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Knowledge of, compliance with and attitudes towards, infection control routines in dental practice: a survey among dental students and dental faculty members in North-West Russia

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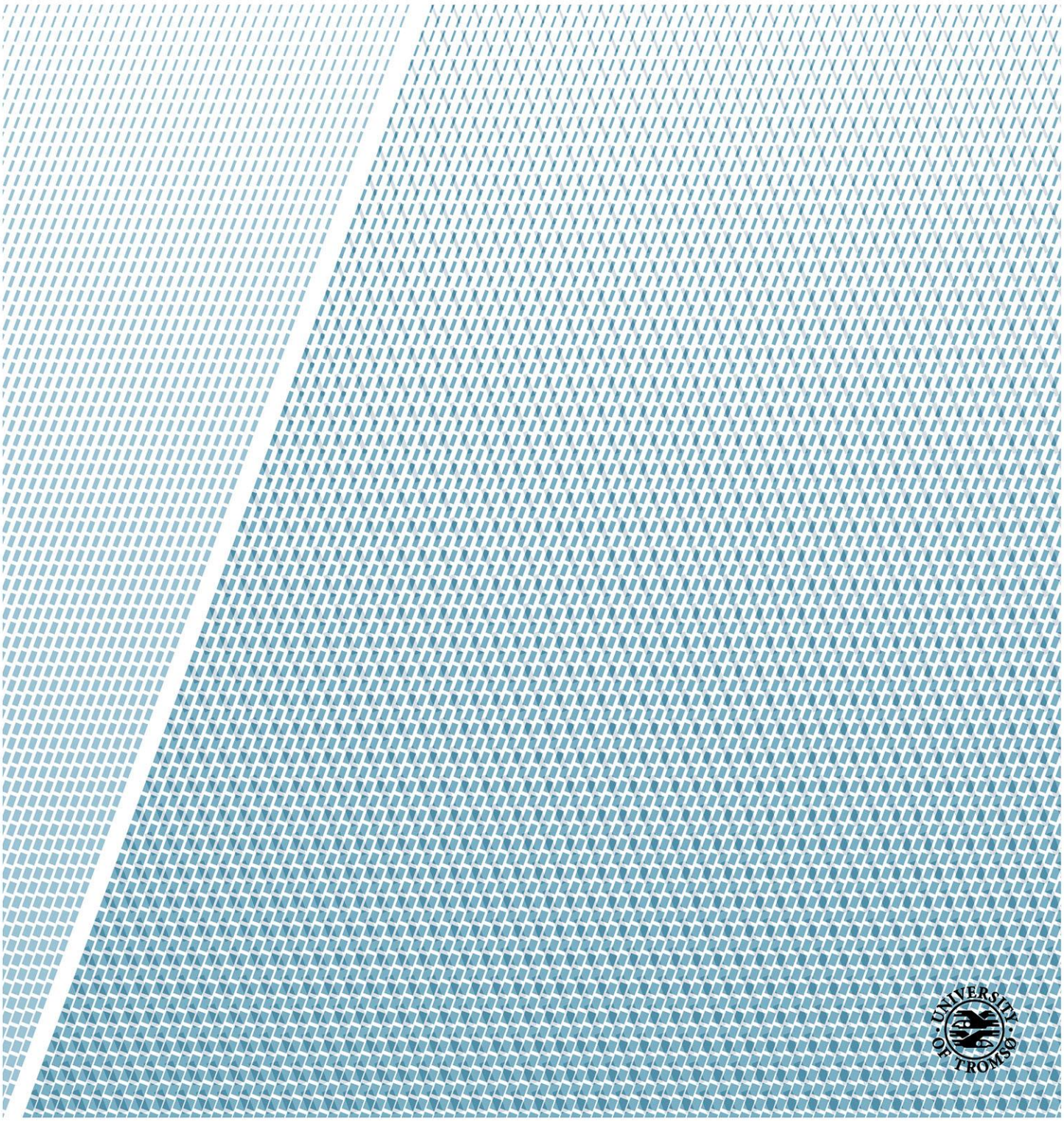

Table of contents

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List of abbreviations

HCAI: healthcare-associated infection

NSMU: Northern State Medical University

MRSA: Methicillin Resistant Staphylococcus Aureus

DHCP: dental healthcare professional

CDCP: Centers for Disease Control and Prevention

PPE: personal protective equipment

VZV: Varicella Zoster Virus

WHO: World Health Organization

Abstract

Aim:

Infections are among the most significant healthcare problems in terms of the global perspective. Its increasing burden on healthcare settings may lead to a higher prevalence of antibiotic resistance, increased morbidity, and mortality among the patients who admit to health care institutions. Several antibiotic-resistant bacteria, including Methicillin Resistant Staphylococcus Aureus (MRSA), which is known to have emerged as a consequence of inadequate antibiotic use, may result in severe healthcare-associated infections. Considering the effectiveness of standard precautions in reducing infection spread, as well as lack of national guidelines for infection control and high prevalence of MRSA carriage in Russia, this master thesis aimed to assess knowledge of, compliance with and attitudes towards, infection control routines in dental practice and its associations with socio-demographic and MRSA-related characteristics among Russian dental students and dental faculty members.

Materials and methods:

This cross-sectional study was conducted at the Northern State Medical University (NSMU), Arkhangelsk, North-West Russia, among Russian dentistry students and dental faculty members. A link to an online self-administered anonymous questionnaire comprised of 27 close-ended questions have been distributed via e-mail, opened for participation in the survey in the period of April through December 2019. The questionnaire was composed of four domains dedicated to socio-demographic characteristics, MRSA-related characteristics, knowledge of, compliance with, and attitudes towards, infection control routines in dental practice. Descriptive statistical analysis and the chi-square test for linear trend were applied using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, New York, USA).

Results:

A total of 107 dental students and 19 dental faculty members participated in the survey, corresponding to a response rate of 19.6% and 39.6%, respectively. Most of the participants were women (75.6%); the majority of respondents attended clinical dental practice (84.2%); 82.7% of the participants were aged between 17 and 24. Less than half of the participants attended a course in infection control during the last two years, and 63.8% of the respondents were screened for MRSA. Five percent of the respondents indicated themselves as positive carriers of MRSA, and 20.5% of the participants reported that MRSA carriage affects their

clinical dental practice. Slightly less than 60% of the participants took precautions when an immunocompromised patient attended the dental clinic.
In the questionnaire section assessing knowledge of infection control, «clothing while treating a patient» and «using facemask when leaving unit» had the poorest scores. Topics with the best scores included «wearing gloves», «the most effective method of infection control», and «when should dentist wash hands». The total score showed that 33.1 % of the respondents had good knowledge, 38.6 % of the respondents had intermediate knowledge, and 24.4 % of the respondents had poor knowledge. The participants showed an acceptable level of compliance with and attitudes towards infection control routines (cumulative percent of "always" and "often" above 70%) on 6 of 10 questions. Based on total score calculation, 40.9% of the participants had good compliance/attitudes, 28.3% of the participants had intermediate compliance/attitudes, and 26.8% of the participants had poor compliance/attitudes.
There were no statistically significant differences in the knowledge of infection control routines across the socio-demographic and MRSA-related characteristics considered. The majority of socio-demographic and MRSA-related characteristics were also not associated with compliance and attitudes. The level of compliance with and attitudes towards infection control routines increased if respondents reported precautions for immunocompromised patients ($p=0.031$).

Conclusion:
Most of the dental students and dental faculty members at the NSMU, Arkhangelsk, North-West Russia reported intermediate knowledge of, good compliance with and attitudes towards, infection control routines in dental practice. Most of the studied socio-demographic and MRSA-related characteristics were not associated with participants' knowledge, compliance, and attitudes. Nevertheless, proportions of respondents reported precautions for immunocompromised patients increased with increasing the level of compliance and attitudes. While compliance and attitudes are the core of the good practice, a suboptimal knowledge of the infection control would decrease their relevance and the clinicians' ability to achieve safe dental practice. Hence, the results of this study emphasize the need for establishing national or regional guidelines for infection control routines in dental practice in Russia.

Keywords: infection control routines, dental practice, knowledge, compliance and attitudes, MRSA, North-West Russia, Arkhangelsk.

1. Introduction

An infection, referred to as invasion and multiplication of microorganisms in the human body, is among the most significant healthcare problems from a global perspective. Infection in the healthcare sector, or healthcare-associated infection (HCAI), remains a serious public health issue. HCAIs affect patients during their admission to healthcare institutions, often as a result of omitting the proposed infection control routines (1), which may lead to patients' prolonged sickness, disability, and death. The prevalence of HCAIs varies from 4% to 12% worldwide (1-3). The most common HCAIs include infections of urinary, gastrointestinal, and lower respiratory tracts and postoperative wound and bloodstream infections (1). HCAIs may result in an increased need for additional antimicrobial therapy and the emergence of resistance to antibiotics among the hospital pathogens (4).

