, could not be tailored to reach only non-responding healthcare workers. Due to that, the total number of approached healthcare workers is unknown, so is the final response rate.

The Ethics Committee of the Faculty of Behavioural Sciences at the University of Twente gave approval for the research (BCE18321) and all participants were thoroughly informed in advance to participation about the content of the study as well as the confidential treatment of the given information. Each respondent filled out the questionnaire individually.

Data Analysis

Data preparation. The data of each respondent were exported to *SPSS 24 Statistics*. All data were screened for invalid or incomplete responses. In case of missing values, pairwise deletion was conducted, since data were identified to be missing completely at random (MCAR) and missing cases on each variable are few compared to the total sample size. This method also minimizes the loss of data, because missing values get excluded in pairs and all observed values for each subject get retained (Dibal, Okafor, & Dallah, 2017; Field, 2013).

New variables short and long durations of work experience. Next, new variables were created for the work experience of participants. Therefore, the two groups of *less than one year* and *one to less than five years* were grouped to the variable *short duration* and the groups *five to ten years* and *more than ten years* were grouped to the variable *long duration* of work experience.

Exploration of data. The data were explored by descriptive analyses of the distribution of participants related to their years of work experience. This was also done to check for an adequate distribution between both groups of participants as well as to get an overview of their characteristics.

Dimensionality of data. In order to identify the dimensionality of the data, an exploratory factor analysis was conducted to analyse whether items are measuring a single construct or multiple, and consequently, if specific items contribute to constituting a scale. At first, the assumptions of a factor analysis were checked by analysing normality and linearity of data, as well as potential outliers (Leech, Barrett, & Morgan, 2013). The exploratory factor analysis was conducted separately for part one and part two of the questionnaire, because it was expected that part one measures experience with and attitudes towards AMR, whereas the second part of the questionnaire focused on IPC. After identifying all factors that have been measured by specific items, those latent variables were recoded as new variables and renamed according to their object of measure. Then, participants' mean scores for each scale were calculated in order to perform further statistical tests.

Internal consistency. To check the internal consistency of the scales, Cronbach's alpha, a lower bound to the true reliability of a scale was calculated for each identified factor. It should be at least 0.7 or higher for a scale considered to be reliable (Cronbach, 1951).

Answering Research Questions.

Sub-Question 1. It was hypothesized that healthcare workers with longer durations of work experience (LWE) have more negative attitudes and experience regarding AMR as well as more positive ones regarding the importance of IPC as means of controlling AMR, resulting

in higher mean scores of participants, compared to healthcare workers with short durations of work experience (SWE) (H_a: μSWE < μLWE). To investigate this hypothesis, an independent-samples t-test as parametric technique was used if data were normally distributed, or with a Mann-Whitney U test as non-parametric technique in case of not normal distribution of data. As the grouping variable, the duration of work experience was used, which was categorical, whereas the respective scales reflected the to-be compared variable and were ordinal. The null hypothesis being investigated states that there is no difference between the mean scores of participants with long durations of work experience (LWE) on the applied scales compared to participants with short durations of work experience (SWE) (H_0: μSWE = μLWE). A significance level of α = .05 was applied.

Also, since the author of this paper is not aware if a power calculation was conducted prior to the data collection, a post-hoc power sensitivity analysis was conducted in order to check the sensitivity of the Mann-Whitney U test based on the sample size, significance level α and the kind of test conducted. Sensitivity refers to the probability that the respective test will reject a false null hypothesis as well as chance of committing a type II error (Murphy, 2002). The calculation was done with the software G*Power. A sensitivity of .03 is considered low, whereas .05 and .07 are considered moderate and high, respectively.

Sub-Question 2. The second research question was *What different improvement processes regarding IPC and the control of AMR are recommended by healthcare workers with long compared to short durations of work experience?* In order to answer this question, all given answers of participants to the open question 'Which processes of improvement would you like to apply regarding the control of AMR?' were imported into Atlas.ti 8.0. To give an in-depth overview of recommendations for one country, only German answers were investigated. Then, all answers not targeting processes related to the transmission of AMR were excluded, e.g. about the prescription behaviour of physicians. The first 40 questionnaires were used to create a coding scheme. The coding process was done in consultation with two other researchers to avoid subjectivity. Hereby, an inductive approach was applied, i.e. generating general principles (codes) from specific observations. During this process, each unit of similar answers was investigated separately to identify the overall topic. Repeating topics were given the same code, whereas new topics were given a new code. After establishing the coding scheme, all remaining questionnaires were coded based on this scheme by applying the constant comparison model, meaning that each new response was compared to the established codes. If one answer did not match into the coding scheme, a new code was generated after consultation with two other researchers to, again, avoid subjectivity. If one answer matched

multiple codes, each of these were applied to the answer. All codes were on the one hand clearly defined and differentiated from each other targeting specific topics, and on the other hand are they still broad enough to cover multiple subtopics related to the overall topic of the code. Eventually, the codes were assigned to the respective answers of participants with long durations and those with short durations of work experience. Then, differences in the distribution of the codes for both groups were analysed by giving a descriptive overview. Hereby, example quotes were translated from German into English.

Results

Exploration of data. As can be seen in Table 1, of the 150 participants with short durations of work experience, 101 were female and 49 were male. Their age ranged from less than 25 to 35 years old (88%). Of the 488 participants with long durations of work experience, 341 were female and 147 were male. In contrast to the group of short durations of work experience, the age of participants in the group of long durations of work experience is relatively evenly distributed in age groups from 25 to 65 years (16-31%), showing that participants in the latter mentioned group were considerably older than in the former mentioned group. In both groups, the number of German and Dutch participants was almost evenly distributed.

