



**Barriers and Bridges to Infection Prevention and Control:  
Results of a Qualitative Case Study of a Netherlands'  
Surgical Unit**

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Complete List of Authors:	Backman, Chantal; University of Alberta, Marck, Patricia; Faculty of Nursing, University of Alberta Krogman, Naomi; University of Alberta, Department of Rural Economy Taylor, Geoff; University of Alberta, Faculty of Medicine and Dentistry Sales, Anne; Ann Arbor Hospital, Deputy Chief, Veterans Affairs Inpatient Evaluation Center Bonten, Marc; University Medical Center Utrecht, Department of Medical Microbiology Gigengack-Baars, Ada; University Medical Center Utrecht, Department of Medical Microbiology
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## ■ Qualitative research review guidelines – RATS

ASK THIS OF THE MANUSCRIPT	THIS SHOULD BE INCLUDED IN THE MANUSCRIPT
<p><b>R Relevance of study question</b></p> <p>Is the research question interesting?</p> <p>Is the research question relevant to clinical practice, public health, or policy?</p>	<p>Research question explicitly stated ✓</p> <p>Research question justified and linked to the existing knowledge base (empirical research, theory, policy) ✓</p>
<p><b>A Appropriateness of qualitative method</b></p> <p>Is qualitative methodology the best approach for the study aims?</p> <p><i>Interviews:</i> experience, perceptions, behaviour, practice, process</p> <p><i>Focus groups:</i> group dynamics, convenience, non-sensitive topics</p> <p><i>Ethnography:</i> culture, organizational behaviour, interaction</p> <p><i>Textual analysis:</i> documents, art, representations, conversations</p>	<p>Study design described and justified e.g., why was a particular method (i.e., interviews) chosen? ✓</p>
<p><b>T Transparency of procedures</b></p> <p><i>Sampling</i></p> <p>Are the participants selected the most appropriate to provide access to type of knowledge sought by the study?</p> <p>Is the sampling strategy appropriate?</p>	<p>Criteria for selecting the study sample justified and explained ✓</p> <p><i>theoretical:</i> based on pre conceived or emergent theory</p> <p><i>purposive:</i> diversity of opinion</p> <p><i>volunteer:</i> feasibility, hard-to-reach groups</p>
<p><i>Recruitment</i></p> <p>Was recruitment conducted using appropriate methods?</p> <p>Is the sampling strategy appropriate?</p> <p>Could there be selection bias?</p>	<p>Details of how recruitment was conducted and by whom ✓</p> <p>Details of who chose not to participate and why ✓</p>
<p><i>Data collection</i></p> <p>Was collection of data systematic and comprehensive?</p> <p>Are characteristics of the study group and setting clear?</p> <p>Why and when was data collection stopped, and is this reasonable?</p>	<p>Method (s) outlined and examples given (e.g., interview questions) ✓</p> <p>Study group and setting clearly described ✓</p> <p>End of data collection justified and described ✓</p>
<p><i>Role of researchers</i></p> <p>Is the researcher (s) appropriate? How might they bias (good and bad) the conduct of the study and results?</p>	<p>Do the researchers occupy dual roles (clinician and researcher)? ✓</p> <p>Are the ethics of this discussed? Do the researcher(s) critically examine their own ✓</p>

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	influence on the formulation of the research question, data collection, and interpretation?
<p><i>Ethics</i></p> <p>Was informed consent sought and granted?</p> <p>Were participants' anonymity and confidentiality ensured?</p> <p>Was approval from an appropriate ethics committee received?</p>	<p>Informed consent process explicitly and clearly detailed ✓</p> <p>Anonymity and confidentiality discussed ✓</p> <p>Ethics approval cited ✓</p>
<p><b>S Soundness of interpretive approach</b></p> <p><i>Analysis</i></p> <p>Is the type of analysis appropriate for the type of study? <i>thematic: exploratory, descriptive, hypothesis generating framework: e.g., policy constant comparison/grounded theory: theory generating, analytical</i></p> <p>Are the interpretations clearly presented and adequately supported by the evidence?</p> <p>Are quotes used and are these appropriate and effective?</p> <p>Was trustworthiness/reliability of the data and interpretations checked?</p>	<p>Analytic approach described in depth and justified ✓</p> <p><i>Indicators of quality: Description of how themes were derived from the data (inductive or deductive)</i> ✓</p> <p>Evidence of alternative explanations being sought ✓</p> <p>Analysis and presentation of negative or deviant cases ✓</p> <p>Description of the basis on which quotes were chosen ✓</p> <p>Semi-quantification when appropriate ✓</p> <p>Illumination of context and/or meaning, richly detailed ✓</p> <p>Method of reliability check described and justified ✓ e.g., was an audit trail, triangulation, or member checking employed? Did an independent analyst review data and contest themes? How were disagreements resolved?</p>
<p><i>Discussion and presentation</i></p> <p>Are findings sufficiently grounded in a theoretical or conceptual framework?</p> <p>Is adequate account taken of previous knowledge and how the findings add?</p> <p>Are the limitations thoughtfully considered?</p> <p>Is the manuscript well written and accessible?</p>	<p>Findings presented with reference to existing theoretical and empirical literature, and how they contribute ✓</p> <p>Strengths and limitations explicitly described and discussed ✓</p> <p>Evidence of following guidelines (format, word count) ✓</p> <p>Detail of methods or additional quotes contained in appendix ✓</p> <p>Written for a health sciences audience</p>
<p>Are <u>red flags</u> present? these are common features of ill conceived or poorly executed qualitative studies, are a cause for concern, and must be viewed critically. They might be</p>	<p><i>Grounded theory: not a simple content analysis but a complex, sociological, theory generating approach</i> <i>Jargon: descriptions that are trite, pat,</i></p>

1 fatal flaws, or they may result from lack of detail or clarity.  
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or jargon filled should be viewed sceptically  
*Over interpretation:* interpretation must be grounded in "accounts" and semi-quantified if possible or appropriate  
*Seems anecdotal, self evident:* may be a superficial analysis, not rooted in conceptual framework or linked to previous knowledge, and lacking depth  
*Consent process thinly discussed:* may not have met ethics requirements  
*Doctor-researcher:* consider the ethical implications for patients and the bias in data collection and interpretation

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17 **peer review a qualitative manuscript.** In *Peer Review in Health Sciences*. Second edition. Edited by Godlee F,  
18 Jefferson T. London: BMJ Books; 2003:219-235  
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## Barriers and Bridges to Infection Prevention and Control: Results of a Qualitative Case Study of a Netherlands' Surgical Unit

### ABSTRACT

#### Objectives:

- To observe the overall work environment including infection prevention and control (IP&C) practices on the target surgical unit;
- To analyze the policies and procedures in the hospital and unit environments;
- To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of their unit environment; and
- To collect monthly specific IP&C related anonymized data.

#### Design:

In this qualitative case study analysis, a socio-ecological approach on health systems informed the research design and provided a framework to better understand the complexity of implementing effective IP&C.

#### Setting:

The study was conducted on a surgical unit at a Netherlands' hospital that reported successful reductions in the prevalence of targeted multidrug-resistant organisms (MDRO).

#### Methods:

Research methods included unit observations (n=3), review of relevant policies and procedures, five practitioner-led photo walkabouts of the unit (n=7), three photo elicitation focus groups with practitioners (n=13), and the review of related IP&C data.

#### Results:

The findings indicate some conditions and processes present that may influence the low prevalence of MDRO, including the 'search and destroy' active surveillance strategy, low occupancy rates, a centralized bed cleaning system, and the presence of an active grass roots Hygiene in Practice group which engages practitioners in several ongoing activities to promote IP&C on the units.

