



A comparative study of hand hygiene and alcohol-based hand rub use among Irish nursing and medical students

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ABSTRACT

Background: In Ireland, the setting for this study, the national prevalence rate of health care-associated infection (HCAI) in acute-care facilities is 5.2%. Hand hygiene and in particular hand rubbing using alcohol-based hand rub (ABHR) is highly efficacious in preventing HCAI transmission. Yet, compliance among healthcare professionals is sub-optimal. Less is known about the practices of nursing and medical students and no study comparing practices among these groups in Ireland was found. Hence, the aim of this study was to provide insight into the current hand hygiene and hand rubbing practices of nursing and medical students in Ireland and, by doing so, contribute to the broader understanding of this topic.

Methods: This observational study employed a cross-sectional, self-reported design. An electronically administered questionnaire was sent to all nursing and medical students from one university. Data were analysed using appropriate software.

Results: The response rate was 37% (323/872). Higher compliance with the World Health Organisation 'my five moments for hand hygiene' model was reported among nursing students (NS) than medical students (MS), with scope for improvement in both disciplines identified. Hand hygiene compliance was highest after body fluid exposure (99.5% NS, 91% MS) and lowest after touching a patient's surroundings (61.5% NS, 57.5% MS). Attitudes towards hand rubbing were largely positive in both disciplines. 16% of NS were not aware of the clinical contraindications to ABHR use, compared to 45% of MS. 9% of NS did not know when to use soap and water and when to use ABHR, compared to 36% of MS. In contrast, more medical students (46%) than nursing students (22%) were routinely using alcohol-based hand rub for decontamination of hands as recommended.

Conclusions: Results suggest scope to review current hand hygiene curricula focusing on the knowledge gaps, the practice deficits and the barriers to ABHR usage identified.

1. Introduction

The burden of health care-associated infection (HCAI) is well documented by the World Health Organization (WHO) and European Centre for Disease Control (ECDC) (WHO, 2013; ECDC, 2013). HCAI results in prolonged hospital stay, increased morbidity and mortality, high healthcare costs, financial burden and increased resistance of microorganisms to antimicrobials, leading to a sharp rise in multi-drug resistant organisms (MDROs) (WHO, 2013; ECDC, 2013). According to the WHO hundreds of millions of patients are affected by HCAI worldwide each year and the ECDC estimates that 25,000 people die in the European Union (EU) annually from infections caused by MDROs with an associated cost of €1.5 billion (WHO, 2013; ECDC, 2013). In Ireland, the setting for this study, the national prevalence rate of HCAI

in acute-care facilities is 5.2% (Health Protection Surveillance Centre, 2012). Hand hygiene is considered the most effective measure a healthcare professional can take to prevent the transmission of HCAI (Health Protection Surveillance Centre, 2012). Yet, even though hand hygiene is simple, cost-effective and highly efficacious in controlling the spread of HCAI, evidence suggests that compliance among healthcare professionals is sub-optimal (Kingston et al., 2016; Erasmus et al., 2010).

2. Background

Hand hygiene is a general term that refers to various actions of hand cleansing suited to different clinical situations, including the action of hand rubbing. Hand rubbing with alcohol-based hand rub (ABHR) is

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globally advocated as the 'gold standard' approach to hand hygiene in most routine patient encounters, except those for which handwashing with soap and water is recommended, for example, when nursing patients with *Clostridium difficile* infections (WHO, 2009). Despite this, the literature seems to focus mainly on broader aspects of hand hygiene with less focus on exploring hand rubbing practices among healthcare professionals and healthcare students.

Poor to moderate hand hygiene knowledge is reported among nursing and medical students (collectively referred to as healthcare students), although nursing students appear to have better knowledge compared to medical students (D'Alessandro et al., 2014; Ariyaratne et al., 2013; van de Mortel et al., 2012, 2010). Poor attitudes are also reported, as low as 12.9%, with better attitudes among nursing than medical students reported (Nair et al., 2014; van de Mortel et al., 2012, 2010; Ariyaratne et al., 2013). Hand hygiene practices are also poor for example, Ariyaratne et al. (2013) found that 67% of healthcare students had poor self-reported practices, while Nair et al. (2014) found nursing students had better practices (62%) compared to medical students (19.6%).