Table 1
Distribution of work experience of healthcare workers (N=638) in gender, age and nationality

			Gender			Age							Nationality		
			Female	Male	Total	<25	25-35	36-45	46-55	56-65	>65	Total	German	Dutch	Total
Work experience	Short	N (%)	101 (67)	49 (33)	150 (100)	37 (25)	94 (63)	15 (10)	3 (2)	1 (1)	0 (0)	150 (100)	85 (57)	65 (43)	150 (100)
	Long	N (%)	341 (70)	147 (30)	488 (100)	1 (< 1)	118 (24)	152 (31)	138 (28)	77 (16)	2 (< 1)	488 (100)	246 (50)	242 (50)	488 (100)
	Total	N (%)	442 (69)	196 (31)	638 (100)	38 (6)	212 (33)	167 (26)	141 (22)	78 (12)	2 (< 1)	638 (100)	331 (52)	307 (48)	638 (100)

Note: Short = short durations of work experience, Long = long durations of work experience.

Dimensionality of data. For the first and second part of the questionnaire, the Kaiser-Meyer-Olkin measure verified 'good' sampling adequacy with KMO = .72 and .78, respectively (Hutcheson & Sofroniou, 1999). This gets supported by Coakes and Ong (2011) who suggested a minimum sample size of five individuals per item for a factor analysis, thus a sample size of 638 on 29 items can be considered sufficient. The Bartlett's Test of Sphericity was significant, indicating moderate correlation between items ($\chi 2$ (66) = 1589.86, $p < 0.001$ and $\chi 2$ (231) = 3214,82, $p < 0.001$, respectively). Also, for both parts a varimax rotation was applied since factors were found to be orthogonal and therefore correlated.

For the first part of the questionnaire, four factors with eigenvalues over Kaiser's criterion of one were identified (Field, 2013). The scree plot was ambiguous to interpret, justifying the retaining of either two or four factors. Due to the large sample size and convergence of the Kaiser's criterion and the scree plot, it was decided to retain four factors. The items that loaded on the same factor indicated that the first factor measures experience with AMR and had high reliability (α=.84). Next, the second and third factor were excluded from further analysis due to low reliability (α=.40 and α=.33, respectively). Also, the fourth factor was excluded since it consisted of only one item measuring attitudes towards the use of broad-spectrum antibiotics, which was perceived to not contribute to the investigation of the transmission of AMR in hospitals.

For the second part of the questionnaire, six factors with eigenvalues over the Kaiser's criterion of one were identified (Field, 2013). The scree plot was again ambiguous, justifying the retaining of either two or six factors. Due to the same argumentation as for part 1, it was decided to retain six factors. The items that loaded on the same factor indicated that the first factor measures experience with received support from supervisors and colleagues in conducting different IPC tasks. The second and third factors measure experience with logistic processes as well as outbreak management in IPC, respectively. The fourth factor measures attitudes towards the perceived importance of diagnostics, infection prevention, logistic and outbreak management as components of IPC, and the fifth factor measures experience with infection prevention processes in IPC. The sixth and last factor was found to measure experience with diagnostics processes in IPC. All factors had high reliabilities (.70 - .87) and were considered subscales of the overall-scale measuring attitudes and experience regarding IPC for further analyses. Table 2 shows a summary of the exploratory factor analyses results for attitudes towards and experience with AMR and IPC.

Table 2

Summary of exploratory factor analysis results including reliability of scales measuring healthcare workers attitudes towards and experience with AMR and IPC

	Rotated factor loadings						
	AMR	IPC					
Item	Experience with AMR	Experience received support IPC	Experience logistic IPC	Experience outbreak management IPC	Attitude importance IPC components	Experience infection prevention IPC	Experience diagnostics IPC
P1_1Problem_PublicHealth	**.72**						
P1_1Problem_NursingHomes	**.78**						
P1_1Problem_OurHospital	**.90**						
P1_1Problem_MyPatients	**.85**						
P1_2Cause_UseFarmingAnimals							
P1_2Cause_TransferNursingHomes							
P1_2Cause_ByPatients							
P1_3Belief_AntibioticsAtRequestPatients							
P1_3Belief_AntibioticsBasedOnLabResults	.51						
P1_3Belief_InformedDiagnosticPolicy	**.74**						
P1_3Belief_DoubtInfectionStartBroadSpectrum							
P1_3Belief_SufficientContribution	**.71**						
P2_1.1Diagnostics_Importance					**.60**		
P2_1.2Diagnostics_Influence							**.80**
P2_1.3Diagnostics_Resources							**.80**
P2_1.4Diagnostics_Knowledge							**.73**
P2_4.1InfectionPrevention_Importance					**.69**		
P2_4.2InfectionPrevention_Influence						**.66**	
P2_4.3InfectionPrevention_Resources						**.76**	
P2_4.4InfectionPrevention_Knowledge						**.64**	
P2_4.5InfectionPrevention_Colleagues		**.67**					
P2_4.5InfectionPrevention_Supervisor		**.82**					
P2_5.1Logistic_Importance					**.64**		
P2_5.2Logistic_Influence			**.78**				
P2_5.3Logistic_Resources			**.78**				
P2_5.4Logistic_Knowledge			**.65**				
P2_5.5Logistic_Colleauges		.52	.56				
P2_5.5Logistic_Supervisor		**.70**	.49				
P2_6.1OutbreakManagement_Importance					**.79**		
P2_6.2OutbreakManagement_Influence				**.72**			
P2_6.3OutbreakManagement_Resources				**.80**			
P2_6.4OutbreakManagement_Knowledge				**.80**			
P2_6.5aOutbreakManagement_Colleagues		**.64**		.52			
P2_6.5bOutbreakManagement_Supervisor		**.77**					
Eigenvalues	2.97	6.73	1.82	1.76	1.53	1.41	1.37
% of variance explained	23.55	15.16	11.51	10.93	9.71	9.69	9.39
α	.84	.87	.84	.80	.70	.72	.73