#### Conclusions:

Further research on the benefits of practitioner-led community of practices on IP&C practices such as the Hygiene in Practice group is also recommended. Additional case studies to compare

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3 these practices to other acute care hospital around the world would be a valuable way to better  
4 understand what IP&C programs are most effective in which contexts, and for what reasons.  
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7 Further data is available by contacting the primary author directly.  
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## 10 11 **SUMMARY**

12 Article focus:

- 13 -To observe the overall work environment including IP&C practices on the target surgical unit;
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- 15 -To analyze the policies and procedures aimed at the prevention and minimization of MDRO in
- 16 the hospital and unit environments;
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- 18 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
- 19 their unit environment; and
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- 21 -To collect monthly specific IP&C related anonymized data.  
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29 Key messages:

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31 The findings indicate some conditions and processes present that may influence the low  
32 prevalence of MDRO, including:  
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- 34 -the 'search and destroy' active surveillance strategy, -low occupancy rates
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- 36 -a centralized bed cleaning system, and
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- 38 -the presence of an active grass roots Hygiene in Practice group which engages practitioners in
- 39 several ongoing activities to promote IP&C on the units.  
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45 Strengths and limitations:

- 46 -Multiple methods of data collection and a broad socio-ecological system approach to study
- 47 IP&C on the unit strengthen this research.
- 48
- 49 -It is possible that staff may have altered their behavior from normal practices during unit
- 50 observations.  
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- 53 -The prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage
- 54 and antibiotic data were collected by hospital personnel not supervised by the researcher,
- 55 limiting the ability to assess the rigor of data collection.  
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3 -The focus of this study was on a specific clinical unit of the hospital.  
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## 8 9 INTRODUCTION

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11 Infection control in the acute care environment is one of the most important issues in  
12 modern healthcare. Healthcare-associated infections (HAI) are not only a potential burden on  
13 patients in terms of increased morbidity and length of stay but also an economic burden on the  
14 healthcare system.[1-3] However, although the importance of infection control is well  
15 recognized and numerous research studies and best practice guidelines have been published on  
16 this topic, infection rates of multidrug-resistant organisms (MDRO) are on the rise in Canada and  
17 in the United States,[4] and infection prevention and control (IP&C) remains a challenge.  
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21 In contrast to the North American situation, the “control of MRSA infections [one of the  
22 MDRO] is reported to be optimal in the Scandinavian countries [and also in the Netherlands],  
23 where strict barrier precautions are in place along with active surveillance culture (ASC)  
24 programs”.[5, p.236] Some European countries such as the Netherlands have been recognized as  
25 world leaders at minimizing MDRO infection rates, in particular MRSA.[6] Yet, strong evidence  
26 on the most effective approaches for achieving good adherence to the simplest measures, such as  
27 hand hygiene, remains elusive, and further knowledge of what drives individuals, organizations  
28 and health systems towards sustainable IP&C practices does not yet exist in the research  
29 literature.[7] To develop a better understanding of what may be shaping the prevention of MRSA  
30 and other MDRO, a case study was conducted in April 2008 on a surgical unit at a Netherlands  
31 hospital that reported a successful reduction in the prevalence of targeted MDRO and another  
32 case study between September and December 2008 on a surgical unit at a Canadian hospital  
33 which reported higher rates of targeted MDRO. In this paper, we discuss the key findings of the  
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3 Netherlands hospital case study and offer recommendations for policy, practice and future  
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5 research.  
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8 The objectives of the research were:  
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- 10 1. To observe the overall work environment including IP&C practices on the target surgical  
11 unit;  
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- 13 2. To analyze the policies and procedures aimed at the prevention and minimization of MDRO  
14 in the hospital and unit environments;  
15
- 16 3. To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of  
17 their unit environment; and  
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- 19 4. To collect monthly specific IP&C related anonymized data on the target surgical unit and in  
20 the facility overall for a duration of 12 months, and the prevalence rates of methicillin-  
21 resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE),  
22 extended spectrum beta-lactamases (ESBLs) and *Clostridium difficile* infections (CDI).  
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## 34 METHODS

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36 The need for more theoretically driven research in IP&C in order to strengthen the rigor  
37 and usefulness of evidence for IP&C has been recognized in the literature.[7-12] One promising  
38 theoretical line of inquiry is supported by Struelens'[8] recommendation to take a broad socio-  
39 ecological approach to the study and management of IP&C. This socio-ecological perspective is  
40 well supported by others including Ali,[9] Gloubeman,[10] Macdonald,[11] and Waldvogel,[12]  
41 who all argue that a host of inter-related social and environmental factors play a critical role in  
42 the emergence and trajectory of infectious diseases in 21<sup>st</sup> century societies and their health  
43 systems.  
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In this study, a socio-ecological approach on health systems informed this research design and provided a framework to better understand the complexity of implementing effective IP&C. A socio-ecological perspective provides “a framework for understanding the diverse personal and environmental factors and the interrelationships among these factors”, [13, p.45] enabling us to more accurately interpret and manage whole systems change. [14,15] In socio-ecological terms, the term whole systems may be conceptualized as nested cycles of system development, degradation, or restoration. [14,16-18]

A whole systems’ perspective on IP&C is compatible with the participatory methods of citizen science that engage communities in collectively studying and assessing the socio-ecological conditions of their environments in order to collaboratively design and implement useful, sustainable repairs. [14,18,19] For the purposes of this study, citizen science is conceptualized as a collaborative process between researchers and participants where members of the community are involved in data collection and data analysis to conduct research and generate evidence. [16,19-21] This research approach draws on related work in the fields of ecosystems management and research, [22] economics, [23] restoration management, [24-27] and health systems. [18,19] It involves seeking multiple sources of data and using a variety of methods to develop integrative knowledge about local places as well as the overall system as a whole. [14,18,21,28]

Using a socio-ecological perspective and the concept of citizen science as theoretical guideposts, core elements of a proposed socio-ecological framework for studying IP&C were defined, [8,12,15,18] and used to inform the research design and conduct of the study (Appendix 1). The framework informed but did not constrain the collection and analysis of the data.

## Setting

The hospital is a 1042-bed tertiary care major teaching and referral center providing general and specialized services for the population of its city and the surrounding area. In 2008, the hospital had approximately 31,420 admissions, 22,564 emergency room visits and over 336,000 outpatient visits. The patient average length of stay was 7.7 days. The hospital occupancy rate was about 80% at any given time. There were 10,668 employees in 2008 including 2,560 nurses. This hospital was chosen because it reported less than 1% MDRO prevalence rates.[29] The case study was conducted on a 34-bed unit, with 6 (18%) single-bed rooms, comprising mainly of orthopedic, cosmetic, urology and general surgery patients. Ethical approval was obtained.

## Data Collection and Analysis

Data were collected and analyzed from multiple sources to gain an in-depth understanding of the case [30,31] from a socio-ecological perspective on health systems. The photographic research methods used, which were adapted from previous work in ecological restoration [27] and health systems research [19,32] consisted of practitioner-led audio-taped photo walkabouts with photo narration and communal photo elicitation forums. Participant guided ecological tours of the hospital helped to foster community participation, local expertise and indigenous ecological knowledge that practitioners have about the places where they work. Unit observation sessions (n=3) were also performed by one of the authors (CB) and field notes were recorded on the work environment of the unit to gain an initial perspective of the overall environment and IP&C practices. In addition, policies and procedures relevant to IP&C practices (n=11) were collected in order to gain a better understanding of the existing practices.

