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ABSTRACT

Background: Healthcare workers (HCW) are recommended to wear non-sterile clinical gloves (NSCG) for direct contact with blood and body fluids to reduce transmission of healthcare associated infections (HCAI). However, there is evidence that inappropriate NSCG-use increases the risk of transmission.

Methods: A mixed methods study comprising observation of NSCG-use during episodes of care in two acute hospitals and semi-structured interviews with HCW. Qualitative data were categorised using thematic analysis. Findings were mapped to the Systems Engineering Initiative for Patient Safety (SEIPS) model and used to develop a strategy for improving NSCG-use.

Results: 278 procedures performed in 178 episodes of care involved the use of NSCG. NSCG were inappropriate for 59% (165/278) procedures; risk of cross-contamination occurred in 49% (87/178) episodes. 26 HCW were interviewed; emotion and socialisation were key factors influencing decisions to use NSCG. Data from observation and thematic analysis were mapped to six interacting components of the SEIPS work-system. Interventions targeting each component were identified to inform quality improvement strategies

Conclusions: Despite more than a decade of intense promotion of hand hygiene as the key measure to protect patients from HCAI, NSCG dominate routine clinical practice and potential cross-contamination occurs in half of care episodes where they are used. Such practice is associated with significant environmental and financial costs and adversely affects patient safety. The application of HFE to the complex social, professional and emotional drivers of inappropriate NSCG behaviour may be more effective than conventional approaches of education and policy in achieving the goal of preventing HAI and improving patient safety.

Key words: Gloves, infection control, healthcare associated infection, hand hygiene, human factors, quality improvement, work systems

BACKGROUND

In healthcare settings, the hands of those delivering patient care act as efficient means of transferring pathogens across environmental surfaces, between patients or contaminated and clean sites on the same patient.[1,2] The use of non-sterile clinical gloves (NSCG) is a routine part of healthcare delivery, forming an element of personal protective equipment and a component of standard precautions where a risk of direct contact with blood and body fluids (BBF) is anticipated.[3] Non-sterile clinical gloves provide an effective barrier against gross contamination of the skin by pathogens potentially present in BBF but pose a risk of cross-contamination when not removed.[4,5] Perversely, the use of NSCG to protect staff from potential infection may increase the risk of healthcare-associated infection (HAI) transmission between the environment and patients and between patients through lack of their timely application and removal.[6,7] There is also some evidence that patients are concerned about the use of NSCG by HCW.[8]

Human factors and ergonomics (HFE) is defined as "*the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance*".[9] The application of HFE in healthcare is an emerging science and while recent work has focused on medication safety, the design of health information technologies, and assessment of patient safety culture, the value of HFE in healthcare has yet to be fully realised. [10, 11, 12] The Systems Engineering Initiative for Patient Safety (SEIPS) model provides a framework for exploring the work system and its impact on processes and outcomes for both patients and HCW. [11, 13]

Research focused on strategies to improve hand hygiene (HH) behaviour fails to adequately account for the increasing and inappropriate use of NSCG.[14, 15] Recent studies have identified that staff wear NSCG for procedures not involving exposure to BBF; frequently do not remove them at the points in care where HH is indicated and do not decontaminate hands following their removal.[3,16] These studies suggest that the factors influencing NSCG-use behaviour are complex and, like many HFE work processes, unlikely to be modified by education interventions.[17] Disgust is an important trigger for HH and glove use; qualitative research also suggests that despite policy and guidance, emotion and socialisation are key drivers for healthcare workers' (HCW) inappropriate use of NSCG.[3,18] While the WHO 5 Moments is based on human factors principles there is limited applied HFE research on use of the SEIPS 2.0 model in infection prevention and control (IPC); applying HFE to the use of NSCG may provide a framework for preventing the transmission of infection and promoting appropriate glove use.[19, 20]

Our study builds on previous research[3] to confirm if similar behaviour and attitudes are apparent in other hospitals and apply SEIPS 2.0 to identify the interacting work systems and processes that influence NSCG-use behaviour, informing strategies for reducing inappropriate NSCG-use and improving patient safety.

METHODS

We undertook a mixed methods approach using observation and qualitative interviews.