Note: Factor loadings <.4 are suppressed, factor loadings >.6 appear bold

Answering Research Questions

Sub-question 1. *Hypothesis 1: Healthcare workers with long durations of work experience have more negative attitudes and experience regarding AMR as well as more positive ones regarding the importance of IPC as means of controlling AMR compared to healthcare workers with short durations of work experience (H_a: μSWE < μLWE).*

Since the data for all scales were found to be not normally distributed, a Mann-Whitney U test was applied to each of them. The distribution of scores in both independent groups was also found to be not equally shaped. As can be seen in Table 3, the Mann-Whitney U test revealed that there are significant differences in mean scores of participants with long compared to short durations of work experience regarding experience with AMR as well as with received support, logistic and diagnostics processes in IPC. The mean scores for the former mentioned group are higher than for the latter mentioned group, which supports that healthcare workers with long durations of work experience have more negative experience regarding AMR and more positive attitudes and experiences regarding the mentioned IPC domains compared to healthcare workers with short durations of work experience. However, no significant differences between both groups were found in regard to experience with outbreak management and infection prevention processes in IPC as well as attitudes towards the perceived importance of IPC components. Hereby it has to be noted that mean scores of all three, especially for the last two mentioned scales were considerably high with μ_{SWE} = 4.02 and μ_{LWE} =4.03 for infection prevention, and μ_{SWE} = 4.40 and μ_{LWE} =4.46 for perceived importance of IPC components on a 5-point Likert scale. Consequently, one can conclude that the null hypothesis can only be partly rejected. In addition, the identified power sensitivity for the conducted tests was low with d = .31, implying a high chance of committing type II errors (Murphy, 2002).

Table 3
Results of the Mann-Whitney U tests showing differences between experiences with AMR and IPC

	Work experience		
	short N = 150	long N = 488	
Scale	M (SD)	M (SD)	p-value (one-sided)
Experience with AMR	4.32 (.75)	4.40 (.75)	*
Experience received support IPC	3.53 (.79)	3.66 (.88)	*
Experience outbreak management IPC	3.50 (.94)	3.46 (1.08)	n.s.
Experience logistic IPC	3.28 (.94)	3.43 (.95)	*
Experience infection prevention IPC	4.02 (.74)	4.03 (.78)	n.s.
Attitude importance IPC components	4.40 (.48)	4.46 (.49)	n.s.
Experience diagnostics IPC	3.37 (.96)	3.50 (1.02)	*

Note: * = $p < .05$, n.s. = not significant, short = short durations of work experience, long = long durations of work experience

Sub-question 2. *What different improvement processes regarding IPC and the control of AMR are recommended by healthcare workers with long compared to short durations of work experience?*

The identified codes in answers given by the participants were *hygiene*, *communication*, *screening*, *isolation*, *time*, *personnel* and *other*, as can be seen in Table 4. The coding scheme was then ordered according to the occurrence of the respective codes in total, listing codes which are mentioned most often at first, and those which were mentioned less frequently at last.

Table 4
Codes of participants answers about their attitude towards work-related improvement processes to control AMR

Code	N
Hygiene	59
Communication	47
Screening	44
Isolation	34
Time	18
Personnel	18
Other	11

Note: N = total number of answers within code

Hygiene. Regarding improvements in hygiene, it stands out that participants mostly focused on increasing the number of training events for the whole hospital staff as well as more time for implementing hygiene processes sufficiently (see Table 5). It was frequently recommended that all staff's compliance to the hospital's official hygiene guidelines should be checked on a regular basis, and some participants have mentioned specific ideas of improvement processes, such as changing gloves more often.

Communication. Within the topic of communication, it became apparent that participants focus on interdisciplinary communication (see Table 5). They pointed out that a better collaboration between different occupational groups, such as microbiologists or pharmacologists should share their expertise providing concrete advice to healthcare workers about how to control AMR. Next, participants recommended more transparency about current AMR patients in specific registers as well as more communication of hospital's hygiene guidelines.

Screening. To focus on the most often recommended improvements in screening processes, participants suggested to screen patients in advance to their hospital stay (see Table 5) by involving general practitioners in the screening process. By that, the results, i.e. if a patient carries a resistant pathogen or does not, would already be available to the hospital staff when the patient arrives. Another recommendation was to screen patients and healthcare workers themselves more often and on a regular basis as well as to increase the speed of screening processes in order to receive results faster which in turn enables faster reactions.

Isolation. Within the topic of isolation improvements, it stands out that participants focused on isolating all incoming patients until the results of the initial screenings are available and negative. Also, patients with AMR should be isolated faster than is currently done, implying immediate reaction of healthcare workers to positive screening results. In addition, participants stated that the physical structure of hospitals needs to get adapted including more isolation rooms and sluices; also, nurses and physicians should get more trained in isolation processes and controlled in their compliance.

Personnel. Regarding the topic of personnel, participants mentioned that more personnel are needed in order to deal sufficiently with patients, including AMR patients. They reported that too few personnel results in time pressure for caring for all patients adequately, which in turn often leads to misbehaviour in hygiene measures.

Other. Lastly, as can be seen in Table 5, a few answers were coded with 'other', because their topics were rarely used by participants. However, due to the relevance of these

recommendations it was decided to not leave them out. For example, answers were related to logistic issues in e.g. transferring AMR patients to different rooms or institutions, or the establishment of clear outbreak management guidelines.

Regarding differences in answers between participants with short compared to long durations of work experience, the content of given recommendations only differed slightly from each other; however, the order of importance of these topics is different in both groups. Hereby, the more often a code was mentioned within a group the more important it is considered to these participants. Both groups considered hygiene processes as the most important area for improvement, especially increasing the number of training events. However, the group of participants with short durations of work experience, then focused on screening and isolation processes; by contrast, the group of participants with long durations of work experience, considered interdisciplinary communication as the next most important improvement area after hygiene (see Table 5).