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3 Aggregated, anonymized IP&C related data were collected including monthly prevalence rates  
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5 for MRSA, VRE, CDI and ESBL (January-December 2008).  
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8 Five practitioner-led photo walkabouts and photo narrations (n=7 participants) of their  
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10 perceptions of the concerns and strengths on their unit in relation to infection control were  
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12 conducted. The individuals who participated in separate photo walkabouts included the infection  
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14 control professional (ICP), a unit leader and unit manager, a senior nurse, a physician, and two  
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16 members of the housekeeping staff (n=7). A total of 194 photographs were taken. Following the  
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18 walkabouts, three separate photo elicitation focus groups (n= 13 participants) were conducted to  
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20 review and discuss the images and narratives collected during the walkabout. The three groups  
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22 were management, health professionals and clinical support staff. The participants were asked to  
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24 provide written comments on each photograph and then each group discussed each picture as a  
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26 whole. Informed consent was obtained from all the participants in the photo walkabouts and  
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28 focus group sessions. Field notes were recorded after each photo walkabout and each photo  
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30 elicitation session to note researcher perceptions about the environment at these times of data  
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32 collection as well as participant dynamics during data collection.  
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39 An iterative data analysis process was conducted to inform data collection and analysis  
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41 throughout successive phases of the research. Atlas.ti version 5.3 software (ATLAS.ti Scientific  
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43 Software Development GmbH, Berlin) was used to support the management and analysis of the  
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45 written and visual data. The qualitative data analysis was initiated first then, as the themes  
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47 became identifiable, the other findings were integrated to better understand the qualitative data.  
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50 The rigor of this study was supported by several measures. Observer bias was minimized  
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52 by using multiple methods to gather and verify evidence on the policies, practices and  
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54 surveillance data on IP&C at the study site. Each photo walkabout and focus group session was  
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3 audio-taped, transcribed, and then verified to ensure accuracy. Follow-up with local experts  
4 including some participants, the manager of infection control and a physician-lead in infectious  
5 diseases, was also executed to ensure accuracy of the data collected. Furthermore, the  
6 observation field notes, photo walkabout and focus group findings were compared with findings  
7 from the other data sources of organizational policies, prevalence rates, and other relevant data  
8 (such as bed occupancy rates) as the iterative data analysis progressed. In addition, a researcher's  
9 journal was kept to capture reflections on all the research related activities.  
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## 20 RESULTS

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22 In the course of the analysis of the case study, six major themes were derived from the  
23 iterative analysis. Each theme is illustrated with select findings below.  
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### 26 *Considerable IP&C challenges were inherent to the design of the clinical unit*

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28 The environmental design, which was evidently complex, refers to the features of the  
29 physical environment or physical space (such as configuration, layout, organization, and other  
30 attributes) and the organization of the work (the nature, flow and safety of work). Workplace  
31 design refers to the design of the work environment, the physical space, and the accessibility of  
32 equipment; the work design is how the staff organizes their work, including the routines and the  
33 workflow on the unit. Both are central to understanding human factors, which is “the scientific  
34 discipline concerned with the understanding of interactions among humans and other elements of  
35 a system, and the profession that applies theory, principles, data and methods to design in order  
36 to optimize human well-being and overall system performance” (International Ergonomic  
37 Association, website).  
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53 An example of the workplace design is the presence of a sink for staff use at the entrance  
54 of each room (Figure 1 Hand Hygiene station outside of patient room (MGMT-2)).  
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A wall mounted soap dispenser, paper towels, a garbage container with lid, a wall mounted alcohol-based hand rub (ABHR) dispenser, and gloves in various sizes are present. The ABHR dispensers can only be found mounted on the wall near the sinks outside the patient rooms, in the dirty utility room and the medication room. There are no additional ABHR dispensers on the unit (Observations, P1, 26).

Another example of workplace design is the garbage cans. One participant described his concerns about the garbage bins with lids:

Here, you washed your hands and you throw away the paper towel and you have to touch the lid of the dirty waste box again and in fact you have dirty hands again. Afterwards, you should use the ABHR. You shouldn't have to touch anything (FG management, P12, 446).

This participant clearly recognized that hands can potentially become contaminated when opening or closing waste baskets. Overall, the environmental design of the unit provides challenges to proper IP&C practices thus leading to many workarounds.

***Nurses and other staff employed a wide variety of workarounds to try to adapt to the design of their care environment***

Workarounds are defined by Amalberti and colleagues [33] as the “adaptation of procedures by workers to deal with the demands of the work” (p. i67). These procedures are often adapted to bypass or avoid a problematic feature of the system that jeopardizes people’s chance of completing their work safely within optimal timeframes and resources. Amalberti’s theory on workarounds relates to how people naturally migrate to the boundaries of what are considered acceptable practices and sometimes violate those boundaries in order to adapt to system features that constrain their ability to accomplish their work. According to Amalberti, workarounds are an inevitable feature of complex systems, and what we need to do is figure out how to facilitate the safest possible adaptations within the context of individual practice and