Throughout the history of antibiotic use, several resistant strains of bacteria have emerged, including Methicillin Resistant Staphylococcus Aureus (MRSA), which is one of the most frequent causes of severe HCAIs (5, 6). MRSA is also capable of cross-infection in dental practice (4, 7, 8). Several studies showed that dental healthcare professionals (DHCPs) with nasal colonization of MRSA could serve as a reservoir for transmission of the latter to co-workers and patients (7, 8). The high nasal colonization rate of MRSA has been reported to occur in DHCPs, particularly in dental students who have clinical experience, posing a risk for cross-contamination (7, 8). Dental practice, equivalent to a day surgical outpatient clinic, implies several invasive procedures conducted through the course of the day (9). It has been proposed that the risk of exposure to potentially pathogenic microorganisms is substantially high, owing to the invasiveness of dental procedures (7). While MRSA is an opportunistic pathogen, posing a particular threat for compromised patients, it also poses a similar hazard if the bacteria is introduced during invasive procedures (4, 7). The infection risk increases significantly if basic infection control routines are neglected (7, 9).

Centers for Diseases Control and Prevention (CDCP) propose strategies for the prevention of HCAIs (10). Standard precautions are the origin of several guidelines and routines for infection control, which are defined by CDCP as "measures practiced by health care personnel to reduce the risk of transmission of infectious agents to patients and employees" (11). Indeed, numerous studies showed that about one-third of all HCAIs could be prevented

abiding infection control programs (4, 12), making such guidelines paramount for any facility providing healthcare services. The three categorical approaches common for all routines are excluding sources of infection from the healthcare environment, enhancing the host's ability to resist infection (i.e., inoculating vaccine), and breaking the chain of infection (7).

The chain of infection is known as series of events necessary for the successful spread of infection. Interference with one or more of these links may prevent the dissemination of an infectious pathogen. The six links comprising chain of infection include etiologic agent, reservoir, portal of exit, mode of transmission, portal of entry, and a susceptible host (6). *Etiologic Agent* can be defined as the microorganism that causes a given infection (5). Etiological agents include bacteria, viruses, fungi, protozoa, helminths, and prions (4). *The reservoir* of infection can be defined as "any person, animal, plant, soil or substance, or a combination of these, in which an infectious agent normally lives and multiplies on, in which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host" (4). In a dental practice, this would imply DHCPs, dental equipment, patients, dental units.

Another item of great concern, which has the potential to be regarded as an eventual infection reservoir, is the water supply, having a direct association to air-water syringes, ultrasonic scalers, and high-speed turbine handpieces. Norwegian guidelines propose that the water systems supplying dental unit are subjected to the establishment of a bacterial biofilm containing *Legionella* among other genera of bacteria, and can theoretically pose a risk of infection for patients (9). Correct routines concerning the disinfection of dental unit and its water systems are therefore of significant importance for infection control in dental settings (9).

Portal of exit is defined as any site where the infectious agent can exit the reservoir, with possible examples including skin, ulcers, mouth, urinal tract, and nose (6). As the spread of infection implies, microorganisms have to be transmitted after leaving the reservoir (for ex., nasal cavity) (7). Correct use of a face mask during patient treatment should interfere with this step (9). *The mode of transmission* describes how a microorganism is being transported from the reservoir to a new host. Different ways of transmission exist, with the significant distinction made between vertical (i.e., from mother to child during birth) and horizontal (i.e., between individuals of the same generation) modes (13).

The pathogen may be transmitted directly between the carrier and a susceptible host, or indirectly through a contaminated intermediate (10, 13). Contact transmission is the most critical and frequent transmission mode in healthcare settings (14). Vehicleborne transmission in the form of water applied through air-water syringes, and exposure to infected blood, in addition to airborne transmission, and droplet spread, are proposed to be of significant importance for cross-contamination in dental practice (7). *Portal of entry* describes the site or anatomical landmark in which the pathogen can enter and subsequently infect the susceptible host, e.g., unsound skin (i.e., wounds, abrasions, or burns) and mucosa (e.g., oral mucosa) (7). The last element of the chain, a *susceptible host*, refers to any individual who poses a risk to be infected by a specific pathogen or becoming a carrier (10).

In recent decades, the topic of infection control and prevention has gained increased relevance in dental practice with guidelines for the prevention of cross-infection (7). DHCPs come across several patients with different social, cultural, and economic backgrounds. Although a general anamnesis should provide the dentist with necessary information regarding the patients' health history, information obtained is limited. Therefore, the application of standard infection control precautions at all times is required (11). Regardless of the anamnesis, all patients and all objects being in contact with patients should be considered a potential source of infection (7, 15). This principle encompasses both the MRSA infection and several other pathogens transmitted both directly and indirectly through respiratory route (e.g., varicella-zoster virus (VZV), mycobacterium tuberculosis), by direct contact (VZV, herpes simplex virus), and through exposure to infected blood (hepatitis virus B, hepatitis virus C and human immunodeficiency virus (4, 7, 16).

On the other hand, DHCPs have an equal ability to infect the patient. Hands of a DHCP may potentially be contaminated with various pathogens, and direct and indirect contact with DHCP`s hands may serve as an infection source, including the transmission of multidrug-resistant strains of bacteria (7, 8, 17). Several studies showed that MRSA is mainly transmitted through contaminated hands of healthcare workers (8, 18, 19). Moreover, as it was previously mentioned, DHCPs and dental students have a high degree of nasal colonization with MRSA (8, 18). Several surfaces in a dental office, such as the dental chair, mouth rinse basin, the suction chamber, and the floor underneath the dental chair, also have

the potential to become polluted by microbes (18, 19). Therefore, profound knowledge of, high compliance with and attitudes towards, infection control routines are essential requirements in preventing the spread of infection between patients and DHCPs (7, 8).

The standard precautions proposed by the CDCP are considered appropriate as means for preventing MRSA transmission in dental healthcare settings (8). Vaccination, basic infection control routines including hand hygiene, personal barrier protection (e.g., facemask, face shield/goggles), instrument disinfection and sterilization, surface decontamination, approaches to decontaminate water systems, and immediate utilization of sharp instruments, are regarded as the essential means for breaking the chain of infection (1, 7, 20, 21). Nevertheless, some studies found that only few DHCPs are implementing all these procedures into their clinical dental practice (22, 23). Therefore, dental education and national guidelines for infection control should play a significant role in obtaining knowledge of, compliance with and attitudes towards infection control routines in dentistry (11). As for any habit or skill, good infection control practice requires proper education throughout the study, resulting in the development of an excellent clinician.

In Russia, previous studies on knowledge of, compliance with and attitudes towards, infection control routines in dental practice among dentistry students and dental faculty members are sparse. However, an odontology master thesis research conducted in 2019 investigated awareness of infection risk during dental treatment. Students in their fifth year of the dentistry study in NSMU, as well as DHCPs in dental clinics across Arkhangelsk region, participated in this study. The study has obtained results indicative of intermediate knowledge on the topic of infection risk (24). A research assessing knowledge of, attitudes towards, and practices of, infection control regarding MRSA was performed on DHCPs in South Korea. The authors found that overall results among the participants were acceptable, although MRSA wasn't perceived as a serious problem by a majority of respondents (8). Another study investigating attitudes, compliance and knowledge, of infection control guidelines among dental faculty members and dental students, was performed at King Saud's University, Saudi Arabia. The findings were indicative of good compliance and attitudes; however, knowledge of the respondents was considered as unsatisfactory (11).

To date, the Russian Federation does not have any national guidelines for infection control routines developed for Russian DHCPs (25). Nonetheless, in 2015 the prevalence of MRSA in the general population has been reported to be 10-25% in Russia (26).

2. Aim of the study

This Master thesis aims to assess knowledge of, compliance with and attitudes towards, infection control routines in dental practice and its associations with socio-demographic and MRSA-related characteristics among Russian dental students and dental faculty members.

3. Material and methods

3.1. Study setting

The study was conducted at the Dental Faculty of the Northern State Medical University (NSMU), Arkhangelsk, North-West Russia. The Dental Faculty of NSMU was established in 1958 for training DHCPs in the European North of Russia. In 2019, there were a total of 546 dental students who attended the NSMU, and 48 dental faculty members affiliated to the dental student clinic.

3.2. Study design and sampling

Our study was performed using a cross-sectional study design, with an anonymous self-administered online form of a questionnaire. All dental students from the first to the fifth year of education, as well as all dental faculty members employed at the dental student clinic of NSMU, met the criteria for inclusion. Every dental student, clinical supervisor, and researcher were invited to answer the questionnaire via e-mail. No sample size calculation was performed.

3.3. Data collection

A questionnaire consisting of 27 close-ended questions was created for use in this study (Appendix I), using the web form tool at www.uio.no, developed by the University of Oslo. The questionnaire was designed by the undersigned group, and feedback was received from an expert in the field, one of our supervisors, Mohammed Al-Haroni. The questionnaire was developed in English and then translated to Russian by a member of the master thesis group, Egor Valkov. The participants answered the online questionnaire in Russian; afterwards, the answers were translated from Russian back to English.