Table 5
Distribution of codes and sub-codes within both groups of work-experience including example quotes of participants

		Work experience			
		short n = 85	long n = 246		
	Code	N (%)	N (%)	Total	Example quote (participant ID)
Hygiene	Increased number of training events	8 (15)	28 (16)	36	*'Train cleaning staff better, they often don't know what they do.' (P 331)*
	More time for hygiene	4 (8)	14 (8)	18	*'Enough time to do the basic hygiene measures (hand hygiene!).' (P 122)*
	Compliance to current hygiene rules	2 (4)	8 (4)	10	*'More control of the whole staff in regard to hand hygiene (including staff from the management).' (P 155)*
	Concrete improvements of hygiene	3 (6)	5 (3)	8	*'Change gloves more often.' (P 295)*
	Generally increasing hygiene	0 (0)	5 (3)	5	*'Improve hygiene measures.' (P 296)*
Total hygiene		**17 (32)**	**60 (34)**	77	
Communication	Interdiscipliary communication	1 (2)	15 (8)	16	*'Interdisciplinarity! [...] providing expertise of pharmacy, microbiology and hygiene to high-risk areas in the hospital, e.g. montly meetings.' (P 63)*
	Transparency about AMR cases	1 (2)	14 (8)	15	*'Improved visibility if patients are AMR-infected.' (P 146)*
	Communication of guidelines	4 (8)	8 (4)	12	*'Clear communication of guidelines for transfer of AMR-infected patients, immediately available and with concrete instructions, e.g. checklists.' (P 20)*
	Information processes	2 (4)	2 (1)	4	*'More information about AMR.' (P 79)*
Total communication		**8 (15)**	**39 (22)**	47	
Screening	Screening prior to hospital stay	7 (13)	16 (9)	23	*'Working together with general practitioners to screen patients prior to their hospital stay.' (P 12)*
	Faster screening process	3 (6)	4 (2)	7	*'More effective and faster screening process.' (P 25)*
	Screening more often	3 (6)	11 (6)	14	*'Extensive screening for resistant bacteria as a matter of routine.' (participant 56)*
Total screening		**13 (25)**	**31 (17)**	44	

(continued)

Table 5 continued

		Work experience			
		short n = 85	long n = 246		
	Code	N (%)	N (%)	Total	Example quote (participant ID)
Isolation	Isolate patients at beginning of hospital stay	4 (8)	9 (5)	13	*'Appropriate isolation of incoming patients until screening result is negative.' (P 118)*
	Isolate patients faster	5 (9)	5 (3)	10	*'Always isolate patients who are suspected carrying resistant bacteria. Not wait for screening results.' (P 113)*
	Physical structure of hospitals	1 (2)	9 (5)	10	*'Isolation rooms in the emergency department (there are no special rooms with sluices for patients who must get isolated).' (P 48)*
	Training in isolation processes	0 (0)	1 (1)	1	*'Training in isolation processes for nurses but also (or maybe especially for physicians) as well as controlling their compliance.' (P 97)*
Total isolation		**10 (19)**	**24 (13)**	34	
Personnel	More personnel	**5 (9)**	**13 (7)**	18	*'More personnel to care for AMR patients.' (P 233)*
Other	Logistic issues	0 (0)	5 (3)	5	*'Improving transportation of patients out of high-risk areas such as the emergency room.' (P 64)*
	Outbreak management guidelines	0 (0)	2 (1)	2	*'An established, in all areas prvailing outbreak management.' (P 277)*
	Specific changes to work processes	0 (0)	1 (1)	1	*'Reduction of urinary tract catheters.' (P 318)*
	Practical realization of guidelines	0 (0)	1 (1)	1	*'Hygiene professionals point out our mistakes to us, but are not able to provide relevant solution approaches to put those into practice.' (P 208)*
	Improve resources	0 (0)	1 (1)	1	*'Hygiene guidelines do not get followed due to [...] a lack of resources (e.g. too few disinfectant dispenser at relevant places).' (P 93)*
	Treating out-patients	0 (0)	1 (1)	1	*'No existing concept for the treatment of out-patients with AMR.' (P 24)*
Total other		**0 (0)**	**11 (6)**	11	
Total		**53 (100)**	**178 (100)**	426	

Note: Total N and % of codes for each group appear in bold, short = short durations of work experience, long = long durations of work experience, percentages refer to the total number of given answers within each group of work experience.

Discussion

This study aimed at investigating new insights into differences in AMR and IPC related attitudes and experience between healthcare workers with different years of work experience. To conclude the results of this research, experiences with AMR, as well as with perceived received support, logistic and diagnostic processes in IPC were different for healthcare workers with different years of work experience; whereby those with long durations have more negative experiences with AMR and more positive attitudes and experiences regarding IPC than their less experienced colleagues. However, experiences with outbreak management, infection prevention and attitudes towards the perceived importance of IPC components were not found to be different for both groups. Regarding concrete improvement processes, healthcare workers recommended explicit improvements in hygiene as means to control AMR. Whereas healthcare workers with short durations of work experience further concentrated on screening and isolation processes, healthcare workers with long durations of work experience focused on (interdisciplinary) communication.

Reflecting on differences in healthcare workers experiences with AMR and with certain domains of IPC, it can be stated that some results confirmed previous expectations about effects, whereas others were surprising. To start, the discovery that experiences with AMR are less negative for healthcare workers with short durations of work experience compared to long durations fits previous research results by Dyar et al. (2013) and Pulcini et al. (2011). The authors stated that undergraduate physicians do not experience AMR as a relevant topic in their work due to a considerable lack of creating awareness of this threat in medical studies. The awareness of AMR was expected to be higher for healthcare workers with longer durations of work experience due to their everyday contact with AMR and the application of hospital guidelines, which was confirmed by this present research.