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3 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the  
4 boundaries and workarounds that constitute problematic violations of safety principles.  
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8 An example of a workaround is the lack of ABHR present at the point of care, requiring  
9 staff members to go out of the room to clean their hands. During my walkabout with a physician  
10 participant, the issue of hand hygiene compliance was discussed in relation to non-single patient  
11 rooms:  
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17 The only problem [is] that they have to wash their hands every, every time they care for a  
18 patient and then go to another. That maybe... that's a risk [of] having more patients in a  
19 room. If you have one patient in a room then you go out and you wash your hands. If you  
20 have four patients in a room, you go to one patient then to the other... (PW physician, P8,  
21 78).  
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24 During my walkabout with the infection control professional, the participant explained the  
25 workflow of staff when they enter a single patient room as follows:  
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29 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR  
30 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other  
31 things and disinfect your hands again with ABHR. So in fact there should be ABHR at  
32 this place ... (PW ICP, P6, 383).  
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35 In these situations, due to system constraints, staff members are required to leave the room to  
36 clean their hands between patients, in order to avoid the kind of safety violation that Amalberti  
37 and colleagues [33] discuss.  
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42 ***Participants viewed organizational and team cultures as integral to the way they enact IP&C***  
43 ***practices in their workplaces***  
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47 In the first set of national interdisciplinary safety competencies established for Canada,  
48 Frank et al. [34] contend that the notion of a culture of patient safety is associated with  
49 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient  
50 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C  
51 became evident in the course of the research.  
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3 For example, during the walkabout with a participating physician and infection control  
4 professional, they explained that there is a change room on the unit where staff can:  
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8 ... put on, [and] take off their own clothes and put on their hospital [uniform] before they  
9 start working (PW physician and ICP, P8, 456).  
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11 During a follow-up, a key informant said:  
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14 Only a few staff members (<5%) wear their uniform outside the hospital. It's a rare  
15 occurrence. Most nurses change uniforms in the hospital (key informant).  
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17 This routine and highly consistent separation of work and street clothing is a notable example of  
18 a shared practice, within the group.  
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20  
21 The unit team also regularly engaged in shared meals. During my observations, the  
22 nurses had their meals and coffee breaks in the staff lounge located on the unit when everyone  
23 was ready to go on break. During my observations on the unit, I observed that eight nurses were  
24 in the staff room taking their break together (Observations, P1, 18). During the walkabout with  
25 the physician, he explained that:  
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28  
29 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).  
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32 This simple activity provides an environment where nurses are encouraged to interact and  
33 communicate with each other. It also has a potential impact on infection prevention as it limits  
34 staff leaving the unit. A key informant during a follow-up discussion also said:  
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38 ... the evening meals and coffee breaks are used in the lounge on the ward. During lunch  
39 all the nurses (and staff) go in two shifts to the restaurant of the hospital (key informant).  
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42 Culture is also reflected by the kinds of communication that occur within a team;  
43  
44 effective communication is important in order to obtain optimal patient outcomes.[34] During  
45 my observations, a clear communication strategy is the isolation card that is found posted  
46 underneath the room number. The card reads "barrière-box" isolation with gloves and gowns  
47 symbols (Observations, P1, 19). A participant said that:  
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3 ... with the isolation room you have this card so everybody who enters the room knows  
4 that this is happening and what you have to wear (PW housekeeping staff, P5, 95).  
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7 As a support staff participant noted:  
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9 ... it's too complex; there are too many different kinds of situations, so we always go to  
10 the nurse. [We ask] the nursing people in the hospital which things we have to do. And  
11 they tell us, we have to wear gloves, you have to put a mask on, or whatever ... (FG  
12 support staff, P10, 1199).  
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15 In contrast, an example of ineffective communication was discussed by another  
16 participant who stated that:  
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19 There's not enough information to the staff about infection control measures during a  
20 [patient] transport. They wear gowns and gloves when they're in the room but they don't  
21 tell the staff what to do during transport, so they're not informed (FG Management, P12,  
22 121).  
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25 Clear mechanisms to promote effective communication amongst staff therefore need to be in  
26 place to minimize the likelihood of adverse events and to ultimately create and support a culture  
27 of safety.[34]  
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33 ***Participants who engaged in communal practice activities tended to monitor and support the***  
34 ***use of recommended IP&C practices***  
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36 In the field of ecological restoration [24-27] and in health systems research, [19,32]  
37 engaged practice refers to the vigilance, attentiveness and awareness of one's practices and each  
38 other's practices in order to reinforce and actively use what one learns to foster better treatment  
39 of each other and the places we share. Within healthcare, the concept of communities of practice,  
40 where groups of professionals work on initiatives to create, implement and evaluate evidence-  
41 based care improvements, may be thought of as one key forum for engaged practice.  
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51 A key grass root Hygiene in Practice (HIP) group, which consists of nurse representatives  
52 of every surgical unit and an infection control professional, oversees and implements several  
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3 activities to promote the use of good hygiene precautions in the hospital. During a follow-up  
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5 discussion, key informants said:  
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8 The HIP group is an initiative of the surgical units and the infection control professional.  
9 The infection control professional attends the meetings of the HIP group every month and  
10 together they make plans on activities and education. It has great value because of the  
11 cooperation (key informant #1). Local initiatives are stimulated by the working group.  
12 They learn to look at their working procedures through the eyes of an infection control  
13 professional (key informant #2).  
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16 An example of their initiative includes the patient-specific storage box for wound care products  
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18 (Figure 2 Green storage box for patient (MGMT-41)):  
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21 This is a box in use. Personal wound products for the patient and they're stored in  
22 here...(PW management, P7, 1138). So every patient when they need a lot of bandage  
23 gets a...green box (PW management, P7, 704). I like this very much; material needed for  
24 one patient is stored in a closed box. The box can be disinfected. No cart is necessary in  
25 the room (FG management, written comments, P20, 16).  
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28 This is an example of a simple yet vital HIP initiative to support IP&C practices.  
29

### 30 ***The use of knowledge about IP&C supported adaptive learning and growth***

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32 The theme of adaptive knowledge use refers to the development and translation of  
33 knowledge into lessons for individuals, teams, organizations and systems to drive sustainable  
34 change.[16,18,22,25,27,35] This adaptive knowledge is critically linked to the ongoing  
35 education, training and feedback that are necessary to encourage IP&C within healthcare.  
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38 An example of adaptive learning and growth is the evidence-informed education  
39 provided by the grass roots HIP group that is built on current staff knowledge and experience,  
40 and is geared to address gaps in practice. All surgical wards have a nurse participating in this  
41 group. Many comments were received on the educational poster created by the HIP group  
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50 (Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:  
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53 Clear, practical information and pictures, gives good information, better because of the  
54 photographs! (FG support staff, written comments, P13, 13).  
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3 Training and education on hand hygiene is provided to units upon request by the unit  
4 manager or the infection control department. There were no hospital-wide hand hygiene  
5 programs or campaigns underway in the hospital during the study period. Monitoring of hand  
6 hygiene compliance was calculated based on product consumption and not on hand hygiene  
7 observations. These comments brought forward by staff themselves are important to the  
8 development of sustainable solutions.  
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18 ***In the face of numerous system constraints, participants viewed engaged leadership as***  
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20 ***important for IP&C***  
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22 The concept of engaged leadership as a critical form of IP&C governance emerged as a  
23 key finding in my study in a variety of ways. At the Netherlands hospital, the infection control  
24 department, consisting of 1.32 FTEs per 250 beds, supports the overall IP&C activities of the  
25 hospital. The IP&C program reports to the Infection Prevention Committee who advises the  
26 Board of Directors on the infection control policies. This committee meets every two months and  
27 discusses all infection control-related issues. If necessary, the IP&C policies are reviewed and  
28 revised accordingly. The Infection Control Committee then reports the changes to the Board of  
29 Directors for endorsement. Twice a year a prevalence rate of nosocomial infections is calculated.  
30 These results are provided to the management teams of each specialty involved, and to the Board  
31 of Directors. Furthermore, the Board of Directors receives a copy of the annual report of the  
32 IP&C department (which includes all the work completed by the IP&C department in the last  
33 year as well as details of any outbreaks that have occurred, etc.).  
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50 An example of a health system level policy in place at the Netherlands hospital is the  
51 central process used for bed cleaning to reduce the risk of bacteria survival on bed surfaces. A  
52 physician participant pointed out:  
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3 ... a bed that's going off the unit to be cleaned... It's going to be washed... in this  
4 building; it's like a car wash ... (PW physician, P8, 272).  
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7 As another participant noted:

8  
9 What a good system...beds are cleaned well at the central bed cleaning department (FG  
10 health professionals, written comments, P26, 08).  
11

12 Also, a yearly report of the antibiotic usage by specialty is provided by pharmacy. The  
13 hospital also provides a booklet consisting of guidelines on antibiotic usage for physicians. The  
14 microbiologists act as consultants to all the physicians in the hospital. However, physicians are  
15 free to prescribe antibiotics at their discretion, which ultimately affects the efficacy of the  
16 process.  
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24 Another health system level policy supported by management is the 'search and destroy'  
25 active surveillance strategy for MRSA. The 'search and destroy' strategy for MRSA is a  
26 screening strategy that is aimed at high risk patients only, defined as patients who come from  
27 foreign countries or patients who have been in contact with pigs or cattle. These patients are  
28 screened on admission for carriage of MRSA (Dutch Working Party on Infection Prevention,  
29 2007). Patients are automatically placed on isolation precautions until the test results are  
30 available.  
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40 Overall, the hospital reports a prevalence count of patients identified with MRSA, VRE,  
41 CDI, and ESBL isolates per month. The hospital does not regularly calculate infection rates for  
42 these organisms. Thus, the estimated prevalence rates were calculated by using the proportion of  
43 cases or prevalence count of patients, over the total population at a given time. The prevalence  
44 rates are outlined in Table 1.  
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**Table 1: Hospital- and Community-Acquired MRSA, VRE, CDI and ESBL Prevalence Rates (per 1,000 patient days) (colonized and infected cases) (Jan-Dec 2008)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>MRSA</b>	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
<b>VRE</b>	5.0	0	0	0	0	0	0	0	0	1.7	0	0
<b>CDI</b>	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
<b>ESBL</b>	25	9.76	16.9	18.2	21.2	16.6	22.6	32.9	23.4	42.7	28.4	33.3

## DISCUSSION

The findings indicate that there are considerable IP&C challenges inherent to the complexity of the hospital environment. Staff employed a wide variety of workarounds or used temporary fixes to adapt to these challenges, and organizational and team cultures were integral to the way that practices were enacted within the workplace. Staff who engaged in the unit's practice activities tended to monitor and support the use of recommended practices, and there were several exemplars of using knowledge about IP&C to support adaptive learning and growth. Also, in the face of numerous system constraints, participants viewed engaged leadership as important for IP&C.