It appears from limited studies, reporting limited data on hand rubbing specifically, that hand rubbing knowledge and practices are also poor among healthcare students, although nursing students are reported to have better knowledge and practices than medical students (Ojulong et al., 2013; Nair et al., 2014; Bargellini et al., 2014; van de Mortel et al., 2012; Ariyaratne et al., 2013). Interestingly, no recent studies addressing this topic were found in the United States of America, Canada, Scandinavia or the United Kingdom and just one study from Ireland was found (Kingston et al., 2017a). In Italy, substantial knowledge deficits relating to ABHR use among healthcare students is reported, based on just three questions which < 50% of students answered correctly (van de Mortel et al., 2012). Significantly higher hand rubbing frequency in Italian nursing students (80%) compared to medical students (47%) was also found by Bargellini et al. (2014). In India and Sri Lanka knowledge of ABHR, based on five questions, was higher among medical students than nursing students, although several gaps in knowledge were identified in both groups (Nair et al., 2014; Ariyaratne et al., 2013). In Namibia, just 34% of nursing students and 20% of medical students correctly answered one knowledge question on the indications for the use of ABHR (Ojulong et al., 2013). No study was found that addressed attitudes towards hand rubbing using ABHR.

In summary, internationally there has not been recent substantial focus on comparing nursing and medical knowledge, attitudes and practices regarding hand rubbing using ABHR. More specifically, no Irish study has explored and compared hand hygiene and hand rubbing practices among nursing and medical students, with just one recent study exploring Irish nursing students' hand hygiene practices found (Kingston et al., 2017a, 2017b). This is despite the prevalence of HCAI, especially MDRO-associated infections and comprehensive evidence that hand hygiene contributes significantly to reducing these (O'Connor et al., 2015). Hence, the objective of this study was to provide insight into the current hand hygiene and hand rubbing practices of nursing and medical students in Ireland and, by doing so, contribute to the broader understanding of this topic.

3. Methods

This observational study employed a cross-sectional, self-report design and aimed to explore nursing students' and medical students' perceptions of their hand hygiene and hand rubbing practices. All students of a Bachelor of Science Nursing (Honours) degree programme ($n = 342$) and of a Graduate Entry Bachelor of Medicine and Surgery degree programme ($n = 530$) within blinded for review, were invited via student email addresses to participate, between March and April 2015. They were provided a link to the online study instrument and to a concise, unbiased explanation of the survey topic. The sample

comprised students across the four cohorts of both programmes. Hand hygiene education and training had been delivered to all cohorts as part of the students' curricula.

Following a literature review, a validated questionnaire originally developed at Columbia University, New York and designed to assess barriers to adherence to US hand hygiene guidelines was selected as the study instrument (Larson, 2004, Centres for Disease Control, 2002). The survey was modified to reflect the WHO hand hygiene guidelines and additional questions were added (WHO, 2009). Two experienced researchers (microbiologists) reviewed the questionnaire for content validity. A pilot study was conducted ($n = 9$) contributing to the reliability and validity of the questionnaire as well as checking completion time and allowing for minor redrafting of some questions for greater clarity. The survey comprised 62 questions, with Likert scale, multiple choice and 'yes or no' questions.

3.1. Statistical Analysis

Data were analysed using Statistical Package for Social Sciences (SPSS), version 24 (IBM-SPSS, Armonk, NY) and Survey Monkey, gold plan version (SurveyMonkey, San Mateo, CA). Descriptive statistics, including frequencies and percentages, were calculated. The relationship between variables was considered where there was a rationale to do so. Parametric testing was not performed as data were ordinal and not normally distributed (Scott and Mazhindu, 2014). The Pearson Chi Square test of independence (suited to the categorical ordinal data i.e. Likert Scale answers) allowed for the testing of association among variables. A significance criterion of $P < 0.05$ for statistical tests was used.

3.2. Ethics

Conduction of the study and its design, taking into consideration published surveys on attitudes to hand hygiene were approved by the Research Ethics Committee of the Faculty of Education and Health Sciences, blinded for review (Approval Number 2014_12_03_EHS). The research was performed in accordance with the code of ethics of the Declaration of Helsinki (2013). There was no risk of physical injury or pain for the research respondents as the study was an observational survey conducted by an anonymous questionnaire among nursing and medical students. There was minimal potential for emotional upset when reflecting on clinical experiences and personal practices. In order to protect the privacy of respondents and the confidentiality of their responses and to minimize the impact of the study on their physical, mental and social integrity the study was conducted anonymously with no identifiable data reported (Declaration of Helsinki, 2013). Participation in the electronic survey indicated consent and was voluntary and anonymous. Finally, the timing of the administration of the survey was planned to ensure that it did not conflict with scheduled exam periods in order to avoid the minimal potential for emotional distress.