The result that healthcare workers with long durations of work experience have more positive experiences with logistic and diagnostics processes, which were measured in terms of perceived influence, knowledge and resources, compared to their less experienced colleagues can be explained by their exposure to trainings events. Healthcare workers in Dutch and German hospitals have to attend training events in the context of AMR on a regular basis, which include logistics as well as diagnostic measures (Chaberny, Wriggers, Behnke, & Gastmeier, 2010). This leads to the fact that healthcare workers with long durations of work experience have attended more of these events than their colleagues with short durations of work experience, thus also received more information about those two topics. Consequently, this regular exposure to relevant information about logistic and diagnostic techniques might

explain the higher perception of knowledge in health care workers with long durations of work experience. This knowledge might lead to more confidence in having influence in the mentioned areas and awareness of applicable resources.

The finding that healthcare workers with short durations of work experience feel less supported by supervisors and fellow colleagues in controlling AMR than their more experienced colleagues is an important disclosure. This could be explained by research conducted by Hertel et al. (2013) connecting work psychology models of motivation and stress with life-span models of aging. In this research, age differences of employees from a range of occupations, including social services, regarding work motivation and stress were investigated. Young employees were found to perceive higher levels of stress and require more guidance in their work compared to older employees, which were found to have higher self-regulation skills in form of active control strategies for perceived stress (Hertel et al., 2013). These findings can be applied to this present study, since healthcare workers with short durations of work experience were considerably younger than those with long durations of work experience. For that reason, healthcare workers with short durations of work experience might in fact not receive less support, but have higher needs for guidance at work than their more experienced colleagues, who rather strive for autonomy.

Next, no indication of differences between groups could be revealed regarding experience with outbreak management and the perceived importance of IPC components, i.e. the importance of diagnostics, infection prevention, outbreak management, and logistics in controlling AMR. Therefore, one could argue that healthcare workers, despite their durations of work experience, make similar experience in their daily work regarding outbreak management and hold similar attitudes about what IPC should include in order to limit AMR. This gets supported by the fact that outbreak management, especially isolation processes, and IPC components, are incorporated in healthcare workers education and also are applied by them on a regularly basis during their practical work (Nicolle & Organization, 2001; Weinstein, 2001). Therefore, both topics are present during healthcare workers education as well as daily practical work. This also explains their relatively high scores on the respective scales, indicating the perception of rather sufficient influence, knowledge and resources regarding outbreak management as well as high awareness about the importance of certain IPC components.

However, it is surprising that no differences between groups in their experience with infection prevention, including relevant hygiene measures, were found, contradicting results of previous literature by Dyar et al. (2013) and Pulcini et al. (2011). In both researches, physicians

with short durations of work experience were found to perceive hygiene as less important in controlling AMR, which was expected to be different for healthcare workers with long durations of work experience. However, the mentioned studies are 6 and 8 years old and might therefore be outdated. During the past years, a number of campaigns promoting improved hygiene in hospitals were implemented in both the Netherlands and Germany (Hellweg, 2018; Preventie.nl, 2018). These campaigns could possibly have affected the awareness of less experienced healthcare workers regarding the importance of hygiene in controlling AMR and that therefore no significant differences were found between both groups. This gets supported by the fact that both groups had relatively high scores on the scale of infection prevention, indicating that they perceive to have sufficient knowledge, influence and resources regarding hygiene measures.

Reflecting on the different recommendations given by healthcare workers with short and long durations of work experience, it became apparent that both groups focus on hygiene as most important improvement area; however, the former mentioned group further focused on rather ad-hoc approaches as screening and isolation processes, whereas the latter mentioned group further focused on communication processes which can be considered as a more reflective approach. This difference might be explainable by a study by Park and Kim (2015) on the effect of workforce aging on organizational performance. The authors stated that the age of employees is positively related to relying on exploitation in work processes. Hereby, exploitation is defined as making use of resources such as on accumulated knowledge or experiences, and is characterized by social cohesion and effective communication (Park & Kim, 2015). This finding can be applied to the context of differences in recommendations given by healthcare workers with different years of work experience. One can assume that those with long durations of work experience, which are also older than their less experienced colleagues, suggest more reflective approaches due to their use of exploitation. Therefore, they focus on social cohesion and the use of accumulated knowledge by applying interdisciplinary communication and collaboration. Their less experienced and younger colleagues, however, focus on less reflective measures, instead concentrating on rather apparent improvement processes directly related to their daily work with AMR patients.

Formulating strengths and limitations of this study, a first strength that can be formulated is that this study provides new insights into healthcare workers' attitudes towards and experience with AMR as well as IPC. To be more specific, this insight is not limited to general experiences, but contains information about different elements of IPC, such as logistic, diagnostics, outbreak management, infection prevention, as well as the perceived importance

of IPC components and perceived support by supervisors and colleagues in controlling AMR. Although the used scales were newly developed, they have shown to be highly internal consistent and to be promising in the investigation of in-depth elements of IPC. In addition, the mentioned insight is given for different years of work experience of various occupations, for instance undergraduate and graduated physicians, nurses, hygiene specialists and medical assistants. Also, participants were from six different hospitals as well as from two different countries, providing insights into healthcare workers attitudes and experiences with slightly different healthcare systems.

Next, limitations for the design of the study can be formulated as well. At first, it has to be mentioned that there is a clear disadvantage of an open question used in a questionnaire survey in so far that there are several answers of participants which are difficult to interpret due to vague wording. These could also not get further clarified because participants could not get asked follow-up questions to elaborate on their statements, which negatively affected the precision of results. Also, the response rate was not known due to the procedure of contacting the participants. Therefore, in terms of credibility of the data, it is not known if the reported attitudes and experiences of participants are representative for all healthcare workers of the six involved hospitals, which affects the generalizability of results. In addition, it has to be mentioned that the scales were newly developed and therefore not validated yet. As a last limitation, the power sensitivity of the conducted tests was low, implying the possibility that more differences between groups could have remained undetected than would have been with a higher sensitivity. These mentioned limitations however are not perceived as too damaging for the study, since significant differences between groups were identified and the obtained data were not considerably negatively influenced by either of the limitations. Nonetheless, despite the limitations, this explorative study gave first insights into attitudes and experiences regarding AMR and IPC of healthcare workers with different durations of work experience.