Findings in the study support the search and destroy strategy for MRSA well documented in the literature [36-38] as one of the major bridges or facilitators to IP&C. In the case study, the monthly MRSA prevalence rate for 2008 ranged from 0-0.67% which is consistent with the rate of less than 1% [29] published in the literature. The control measures in the search and destroy strategy included preemptive isolation of patients, repeated screening of staff for MRSA, repeated attempts at decolonization of MRSA positive patients and staff and high levels of environmental cleaning.

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Monthly screenings for VRE were also performed in the intensive care, hematology, and nephrology units. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The CDI prevalence rate ranged from 0-0.8% and although additional screening on high risk patients for ESBLs was performed, the monthly ESBL prevalence rate was somewhat higher, 0.98%-4.27%. Although MRSA, VRE and CDI rates may be below 1%, other pathogens such as ESBL may not appear to be as controlled. A comprehensive infection prevention control program for all MDRO should focus on the control of many pathogens simultaneously, including those pathogens that have not yet been identified.

Another factor that can have an impact on the rate of MDRO is the occupancy rate which was reported as approximately 80%. Studies have shown that lower occupancy rates are linked to lower infection rates (National Audit Office, 2004). In a study in Northern Ireland, the bed occupancy rate was found to have a significant positive correlation with MRSA rates in hospitals.[39] Also, another study by Borg [40] found a significant correlation between the bed occupancy rate and the MRSA infection rates. Similarly, Borg and colleagues [41] concluded that periods of high occupancy levels were associated with higher MRSA incidence rates. In another study by the Department of Health in the UK,[42] concluded that hospitals with higher than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good control of infections”.[43, p.1401] Thus, the results of our case study support the notion that the bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the prevalence of MDRO infections.

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Another bridge to IP&C is the support provided by management for the Hygiene in Practice (HIP) group. This grassroots group incorporates sound IP&C practices into the workplace. The group also provides support amongst individuals to value IP&C in the workplace, thus fostering the organizational and team culture of safety by promoting group norms in favor of good practice. Furthermore, the group promotes adaptive learning and growth by developing and translating knowledge to minimize poor IP&C practices. According to a study by the Plexus Institute (2009), healthcare workers who take ownership of the infection control issues on a unit can significantly improve MDRO rates. While we are well aware of the benefits of the support from IP&C experts, it is worth exploring which kind of community of practice (e.g. unit-based practitioner-led or IP&C-led) have a greater influence on IP&C practices.

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A further support for IP&C is the high level of environmental cleaning. This includes the central bed washing system which consists of the thorough washing of all hospital beds after patient discharge. According to the Dutch Working Party on Infection Prevention Bed and Accessories guidelines (2007), “machine cleaning is preferred to manual cleaning” because of the consistency in the cleaning procedure, the high temperatures for washing and rinsing, the heavy work of manually washing a bed and the better tracking mechanism of clean beds throughout the hospital. It is worthwhile exploring this practice in further details.

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Despite the recommended IP&C practices in place, some barriers were evident. For example, the findings clearly showed the presence of environmental design challenges which can have a great impact on IP&C by creating a wide range of workarounds that are often adapted by staff to curtail the challenging care environment.[44] As Amalberti and colleagues [33] argue, staff naturally migrate to the boundaries and violate the acceptable practices in order to adapt to a system that is not amenable. For example, staff will less likely clean their hands if they do not

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2  
3 have proper access to soap and water or an ABHR.[45,46] In this case study, the ABHR  
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5 dispensers were only located outside the patient rooms. According to the WHO Guidelines on  
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7 Hand Hygiene in Health Care (2009), the ABHR dispensers should be located in the patient  
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9 rooms at point of care. In addition, others support that the dispensers should also be placed in  
10  
11 many convenient and accessible locations for staff.[47-49]  
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15 Other environmental design issues that pose barriers to IP&C were also observable, such  
16  
17 as garbage bins that require handling to open, hand operated taps, multi-bed rooms with shared  
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19 toilets, and lack of storage space. It is likely that similar design issues abound in most acute care  
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21 hospitals. Rathert and colleagues [50] recommend that organizations examine how the  
22  
23 implementation of policies and procedures influence the work and work environment of nurses  
24  
25 in order to avoid unfavourable workarounds. It is a tribute to the empowerment and ingenuity of  
26  
27 the staff that they innovate workarounds to try to deal with these systemic barriers and support  
28  
29 effective control of MDRO.  
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34 The method used to monitor adherence to hand hygiene practices is the unit-based  
35  
36 consumption of ABHR. There are no recommendations on how to monitor compliance of hand  
37  
38 hygiene in the Dutch guideline of hand hygiene for staff (Dutch Working Party on Infection  
39  
40 Prevention, 2007). However, the recommended method to monitor hand hygiene compliance,  
41  
42 according to the WHO Guidelines on Hand Hygiene in Health Care, is by direct observations.  
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44 Product consumption monitoring cannot determine if hand hygiene is performed correctly and at  
45  
46 appropriate times. It may also not properly reflect the overall product consumption by healthcare  
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48 providers, as it may also include the amount of product used by visitors and/or patients (World  
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50 Health Organization, 2009).  
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Furthermore, although a report of the antibiotic usage by physician is provided by the pharmacy department on an annual basis, physicians are permitted to prescribe antibiotics at their discretion. This may limit the efficacy of the process. More stringent guidelines on the restrictive use of antibiotics are needed as there is a trend for hospital pathogens to become more resistant in the future.[51]

There were several limitations to this study. It is possible, for instance, that staff may have altered their behavior from normal practices during unit observations. Furthermore, the prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage and antibiotic data were collected by hospital personnel not supervised by the researcher, limiting the ability to assess the rigor of data collection. In addition, the focus of this study was on a specific clinical unit of the hospital. I attempted to address these limitations by incorporating multiple methods of data collection and by taking a broad socio-ecological system approach to study IP&C on the unit. However, if feasible, it would be preferable in future case studies to collect all data across sites through one researcher and study entire organizations or perhaps even regions to obtain a more comprehensive picture of some aspects of the complex phenomena of IP&C.