Observational audit of glove use

A validated audit tool was used in two acute hospitals to record the sequence of donning and removing NSCG, HH and items touched during episodes of care.[21] Observation periods began when a HCW donned gloves for an episode of care and ended on when the episode was completed. Omission of HH before donning NSCG was not considered as a risk of cross-contamination; HH following NSCG removal was considered adequate if local protocol was adhered to; NSCG-use was considered appropriate if the procedure involved potential or actual contact with BBF, mucous membranes, situations required by local policy (e.g. patient under isolation precautions) or contact with substances hazardous to health.[21] Observations were conducted by a member of the IPC team during January-June 2014 in different types of wards. Staff were unaware of the purpose of the audits to minimise the Hawthorne effect.

Data were analysed using SPSS 19; Pearson's Chi-Squared (or Fishers exact test for small samples) was used to assess the statistical significance of the variables.

Interviews with healthcare workers

Healthcare workers were recruited through an advert in the trust staff e-newsletter. To encourage openness, a member of the university research team conducted semi-structured interviews with staff who responded. Written consent was obtained from participants prior to conducting each interview. The interview schedule explored factors that influenced decisions to wear NSCG and to challenge their use in other HCW.

Interviews were digitally recorded and transcribed verbatim; transcripts were analysed using a six-step thematic analysis described previously.[3,22] Following initial familiarisation, the data were manually coded, preliminary themes and categories identified, refined and checked to confirm they captured the essence of the data. Saturation was reached when no further meanings or perceptions could be found within the data set. Finally, two researchers integrated the themes with

the framework developed in the previous study[3]; descriptors for the themes were agreed and a refined framework incorporating the new data generated.

Application of SEIPS 2.0

To describe the use of NSCG-use in the context of a work system, the SEIPS 2.0 model was used to map the refined thematic framework to the six work system components.[11] This analysis was used to consider strategies that could be applied to improve processes and outcomes and reduce high-risk NSCG-use behaviour.

Ethical approval

Observations of NSCG-use formed part of routine clinical audit undertaken by the IPC team and did not require ethical approval. Ethical approval for interviews with HCW was granted by the College Research Scrutiny and Ethics Committee and access agreed by the trust Research and Development department.

RESULTS

Observational audit of the NSCG-use

A total of 194 episodes of care were observed with 178 (91.8%) involving the NSCG-use; 278 procedures were performed and NSCG-use was inappropriate for 59% (165/278), but varied between hospital A (37/88; 42%) and B (128/190; 67.4%) ($p < 0.001$). The procedures for which NSGG were most commonly worn are shown in Table 1; few involved a risk of BBF contact and in 5% of episodes HCW wore NSCG for a prolonged period without performing any procedure.

Table 1: Ten most common procedures associated with HCW use of non-sterile clinical gloves

Procedure	Frequency observed	% of all procedures
Cleaning	37	13.3
Mobilisation of patient	36	12.9
Handling linen/bed making	35	12.6
IV device manipulation	28	10.1
Personal hygiene	21	7.6
Toileting (including contact with commodes/urinals)	20	7.2
Handling equipment	20	7.2
Manipulation of invasive device (non-IV)	16	5.8
Attention to patient	16	5.8
No particular task	14	5.0

The overall rate of cross-contamination associated with episodes of care where NSCG were used was 49% (87/178); the rate of cross-contamination varied from 58% (40/69) at hospital A to 42% (47/109) at hospital B (p = 0.065) and there was no significant difference between staff groups. The moments of HH where cross-contamination occurred are shown in Table 2.

Table 2: Moments of hand hygiene associated with cross-contamination

Moment of hand hygiene	Description of cross-contamination *(from Wilson et al 2015[21])*	Episodes of care where cross-contamination observed (N = 178) No. (%)
1	Gloves in contact with any part of the environment outside the patient's zone before direct contact with the patient's intact skin	37 (21)
2	Gloves touched any non-sterile object e.g. patient skin, bed linen or patient sites before an aseptic task e.g. wounds, invasive device.	17 (10)
3	Gloves used in contact with BBF subsequently touch a surface or patient	27 (15)
4	Gloves used for contact within patient zone not removed, or removed but hand hygiene not performed, before contact with an object outside patient zone	53 (30)
5	Gloves not removed, or removed but hand hygiene not performed after contact within the healthcare zone	21 (12)