Next, recommendations for further research can be formulated. Although the newly developed scales have shown to be promising in measuring indications of expected effects, they should get further validated. This can be done by conducting a confirmatory factor analysis and then applying the potential adapted scales to groups with highly different attitudes and experiences regarding AMR and IPC, such as expected in experienced AMR-professionals within a hospital (e.g. hygiene-experts) and inexperienced interns. In addition, in order to prevent misinterpretations of answers by the researcher, open questions should be avoided in the questionnaire. However, in order to still get in-depth insights into healthcare workers attitudes regarding specific improvement processes in IPC to control AMR, interviews or focus

groups should be applied in addition to the questionnaire. By doing that, both attitudes and experiences regarding AMR and IPC as well as in-depth insight into improvement processes can be covered. Also, follow-up research should be focused on differences in attitudes and experiences of healthcare workers with different work occupations, such as physicians, nurses and medical assistants, as well as durations of work experience in order to investigate potential opposing views between these occupations throughout their work life. Each of the mentioned occupations has different responsibilities at work which might lead to unique and distinctive insights into the problem of AMR. The clarification of these might be the key to better understand the complex problem with AMR and its control. Next, it should be tested in how far the recommendations of participants about improvement processes can be realized by for example the hospitals or the government. For example, increasing the number of training events in hygiene imply considerations about additional costs and expenditure of time, which is already perceived as too few by healthcare workers. Therefore, some recommendations might contradict each other, which needs to get identified and aimed to solve.

Lastly, practical applications of this study's results for the field of healthcare can be formulated. Since healthcare workers with short durations of work experience have less negative attitudes towards AMR in general and also less positive experience with the domains of diagnostics and logistics in IPC, these topics should be addressed clearer and get more elaborated on during the respective studies or apprenticeships of healthcare workers. Increasing knowledge and awareness in these topics can get supported by additional training events for healthcare workers with short durations of work experience. By focusing on a theoretical as well as practical basis, a higher awareness of the importance of these topics can be achieved, which in turn is expected to lead to more serious taking in later work life. In addition, healthcare workers with short durations of work experience should receive more support from supervisors in all domains of IPC as means to control AMR, since indications were found that they feel less supported than their more experiences colleagues. Additionally, perceived organizational support at work was found to be positively related to higher work performances, especially in young employees, and could therefore be an effective approach in controlling AMR (Meyers, Kooij, Kroon, de Reuver, & van Woerkom, 2018).

The content of answers from the open question regarding improvement processes in IPC can also be used for formulating recommendations in the field of healthcare. Hereby, the improvement of hygiene measures was identified as most important for controlling AMR. Whereas the specific recommendation of having more time for hygiene processes is rather difficult to implement due to personnel and economic matters, the suggestions about increasing

numbers of training events for the hospital staff as well as compliance of the staff to hygiene guidelines is implementable. In regard to attending staff, it should be focused on healthcare workers with short durations of work experience especially, in order to increase their awareness of AMR. However, also their more experienced colleagues should attend more training events in hygiene and the context of AMR in order to improve their hygiene practices and maintain their awareness and knowledge about this topic. Regarding the specific content of these training events, a study by Chassin, Mayer and Nether (2015) revealed the effectiveness of targeting concrete reasons of non-compliance to hygiene guidelines. This customized approach could be applied to each department or hospital separately in order to improve the efficiency compared to a 'one-size-fits-all' approach as most training events have (Chassin et al., 2015). It could further be effective to involve health care workers of different years of work experience in the development of those training events to identify topics that they personally perceive as difficult to apply in their daily work and which they perceive to need more advice about.

It was further recommended to pre-emptive isolate patients in the beginning of their hospital stay, which was actually found to be effective in limiting the transmission of AMR in the Netherlands (Bode et al., 2011). Similarly, the pre-emptive screening of patients prior to their hospital stay was found to be effective in order to decrease the transmission of AMR. This preventive approach was investigated in previous research by Karkey et al. (2018), who focused on the transmission of the bacterial genus Serratia in a hospital in Nepal, India. Hospital outbreaks have been successfully overcome by pre-emptive screening of patients. Also recommended was interdisciplinary communication, which is already known to be effective in better understanding and controlling AMR (Knight, Lambert, Feil, Holmes, & Lindsay, 2018). This could be implemented by a monthly meeting with specialists of different occupations including microbiologists and hygiene experts as well as nurses, physicians and cleaning staff (Knight et al., 2018). A collaboration of these occupations can lead to more effective interventions to limit AMR as well as highlight transmission hotspots (Knight et al., 2018). Also, the healthcare workers attending these meetings should have short as well as long work experience to make sure that both groups increase their knowledge and apply it during their work.

References

Acar, J., & Rostel, B. (2001). Antimicrobial resistance: an overview. *Revue Scientifique et Technique-Office International des Epizooties, 20*(3), 797-810.

Bode, L., Wertheim, H., Kluytmans, J., Bogaers-Hofman, D., Vandenbroucke-Grauls, C., Roosendaal, R., . . . Van Belkum, A. (2011). Sustained low prevalence of meticillin-resistant Staphylococcus aureus upon admission to hospital in The Netherlands. *Journal of Hospital Infection, 79*(3), 198-201.

Cars, O., Högberg, L. D., Murray, M., Nordberg, O., Sivaraman, S., Lundborg, C. S., . . . Tomson, G. (2008). Meeting the challenge of antibiotic resistance. *Bmj, 337*, a1438.

Chaberny, I. F., Wriggers, A., Behnke, M., & Gastmeier, P. (2010). Antibiotikaresistenz: Präventionsmaßnahmen deutscher Krankenhäuser bei MRSA. *Dt Ärztebl, 107*(37), 631-637.