4. Results

A response rate of 37% (323/872) was achieved. Of the 323 respondents 70% ($n = 225$) were nursing students and 30% ($n = 98$) were medical students. Ninety-four percent ($n = 212$) of the nursing student respondents were female and 58% ($n = 57$) of the medical student respondents were female.

4.1. Learning Resources

The majority of healthcare students (92% nursing and 82% medical) agreed that relevant teaching and learning resources were readily accessible in the university. However, 91% ($n = 190$) of nursing students, compared to 58% ($n = 49$) of medical students ($p < 0.001$), considered that relevant teaching and learning resources were readily

accessible in clinical practice. Awareness of international hand hygiene guidelines was higher among nursing students with just 3% of nursing students compared to 16% of medical students ($p < 0.001$) reporting unfamiliarity with the WHO hand hygiene guidelines (WHO, 2009). Awareness of national hand hygiene guidelines was generally lower with 34% of nursing students and 52% of medical students ($p = 0.002$) reporting unfamiliarity with these guidelines (Health Service Executive, 2005). 95% of nursing students and 74% of medical students were aware that the Irish Health Information and Quality Authority (HIQA) conducts inspections of adherence to national hand hygiene standards and 45% and 17% respectively had their practice inspected by HIQA inspectors. Yet, 18% of nursing students and 48% of medical students ($p < 0.001$) were unfamiliar with these national HIQA standards (HIQA, 2009).

4.2. Attitudes

Both positive and negative attitudes to hand hygiene were explored. Our data indicate statistically significant differences in attitudes with more positive attitudes among nursing than medical students. Ninety three percent of nursing students compared to 72% of medical students considered hand hygiene practices relevant to their clinical practice ($p < 0.001$), while 94% of nursing students compared to 84% of medical students agreed that hand hygiene improves patient outcomes ($p < 0.001$). 7% ($n = 15$) of nursing students and 11% ($n = 9$) of medical students reported that it is not practical to follow recommended hand hygiene practices, while 13% ($n = 25$) of nursing students compared to 21% ($n = 16$) of medical students reported that they do not have time to stay informed about new developments in hand hygiene ($p = 0.009$). This is despite 22% of nursing students and 12.8% of medical students reporting personal experience of a HCAI. Ninety six percent of nursing students compared to 78% of medical students reported implementing hand hygiene recommendations ($p < 0.001$).

4.3. Practice

Self-reported hand hygiene practices were explored, using the ‘my five moments for hand hygiene’ framework (WHO, 2009), and significantly greater compliance was reported among nursing students compared to medical students (see Table 1). Compliance with hand hygiene before performing a clean or aseptic procedure, moment 2, was greater among nursing students (98.5%) than medical students (87%) ($p = 0.004$) and compliance with hand hygiene after touching a patient, moment 4, was also greater among nursing (87%) compared to medical students (80%) ($p = 0.001$). Overall, students were most compliant with hand hygiene after body fluid exposure, moment 3, with 99.5% compliance among nursing students, compared to 91% among medical students. Least compliance with hand hygiene after touching a patient's surroundings, moment 5, was reported in both cohorts, among 61.5% of nursing students and 57.5% of medical students ($p = 0.026$). Equal compliance was reported among nursing and medical students with hand hygiene before touching a patient, moment 1, with a mean compliance of 85.5%. When data were compared across the 4 years of the programmes in both disciplines interesting trends emerged. It was evident that 3rd and 4th year medical students were more compliant with the WHO model than 1st and 2nd medical students, while among nursing students the reverse was evident.

4.4. Hand Rubbing

Attitudes towards hand rubbing with ABHR were explored and were largely positive in both disciplines, with the majority reporting that ABHR is practical to use and convenient and that adherence to hand rubbing is expected in clinical practice. The majority (94%) disagreed that they do not have time to use ABHR, while 80% of nursing and 71%

Table 1
Compliance with ‘my five moments for hand hygiene’ framework (WHO, 2009) by discipline.