The questionnaire gathered socio-demographic information and MRSA-related characteristics of the study participants, as well as information on their knowledge of, compliance with and attitudes towards infection control routines in dental practice. Socio-demographic variables included gender, age group (17-24 years/25 years and more), occupation (dental student/dental faculty member), and attendance at clinical dental practice by dental students (pre-clinical/clinical dental students).

Regarding MRSA-related characteristics, the respondents were asked to report whether they attended a course in infection control during the last two years; whether they were screened for MRSA; whether they were a carrier of MRSA; whether the MRSA carriage affects their clinical dental practice; whether they take precautions when an immunocompromised patient attends the dental clinic. Responses on these questions were given as "yes", "no", "do not know", excluding the question "attended a course in infection control during the last two years", where only two answer options, "yes" and "no" were used. The answer options "no" and "do not know" were combined in statistical analysis.

The questionnaire then proceeds to questions assessing participant's knowledge of infection control routines. A total of eight questions were asked. They included information on the use of clothing while treating patients, facemask when leaving the unit, and use of gloves. Information on the most effective method of infection control, the best method for reducing both direct and indirect transmission, and the correct way of handling and disinfection of the unit was also obtained. Finally, the respondents were asked to report when the dentist should wash hands and disinfect hands. Each item presents with between three and five answer alternatives, ranked from the least correct to the most correct one. The most correct answer was defined by the national guidelines for infection control at student dental clinics in Norway, which are, in turn, based on propositions from CDCP (9). Questions scored from zero through two points, with zero points indicating the least correct answer and 2 points indicating the most correct answer. One point was given to the answer regarded as intermediate knowledge.

The last section of the questionnaire collected information on self-reported compliance with specific infection control procedures, as well as the respondent's attitude towards the proposed routines. A total of 10 items assessing participant's compliance and attitudes were borrowed mainly from a study performed by Alharbi et al. (11). Some minor changes were made, including the introduction of two items concerning the disinfection of hands, the omission of three inapplicable items proposed by Alharbi et al., and renaming the section to compliance and attitudes. The latter was done in order to test either domain, as well as giving non-clinical dental students an opportunity to report their hypothetical adherence to the infection control statements. The participants were asked to report how often they wash hands prior to wearing gloves, disinfect hands prior to wearing gloves, disinfect hands after taking off gloves, use gloves during treatment, change gloves between patients, wear

facemask during treatment, change facemask between patients, disinfect face shield or goggles between patients, use a protective gown during treatment, and change protective gown between patients. Responses were given on a 5-point Likert scale: (5) always, (4) often, (3) sometimes, (2) rarely, and (1) never.

3.4. Statistical analysis

For the knowledge of infection control routines section, percentages of respondents corresponding to good, intermediate, and poor knowledge were presented for each item. In addition, the total score of every participant was calculated (excluded the missing data). Poor knowledge was defined as a total score of less than 33.3th percentile (corresponding to ≤7 points), intermediate knowledge in case of values between 33.3th and 66.6th percentiles (corresponding to 8-9 points), and good knowledge implying values above 66.6th percentile (corresponding to ≥10 points).

For the compliance with and attitudes towards infection control routines section, the results were presented in a similar manner. Poor compliance/attitudes were defined as a total score of less than 33.3th percentile (corresponding to ≤41 points), intermediate compliance/attitudes in case of values between 33.3th and 66.6th percentiles (corresponding to 42-45 points), and good compliance/attitudes implying values above 66.6th percentile (corresponding to ≥46 points). In addition, the cumulative proportion of respondents answering “always” and “often” should be at least 70% to represent an acceptable level of compliance with and attitudes to infection control routines.

Descriptive statistical analysis was performed using Package for Social Sciences IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, New York, USA). The chi-square test for linear trend was used to compare proportions of the respondents with overall good, intermediate, and poor knowledge/compliance/attitudes between categories of socio-demographic and MRSA-related characteristics. The level of significance was set at $p<0.05$ for all statistical hypotheses.

3.5. Ethical considerations

The local Ethical Committee of the NSMU approved the survey.

4. Results

A total of 107 dental students and 19 dental faculty members participated in the survey, corresponding to a response rate of 19.6% and 39.6%, respectively. The majority of respondents were women. Most of the study participants were in the age group of 17-24 years. More than 80% of the respondents were dental students, and most of them attended clinical dental practice. Less than half of the study participants attended a course in infection control during the last two years, and more than 60% of respondents were screened for MRSA. Five percent of the respondents indicated themselves as positive carriers of MRSA, and 20.5% of the participants reported that MRSA carriage affects clinical dental practice. Slightly less than 60% of the participants took precautions when an immunocompromised patient attended the dental clinic (Table 1).

On the knowledge of infection control routines, topics that scored poor knowledge were "clothing while treating a patient" (85.8% of respondents) and "facemask when leaving the unit" (48.0% of respondents). Topics that scored good knowledge were "wearing gloves", "the most effective method of infection control", and "when should dentist wash hands", with over 60% of respondents showing good knowledge (Table 2).

The total score was calculated (excluded the missing data), according to which 42 respondents (33.1%) had good knowledge, 49 (38.6%) had intermediate knowledge, and 31 (24.4%) had poor knowledge.

Table 1. Socio-demographic and MRSA*-related characteristics of the study participants (n=127).

Characteristics	n (%)
Gender	
Male	31 (24.4)
Female	96 (75.6)
Age group (years)	
17-24	105 (82.7)
25 and more	22 (17.3)
Occupation	
Dental student	107 (84.2)
Dental faculty member**	19 (15.0)
Missing data	1 (0.8)
Attendance at the clinical dental practice	
Pre-clinical dental students	16 (15.0)
Clinical dental students	86 (80.4)
Missing data	5 (4.6)
Attended course in infection control last 2 years	
Yes	60 (47.2)
No	66 (52.0)
Missing data	1 (0.8)
Screened for MRSA	
Yes	81 (63.8)
No	34 (26.8)
Don’t know	12 (9.4)
Carrier of MRSA	
Yes	6 (4.7)
No	96 (75.6)
Don’t know	24 (18.9)
Missing data	1 (0.8)
Carriage affects clinical dental practice	
Yes	26 (20.5)
No	55 (43.3)
Don’t know	34 (26.8)
Missing data	12 (9.4)
Precautions for an immunocompromised patient	
Yes	74 (58.3)
No	38 (29.9)
Don’t know	9 (7.1)
Missing data	6 (4.7)

* Methicillin Resistant Staphylococcus Aureus

** Clinical supervisor/Researcher

Table 2. Knowledge of infection control routines in the study participants (n=127).

Questions on infection control routines	Good knowledge, n(%)	Intermediate knowledge, n(%)	Poor knowledge, n(%)	Missing data, n (%)
Clothing while treating a patient	15 (11.8)	3 (2.4)	109 (85.8)	0 (0)
Facemask when leaving the unit	38 (29.9)	26 (20.5)	61 (48.0)	2 (1.6)
Wearing gloves	80 (63.0)	10 (7.9)	37 (29.1)	0 (0)
The most effective method of infection control	88 (69.3)	35 (27.6)	3 (2.4)	1 (0.8)
The best method for reducing direct/indirect transmission	48 (37.8)	61 (48.0)	17 (13.4)	1 (0.8)
When should the dentist wash hands	81 (63.8)	0 (0)	46 (36.2)	0 (0)
When should the dentist disinfect hands	36 (28.3)	59 (46.5)	31 (24.4)	1 (0.8)
Handling and disinfection of the unit	54 (42.5)	33 (26.0)	40 (31.5)	0 (0)

The respondents showed an acceptable level of compliance with and attitudes towards infection control routines (cumulative percent of "always" and "often" above 70%) on 6 of 10 questions. Nevertheless, the topics related to "disinfection of the hands with 70% alcohol solution after taking off gloves", "changing face mask between patients", "wearing a protective gown during treatment" and "changing protective gown between patients" showed an unacceptable level of compliance and attitudes (cumulative percent of "always and "often" below 70%) (Table 3).

The total score was calculated (excluded the missing data), according to which 52 (40.9%) of the respondents had good compliance and attitudes, 36 (28.3%) had intermediate compliance and attitudes, and 34 (26.8%) had poor compliance and attitudes.

Table 3. Compliance with and attitudes towards infection control routines in the study participants (n=127).