Chassin, M. R., Mayer, C., & Nether, K. (2015). Improving hand hygiene at eight hospitals in the United States by targeting specific causes of noncompliance. *The Joint Commission Journal on Quality and Patient Safety, 41*(1), 4-12.

Coakes, J. C. a. O., C. (Ed.) (2011). *SPSS Version 18.0 for Windows Analysis Without Anguish* (1st ed. ed.). Dougall Street, Milton: John Wiley & Sons Australia, Ltd.

Cookson, B. (2005). Clinical significance of emergence of bacterial antimicrobial resistance in the hospital environment. *Journal of applied microbiology, 99*(5), 989-996.

Cosgrove, S. E. (2006). The relationship between antimicrobial resistance and patient outcomes: mortality, length of hospital stay, and health care costs. *Clinical Infectious Diseases, 42*(Supplement_2), S82-S89.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297-334.

Dibal, N. P., Okafor, R., & Dallah, H. (2017). Challenges and implications of missing data on the validity of inferences and options for choosing the right strategy in handling them. *International Journal of Statistical Distributions and Applications, 3*(4), 87-94.

Dyar, O. J., Pulcini, C., Howard, P., Nathwani, D., ESGAP, Policies), E. S. G. f. A., . . . Harbarth, S. (2013). European medical students: a first multicentre study of knowledge, attitudes and perceptions of antibiotic prescribing and antibiotic resistance. *Journal of Antimicrobial Chemotherapy, 69*(3), 842-846.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.): SAGE Publications Inc.

Giblin, T. B., Sinkowitz-Cochran, R. L., Harris, P. L., Jacobs, S., Liberatore, K., Palfreyman, M. A., . . . Cardo, D. M. (2004). Clinicians' perceptions of the problem of antimicrobial resistance in health care facilities. *Archives of internal medicine, 164*(15), 1662-1668.

Haddadin, A., Fappiano, S., & Lipsett, P. A. (2002). Methicillin resistant Staphylococcus aureus (MRSA) in the intensive care unit. *Postgraduate Medical Journal, 78*(921), 385-392.

Harbarth, S., Samore, M. H., Lichtenberg, D., & Carmeli, Y. (2000). Prolonged antibiotic prophylaxis after cardiovascular surgery and its effect on surgical site infections and antimicrobial resistance. *Circulation, 101*(25), 2916-2921.

Hellweg, L. (2018). Compliance-Steigerung der Händehygiene anhand visueller Medien. *Hyg Med Spezial 2018.* Retrieved from https://www.krankenhaushygiene.de/ccUpload/upload/files/hm/2018_03_18_Hygiene_medial_vermitteln_Beitraege.pdf

Helms, M., Vastrup, P., Gerner-Smidt, P., & Mølbak, K. (2002). Excess mortality associated with antimicrobial drug-resistant Salmonella Typhimurium. *Emerging infectious diseases, 8*(5), 490.

Hertel, G., Thielgen, M., Rauschenbach, C., Grube, A., Stamov-Roßnagel, C., & Krumm, S. (2013). Age differences in motivation and stress at work *Age-differentiated work systems* (pp. 119-147): Springer.

Holmes, A. H., Moore, L. S., Sundsfjord, A., Steinbakk, M., Regmi, S., Karkey, A., . . . Piddock, L. J. (2016). Understanding the mechanisms and drivers of antimicrobial resistance. *The Lancet, 387*(10014), 176-187.

Hutcheson, G. D., & Sofroniou, N. (1999). *The multivariate social scientist: Introductory statistics using generalized linear models*: Sage.

Karkey, A., Joshi, N., Chalise, S., Joshi, S., Shrestha, S., Thi Nguyen, T. N., . . . Boinett, C. J. (2018). Outbreaks of Serratia marcescens and Serratia rubidaea bacteremia in a central Kathmandu hospital following the 2015 earthquakes. *Transactions of The Royal Society of Tropical Medicine and Hygiene, 112*(10), 467-472.

Knight, G., Lambert, H., Feil, E., Holmes, M., & Lindsay, J. (2018). The importance of cross-disciplinary research to combat antimicrobial resistance: introducing a new pop-up journal, X-AMR. *Microbial genomics, 4*(7).

Lee, C.-R., Cho, I., Jeong, B., & Lee, S. (2013). Strategies to minimize antibiotic resistance. *International journal of environmental research and public health, 10*(9), 4274-4305.

Leech, N., Barrett, K., & Morgan, G. A. (2013). *SPSS for intermediate statistics: Use and interpretation* (3rd ed.): Routledge.

Lipsitch, M., & Bergstrom, C. T. (2002). Modeling of antibiotic resistance in the ICU-US slant: Kluwer.

Loughlin, C., & Barling, J. (2001). Young workers' work values, attitudes, and behaviours. *Journal of occupational and organizational Psychology, 74*(4), 543-558.

Meyers, M. C., Kooij, D., Kroon, B., de Reuver, R., & van Woerkom, M. (2018). Organizational support for strengths use, work engagement, and contextual performance: the moderating role of age. *Applied Research in Quality of Life*, 1-18.

Murphy, K. (2002). Using power analysis to evaluate and improve research. *Handbook of research methods in industrial and organizational psychology*, 119-137.

Nicolle, L. E., & Organization, W. H. (2001). *Infection control programmes to contain antimicrobial resistance*. Retrieved from https://www.who.int/csr/resources/publications/drugresist/infection_control.pdf

Park, J., & Kim, S. (2015). The differentiating effects of workforce aging on exploitative and exploratory innovation: The moderating role of workforce diversity. *Asia Pacific Journal of Management, 32*(2), 481-503.

Preventie.nl, R. (2018). Alles over de leeromgeving hygiënisch werken. Retrieved from https://www.resistentiepreventie.nl/leeromgeving-lees-meer/

Pulcini, C., Williams, F., Molinari, N., Davey, P., & Nathwani, D. (2011). Junior doctors' knowledge and perceptions of antibiotic resistance and prescribing: a survey in France and Scotland. *Clinical Microbiology and Infection, 17*(1), 80-87.