	Strongly agree % (n)	Agree % (n)	No opinion % (n)	Disagree % (n)	Strongly disagree % (n)	p value
Moment 1: I always perform hand hygiene before each patient contact						
Nursing students	45% (94)	40% (83)	2.5% (5)	11% (24)	1.5% (3)	0.004
Medical students	52% (44)	34% (29)	10.6% (9)	2.4% (2)	1% (1)	
Moment 2: I always perform hand hygiene before a clean/aseptic procedure						
Nursing students	85% (178)	13.5% (28)	0.5% (1)	0.5% (1)	0.5% (1)	0.000
Medical students	74% (63)	1.3% (11)	13% (11)	0.0% (0)	0.0% (0)	
Moment 3: I always perform hand hygiene after body fluid exposure risk						
Nursing students	91% (190)	8.5% (18)	0.0% (0)	0.5% (1)	0.0% (0)	0.001
Medical students	81% (69)	1.0% (8)	8% (7)	1% (1)	0.0% (0)	
Moment 4: I always perform hand hygiene after touching a patient						
Nursing students	50% (105)	37% (77)	4% (8)	9% (19)	0.0% (0)	0.001
Medical students	47% (40)	33% (28)	16.5% (14)	3.5% (3)	0.0% (0)	
Moment 5: I always perform hand hygiene after touching a patient's surrounding						
Nursing students	24.5% (51)	37% (78)	9% (19)	28% (58)	1.5% (3)	0.026
Medical students	21% (18)	36.5% (31)	21% (18)	18% (15)	3.5% (3)	

Table 2
Factors influencing alcohol-based hand rub use.

Personally, the single most important factor that influences me to adhere to the use of alcohol-based hand rub is:			
Answer options	Total % (n)	Nursing student % (n)	Medical student % (n)
Prevention of cross infection	34.5% (92)	37.5% (73)	26% (19)
Infection control policy	22.5% (60)	27% (52)	11% (8)
Personal protection	17.6% (47)	17.5% (34)	17.2% (13)
Patient outcomes	14.2% (38)	10% (19)	26% (19)
Evidenced-based practice	6.0% (16)	4.5% (9)	9.5% (7)
Convenience	3.0% (8)	2% (4)	5.5% (4)
No opinion	1.1% (3)	1% (2)	1.5% (1)
Patient/public expectations	0.7% (2)	0.5% (1)	1.5% (1)
Role model influences	0.4% (1)	0.0% (0)	1.5% (1)
Other (please specify)	0.0% (0)	0.0% (0)	0.0% (0)

of medical students agreed that hand rubbing helps to standardise care and ensure patients are treated in a consistent way. 91% of nursing students agreed that ABHR is readily available in clinical practice compared to 76% of medical students ($p < 0.001$). Factors that positively influence ABHR use were explored (see Table 2). The single most important factor identified among nursing students (37.6%) and among medical students (26%) was 'prevention of cross infection'. Medical students were equally influenced by patient outcomes (26%). 'Personal protection' was identified by over 17% of both cohorts while 'infection control policy' influenced 27% of nursing students and 11% of medical students.

Over 90% of healthcare students felt competent using ABHR in accordance with recommendations. Yet, statistically significant knowledge gaps relating to the WHO recommendations around ABHR use were identified, particularly among medical students. Nine percent ($n = 19$) of nursing students compared to 36% ($n = 31$) of medical students did not know when to use soap and water and when to use ABHR ($p < 0.001$). In addition, 16% ($n = 34$) of nursing students compared to 45% ($n = 38$) of medical students were not aware of the clinical contraindications for using ABHR ($p < 0.001$). Cross-tabulation and comparative analysis of both of these variables revealed a trend among medical students towards greater knowledge among 3rd and 4th year students compared to 1st and 2nd year students. A comparable trend among nursing students was not found.

Despite the knowledge gaps identified, particularly among medical students, significantly greater compliance with optimal ABHR use was reported among medical students compared to nursing students (see Table 3). 22% of nursing students reported to use ABHR "almost always" ($> 90\%$ of the time), compared to 47% of medical students. 46% of nursing students and 45% of medical students reported using ABHR often (51%–90% of the time), while 27% of nursing students compared to 7% of medical students reported using ABHR sometimes (10%–50%

Table 3
Hand rubbing using alcohol-based hand rub by discipline and combined.