## CONCLUSION

This case study provided in-depth knowledge of the socio-ecological conditions present on a surgical unit at a Netherlands hospital that reported rates of MDRO below 1%. These findings suggest there is merit in further exploring the potential benefits of such health system practices for optimal prevention and control of MDRO in modern hospital environments. Further research on the benefits of practitioner-led community of practices on IP&C practices such as the Hygiene in Practice group is also recommended. Additional case studies to compare these



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3 practices to other acute care hospital around the world would be a valuable way to better  
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5 understand what IP&C programs are most effective in which contexts, and for what reasons.  
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## 10 11 **DATA SHARING**

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14 Supplementary data is available by contacting the primary author.  
15

## 16 **COMPETING INTERESTS**

17  
18 None.  
19

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21  
22  
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26 Control (2008).  
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## 29 **CONTRIBUTORSHIP**

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32 All of the authors made substantial contributions to the conception and design of the study and  
33 the analysis and interpretation of the data. Chantal Backman drafted the article; all of the authors  
34 revised the manuscript critically for important intellectual content and approved the final version  
35 submitted for publication. Chantal Backman had full access to all of the data in the study and  
36 takes responsibility for the integrity of the data and the accuracy of the data analysis.  
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**Appendix 1: Core elements of a proposed socio-ecological framework for studying IP&C**  
(Table reprinted from Backman et al. [52])

Core Elements	Definitions
Citizen science	The notion of citizen science refers to individuals working collaboratively with communities, governing bodies and others to conduct research and generate evidence.[14,18,19]. This includes using a participatory and collaborative approach to the design, conduct and analysis of IP&C research, involving members of the community in data collection and data analysis wherever feasible and appropriate and seeking multiple sources of data (including sources of indigenous or local knowledge) and using a variety of methods to develop integrative knowledge about local places as well as the larger system.[16,19-21]
Place ethic	According to Lawrence Buell [53] and Higgs,[26,27] a place ethic is shown in the ways that individuals treat and support each other and the places they share. Place ethic refers to the importance of fostering a deep understanding of and respect for the history, culture, knowledge and rituals of communities. In this research, thinking about place ethic includes inquiring about what people see as important in the care of each other and their environment, how they reinforce and support each other to value IP&C, and whether respect for historical knowledge informs how a place functions over time.
Engaged practice	The concept of engaged practice refers to the creation, implementation and evaluation of sound practices that are evidence-informed.[18,24-27] This includes self monitoring and adjustment of daily IP&C practices (e.g.: audits, equipment checks), using local feedback processes to continually improve workflow, work design, and processes at the individual, team, and healthcare community levels.
Adaptive learning and growth	The idea of adaptive learning and growth refers to the development and use of knowledge translation strategies that disseminate learnings across individuals, teams, organizations and system levels to drive sustainable changes.[16,18,22,25,27,35] This includes evidenced-informed management of MDRO, screening policies, resource allocation decisions about patient care staffing, housekeeping, availability of equipment and supplies, staff and public education policies and funding.

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**Barriers and Bridges to Infection Prevention and Control:  
Results of a Qualitative Case Study of a Netherlands'  
Surgical Unit**

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## ■ Qualitative research review guidelines – RATS

ASK THIS OF THE MANUSCRIPT	THIS SHOULD BE INCLUDED IN THE MANUSCRIPT
<p><b>R Relevance of study question</b></p> <p>Is the research question interesting?</p> <p>Is the research question relevant to clinical practice, public health, or policy?</p>	<p>Research question explicitly stated ✓</p> <p>Research question justified and linked to the existing knowledge base (empirical research, theory, policy) ✓</p>
<p><b>A Appropriateness of qualitative method</b></p> <p>Is qualitative methodology the best approach for the study aims?</p> <p><i>Interviews:</i> experience, perceptions, behaviour, practice, process</p> <p><i>Focus groups:</i> group dynamics, convenience, non-sensitive topics</p> <p><i>Ethnography:</i> culture, organizational behaviour, interaction</p> <p><i>Textual analysis:</i> documents, art, representations, conversations</p>	<p>Study design described and justified e.g., why was a particular method (i.e., interviews) chosen? ✓</p>
<p><b>T Transparency of procedures</b></p> <p><i>Sampling</i></p> <p>Are the participants selected the most appropriate to provide access to type of knowledge sought by the study?</p> <p>Is the sampling strategy appropriate?</p>	<p>Criteria for selecting the study sample justified and explained ✓</p> <p><i>theoretical:</i> based on pre conceived or emergent theory</p> <p><i>purposive:</i> diversity of opinion</p> <p><i>volunteer:</i> feasibility, hard-to-reach groups</p>
<p><i>Recruitment</i></p> <p>Was recruitment conducted using appropriate methods?</p> <p>Is the sampling strategy appropriate?</p> <p>Could there be selection bias?</p>	<p>Details of how recruitment was conducted and by whom ✓</p> <p>Details of who chose not to participate and why ✓</p>
<p><i>Data collection</i></p> <p>Was collection of data systematic and comprehensive?</p> <p>Are characteristics of the study group and setting clear?</p> <p>Why and when was data collection stopped, and is this reasonable?</p>	<p>Method (s) outlined and examples given (e.g., interview questions) ✓</p> <p>Study group and setting clearly described ✓</p> <p>End of data collection justified and described ✓</p>
<p><i>Role of researchers</i></p> <p>Is the researcher (s) appropriate? How might they bias (good and bad) the conduct of the study and results?</p>	<p>Do the researchers occupy dual roles (clinician and researcher)? ✓</p> <p>Are the ethics of this discussed? Do the researcher(s) critically examine their own ✓</p>

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	influence on the formulation of the research question, data collection, and interpretation?
<p><i>Ethics</i></p> <p>Was informed consent sought and granted?</p> <p>Were participants' anonymity and confidentiality ensured?</p> <p>Was approval from an appropriate ethics committee received?</p>	<p>Informed consent process explicitly and clearly detailed ✓</p> <p>Anonymity and confidentiality discussed ✓</p> <p>Ethics approval cited ✓</p>
<p><b>S Soundness of interpretive approach</b></p> <p><i>Analysis</i></p> <p>Is the type of analysis appropriate for the type of study? <i>thematic: exploratory, descriptive, hypothesis generating framework: e.g., policy constant comparison/grounded theory: theory generating, analytical</i></p> <p>Are the interpretations clearly presented and adequately supported by the evidence?</p> <p>Are quotes used and are these appropriate and effective?</p> <p>Was trustworthiness/reliability of the data and interpretations checked?</p>	<p>Analytic approach described in depth and justified ✓</p> <p><i>Indicators of quality: Description of how themes were derived from the data (inductive or deductive)</i> ✓</p> <p>Evidence of alternative explanations being sought ✓</p> <p>Analysis and presentation of negative or deviant cases ✓</p> <p>Description of the basis on which quotes were chosen ✓</p> <p>Semi-quantification when appropriate ✓</p> <p>Illumination of context and/or meaning, richly detailed ✓</p> <p>Method of reliability check described and justified ✓ e.g., was an audit trail, triangulation, or member checking employed? Did an independent analyst review data and contest themes? How were disagreements resolved?</p>
<p><i>Discussion and presentation</i></p> <p>Are findings sufficiently grounded in a theoretical or conceptual framework?</p> <p>Is adequate account taken of previous knowledge and how the findings add?</p> <p>Are the limitations thoughtfully considered?</p> <p>Is the manuscript well written and accessible?</p>	<p>Findings presented with reference to existing theoretical and empirical literature, and how they contribute ✓</p> <p>Strengths and limitations explicitly described and discussed ✓</p> <p>Evidence of following guidelines (format, word count) ✓</p> <p>Detail of methods or additional quotes contained in appendix ✓</p> <p>Written for a health sciences audience</p>
<p>Are <u>red flags</u> present? these are common features of ill conceived or poorly executed qualitative studies, are a cause for concern, and must be viewed critically. They might be</p>	<p><i>Grounded theory: not a simple content analysis but a complex, sociological, theory generating approach</i>Jargon: descriptions that are trite, pat,</p>

1 fatal flaws, or they may result from lack of detail or clarity.  
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or jargon filled should be viewed sceptically  
*Over interpretation:* interpretation must be grounded in "accounts" and semi-quantified if possible or appropriate  
*Seems anecdotal, self evident:* may be a superficial analysis, not rooted in conceptual framework or linked to previous knowledge, and lacking depth  
*Consent process thinly discussed:* may not have met ethics requirements  
*Doctor-researcher:* consider the ethical implications for patients and the bias in data collection and interpretation

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17 **peer review a qualitative manuscript.** In *Peer Review in Health Sciences*. Second edition. Edited by Godlee F,  
18 Jefferson T. London: BMJ Books; 2003:219-235  
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## Barriers and Bridges to Infection Prevention and Control: Results of a Qualitative Case Study of a Netherlands' Surgical Unit

### ABSTRACT

#### Objectives:

- To observe the overall work environment including infection prevention and control (IP&C) practices on the target surgical unit;
- To analyze the policies and procedures in the hospital and unit environments;
- To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of their unit environment; and
- To collect monthly specific IP&C related anonymized data.