In 62% (54/87) of episodes, cross-contamination occurred at more than one moment of HH as NSCG were not removed after or between procedures. Moment 1 cross-contamination occurred when NSCG were donned at a dispenser by the door to the room/bay and then touched items outside the patient zone prior to contact with the patient. Hand hygiene was not performed after NSCG removal in 41% (72/175) of episodes. Nurses were significantly less likely to decontaminate hands after NSCG removal than allied health professionals (AHP) (48/111 vs 1/14 p=0.002)

Themes associated with healthcare workers' decision to wear NSCG

Interviews were conducted with 16 nurses, six healthcare assistants, three AHPs and one doctor. Thematic analysis confirmed that the use of NSCG was underpinned by two key themes of emotion

and socialisation.[3] Socialisation comprised three sub-themes: professional socialisation, which reflected the influence of training, peers and usual ways of working; organisational socialisation, which reflected the influence of local policy, attitudes and behaviours; empathetic socialisation, which reflected consideration of the feelings or opinions of both patients and colleagues. Emotion comprised four sub-themes: fear, which reflected the need to protect self, patients and others; disgust, which related to touching body fluids or something unpleasant or unsightly; depersonalisation of intimate contact; and ease of mind, which related to conferring reassurance, safety and reliability (Table 3)

Table 3: Thematic analysis of factors that influence the decision of healthcare workers to wear gloves

Dimension	Sub-theme	Category	Description
Emotion	Fear	Self protection (specific threats)	Protect against contamination by substances perceived to be dangerous to self such as body fluids, dirt, infection, uncleanliness, cleaning agents, antibiotics, something contagious
		Self Protection (unknown threats)	Protect from potential threats when patient not known to healthcare worker
		Protect patients	Prevent contamination of the patient or cross-contamination to other patients; prevent infections spreading
		Making a mistake	Being accused of not being safe or of doing the wrong thing
	Disgust	Unsightliness	Avoid contact with skin or other parts of the patient that look nasty or perceived to be unpleasant or messy
		Dirt	Avoid contact with anything perceived to be 'bad', dirty or not clean
		Body fluids	Avoid getting body fluids or secretions on bare hands
	Psychological barrier	Negative	Making the patient feel dirty or uncomfortable
		Positive	Depersonalisation - avoiding using bare hands to touch intimate areas of the patient
	Ease of mind	Safety	Confer sense of safety against contact with potential hazards
		Reliability	Hand hygiene is not sufficient, gloves are reliable
		Reassurance	Feeling comfortable delivering care, being cautious and safe
Socialisation	Professional	Instinctive	Part of routine practice, something you do automatically without thinking or assessing need
		Role modeling	Practice adopted from copying behavior of respected peers
		Training	Behaviour instilled during ward (informal) or classroom-based (formal) training
		Peer pressure	Follow practice of others to fit in with norm
		Looking out for yourself	Personal perceptions of situations where you want to wear gloves take precedence
	Organisational	Policy	Decision driven by perceived requirements of policy to protect yourself and patients
		Availability	Gloves are everywhere, are quick and easy to out on and save time
	Empathetic	Patient feelings	Stigmatisation of the patient, creates barrier to touch, impersonal
		Patient expectations	Gloves perceived to confer protection, to be hygienic; gives patient confidence hands are clean
		Staff opinions	If that is what staff feel they need to do, it is their prerogative to wear gloves

The impact of emotion on the decision to wear NSCG

The decision to wear NSCG was strongly influenced by an emotional need for protection of self, driven by fear and disgust. These emotions were rationalised by misperception of risk, in particular the conflation of the concepts of universal precautions and contact precautions (CP) resulting in NSCG-use for all patient contact:

> *"Obviously the idea is to protect yourself and the patient from infection so I suppose you could say that you should wear them all the time, which all of us do to be honest, you don't know what patients have got infections you don't know that if you haven't got information then you need to treat everybody the same so you're protecting yourself and you're protecting the public". 383: p.2; L33*

The need to wear NSCG to prepare intravenous drugs was also commonly cited, with a perception that handling antibiotics posed a risk:

> *"I'm allergic to penicillin so I can't get any penicillin on me at all but for other nurses it is just about limiting the amount of antibiotic they are exposed to on their skin." 172: p.2; L24*

Whilst some HCW mentioned avoiding contact with BBF, more commonly NSCG were considered necessary as a physical protection against unspecified contamination or with the risk of likely contact with BBF being grossly over-estimated:

> *"...if you didn't have gloves [for toileting] because you think well what am I going to get from this, you know I am just going to get all sorts of bad stuff on me." 184: p.1; L16*

The decision to wear NSCG was also influenced by a feeling of disgust and associated with perceived 'uncleanliness':

> *"Some older men or women don't always get to... you know…can't always wash their own clothes and things. They cannot always be as clean as they might have been when they were younger". 382: p.2; L26*

or 'unsightliness':

> *"When patients have got skin conditions even when you know that it's not anything which is contagious and catching...it looks horrible…"* 174: p.6; L9

The perception of risk to themselves from contact with patients resulted in HCW using NSCG in order to create an 'ease of mind':

"I was told in Induction that we don't need gloves for washing patients because of the barrier thing but, for me, I don't feel comfortable not wearing gloves. I feel a lot safer and I feel a lot more relaxed." 184: p.3; L29

The drive to perform HH triggered by disgust and contact with things perceived to be dirty or unpleasant, was counteracted by NSCG-use:

"Sometimes I get…quite a bit OCD when washing my hands so I find that when I've got the gloves on I'm less OCD about needing to wash my hands so …when I've taken them off they still feel like dirty and I'll wash them, but if I haven't got them on I'm much more conscious that I haven't got the gloves on." 176: p. 1; L10

The decision to wear NSCG was also influenced by the need to depersonalise care and avoid inadvertently showing the patient feelings of disgust at carrying out a particular task and to protect the dignity of the patient when performing intimate tasks such as washing genital areas:

"I'd take a judgment from the patient I think because sometimes they might be more uncomfortable if you didn't wear gloves whereas if you've got your gloves on I am a bit more clinical so they feel a bit more dissociated from it." 182: p.4; L7

'…if I'm doing something that can be quite personal to someone, like giving them a wash or things, if I wasn't confident I know that they would see that I'm not confident and it just wouldn't make it very nice for them.' 184: p.4; L2

The impact of socialisation on the decision to wear NSCG

Organisational socialisation in the form of local policies and procedures were cited as an important determinant of when NSCG should be worn. Examples given demonstrated both inconsistency in practice and unfamiliarity with local policy (Table 1).

Additionally, there was a perception that NSCG were more effective at preventing cross-infection than HH:

"Even if you wash your hands well you can't guarantee that they're totally clean." 174: p.1; L10

The organisation was also seen to endorse NSCG-use by making them widely available, and HCW considered that their use saved time:

"It takes what five seconds to pull a pair of gloves from a dispenser and put them on…" 183: p.2; L32

"People just go from bed to bed and take their gloves off and just put another pair on." 182: p.5; L14

Responses also suggested that empathy had an effect on the decision to wear NSCG; with HCW recognising that wearing NSCG may give the patient the impression they are dirty or contagious and the therapeutic relationship would be damaged:

"Touch is very important I think, when you are touching someone when you are wearing gloves it a barrier and I think it raises a lot of stigma." 182: p.2; L7

Some HCW mentioned that professional socialisation, the behaviour of peers and content of training were important influences on their use of NSCG. They referred to wearing NSCG as being 'automatic', something that they would do routinely without necessarily assessing whether NSCG were required for a given situation. More commonly there was a strong sense that wearing NSCG was a personal decision that others had no authority to influence:

"I would use personal experience and knowledge. I wouldn't be influenced by somebody saying you don't need to wear gloves if I feel I need to wear gloves I would wear them." 171: p.2; L18

"It's a personal decision as to whether you feel you want to wear gloves for…because you don't want to touch that skin, that's a completely personal point of view." 387: p.3; L8

The concept that NSCG-use was a matter of individual choice made it difficult for some HCW to challenge inappropriate use:

"Well sometimes I've just mentioned that actually you don't really need your gloves on and a couple of them have said 'oh but I prefer to' and I'm not going to say well take them off because that's not really my place." 172: p.5; 18