Compliance and attitudes	Always, n(%)	Often, n(%)	Sometimes, n(%)	Rarely, n(%)	Never, n(%)	Missing data, n (%)
Wash your hands prior to wearing gloves	108 (85.0)	15 (11.8)	3 (2.4)	0 (0)	1 (0.8)	0 (0)
Disinfect your hands with 70% alcohol solution prior to wearing gloves	62 (48.8)	28 (22.0)	19 (15.0)	11 (8.7)	7 (5.5)	0 (0)
Disinfect your hands with 70% alcohol solution after taking off gloves	45 (35.4)	21 (15.5)	25 (19.7)	13 (10.2)	22 (17.3)	1 (0.8)
Wear gloves during treatment	124 (97.6)	0 (0)	0 (0)	0 (0)	1 (0.8)	2 (1.6)
Change gloves between patients	124 (97.6)	0 (0)	0 (0)	0 (0)	1 (0.8)	2 (1.6)
Wear face mask during treatment	122 (96.1)	3 (2.4)	0 (0)	0 (0)	1 (0.8)	1 (0.8)
Change face mask between patients	57 (44.9)	24 (18.9)	19 (15.0)	15 (11.8)	11 (8.7)	1 (0.8)
Disinfect face shield/googles between patients	95 (74.8)	11 (8.7)	7 (5.5)	2 (1.6)	11 (8.7)	1 (0.8)
Wear a protective gown during treatment	81 (63.8)	7 (5.5)	15 (11.8)	2 (1.6)	20 (15.7)	2 (1.6)
Change protective gown between patients	72 (56.7)	8 (6.3)	14 (11.0)	10 (7.9)	21 (16.5)	2 (1.6)

There were no statistically significant differences in the knowledge of infection control routines across the socio-demographic and MRSA-related characteristics considered (Table 4).

Table 4. Socio-demographic and MRSA*-related characteristics associated with knowledge of infection control routines in the study participants

Characteristics	Knowledge of infection control routines			
	Good, n(%)	Intermediate, n(%)	Poor, n(%)	P-Value**
Gender				0.642
Male	10 (33.3)	11 (36.7)	9 (30.0)	
Female	32 (34.8)	43 (42.2)	22 (23.9)	
Age group (years)				0.731
17-24	34 (33.7)	41 (40.6)	26 (25.7)	
25 and more	8 (38.1)	8 (38.1)	5 (23.8)	
Occupation				0.266
Dental student	32 (31.3)	43 (42.2)	27 (26.5)	
Dental faculty member***	4 (21.0)	6 (31.6)	9 (47.4)	
Attendance at the clinical dental practice				0.230
Pre-clinical dental students	4 (28.6)	4 (28.6)	6 (42.8)	
Clinical dental students	28 (33.7)	37 (44.6)	18 (21.7)	
Attended course in infection control last 2 years				0.315
Yes	20 (34.5)	19 (32.7)	19 (32.8)	
No	22 (32.9)	29 (46.1)	12 (19.0)	
Screened for MRSA				0.468
Yes	28 (35.9)	32 (41.0)	18 (23.1)	
No/Don't know	14 (31.8)	17 (38.7)	13 (29.5)	
Carrier of MRSA				0.185
Yes	4 (66.6)	1 (16.7)	1 (16.7)	
No/Don't know	38 (33.0)	47 (40.9)	30 (26.1)	
Carriage affects clinical dental practice				0.700
Yes	10 (41.6)	7 (29.2)	7 (29.2)	
No/Don't know	26 (29.9)	40 (46.0)	21 (24.1)	
Precautions for an immunocompromised patient				0.759
Yes	27 (37.0)	24 (32.9)	22 (30.1)	
No/Don't know	13 (20.5)	23 (52.3)	8 (18.2)	

*****Methicillin Resistant Staphylococcus Aureus
******P-value from the chi-square test for linear trend; all missing values were excluded
******* Clinical supervisor/Researcher

The associations of socio-demographic and MRSA-related characteristics with compliance /attitudes are shown in Table 5. There was a tendency towards better compliance and attitudes among those who claimed that their MRSA-carriage affects their clinical dental practice,

although the chi-square test for linear trend did not reach statistical significance (p=0.058). The level of compliance with and attitudes towards infection control routines increased if respondents took precautions for immunocompromised patients (p=0.031 from the chi-square test for linear trend).

Table 5. Socio-demographic and MRSA*-related characteristics associated with compliance with and attitudes towards infection control routines in the study participants

Characteristics	Compliance/attitudes			
	Good, n(%)	**Intermediate, n(%)**	**Poor, n(%)**	**P-Value ****
Gender				0.914
Male	14 (46.7)	6 (20.0)	10 (33.3)	
Female	38 (41.3)	30 (32.6)	24 (26.1)	
Age group (years)				0.794
17-24	42 (41.6)	31 (30.7)	28 (27.7)	
25 and more	10 (47.6)	5 (23.8)	6 (28.6)	
Occupation				0.689
Dental student	41 (40.2)	33 (32.4)	28 (37.4)	
Dental faculty member***	10 (52.6)	3 (15.8)	6 (31.6)	
Attendance at the clinical dental practice				0.216
Pre-clinical dental students	8 (50.0)	6 (37.5)	2 (12.5)	
Clinical dental students	32 (30.5)	25 (30.9)	24 (20.6)	
Attended course in infection control last 2 years				0.681
Yes	22 (39.3)	18 (32.1)	16 (28.6)	
No	29 (44.6)	18 (27.7)	18 (27.7)	
Screened for MRSA				0.735
Yes	35 (44.9)	21 (26.9)	22 (28.2)	
No/Don't know	17 (38.6)	15 (34.1)	12 (27.3)	
Carrier of MRSA				0.559
Yes	4 (66.6)	0 (0)	2 (33.4)	
No/Don't know	47 (40.9)	36 (31.1)	32 (27.8)	
Carriage clinical dental practice				0.058
Yes	15 (60.0)	7 (28.0)	3 (12.0)	
No/Don't know	35 (41.2)	26 (30.6)	24 (28.2)	
Precautions for an immunocompromised patient				0.031
Yes	37 (52.9)	18 (25.7)	15 (21.4)	
No/Don't know	14 (30.4)	17 (37.0)	15 (32.6)	

*****Methicillin Resistant Staphylococcus Aureus
******P-value from the chi-square test for linear trend; all missing values were excluded.
******* Clinical supervisor/Researcher

5. Discussion

5.1. Methodological challenges

The validity of a study is an essential concept in its results' interpretation. There are two main types of validity: internal validity and external validity. Internal validity is defined as the degree to which findings and conclusions drawn from the study truly reflect the traits of the tested population. Numerous factors can damage the internal validity of the study (27), including selection bias, information bias, and confounding.

Selection bias is defined as systematic errors in the method implemented for the selection of study participants (28). We invited all dental students and all dental faculty members of the NSMU to participate in the survey. However, a total of 107 dental students participated in the survey, corresponding to a low response rate of 19.6%. Therefore, it cannot be ruled out that there were systematic differences in important study characteristics between the dental students who did and did not participate in the study. Indeed, the sample was not well balanced, with a lower number of pre-clinical dental students than clinical dental students. Moreover, a comparably low number of dental faculty members (n=19) among the respondents makes it challenging to compare their results to the results of dental students.

Information bias is defined as systematic errors in the approach used to collect and measure the data (28). In the present study, we used an online form of a self-administered anonymous questionnaire. The questionnaire was developed in English and then translated to Russian. Nevertheless, significant limitations of this study are indeed linked to the production of the questionnaire form. The very idea of developing a new questionnaire can seem simple, and nonetheless, without a proper approach, various challenges and biases emerge. This is particularly true for the development of a questionnaire aimed to assess a study population of a different native language. Previous surveys (11, 23) which aimed to evaluate knowledge of, compliance with and attitudes towards infection control routines among DHCPs and dental students, had established questionnaire forms, which could readily be used for this study. The compliance section is, in essence, entirely adopted from the survey conducted by Alharbi et al. (11), with an introduction of a few minor changes. While using a preexisting questionnaire saves both time and resources (29, 30), the problems arise either when the questionnaire

measuring the construct in question does not exist, or when an existing questionnaire form is unavailable in a language comprehended by the targeted study population (29). Despite the pluricentricity of the English language, it is considered foreign in Russia (31). Thus, the need for translating the questionnaire form to Russian seemed mandatory in case of this Master thesis.

The questionnaire was initially made in English and later translated to Russian before being distributed to the study participants. The translation was done by a trilingual (Russian, English, Norwegian) dental student, affiliated to the undersigned study group (Egor Valkov). The chosen method of translation is considered weak. It is proposed that the forward translation of the original questionnaire (i.e., the one written in English) to the language of interest should be conducted by a minimum of two independent translators (29). It is preferred that the translators are bilingual and translate the questionnaire into their native language. It is further suggested that one of the translators is aware of the objective investigated by the questionnaire, while the other one is not – termed naive translator. The eventual discrepancies in translations can then be confronted and resolved either by original translators, at worst, or with an addition of another bilingual translator not affiliated to the previous two translations, at best.

Moreover, the method of the backward translation may positively influence the soundness of the translated questionnaire, ensuring the exclusion of misunderstandings or unclear wording in the initial translation (29, 32). This method also implies two independent translators, as in the case of the two desirable initial translations. Likewise, the form should be translated into the native language of newly included translators, which is English in this instance. With the purpose of further elimination of bias, it is recommended that the translators are blinded to the objective and topic of the study in question (29). Finally, the original and back-translated forms of the questionnaire should be compared to be sure in the conceptual and functional equivalence of the two forms.
Hence, with regards to the aforementioned propositions, the means of translation used by the undersigned study group are methodologically unsound.