Tenover, F. C. (2006). Mechanisms of antimicrobial resistance in bacteria. *The American journal of medicine, 119*(6), S3-S10.

Weinstein, R. A. (2001). Controlling antimicrobial resistance in hospitals: infection control and use of antibiotics. *Emerging infectious diseases, 7*(2), 188.

Appendix A

Survey: Antimicrobial Resistance & Infection Control

Combat antibiotic resistance

The durability of modern healthcare is threatened by antibiotic resistance. The "hospital" and University of Twente (UT) are fighting together against antibiotic resistance within the framework of the European INTERREG project.

This survey is about your experiences with antibiotic resistance and infection prevention in hospitals.

It takes about 15 minutes to complete the questionnaire and the results are processed anonymously. Online version: "weblink".

Sociodemographic information

Q1. What is your age? (O <25 years, O 25-35 years, O 36-45 years, O 46-55 years, O 56-65 years, O >65 years)

Q2. What is your gender? (O Female, O Male)

Q3. In which hospital do you work? (O "Hospital", etc.)

Q4. At which department do you work? (O "Anaesthesiology", etc.)

Q5. What is your function? (O Medical specialist, O Nurse).

Q6. How many years of experience do you have in this function? (O <1 year, O ≥1 year <5 years, O 5-10years, O >10 years)

Q7. How many years of experience do you have at this hospital? (O <1 year, O ≥1 year <5 years, O 5-10years, O >10 years)

You have indicated that you are a nurse. Perhaps not all questions can be answered based on your primary duties / responsibilities (e.g. prescribing antibiotics), but researchers expect you to have an opinion on these issues. We therefore ask you to answer the questions in the best possible way based on your work experience and your collaboration with doctors.

Part 1: Your experiences with the antimicrobial resistance problem

Please indicate on a scale of 1 (Fully disagree) to 5 (Fully agree) to what extent you agree with these statements.

Q1a. AMR is a problem for public health.

Q1b. AMR is a problem for nursing homes.

Q1c. AMR is a problem for our hospital.

Q1d. AMR is a problem for my patients.

Q2a. One of the leading causes of AMR is the improper use of antibiotics in farming animals.

Q2b. One of the leading causes of AMR is the improper use of antibiotics by patients.

Q2c. One of the leading causes of AMR is the transfer of nursing home patients to the hospital.

Q3. I believe that antibiotics are prescribed at the request of patients.

Q4. I believe that antibiotic prescriptions should be based on lab results.

Q5. I am sufficiently informed about the diagnostic policy.

Q6. I believe that broad spectrum antibiotics should be provided when there is doubt of an infection.

Q7. I believe that I can contribute sufficiently to limit AMR.

Part 2: Your experiences with hospital processes related to antimicrobial resistance

Part 2A: Screening diagnostics

The process of finding out if a patient carries a resistant bacteria (incl. screening, taking cultures and testing cultures).

Q2A.1. How important do you think screening diagnostics are to limit AMR? (1: Not important-5:Very important)

Q2A.2. Do you feel like you have sufficient influence on screening diagnostics to limit AMR? (1: Insufficient-5:Sufficient)

Q2A.3. Do you have sufficient resources for screening diagnostics to limit AMR? (1: Insufficient-5:Sufficient)

Q2A.4. Do you have sufficient knowledge for screening diagnostics to limit AMR? (1: Insufficient-5:Sufficient)

Part 2D: Infection control

The implementation of suitable hygiene measures for infection and transmission prevention (e.g. antisepsis, hand hygiene, use of personal protective equipment, and cleaning of equipment and rooms).

Q2D.1. How important do you think hygiene measures are to limit AMR? (1: Not important-5:Very important)

Q2D.2. Do you feel like you have sufficient influence on hygiene measures to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.3. Do you have sufficient resources for hygiene measures to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.4. Do you have sufficient knowledge for hygiene measures to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.5. Do you have sufficient support from colleagues for hygiene measures to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.6. Do you have sufficient support from your supervisor for hygiene measures to limit AMR? (1: Insufficient-5:Sufficient)

Part 2E: Logistics

The planning of HRMO patients at treatment centers, OR's, day admission and nursing unites (isolation rooms, single rooms).

Q2D.1. How important do you think logistics is to limit AMR? (1: Not important-5:Very important)

Q2D.2. Do you feel like you have sufficient influence on logistics to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.3. Do you have sufficient resources for logistics to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.4. Do you have sufficient knowledge for logistics to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.5. Do you have sufficient support from colleagues for logistics to limit AMR? (1: Insufficient-5:Sufficient)

Q2D.6. Do you have sufficient support from your supervisor for logistics to limit AMR? (1: Insufficient-5:Sufficient)

Part 2F: Outbreak management

The actions and responsibilities during an outbreak.

Q2D.1. How important do you think outbreak management is to limit AMR? (1: Not important-5:Very important)
Q2D.2. Do you feel like you have sufficient influence on outbreak management to limit AMR? (1: Insufficient-5:Sufficient)
Q2D.3. Do you have sufficient resources for outbreak management to limit AMR? (1: Insufficient-5:Sufficient)
Q2D.4. Do you have sufficient knowledge for outbreak management to limit AMR? (1: Insufficient-5:Sufficient)
Q2D.5. Do you have sufficient support from colleagues for outbreak management to limit AMR? (1: Insufficient-5:Sufficient)
Q2D.6. Do you have sufficient support from your supervisor for outbreak management to limit AMR? (1: Insufficient-5:Sufficient)

Part 3
Q3.2. Which processes of improvement would you like to apply regarding the control of AMR. (open-ended question)

End of the survey
This is the end of the survey. Thank you for participating in this study on behalf of the research team.
Would you like to be updated about the results of this study and participate in follow-up studies? Please enter you email-address here.