Application of SEIPS 2.0

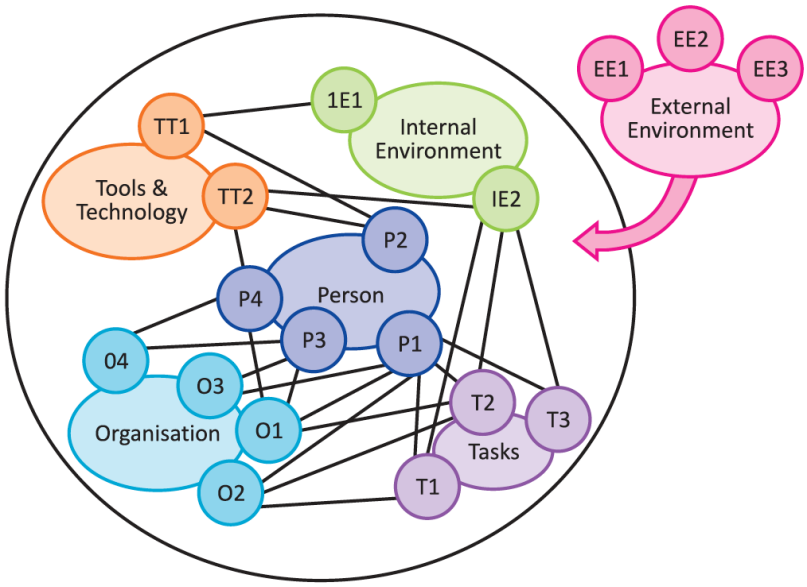
The observational data, themes and subthemes arising from qualitative interviews (Table 3) were mapped to the six interacting components of the work system described in SEIPS 2.0.[11] (Table 4).

Table 4: SEIPS 2.0 Human Factors Framework applied to the use of clinical gloves in acute healthcare settings

SEIPS Factor	Components of the work system influencing use of gloves
Tools/ Technology	Dispensers located outside patient zone Alcohol gel not accessible at bedside
Person(s)	Imprecise risk assessment results in gloves being used for procedures with no BBF contact Decision to wear gloves informed by emotion rather than policy/evidence Gloves perceived as more reliable that hand hygiene HCW not aware of infection control policy HCW not aware of compromising patient safety through inappropriate glove use Use of gloves perceived as personal decision Use of gloves as a psychological barrier
Tasks	HCW commonly perform more than one task during episode of care therefore difficult to apply 5MHH Ambiguity about when gloves are required Gloves put on before direct contact with the patient Gloves not removed between different tasks Hand hygiene not performed after gloves are removed Contact precautions drives donning gloves on entering the room & not changing between procedures
Organisational factors	Appropriate use of gloves not incorporated in standard infection control policies Emphasis on routine use of gloves for contact precautions Behaviour leant from observing other HCW Challenging inappropriate use of gloves considered unacceptable
Internal environment	Pressure to adhere to behaviour norms No agreement on when and where gloves should be used Challenging inappropriate use of gloves considered unacceptable
External environment	Government directives to reduce HAI make HCW cautious about making mistakes Contact precautions policies to prevent transmission of MDRO focus on routine use of gloves Behaviour leant from training/tutors Gloves to convey hygiene to patients Patients prefer HCW to use gloves for intimate hygiene

This was used to develop an Ishikawa diagram that begins to describe the processes that could be used to redesign the system and make it easier for staff to 'do the right thing' in terms of NSCG-use (Figure 1).

Figure 1: Strategies for achieving appropriate hand hygiene (HH) and non-sterile clinical gloves use in clinical settings based on processes in the SEIPS model.