In clinical practice the percentage of the time I use alcohol-based hand rub for hand hygiene is:			
Answer options	Combined % (n)	Nursing student % (n)	Medical student % (n)
Never	1% (3)	1% (2)	1% (1)
Rarely ($< 10\%$ of time)	2% (7)	4% (7)	0% (0)
Sometimes (10–50% of time)	22% (58)	27% (53)	7% (5)
Often (51–90% of time)	46% (122)	46% (89)	45% (33)
Almost always ($> 90\%$ of time)	29% (77)	22% (43)	47% (34)

of the time). Five percent of nursing students compared to 1% of medical students reported to using ABHR rarely or never. Further analysis revealed that 4th year medical students and 2nd year nursing students were most compliant overall.

Similar trends were evident across the disciplines regarding barriers to hand rubbing using ABHR. Thirty-seven percent ($n = 73$) of nursing students and 39% ($n = 29$) of medical students considered that hands do not feel clean following ABHR use. Thirty-four percent ($n = 67$) of nursing students and 24% ($n = 18$) of medical students reported that ABHR was unpleasant to use. When identifying the single most important barrier to adhering to ABHR use, respondents in both disciplines most frequently cited skin sensitivity (32% nursing and 25% medical) and skin damage (20% nursing and 20% medical), with just 21% of nursing students and 23% of medical students reporting no barriers. Just over 50% of healthcare students agreed that if they followed the recommendations on hand rubbing using ABHR they would be likely to experience dermatology issues. Supporting this, 49% of nursing students and 35% of medical students reported to have personally experienced a dermatology issue arising from hand hygiene and 59% of nursing students and 37% of medical students had observed a colleague with such a dermatology issue.

5. Discussion

Previous studies suggest that nurses are more compliant with hand hygiene than doctors (Randle et al., 2010; McLaws et al., 2009; Pittet, 2000). However, fewer cross-disciplinary studies comparing hand hygiene behaviour among healthcare students are available (van de Mortel et al., 2010), despite direct patient contact during internships and clinical placements, which increases students' risk of becoming mediators of HCAI or contracting a HCAI (Al-Khawaldeh et al., 2015; Bargellini et al., 2014; Ojulong et al., 2013). In this study, self-reported hand hygiene and hand rubbing attitudes and practices among nursing and medical students are explored to determine patterns of behaviour among these cohorts during formative education years. The study is important in contributing to a broader understanding of the topic, providing insight into current practices of future healthcare professionals and may be used to underpin curricular reform.

It is argued that self-report design predicts intention to comply rather than actual performance (O'Boyle et al., 2001; Borg et al., 2009) and that respondents may report better practices than their actual practices, leading to artificially high results (Gould et al., 2011; Larson et al., 2004). Therefore, a cautious approach to interpreting results was adopted. A number of potential biases associated with a self-report design using a voluntary survey that may have implications for the interpretation of study results were considered (Polit and Beck, 2013; The Joint Commission, 2009).

The potential for a response bias, where those who responded to the survey may have been positively disposed to the survey topic was considered, particularly in interpreting the predominantly positive attitudes reported. A social desirability bias where respondents may have misrepresented their attitudes or practices in line with prevailing social views was also considered. The pedagogical focus on the recommendations of the WHO *Guidelines* in the education setting of respondents may have led some healthcare students to know what answers were expected in the survey. Therefore, the survey results may have reflected students' exposure and absorption of what they should be saying rather than what they actually did. Hence, some responses may be more indicative of intention to comply as opposed to actual compliance (Borg et al., 2009). As respondents were asked to recall past hand hygiene practices, a recall bias was also considered because memories are imperfect and vary based on perception. An extreme response bias, where respondents may consistently display a tendency to select extreme positive or negative answer options and an acquiescence response bias, where respondents display a tendency to agree with responses regardless of content were also considered, given the nature of

the Likert scale answer options used in the surveys.

Adherence to the WHO 'my five moments for hand hygiene' model which aims to increase self-efficacy among healthcare workers by providing clear and explicit advice about when to integrate hand hygiene into multifaceted care tasks was explored (WHO, 2009). Compliance among healthcare students with the moments or indications for hand hygiene in the model is of great importance in contributing to the infection prevention and control agenda. Yet, the literature reports sub-optimal adherence to WHO hand hygiene recommendations among nursing and medical students (Nair et al., 2014; Herbert et al., 2013; Graf et al., 2011). This study also reports less than optimal compliance with the WHO model among healthcare students and considerable variation in compliance across the five moments and across disciplines, with statistically significant better practice reported among nursing students compared to medical students.