#### Design:

In this qualitative case study analysis, a socio-ecological approach on health systems informed the research design and provided a framework to better understand the complexity of implementing effective IP&C.

#### Setting:

The study was conducted on a surgical unit at a Netherlands' hospital that reported successful reductions in the prevalence of targeted multidrug-resistant organisms (MDRO).

#### Methods:

Research methods included unit observations (n=3), review of relevant policies and procedures, five practitioner-led photo walkabouts of the unit (n=7), three photo elicitation focus groups with practitioners (n=13), and the review of related IP&C data.

#### Results:

The findings indicate some conditions and processes present that may influence the low prevalence of MDRO, including the 'search and destroy' active surveillance strategy, low occupancy rates, a centralized bed cleaning system, and the presence of an active grass roots Hygiene in Practice group which engages practitioners in several ongoing activities to promote IP&C on the units.

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#### Conclusions:

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12 these practices to other acute care hospital around the world would be a valuable way to better  
13 understand what IP&C programs are most effective in which contexts, and for what reasons.  
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15 Further data is available by contacting the primary author directly.  
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## 20 **SUMMARY**

21 Article focus:

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24 -To observe the overall work environment including IP&C practices on the target surgical unit;  
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26 -To analyze the policies and procedures aimed at the prevention and minimization of MDRO in  
27 the hospital and unit environments;  
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29 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of  
30 their unit environment; and  
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32 -To collect monthly specific IP&C related anonymized data.  
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37 Key messages:

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39 The findings indicate some conditions and processes present that may influence the low  
40 prevalence of MDRO, including:  
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43 -the 'search and destroy' active surveillance strategy, -low occupancy rates  
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45 -a centralized bed cleaning system, and  
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48 -the presence of an active grass roots Hygiene in Practice group which engages practitioners in  
49 several ongoing activities to promote IP&C on the units.  
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51 Strengths and limitations:

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53 -Multiple methods of data collection and a broad socio-ecological system approach to study  
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55 IP&C on the unit strengthen this research.  
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57 -It is possible that staff may have altered their behavior from normal practices during unit  
58 observations.  
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-The prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage



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12 limiting the ability to assess the rigor of data collection.

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14 -The focus of this study was on a specific clinical unit of the hospital.

## 15 16 17 **INTRODUCTION**

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20 Infection prevention and control (IP&C) in the acute care environment is one of the most  
21 important issues in modern healthcare. Healthcare-associated infections (HAI) are not only a  
22 potential burden on patients in terms of increased morbidity and length of stay but also an  
23 economic burden on the healthcare system.[1-3] However, although the importance of IP&C is  
24 well recognized and numerous research studies and best practice guidelines have been published  
25 on this topic, infection rates of multidrug-resistant organisms (MDRO) are on the rise in Canada  
26 and in the United States,[4] and IP&C remains a challenge. In contrast to the North American  
27 situation, the “control of MRSA infections [one of the MDRO] is reported to be optimal in the  
28 Scandinavian countries [and also in the Netherlands], where strict barrier precautions are in place  
29 along with active surveillance culture (ASC) programs”.[5, p.236] Some European countries  
30 such as the Netherlands have been recognized as world leaders at minimizing MDRO infection  
31 rates, in particular MRSA.[6] Yet, strong evidence on the most effective approaches for  
32 achieving good adherence to the simplest measures, such as hand hygiene, remains elusive, and  
33 further knowledge of what drives individuals, organizations and health systems towards  
34 sustainable IP&C practices does not yet exist in the research literature.[7] To develop a better  
35 understanding of what may be shaping the prevention of MRSA and other MDRO, a case study  
36 was conducted in April 2008 on a surgical unit at a Netherlands hospital that reported a  
37 successful reduction in the prevalence of targeted MDRO. In this paper, we discuss the key

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findings of the Netherlands hospital case study and offer recommendations for policy, practice



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12 The objectives of the research were:

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14 1. To observe the overall work environment including IP&C practices on the target surgical  
15 unit;  
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17 2. To critically review the policies and procedures aimed at the prevention and minimization of  
18 MDRO in the hospital and unit environments;  
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20 3. To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of  
21 their unit environment; and  
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23 4. To collect monthly specific IP&C related anonymized data on the target surgical unit and in  
24 the facility overall for a duration of 12 months, and the prevalence rates of methicillin-  
25 resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE),  
26 extended spectrum beta-lactamases (ESBLs) and *Clostridium difficile* infections (CDI).  
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## 38 METHODS

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40 The need for more theoretically driven research in IP&C in order to strengthen the rigor  
41 and usefulness of evidence for IP&C has been recognized in the literature.[7-12] One promising  
42 theoretical line of inquiry is supported by Struelens' [8] recommendation to take a broad socio-  
43 ecological approach to the study and management of IP&C. This socio-ecological perspective is  
44 well supported by others including Ali,[9] Gloubeman,[10] Macdonald,[11] and Waldvogel,[12]  
45 who all argue that a host of inter-related social and environmental factors play a critical role in  
46 the emergence and trajectory of infectious diseases in 21<sup>st</sup> century societies and their health  
47 systems.  
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In this study, a socio-ecological approach on health systems informed this research  
design and provided a framework to better understand the complexity of implementing effective  
IP&C. A socio-ecological perspective provides “a framework for understanding the diverse

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12 personal and environmental factors and the interrelationships among these factors”,[13, p.45]  
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14 enabling us to more accurately interpret and manage whole systems change.[14,15] In socio-  
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16 ecological terms, the term whole systems may be conceptualized as nested cycles of system  
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18 development, degradation, or restoration.[14,16-18]  
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21 A whole systems’ perspective on IP&C is compatible with the participatory methods of  
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23 citizen science that engage communities in collectively studying and assessing the socio-  
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25 ecological conditions of their environments in order to collaboratively design and implement  
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27 useful, sustainable repairs.[14,18,19] For the purposes of this study, citizen science is  
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29 conceptualized as a collaborative process between researchers and participants where members  
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31 of the community are involved in data collection and data analysis to conduct research and  
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33 generate evidence.[16,19-21] This research approach draws on related work in the fields of  
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35 ecosystems management and research,[22] economics,[23] restoration management,[24-27] and  
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37 health systems.[18,19] It involves seeking multiple sources of data and using a variety of  
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39 methods to develop integrative knowledge about local places as well as the overall system as a  
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41 whole.[14,18,21,28]  
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48 Using a socio-ecological perspective and the concept of citizen science as theoretical  
49  
50 guideposts, core elements of a proposed socio-ecological framework for studying IP&C were  
51  
52 defined,[8,12,15,18] and used to inform the research design and conduct of the study (Appendix  
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54 1). The framework informed but did not constrain the collection and analysis of the data.  
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## 56 57 **Setting**