External Environment
EE1 Economic impact of glove use
EE2 Impact of clinical waste on climate change
EE3 National policy

Internal environment
IE1 Location of glove dispensers
IE2 Location of alcohol handrub

Tools & Technology
TT1 Gloves accessible at point of care
TT2 Alcohol handrub available at point of care

Organisation
O1 Agreed standard for use of gloves & alcohol handrub
O2 Clear policy on use of gloves & alcohol handrub
O3 Compliance with standards measured
O4 Hazards of inappropriate glove use explicit

Tasks
T1 Decision points for hand hygiene defined
T2 Appropriate use of gloves defined
T3 Use of gloves during contact precautions defined

Person
P1 Staff trained & competent
P2 Signposting for patients on appropriate glove use
P3 Challenge of poor practice facilitated
P4 Clinical team agree standards of practice

DISCUSSION

This study demonstrated that in acute healthcare settings NSCG are commonly used for episodes of care where their use is not indicated.[3,6,8,16] They are donned too early, removed too late and not changed at critical points in the delivery of patient care. Consequently, NSCG-use is associated with a significant potential for cross-contamination and transmission of HAI. Whilst a key factor in the misuse of NCG is a lack of knowledge and situational understanding, emotion and socialisation are also powerful drivers of HCW use of NSCG. The need for self-protection against contact with 'dirt' or 'unpleasantness' is strongly personal.

The SEIPS 2.0 model describes six work system components: persons, tasks, tools and technology,

organisation, internal and external environments, that are configured at '*a moment in time*' to produce physical, cognitive and socio-behavioural processes that shape desired or undesirable outcomes.[11] We have considered our findings on NSCG-use in the context of this framework.

Person

Person-centredness and wellbeing is a key principle of HFE[23] and is placed at the centre of SEIPS 2.0 to highlight the need for work systems to support people to do the right thing. In the model, 'Person' relates to the characteristics of professional and non-professional carers and the patient. These include physical traits, social skills and experience, but also the beliefs and values that shape the performance of a task.[24] These characteristics map our theme of emotion and the sub-theme of professional socialisation.

Our study highlights misconceptions that HCW have about 'risk' which drive NSCG-use, as they perceive NSCG to offer greater protection than HH in preventing transmission of infection to themselves. Since their primary focus is self-protection, HCW are less likely to consider the risk the contaminated NSCG present to patients. This is illustrated by the ubiquitous use of NSCG for activities that do not involve contact with BBF or other hazardous substances suggesting that the use of NSCG to protect hands from contact with pathogens is driven by factors similar to those that drive inherent HH. Whitby *et al*[18] propose that the intention to perform HH in healthcare settings is primarily driven by behaviour acquired in childhood and strongly influenced by perceptions of exposure to 'dirt' or 'germs'. The perceptions of some HCW in this study that contact with older people and their belongings was 'more risky' because they could not look after themselves, align with our previous findings and Whitby's assertion that a family source is considered less harmful than non-family and public sources of contamination.[18] Also similar is the observation that HCW use NSCG to minimise embarrassment when attending to intimate areas and that the intention to perform HH is strong when hands have been somewhere considered to be 'emotionally dirty'.[18,25] Healthcare workers also indicated that patient preference was a reason for using NSCG for intimate care. These findings suggest that NSCG-use may have the perverse effect of neutralising the triggers that would normally induce HH and explain the HH opportunities that are missed. Addressing these 'person factors' within the work system will be an essential component of successful improvement strategies and will require more than the usual approach of information and education to modify the powerful driver of emotion in HH and NSCG behaviour.

Task

Using NSCG would not at first appear to be a complex task, but the interaction of work system factors results in complicated decisions about when to don and remove NSCG during episodes of care. The observational data demonstrates that several tasks/procedures comprise a single episode of patient care, making it difficult for HCW to identify where in the sequence of care NSCG should be removed. Healthcare workers develop work-arounds rather than accurately assessing the risk of exposure to BBF and fail to recognise the risk of cross-contamination between the environment and patients. Thus NSCG are commonly donned long before direct contact with the patient, not removed between different tasks, and HH omitted after they are removed. Other work highlights that the reality of donning NSCG after performing HH is almost impossible[26], suggesting that there needs to be a reappraisal of organisational and current external environment factors such as national guidance.