The study reports highest compliance in both disciplines with moment 3 of the model, hand hygiene after body fluid exposure risk. This, coupled with 17.5% of healthcare students identifying 'self-protection' as the primary influencer in their use of ABHR, suggests that the risks associated with body fluid exposure are resonating with healthcare students. It also suggests that many healthcare students may be performing hand hygiene for protection against HCAI, as compliance is greatest after potential exposure to body fluid. Self-protection as a consistent motivator to performing hand hygiene is also reported among healthcare professionals and healthcare workers (Smiddy et al., 2015; Erasmus et al., 2009; Borg et al., 2009; Whitby et al., 2006).

Compliance with moment 5, hand hygiene after touching a patient's surroundings was poor and this suggests that both nursing and medical students frequently miss this opportunity for hand hygiene, despite the evidence that the healthcare environment contributes significantly to HCAI transmission (FitzGerald et al., 2013, Randle et al., 2013, Chemaly et al., 2014). Hand hygiene after touching a patient's surroundings was previously reported as the most commonly missed opportunity among healthcare professionals, with rates as low as 36% reported (FitzGerald et al., 2013, Randle et al., 2013). Our results compare more favourably, with a mean compliance rate of 59.5% among healthcare students. However, a recent study by Price et al. (2016) suggests that compliance with hand hygiene following moment five has improved among healthcare workers with 93% compliance reported. Results of our study suggest scope among educators to revisit current teaching, learning and assessment approaches to this important evidence-based model of practice, with a view to improving compliance among all healthcare students with all five, equally important, moments of the model.

Humphreys and Richards (2011) and O'Brien et al. (2009) advise that in order to ensure safe practitioners, relevant and adequate knowledge that informs attitudes and leads to appropriate professional practice is essential. Scheithauer et al. (2012) found a steady increase in hand hygiene compliance among German medical students who received repeated hand hygiene training throughout their programme. The trend in this study among 3rd year and 4th year medical students towards greater compliance with the 'my five moments for hand hygiene' model, parallels with increased exposure to and participation in clinical practice in the latter two years of the programme, while the first two years of the programme focus more on theoretical content delivery and simulated learning opportunities. Nursing students also have increased clinical practice experience in year three and four of the programme. However, the trend among nursing students was towards greater compliance in year one and two of the programme. Further research exploring the impact of the timing and delivery of hand hygiene education on healthcare students' practice would be useful in determining an optimal pedagogical approach to hand hygiene education and training and to determining patterns of behaviour based on programme year.

Since ABHR is ineffective when caring for patients with *Clostridium difficile* infection (WHO, 2009), it is a cause for concern that almost half

of medical students were not aware of the clinical contradictions for ABHR use and that over one third did not know when to use soap and water and when to use ABHR. Significantly fewer nursing students also reported these knowledge gaps. The knowledge deficit was more apparent among 1st and 2nd year medical students and mirrors research that identifies knowledge gaps among 1st and 2nd year German medical students (Graf et al., 2011; Scheithauer et al., 2012). Given that Kelčíková et al. (2012) found a direct correlation between significant deficits in hand hygiene education, insufficient levels of knowledge and associated poor compliance by students, curricular adjustments may be necessary to ensure clarity among healthcare students around these important concepts that can significantly impact patient care delivery.

Huang et al. (2013) suggest that skill and performance is greatly influenced by learning resources. Adequate resources that facilitate knowledge acquisition and self-directed learning both in university and in clinical practice during formative education years are important. We found that despite an expectation of adherence to recommended hand hygiene guidelines in clinical practice, significantly fewer medical students compared to nursing students, considered teaching and learning resources accessible in clinical practice, suggesting scope for improvement in resource provision. In 2009 O'Brien et al. in a survey of teaching and learning of HCAI in UK and Irish medical schools, found scope to introduce both more innovative teaching techniques and a shared pool of educational resources, that might include online resources. Others have discussed the value of quality assured health-related websites, relevant journals and textbooks and inter-professional teaching opportunities in both university and clinical practice settings (Kulkarni et al., 2013). Our findings suggest continued scope to improve the provision of shared educational resources accessible to both nursing and medical students in both the academic and clinical practice settings.