Eight of the questions in the questionnaire described the knowledge of infection control routines in dental practice. The questions were developed in consensus by members of the study group, with a theoretical background from the gold standard established by Norwegian

Workshop for Infection Control in Clinical Odontology. While being innovative has benefits on some occasions, the opposite may be true when developing a questionnaire. Developing a new questionnaire or modifying an established one may result in certain limitations, such as being unable to soundly compare the findings of the intended study with those from other studies (29, 30). Moreover, preliminary piloting is required, which implies testing of the questionnaire on a small sample of respondents who will not participate in the main study. Piloting may disclose confusing questions and allow pilot participants to offer their input to improve the clarity of the form. A pilot study can be conducted several times, whether it should be necessary (29).

Vague close-ended questions and answer alternatives could be interpreted in numerous ways by different respondents, biasing the results obtained (29, 33). In general, it is suggested that questions should be laconic and to the point (30). Nevertheless, in the present study the questionnaire used was not pilot-tested. Omitting the opportunity to enhance how well the questionnaire can be comprehended may have left some or several of the eight questions ambiguous to the respondents. Moreover, the possible answers are purposely arranged in such a manner that several alternatives could be correct to a certain degree, with one being the most correct answer. This may augment the incomprehensibility further.

Nonetheless, although the limitations are apparent, the questionnaire is established strictly following the proposed guidelines (9). The section on compliance/attitudes was mostly borrowed from a study performed on dental faculty members and students affiliated to King Saud University, Riyadh, Kingdom of Saudi Arabia (11). On the other hand, just because a questionnaire has been piloted and used in other studies, does not imply its' validity or reliability in our setting (30).

When assessing the relationship between knowledge/compliance/attitudes and socio-demographic and MRSA-related characteristics of the respondents, these associations should be controlled for confounders. A confounding factor is a variable that affects other studied variables in such a manner that the results do not reflect the actual relationship (34). A multivariable analysis is often used to control for confounders. Only descriptive statistics and bivariable analyses were applied in the case of our study. We did not find statistically significant associations in the bivariable analysis, except the association between precautions for an immunocompromised patient who attends dental clinic, and compliance with and

attitudes towards, infection control routines. Small sample size and differences in the number of respondents across categories of socio-demographic and MRSA-related characteristics (e.g., considerably lower number of non-clinical dental students than clinical dental students) might partly explain the results obtained. Hence, multivariable analysis was not used in the study, making control for confounders non-applicable.

The external validity of a study reflects how well the obtained results could be generalized to other individuals, that are in the same target population but were not participating in the survey. Given that only dental students and dental faculty members of the NSMU were invited to the survey, we can't make a generalization of our findings to neither all Russian dental students nor all DHCPs in North-West Russia.

Reliability, defined as a measure of the consistency of the results obtained, is another crucial concern of a study, along with its validity (29). One of the typical methods for assessment of reliability is test-retest reliability, which is estimated by repeated administration of the same questionnaire or retesting with a paraphrased questionnaire form measuring the same construct. The correlation between responses is evaluated using Pearson's product-moment correlation coefficient (Pearson's r), referred to as the coefficient of stability. A higher coefficient indicates a more durable test-retest reliability, which in turn reflects that the individuals' responses over time are less probable of being the reason for the eventual measurement error of the questionnaire. In our study, we did not assess test-retest reliability.

These methodological challenges should be taken into consideration when interpreting the results of the current study.

5.2. Knowledge of infection control routines in dental practice

The first item on the knowledge section concerned clinical clothing, formulated as "*clothing while treating a patient should be*". The question presents five alternatives, two of which are "*without sleeves*" and "*sleeves covering shoulders*". Both alternatives may reflect the same logic behind infection control routines, particularly the desire to reduce the probability of cross-contamination while using long-sleeved clothes, which could be confusing to the respondents. On the other hand, Cambridge dictionary defines the word "sleeve" as "the part

of the jacket, shirt, etc. that covers your arm" (35), while the infection control guidelines suggest that the sleeves should not be below the elbow:

"*Clinical clothing should be changed every day or even more often if needed. Clinical clothing must have short sleeves above the elbow, enhancing clinician's ability to perform hygienic procedures on one's hands, wrists, and forearms (9)."*

Hence, the alternative "sleeves covering shoulders" was considered correct, granting two points. The alternative *"without sleeves"* was consistent with intermediate knowledge and was given 1 point. The remaining three alternatives scored zero points. According to results, 11.8 % of the participants had good knowledge, 2.4 % had intermediate knowledge, while the remaining 85.8 % had poor knowledge. As far as we know, no previous study has considered this aspect of clinical wear. Nevertheless, the study by Danielsen, Fredriksen, and Singh, has gathered similarly suboptimal results concerning knowledge of infection control routines with regards to clothing, where only 8% and 4.6% of the respondents reported to have a routine for changing clinical wear and change clinic clothes every day, respectively (24).

The second item on the knowledge section concerned the use of the face mask and was formulated as "when you leave the unit for a short period, what do you do with the face mask". The Norwegian workshop for infection control in clinical odontology proposes the following:

"The facemask is used to protect the operator, shielding nose and mouth in procedures where splashes of bodily fluids may occur, as well as reducing inhalation of aerosols. Face masks should only be used once and never be pulled down to the neck. Face masks should not be reused. In case the unit is left, the face mask should be disposed, and changed with a new face mask upon returning. The effectiveness of the facemask is dependent on the degree of filtration and leakage of the face mask. The face mask should cover the mouth and nose. Face masks are disposable single-time-use items and should be changed between every patient and in the case of being visibly contaminated or moist (9)."

Among the five answer options, two alternatives "*should be taken off, and can be reused after returning back to the unit*" and "*should be thrown and changed with a new face mask after*

returning back to the unit" stood out as the ones pursuing good infection control practice. The idea of leaving the facemask chairside strives for reducing the probability of indirect transmission, as the facemask may be contaminated with aerosols or biological fluids. At the same time, the guidelines emphasize that the face mask is a single-time-use item, and reusing may be fraught with cross-contamination (9). The face mask should be considered used the moment it is taken off and hence thrown. Therefore, the option "*should be thrown and changed with a new face mask after returning back to the unit*" granted 2 points, while the option *"should be taken off and can be reused after returning back to the unit"* was given 1 point. The remaining alternatives scored zero points.

According to the results, a total of 29.9 % of the respondents had good knowledge, 20.5 % had intermediate knowledge, and 48.0 % had poor knowledge of this item. This result is slightly worse than the findings of Danielsen et al., where 56.3% answered correctly on the question regarding the use of the face mask (24). The question was formulated differently compared to ours, and concerned whether the respondents used to change their face mask between every patient. Considering that both versions intended to track the desirable infection control practice, the knowledge on the face mask topic was suboptimal in both studies.

The third item concerned the use of gloves. According to the workshop, gloves should be applied when in contact with body fluids, mucosa, broken skin, and contaminated objects. Gloves serve as an additional barrier between the patient and the health care professional and protect both. The workshop states further:

"Hand hygiene should be performed before and after using gloves. Gloves should be the last protective gear applied. The gloves should be used upon examination and treatment of the patient, upon direct contact with contaminated instruments, as well as cleaning and disinfection of the working place and unit. Further, the gloves are to be used when direct contact with blood, bodily fluids, secrets, wounds, and mucosa is anticipated. Change gloves between different procedures if the gloves have come in contact with potentially contaminated areas. Change gloves in case of visible contamination and damage. The gloves are removed and disposed directly after the dental procedure is done. Changing gloves between patients is considered mandatory (9).

The two most correct alternatives suggested that gloves should be worn "*when direct contact*

with blood, other body fluids and secretes, open wounds and mucosa are expected" or "*anytime during patient treatment and post-treatment disinfection and cleaning of the unit*". While the former alternative is considered common sense for all healthcare professionals (36), direct and/or indirect contact with various biological fluids and mucosa can reasonably be anticipated during dental treatment at all times. Furthermore, the unit should be considered contaminated after patient treatment and thus disinfected – which necessitates the application of gloves. This makes the latter alternative most correct; however, both granted points (one and two points, respectively).

Considering that all of the remaining alternatives were wrong, 63.0 % of the respondents had good knowledge, 7.9 % had intermediate knowledge, and 29.1 % had poor knowledge. This result is considerably poorer than that of Danielsen et al., where 100% of the DHCPs and last years' dentistry students answered to change gloves between every patient, as well as having a routine regarding gloves wearing in their clinic (24). The probable reason for the diversity of results is different formulation and different presented alternatives, as in the case with the second item.

The fourth item asked respondents to pick the most effective method of infection control among three possible alternatives, with the two most correct being "*basic infection control routines*" and "*autoclaving*". The workshop states straight forward that the most effective measure for infection control is basic infection control routines (9). While autoclaving is the most reliable (11) and a sophisticated method for effectively sterilizing appropriate equipment, several items used by the dentist are non-autoclavable. Hence, the guidelines suggest that basic infection control routines are the most effective method of infection control, namely being the most *cost-effective* method (9, 22). Nevertheless, the way in which question was formulated ("*choose the most effective method of infection control*") did not concretely imply what the investigators was having in mind and should have been paraphrased.