Tools and technology

The availability and location of NSCG form part of the tools and technology element of SEIPS 2.0; this has an impact on how HCW use them for standard infection control precautions (SICP), where direct contact with BBF is anticipated, and in CP where 'high risk' patients are isolated in single rooms and routine use of NSCG for all care is recommended.[27] Our observations indicate that in acute wards/units NSCG are widely available but rarely located at the patient's bedside, thereby driving the tendency to don NSCG early in an episode of care and increasing the risk of cross-contamination. Where CP are in place, NSCG are generally located outside the patient's room and are only removed before leaving. In both SICP and CP the location of NSCG discourages HCW from changing them when they move from one task to another during an episode of care for the same patient. This increases the risk of infection through contamination of susceptible sites from NSCG. The speed and ease with which NSCG can be used and practical problems of donning NSCG following HH may prompt HCW to prolong the use NSCG in preference to HH.[28]

Organisation

The organisation elements of SEIPS 2.0 encompass resources such as time, training, policies as well as cultural and social norms or 'how things are done around here'. This links closely to the theme and sub-themes of socialisation (Table 3). The strong influence of cultural norms and lack of leadership was evident in our results, with perceived peer pressure to use NSCG.[29] This, together with a perceived social norm that the decision to wear NSCG is a personal one, undermined the ability of HCW to challenge the practice of others.

There was a lack of understanding about how infection is transmitted and the assessment of risk for various care and technical tasks, with a gap between the content of training and reality of practice. Our study suggests that the trigger points for donning and removing NSCG are not supported by clear IPC policy, leading to method and task ambiguity.[28] This may result in HCW attributing their confusion and inappropriate NSCG-use to local or national policy, suggesting that IPC policy needs to be much clearer about how and when NSCG should be used, and more closely aligned to the practical realities of the task, tools and person elements of the work system.

Internal environment

SEIPS 2.0 relates to the physical environment where work processes occur, and generally includes factors such as the layout of wards/units or bed-spaces, space, ventilation and lighting. In this study we identified that the location of glove dispensers was the main environmental factor influencing NSCG-use. As previously highlighted, dispensers are remote from the patient bed space, often located at the entrance to the room or bay or by hand basins.

External environment

The impact of the external environment on work systems and processes is a new component of the SEIPS model. It takes account of the effect that health and social policy, regulation, economic conditions and ecological factors may have on the work system.

Global and national initiatives aimed at reducing infections caused by methicillin-resistant *Staphylococcus aureus* and *Clostridium difficile* have included a focus on the contribution hands make to spreading HAI.[30,20] This has increased the emphasis on demonstrating poor compliance and inadequate technique, contributing to HCW perception that HH is ineffective.[32] Whilst the purpose of the HH messaging is to encourage timely and effective HH in patient care, other IPC interventions such as CP may have perpetuated this perspective. Contact precautions require the HCW to '*wear a gown and gloves for all interactions that may involve contact with the patient or potentially contaminated areas in the patient's environment'*[27], reinforcing the message that the universal use of NSCG prevents the transmission of infection and that HH alone is insufficient. Universal gloving lacks a sound theoretical base and has an adverse effect on HH practice.[33,34}

The economic and environmental impact of NSCG-use is also an important consideration. Our work has demonstrated the widespread use of NSCG by all professional groups, across diverse acute care settings and indicated that in approximately 60% of occasions their use is unnecessary as no

contact with BBF or other potentially infectious material occurs. Since NSCG are classed as clinical waste they are incinerated or disposed of in other managed waste systems.[35] The inappropriate and over-use of NSCG means they could be considered as domestic waste. This incurs unnecessary cost and increases the potential damage to the environment associated with these disposal processes.[36] It is also evident that the ubiquitous use of NSCG in delivering healthcare will have an upstream cost implication. Although NSCG are relatively inexpensive, there is some evidence that significant potential savings are possible. For a 500-bed hospital in this study the cost of NSCG was £300 000 per annum [personal communication: Linda Hosie, 2013]. Since more than half of these NSCG are used unnecessarily, service improvement strategies targeting NSCG are not only likely to be cost effective but free up resources for other aspects of patient care.

CONCLUSION

Despite more than a decade of intense promotion of HH as the key measure to protect patients from infection, this study has demonstrated that NSCG dominate routine clinical practice and that potential cross-contamination occurs in half of the episodes where they are used. The unnecessary use of NSCG impacts on patient safety and is associated with significant environmental and financial costs. The conventional approach of using policy and education to change behaviour are unlikely to be effective in addressing this multifaceted problem. The application of HFE to the complex social, professional and emotional drivers of inappropriate NSCG behaviour may be more effective in achieving the goal of preventing HAI and improving patient safety.

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Conflicts of Interest

None

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