Given the gaps in knowledge identified around ABHR use, it is perhaps unsurprising that suboptimal hand rubbing practices emerged, with less than one third of healthcare students using ABHR for hand hygiene 'almost always' or > 90% of the time. In contrast to previous research by van de Mortel et al. (2012) which found higher hand rubbing frequency among nursing students compared to medical students, we found nursing students were less compliant. Just over one in five were routinely using ABHR for hand hygiene, compared to 47% of medical students, even though just 3% of nursing students reported being unfamiliar with the WHO guidelines compared to 16% of medical students (WHO, 2009). When compared to the routine utilisation of ABHR by doctors in Ireland (39%) routine ABHR use among medical students was greater (47%) in this study (Kingston et al., 2017b). The low compliance in both disciplines suggests that adherence to national and international guidelines is poor and in particular, the recommendation that routine day-to-day hand hygiene be performed using ABHR appears not to be reaching all students. Further research is recommended that explores why the uptake of ABHR is low and why soap and water appears to be favoured among many healthcare students.

Barriers to hand rubbing using ABHR may inform reasons for sub-optimal use among nursing and medical students. Barriers identified in this study include skin sensitivity (30%) and skin damage (20%), with over half of students believing that if they follow the hand rubbing recommendations they will experience dermatology issues. This is despite evidence that hand rubbing with ABHR causes less skin damage than washing with soap and water (Graham et al., 2005; Pittet, 2000; Larson et al., 2000). It is important that this perception among healthcare students is addressed, in order that greater compliance can be achieved. However, given that 49% of nursing students and 35% of medical students in this study reported personal experience of a dermatology issue, this suggests there is scope also to continue to review the selection of ABHR products, ensuring that guidelines are followed and that irritating products are identified and replaced. Addressing perceived barriers to ABHR use among healthcare students in

undergraduate education may also prove fruitful.

Limitations of the study design are discussed earlier and include the potential biases associated with self-report design. To offset these potential biases non-judgmental sensitively worded questions were used and questions were counterbalanced with positively and negatively worded questions. The inclusion of a neutral response option also allowed respondents to opt out of a response and thereby avoiding inaccurate answers. In addition, conducting the survey online automatically reduced the potential for biases somewhat, because the questions were self-administered thus facilitating honesty among respondents. In addition, anonymity and confidentiality were guaranteed. The transferability of the study's findings may be limited as the work was performed in a single Faculty in a single University. In addition, the large difference in response rates and sample sizes among nursing students and medical students participating in the survey has implications for the interpretation and the generalizability of the results. However, it is reasonable to speculate that opinions expressed in this study may be representative, in general, of their peers (i.e. programme of study, gender, third-level education) within the Irish population. Furthermore, findings are validated by similar results reported elsewhere (Jeong and Kim, 2016; Bargellini et al., 2014; Herbert et al., 2013; van de Mortel et al., 2012; van de Mortel et al., 2010).

6. Conclusion

Despite reported improvements in patient safety education (Patey et al., 2011) results of this study suggest that a challenge persists. Channelling the reported positive attitudes towards ABHR use among healthcare students to achieving improvements in hand hygiene practice is required and reviewing infection prevention and control curricula and pedagogical approaches seems warranted. Underpinning nursing and medical curricula with national and international evidence-based hand hygiene guidelines (WHO, 2009; HSE, 2005; HSE, 2015) may prove useful in addressing knowledge deficits and improving practice (Kelčíková et al., 2012). Particular focus on the indications for hand hygiene as outlined in the WHO (2009) 'my five moments for hand hygiene' framework is required. Paying greater attention to routine ABHR utilisation and the perceived barriers to its use is also warranted. Consideration of a stepwise or spiral approach to the infection prevention and control curricula might also prove useful by incrementally delivering content throughout the four years of the degree programmes in order to prevent the adoption of suboptimal practice among students as they progress and to improve the overall quality of patient care.

Nursing and medical students make a valuable contribution to healthcare delivery on their journey to becoming competent, safe and effective healthcare professionals upon graduation. Health service providers, while concomitantly ensuring patient safety, have a responsibility to assist students in their endeavour to learn by providing a supportive clinical learning environment. Providing strong and supportive leadership, an open and inclusive organisational culture, providing mentors and positive role models, while also involving students in a team approach to improving hand hygiene compliance, will all serve to support healthcare students as they progress through their career trajectories and will ultimately serve to improve patient outcomes. Our findings may prove useful to those developing and delivering nursing and medical education programmes and infection prevention and control curricula.

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