According to results, 37.8 % of the participants had good knowledge, 48.0 % of the participants had intermediate knowledge, picking autoclaving as the most effective method of infection control, and 13.4 % of the participants had poor knowledge. In contrast, in the study by Danielsen et al., where more attention was given to the method of autoclaving itself, a mean of 76.4% of the respondents showed good knowledge on this aspect of infection control (24). This comparison could suggest that autoclaving is a more recognized method among the

DHCPs and students, and the value of simple infection control measures is underestimated. Indeed, the reliability of autoclaving is indisputable, considering the tool which is about to be sterilized is suitable for heat processing. Hence, if the question was formulated as "what is the most reliable method of sterilization", then autoclaving would be the correct answer alternative – as in the case of study performed by Alharbi et al., where 84.1% of the respondents answered correctly on the latter question (11). Nonetheless, the proportion of respondents in our study who performed poorly on that item was negligible, as in the case with the two studies mentioned above.

The fifth item encouraged respondents to choose the number one priority method for reducing the probability of direct and indirect transmission of bacteria, in an attempt to assess the participant's knowledge regarding hand hygiene. Hand hygiene is one of the most essential and cost-effective measures to prevent the spread of infection (37). World Health Organization (WHO) has developed a checklist named "My 5 Moments for hand Hygiene", which describes five situations where hand hygiene is appropriate, including: before touching the patient, before all aseptic procedures, after the risk of contact with body fluids, after touching the patient and after touching surroundings around the patient (38). In addition to the checklist proposed by WHO, the Norwegian Institute of Public Health has identified additional situations where hand hygiene might be favorable, with regards to infection control. These include: after removal of gloves, after touching objects in the disinfectant room, after handling of waste or contaminated equipment, after visiting the toilet, after coughing or sneezing in hands, before entering clean areas (e.g., kitchen or the medicine room), before eating or preparing food and before entering or exiting the ward (39, 40).

Furthermore, the workshop proposes that disinfection with alcohol-based hand disinfectants is the first-choice method of hand hygiene. The exception is if the hands are visibly contaminated with dirt, then hand hygiene should be done through handwashing with soap and water. The percentage of alcohol in the alcohol-based hand disinfectant should be between 70-90% (9).

Hence, the three answer alternatives comprising the fifth item, being "*washing hands with soap*", "*disinfecting hands with a 70% alcohol solution*" and "*correct gloves wearing*", all seemed equitably correct. Washing hands with soap is indeed a suitable method for the reduction of surface bacteria and removing surfacing dirt in particular.

However, excessive frequent handwashing with soap and water is fraught with the appearance of skin wounds, penetrating the integumentary barrier, and increasing susceptibility to the transmission of blood-borne diseases.

Therefore, it is proposed by the guidelines that hands should primarily be washed before and after the patient's treatment. In principle, healthy skin is a decent infection-blocking barrier in itself. For that reason, gloves are predominantly being used to reduce the contamination of the skin and frequent handwashing. Still, it also reduces the number of microorganisms transferred in case of a needlestick-injury. Lastly, solutions containing high amounts of ethanol and/or isopropyl alcohol are proved to be an effective disinfection agent in reducing the surface bacteria, with the potential of being used on various surfaces (9, 36).

The workshop proposes further that proper hand hygiene (disinfection and/or handwashing, with *disinfection* being the priority choice) dramatically reduces the risk of direct transmission. It suggests that hand hygiene and *appropriate use of gloves* may limit indirect transmission. Since the fifth item presented alternatives intended to reduce the probability of both direct and *indirect* transmission, the aforementioned evidence suggests that the application of a 70% alcohol solution was indeed the most correct alternative (9). At the same time, surprisingly enough, a proper use of gloves seems to be a better measure for the reduction of cross-contamination with bacteria than washing hands with a soap. Nevertheless, the presented answer alternatives and the question in itself are extraordinarily ambiguous and ought to be formulated better. According to the results, 38.8 % of the respondents had good knowledge, 48.0 % had intermediate knowledge, and 13.4 % had poor knowledge on the fifth item.

The sixth item concerned handwashing, formulated as "*when the dental healthcare worker should wash his/her hands*". Between the two alternatives "*prior to patient treatment and whenever the gloves are taken off during the treatment*" and "*prior to patient treatment and after the patient treatment*", the latter was considered correct, for the reasons mentioned above. The gloves may be taken off several times in the course of treatment, and frequent washing with water and soap may be damaging to the skin (9). The alternative *"prior to patient treatment"* was considered wrong, as the present guidelines emphasize the need for performing hand hygiene both before and after the contact with patient (9, 39).

According to the results, 63.8 % of respondents had good knowledge, while 36.2 % had poor knowledge. In contrast, Danielsen et al., obtained a better result with a mean of 75.1% correct answers on the domain of personal hygiene, where 84.9% of the respondents reported to wash their hands between every patient (24). The difference observed may once again be a product of somewhat ambiguous formulation of the item in the present study.

The seventh item was formulated in a similar manner, presenting the same answer alternatives, but handwashing was substituted with "hand disinfection using a 70% alcohol solution" instead. The guidelines suggest that hand hygiene (preferably disinfection) should be performed just before embarking the treatment, as well as each time the gloves are taken off, simultaneously discouraging frequent handwashing with soap. Hence, the alternative "*prior to patient treatment and whenever the gloves are taken off during the treatment*" was considered correct in that case (9).

According to results, 28.3 % had good knowledge, 46.5 % had intermediate knowledge, and 24.4 % had poor knowledge on the seventh item. In comparison, 49.4% of the respondents reported to disinfect their hands between every patient in the study by Danielsen et al. (24). Similarly, 54.6% of the respondents reported to use an antiseptic alcohol solution as a means to wash their hands in the study performed by Alharbi et al. (11). This suggests that the great value of an antiseptic alcohol solution, in the matter of infection control, is not well known nor recognized among dentistry students.

The eighth item concerned the handling, disinfection, and cleaning of the unit. No direct question was being asked. Instead, respondents were encouraged to choose an appropriate alternative to continue the sentence "*handling, disinfection and cleaning of the unit should be done*". Although the starting point was straight forward, the presented answer alternatives were complexly formulated, with the potential to confuse the respondents. The alternatives *"should be done before and after the patient treatment, by changing the disposable items, disinfecting the surroundings, and running a disinfectant through the suction chamber <u>after the patient treatment and by the end of the day</u>"* and *"Should be done before and after the patient treatment, by changing the disposable items, disinfecting the surroundings, and running a disinfectant through the suction chamber <u>by the end of the week</u>"* were considered correct among the four presented.

The guidelines propose that the suction chamber should be rinsed with plenty of cold water after each patient, as well as being rinsed with a disinfectant *at least twice a day*, favoring disinfection after each patient. Furthermore, the disinfection of the unit and its surroundings is paramount both before and after the patient treatment, in order to reduce the risk of cross-contamination (9). On that premise, the former alternative is considered the most correct, although compliance with this proposition is questionable in practice owing to the continuous work schedule of dentists.

According to results, 42.5% of respondents had good knowledge, 26.0% of respondents had intermediate knowledge, and 31.5% of respondents had poor knowledge. In comparison, a mean 71.1% of the respondents picked correct answers on the domain of unit/work surface in the study by Danielsen et al. (24). This could suggest that Russian DHCPs and dental students are having reproducible intermediate knowledge on the topic of maintenance and disinfection of the unit, considering the fact that a total of 68.5% of the respondents in our study picked the alternatives which were both correct to a certain degree. There was however no question which reproduced the essence of our formulation, and the apparent similarity should be interpreted with care (24).

Our study found an overall intermediate knowledge (mostly having good or intermediate scores on 6 of 8 items) of infection control routines in dental practice among dental students and dental faculty members of the NSMU, Arkhangelsk, North-West Russia. A similar result was obtained by Alharbi et al., although the questions assessing participant's knowledge were constructed differently and had a focus on other topics (11). On the contrary, the items "*clothing while treating patients*" and "*facemask when leaving the unit*" had considerably low scores, with 85.8% and 48.0% of respondents having poor knowledge on these topics, respectively. This result is similar to the findings of the master thesis study by Danielsen, Fredriksen and Singh (24), which concluded that dentists and dental students of the last year of education have suboptimal infection control routines concerning protective wear (24). This suggests a potential for improvement in this particular domain.

5.3. Compliance with and attitudes towards infection control routines in dental practice

The first item encouraged participants to rate their compliance with and attitudes towards *hand washing prior to wearing gloves*. Hand washing is regarded as one of the most effective infection control measures aiming to prevent the spread of infection. Both multi-resistant strains of bacteria and other agents causing HCAIs are effectively controlled, owing to adequate hand hygiene (17). According to the results, 85.0% of respondents considered themselves to always wash their hands before wearing gloves, hence regarded as a routine with good compliance and attitudes (>70%). The result of this item is better than that of Alharbi et al., where 52.2% of DHCPs and 31.3% of dental students reported to always wash their hands prior to wearing gloves (11).

However, the statement "*wash your hands prior to wearing gloves*" is obscure in the way it is formulated concerning the proposed routines. The present formulation may imply handwashing every time gloves are removed, which may happen several times during the treatment of the same patient. Despite hand washing is an effective infection control measure, frequent exposure to soap and water results in wounded skin, making the individual susceptible to blood-borne infections, and therefore undesirable. On the contrary, hand hygiene is paramount prior to the first application of gloves before the treatment of a new patient. This approach is suggested to reduce the risk of cross-contamination (9). Moreover, the guidelines state that gloves should be the last protective gear applied before treatment and are considered mandatory for all dental procedures. Hence, the statement should have been paraphrased to "wash your hands prior to patient treatment", while the results obtained in the case of present formulation could be interpreted in either way.

The second item asked respondents to consider their compliance with and attitudes towards the statement "*disinfect your hands with 70% alcohol solution prior to wearing gloves*". Disinfecting hands with 70-90% alcohol solution is considered a superior alternative to handwashing with soap and water in case of no visible contamination (9). A total of 48.8% of the respondents reported to disinfect their hands on all occasions, while 22.0% stated to disinfect their hands often. Thus, the cumulative 70,8% of respondents answering "always" and "often" corresponded to good compliance.

On the other hand, only a cumulative 50.9% of respondents reported good compliance with *disinfecting their hands after the removal of gloves*. This result indicates that merely half of the study participants have adequate hand disinfection routines after gloves disposal. Identically, as previously mentioned, only half of the respondents who were participating in the study by Danielsen et al, reported to disinfect their hands between every patient (24). This suggests that there is a room for improvement in this topic, in terms of advocating a more frequent use of alcoholic disinfectant solutions, considering their effectiveness for infection control purposes.

The workshop proposes that hand hygiene should always be performed after the gloves are removed. Hand hygiene is proven to reduce the occurrence of pathogens on hands substantially and is considered the single most crucial factor for reducing the transmission of pathogens between individuals (22), elucidating its cost-effectiveness and importance (37). As previously mentioned, frequent hand washing may lead to skin lesions, being a manifestation of *contact dermatitis*. The latter is classified as either allergic or irritant, with the irritant variation often being the case in dental health care (22), manifesting as regions with erythematous, dry, and wounded skin. Disinfectant alcoholic solutions are proven not to cause contact dermatitis, hence making disinfection of the hands a more desirable hygienic approach in case of gloves removal (9).

The next two items encouraged the participants to report their compliance with and attitude towards *wearing gloves during treatment* and *changing gloves between patients*. Gloves are an essential aid in infection control measures. When properly used, gloves protect the hands of DHCPs against microorganisms from potentially infected bodily fluids and blood, as well as reducing the probability of cross-infection (9). As previously mentioned, gloves are of great importance during several dental procedures. Changing the gloves between patients is considered essential in order to reduce the risk of cross-infection. On the other hand, frequent and prolonged use of gloves is fraught with occupationally related contact dermatitis, among other things, owing to the same etiology as frequent exposure to water and soap (frequent exposure to moisture) (41). Some of the suggested approaches to reduce the probability of contact dermatitis are the frequent change of gloves, as well as frequent application of moisturizing cream (9).

Nearly all respondents consider themselves being utterly compliant and having a good attitude towards always wearing gloves during dental treatment, as well as changing gloves between patients. A total of 97.6% of respondents picked the alternative "always" on both statements. The high compliance on these items is similar to that of the results obtained by Alharbi et al., where over 95% of both DHCPs and dental students reported to always wear gloves during treatment and to always change gloves between patients (11).

As in the case with the gloves, nearly all participants reported good compliance with *wearing a face mask during patient treatment*, with 96.1% of respondents who chose the alternative "always". The same pattern was observed in the study performed by Alharbi et al., with 92.2% of DHCPs and 90.7% of dental students picking the alternative "always" (11). On the contrary, compliance with and attitudes towards *changing the face mask between patients* were considerably lower: 63.8% of respondents had an acceptable level of compliance and attitudes, while only 44.9% of respondents picked the alternative "always". In contrast, 64.4% of dental students and 73.1% of DHCPs reported always to change face mask between patients in the study by Alharbi et al. (11). The observed difference may suggest an inferior knowledge in recognizing face mask as a potential source for cross-infection, on part of the Russian respondents. This assumption is likely due to an identically poor result on knowledge of correct face mask wearing routines, among the participants of our study.

According to the guidelines, the face mask should be used in order to protect the operator during procedures where splashing and the occurrence of aerosols are likely to happen. The guidelines state further in a straight forward manner that face mask is to be used during every patient treatment, and should always be changed between patients (or when visibly moist) (9, 22). Another study proposes that the protection given by a face mask has a reciprocal function, protecting the operator from large particles and droplet spatter, as well as protecting the surroundings from microorganisms colonizing the wearer (22), inhibiting cross-infection further.

As previously mentioned, dental practice is associated with frequent occurrence of splashes and production of aerosols, hence making a face shield or goggles paramount in protecting the ophthalmic mucosa (9). The guidelines state that protection goggles or a *visor* are to be used during treatment, which may potentially result in the formation of aerosol (9). Reusable personal protective equipment (PPE), such as protective eyewear and face shields, should be

disinfected between every patient treatment (22). Goggles could also be manufactured for single-time-use, and thus should be disposed of after treatment (9).

No item was created to assess how often participants use goggles, face shield or visors, being a minor limitation of the compliance section. Nevertheless, respondents were encouraged to rate their compliance with and attitudes towards the *disinfection of face shield/goggles between patients*. Of the total respondents, 83.5% reported good compliance and attitude towards disinfecting face shield/goggles between patients, with 74.8% picking the alternative "always". In comparison, 52.2% of DHCPs and 51.5% of dental students reported themselves to always disinfect face shield between patients in the study by Alharbi et al. (11).

The last topic in the section concerned participant's compliance and attitudes towards *wearing a protective gown during treatment* and *changing protective gown between patients*. Although inconsistent with good compliance and attitudes, the two presented statements have intermediate results. A total of 63.8% of respondents claimed to always wear a protective gown during treatment. Likewise, 63.0% of respondents reported to always change the protective gown between patients. In the study by Alharbi et al., 92.1% and 67.8% of the dental students, and 70% and 48.9% of DHCPs, reported to always wear a protective gown during treatment and change protective gown between patients, respectively (11). The difference observed may be due to stricter routines in King Saud's University. It is likely that not all university affiliated dental clinics consider the use of a protective gown mandatory in all cases. This corresponds to a lower compliance and attitude towards the topic among the participants of our study.

Protective clothing (e.g., gowns) is considered an essential element of PPE. Disposable plastic gowns are used to protect DHCP and in order to reduce the risk of cross-contamination during procedures anticipated to produce spatter or spray. The gown can also occasionally be used in situations requiring an extra barrier (e.g., treating an infectious patient) (9). Virtually all dental procedures have the potential to produce splatter, which necessitates the use of a protective gown. The Norwegian guidelines also state that the gown should be changed or disposed of in-between patients (40).

The study participants had overall good compliance with, and attitudes towards, infection control routines. The majority of respondents (>90%) consider themselves always to wear

gloves during treatment, change gloves between patients, and wear a face mask during treatment. These results are comparable to the ones obtained by Alharbi et al. (11). In contrast with this study, a considerably more significant proportion of respondents who reported to always wash their hands prior to wearing gloves was found in our study (85.0% vs 31.3%). On the other hand, the number of respondents who change face masks between patients, wear a protective gown during treatment, and change it between patients was substantially lower among dental students and dental faculty members at the NSMU. Better compliance and attitudes could be cultivated on these topics.

5.4. Association of knowledge and compliance/attitudes with socio-demographic and MRSA characteristics

The majority of respondents were women (75.6%). The knowledge of infection control routines was lower among males than among females, although the differences were negligible and statistically insignificant. The same pattern is valid for the respondent's compliance and attitudes, except for a slightly higher proportion of male respondents having good compliance and attitudes (46.7% vs 41.3%). Although insignificant, these results could reflect a more responsible nature of female students, being more adherent to the curriculum, and having a greater desire to learn more about infection control.

Dental students had an overall better knowledge compared to dental faculty members: 31.3% and 42.2% of dental students showed good and intermediate knowledge, respectively, whereas corresponding figures were 21.0% and 31.6% among dental faculty members. Nevertheless, compliance with and attitudes towards infection control routines were higher among dental faculty members (52.6% vs. 40.2%). This result may reflect student's recent theoretical training on infection control routines and hence being more updated on the subject. In contrast, dental faculty members are more adherent to the routines owing to their higher experience and recognition of infection control being an essential topic in dentistry. However, these differences were not statistically significant. A considerably lower number of dental faculty members (n=19) compared to the number of dental students (n=107) participated in the study. Therefore, one may assume that a low statistical power of the present study did not allow us to find statistically significant differences. Alharbi et al. found almost identical

results on knowledge and compliance in both groups, although these findings were also insignificant (11).

A higher level of knowledge of infection control routines was found in dental students who attended clinical dental practice than in pre-clinical students. One may assume that dental students at their clinical stage of education have a more in-depth insight into infection control owing to their practice. In contrast, pre-clinical students seem to have better compliance and attitudes. Although pre-clinical students do not have clinical lessons, the given item corresponds to their hypothetical compliance with, and attitudes towards, proposed routines. This finding could be partly explained by the assumption that pre-clinical students have a more serious and responsible attitude towards infection control, whereas clinical students having experience in dental practice might decrease their adherence to the routines. Nevertheless, these results were insignificant and should be interpreted with caution, given a small number of pre-clinical students in our study.

A total of 47.2% of the participants reported having attended a course in infection control during the last two years. Although the proportion of respondents showing good knowledge was similar in those who did and did not attend the course (34.5% and 32.9%, respectively), a higher proportion of poor knowledge was surprisingly found in attenders (32.8% vs. 19.0%). However, these differences did not reach the level of statistical significance. Compliance and attitudes towards infection control routines were similar among both groups, with negligible insignificant differences. One may speculate that a curriculum of the courses should be revised to increase the level of acquired knowledge/compliance/attitudes related to the infection control routines in dental practice.

A relatively high number of respondents (20.5%) reported that their clinical dental practice is being affected by their MRSA carriage, although only few responders (4.7%) reported their presumably actual MRSA carriage. While this may be regarded as a case of over-reporting or under-reporting, the difference is likely due to the ambiguousness of the question. The questionnaire asked whether respondents consider if their MRSA carriage affects their clinical dental practice. Thus, several respondents may have interpreted the question as concerning a hypothetical carriage. Nevertheless, a total of 41.6% of the respondents who agreed that MRSA carriage affects their clinical practice had good knowledge, compared to 29.9% of those who disagreed or did not know. Among those who reported being screened for MRSA,

35.9% of participants had good knowledge of infection control routines, while 41.0% and 23.1% of participants showed intermediate and poor knowledge, respectively. This result is consistently better in comparison to those who were not screened or did not know whether they were screened for MRSA (31.8%, 38.7%, 29.5%, respectively). Moreover, the proportion of MRSA-carriers who had good knowledge of infection control routines was double the proportion of those who were not MRSA-carriers or did know about their carriage (66.6% vs 33.0%). Nevertheless, all these differences were not statistically significant.

A similar pattern was observed in compliance and attitudes concerning MRSA-related characteristics. Although statistically insignificant, there was a tendency towards better compliance and attitudes among those who claimed that their MRSA-carriage affects their clinical dental practice ($p=0.058$). These results may reflect a higher awareness of infection control routines among the participants screened for MRSA and the confirmed MRSA-carriers. Nevertheless, a study performed by Yoo et al. (8) found that nasal MRSA-carriers reported lower knowledge scores compared to non-MRSA-carriers, although the differences were also not statistically significant. The researchers suggested that nasal MRSA carriage may result from a lower level of knowledge/compliance/attitudes to infection control routines. Moreover, it has been reported that DHCPs tend to affirm that neither their country nor their workplace is having problems with MRSA, which may reflect a lower perception of the problem's actual magnitude (8). More research is needed to assess the association between MRSA carriage based on objective criteria and knowledge of, compliance with and attitudes towards infection control routines in Russian DHCPs.

In our study, we found that the level of compliance with and attitudes towards infection control routines increased if respondents took precautions for immunocompromised patients. This finding may reflect an increased awareness of infection control routines for immunocompromised patients among dental students and dental faculty members of the NSMU. Indeed, guidelines suggest that the treatment of immunocompromised patients should be the last treatment of the day. It is proposed that the treatment should be performed in a separate room. The main goal of this approach is to reduce cross-contamination between patients and protect other susceptible patients outside the treatment room (9), which is the main message of infection control routines.

6. Conclusion

Most of the dentistry students and dental faculty members at the NSMU, Arkhangelsk, North-West Russia reported intermediate knowledge of, good compliance with and attitudes towards, infection control routines in dental practice. Items that showed poor knowledge included "use of clothing while treating a patient" and "use of facemask when leaving the unit". The study participants reported poor compliance and attitudes in topics related to "disinfection hands with 70% alcohol solution after taking off gloves", "changing face mask between patients", "wearing a protective gown during treatment" and "changing protective gown between patients". In our study, most of the studied socio-demographic and MRSA-related characteristics were not associated with participant's knowledge, compliance, and attitudes. However, proportions of the respondents who reported precautions for immunocompromised patients increased with the increasing level of compliance and attitudes. While compliance and attitudes are the core elements of good practice, a suboptimal knowledge of infection control would decrease their relevance and the clinicians' ability to achieve safe dental practice. Hence, the results of this study emphasize the need for establishing national or regional guidelines for infection control routines in dental practice in Russia.

Future studies on this topic among Russian dental students and dental faculty members should be carefully planned and conducted, given that there is room for improvement in several issues of infection control routines in dental practice in Russia. A similar study among Norwegian dental students and dentists would also be interesting to compare the knowledge of, compliance with and attitudes towards, infection control routines in Russia and Norway.

7. References

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8. Appendix

THE QUESTIONNAIRE

Demographic questions:

Select your gender:
- Male
- Female

Select your age group:
- 17-18
- 19-20
- 21-22
- 23-24
- 25-26
- 27+

Select your occupation:
- Dental student
- Clinical supervisor
- Researcher

If student, choose the year of study:
- 1st year
- 2nd year
- 3rd year
- 4th year
- 5th year

Questions regarding Methicillin Resistant Staphylococcus Aureus (MRSA) status

Have you been screened for MRSA carriage?
- Yes
- No
- Don't know

Are you a positive carrier of MRSA?
- Yes
- No
- Don't know

Does the carriage affect your clinical performance? E.g. more thorough hands hygiene etc.
- Yes
- No
- Don't know

If an immunocompromised patient shows up for treatment, are there any additional special precautions being taken?
- Yes
- No
- Don't know

Questions regarding infection control. Some items present with apparently similar alternatives, which seem to be equally correct. Choose the alternative you agree the most with.

Clothing while treating a patient should be:
1 – without sleeves
2 – sleeves covering shoulders
3 – sleeves covering the elbow
4 – sleeves just below the elbow
5 – sleeves covering wrists

When you leave the unit for a short period of time (e.g. in order to get something of importance for the treatment), what do you do with your face mask?
1 – the face mask is pulled down on the chin
2 - the face mask is left covering the mouth
3 - the face mask is left covering the mouth and the nose
4 – the face mask is taken off, and is reused upon returning back to the unit
5 – the face mask is disposed, and changed with a new face mask upon returning back to the unit

The gloves must be worn during…:
1 - … disinfection and cleaning of the unit/working place
2 - … extra- and intraoral examination of the patient
3 - … anytime during patient treatment and post treatment disinfection and cleaning of the unit/working place
4 - … when direct contact with blood, other body fluids and secretes, open wounds and mucosa are expected
5 - … upon direct physical contact with the patient and contaminated/used instruments

The most effective method of infection control is:
1 – basic infection control routines – hand hygiene, correct and appropriate use of the gloves and face mask, proper clothing and equipment, proper disinfection of the unit.
2 – autoclavation – thermal treatment of all recyclable items and instruments.
3 – well-timed prescription of an antibiotic agent.

What is the best method for reducing the probability of contact (direct and indirect) transmission of bacteria, in your opinion?
1 – washing hands with a soap,
2 – application of a 70% alcohol solution,
3 – appropriate wearing of gloves

When should a dental healthcare worker wash his/her hands?
1 – prior to patient treatment,
2 – prior to patient treatment and whenever the gloves are taken of during the treatment,
3 – prior to patient treatment and after the patient treatment

When should a dental healthcare worker disinfect his/her hands with a 70% alcohol solution?

1 – prior to patient treatment,
2 – prior to patient treatment and whenever the gloves are taken of during the treatment,
3 – prior to patient treatment and after the patient treatment

Handling, disinfection and cleaning of the unit…:
1 – …should be done **before and after** the patient treatment, and include changing of the disposable items, disinfecting the unit, and running a disinfectant through the suction chamber **before and after each patient** treatment, and in the **end of the working day**.
2 - …should be done **before and after** the patient treatment, and include changing the disposable items, disinfecting the unit, and running a disinfectant through the suction chamber **by the end of the week**.
3 – …should be done **before** the patient treatment, by changing the disposable items, disinfecting the unit, and running a disinfectant through the suction chamber **by the end of the week**.
4 – …should be done **after** the patient treatment, by changing the disposable items, disinfecting the surroundings, and running a disinfectant through the suction chamber **by the end of the week**.

Questions regarding compliance with, and attitudes towards, infection control. What is your attitude and compliance regarding the following statements?

Wash your hands prior to wearing gloves?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Disinfect your hands with 70% alcohol solution prior to wearing gloves?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Wash your hands after taking of gloves?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Disinfect your hands with 70% alcohol solution after taking of gloves?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Wear gloves during treatment?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Change gloves between patients?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Wear face mask during treatment?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Change face mask between patients?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Disinfect the face shield/goggles between patients?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Wear a protective gown during treatment?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never

Change the protective gown between patients?
1 – always, 2 – often, 3 – sometimes, 4 – rarely, 5 – never