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59 The hospital is a 1042-bed tertiary care major teaching and referral center in The  
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Netherlands providing general and specialized services for the population of its city and the  
surrounding area. In 2008, the hospital had approximately 31,420 admissions, 22,564 emergency

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12 room visits and over 336,000 outpatient visits. The patient average length of stay was 7.7 days.  
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14 The hospital occupancy rate was about 80% at any given time. There were 10,668 employees in  
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16 2008 including 2,560 nurses. This hospital was chosen because it reported less than 1% MDRO  
17  
18 prevalence rates.[29] The case study was conducted on a 34-bed unit, with 6 (18%) single-bed  
19  
20 rooms, comprising mainly of orthopedic, cosmetic, urology and general surgery patients. Ethical  
21  
22 approval was obtained through the University of Alberta Health Ethics Review Board and the  
23  
24 study hospital's Medical Ethics Review Committee.  
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### 31 **Data Collection and Analysis**

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33 Data were collected and analyzed from multiple sources to gain an in-depth  
34  
35 understanding of the case [30,31] from a socio-ecological perspective on health systems. The  
36  
37 photographic research methods used, which were adapted from previous work in ecological  
38  
39 restoration [27] and health systems research [19,32] consisted of practitioner-led audio-taped  
40  
41 photo walkabouts with photo narration and communal photo elicitation forums. Participant  
42  
43 guided ecological tours of the hospital helped to foster community participation, local expertise  
44  
45 and indigenous ecological knowledge that practitioners have about the places where they work.  
46  
47 Unit observation sessions (n=3) were also performed by one of the authors (CB) and field notes  
48  
49 were recorded on the work environment of the unit to gain an initial perspective of the overall  
50  
51 environment and IP&C practices. Nursing, medical, housekeeping and other hospital personnel  
52  
53 on the unit were informed that the study was taking place and that the observations collected  
54  
55 would be shared with them, and with the hospital in aggregate form only. The first author made it  
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57 clear that the specific findings would not be linked to any individuals. In addition, policies and  
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59 procedures relevant to IP&C practices (n=11) were collected in order to gain a better  
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12 understanding of the existing practices. Aggregated, anonymized IP&C related data were  
13 collected including monthly prevalence rates for MRSA, VRE, CDI and ESBL (January-  
14 December 2008).  
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18  
19 Five practitioner-led photo walkabouts and photo narrations (n=7 participants) of their  
20 perceived concerns and strengths on their unit in relation to IP&C were conducted. The  
21 individuals who participated in separate photo walkabouts included the infection control  
22 professional (ICP), a unit leader and unit manager, a senior nurse, a physician, and two members  
23 of the housekeeping staff (n=7). A total of 194 photographs were taken. Following the  
24 walkabouts, three separate photo elicitation focus groups (n= 13 participants) were conducted to  
25 review and discuss the images and narratives collected during the walkabout. The three groups  
26 were management, health professionals and clinical support staff. The participants were asked to  
27 provide written comments on each photograph and then each group discussed each picture as a  
28 whole. Informed consent was obtained from all the participants in the photo walkabouts and  
29 focus group sessions. Field notes were recorded after each photo walkabout and each photo  
30 elicitation session to note researcher perceptions about the environment at these times of data  
31 collection as well as participant dynamics during data collection.  
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50 An iterative data analysis process was conducted to inform data collection and analysis  
51 throughout successive phases of the research. Atlas.ti version 5.3 software (ATLAS.ti Scientific  
52 Software Development GmbH, Berlin) was used to support the management and analysis of the  
53 written and visual data. The qualitative data was coded into thematic categories. These categories  
54 were compared and contrasted in relation to the patterns identified that relate to IP&C. As  
55 coding, comparing, and contrasting within the qualitative data progressed in iterative cycles of  
56 data collection and data analysis, potential links between various groupings of coded visual and  
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12 textual data, related emerging theory and research literature were identified and discussed within  
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14 the research team. Our analysis was sensitive to the policies and procedures, prevalence rates,  
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16 and other hospital documents that helped contextualize these specific findings.  
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18  
19 The rigor of this study was supported by several measures. Observer bias was minimized  
20  
21 by using multiple methods to gather and verify evidence on the policies, practices and  
22  
23 surveillance data on IP&C at the study site. Each photo walkabout and focus group session was  
24  
25 audio-taped, transcribed, and then verified to ensure accuracy. Follow-up with local experts  
26  
27 including some participants, the manager of IP&C and a physician lead in infectious diseases,  
28  
29 was also executed to ensure accuracy of the data collected. Furthermore, the observation field  
30  
31 notes, photo walkabout and focus group findings were compared with findings from the other  
32  
33 data sources of organizational policies, prevalence rates, and other relevant data (such as bed  
34  
35 occupancy rates) as the iterative data analysis progressed. In addition, a researcher's journal was  
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37 kept to capture reflections on all the research related activities.  
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## 42 RESULTS

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45 In the course of the analysis of the case study, six major themes were derived from the  
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47 iterative analysis. Each theme is illustrated with select findings below.  
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### 49 *Considerable IP&C challenges were inherent to the design of the clinical unit*

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52 The environmental design consists of both workplace and work design. Workplace design  
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54 refers to the design of the work environment, the physical space, and the accessibility of  
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56 equipment; the work design is how the staff organizes their work, including the routines and the  
57  
58 workflow on the unit. Both are central to understanding human factors, which is “the scientific  
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60 discipline concerned with the understanding of interactions among humans and other elements of  
61  
62 a system, and the profession that applies theory, principles, data and methods to design in order

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12 to optimize human well-being and overall system performance” (International Ergonomic  
13 Association, website).

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17 An example of the workplace design is the presence of a sink for staff use at the entrance  
18 of each room (Figure 1 Hand Hygiene station outside of patient room (MGMT-2)).

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21 A wall mounted soap dispenser, paper towels, a garbage container with lid, a wall  
22 mounted alcohol-based hand rub (ABHR) dispenser, and gloves in various sizes are present. The  
23 ABHR dispensers can only be found mounted on the wall near the sinks outside the patient  
24 rooms, in the dirty utility room and the medication room. There are no additional ABHR  
25 dispensers on the unit (Observations, P1, 26).

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27  
28 Another example of workplace design is the garbage cans. One participant described his  
29 concerns about the garbage bins with lids:

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32  
33 Here, you washed your hands and you throw away the paper towel and you have to touch  
34 the lid of the dirty waste box again and in fact you have dirty hands again. Afterwards,  
35 you should use the ABHR. You shouldn't have to touch anything (FG management, P12,  
36 446).

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39 This participant clearly recognized that hands can potentially become contaminated when  
40 opening or closing waste baskets. Overall, the environmental design of the unit provides  
41 challenges to proper IP&C practices thus leading to many workarounds.

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51 ***Nurses and other staff employed a wide variety of workarounds to try to adapt to the design of***  
52 ***their care environment***

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56 Workarounds are defined by Amalberti and colleagues [33] as the “adaptation of  
57 procedures by workers to deal with the demands of the work” (p. i67). These procedures are  
58 often adapted to bypass or avoid a problematic feature of the system that jeopardizes people’s  
59 chance of completing their work safely within optimal timeframes and resources. Amalberti’s  
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11 considered acceptable practices and sometimes violate those boundaries in order to adapt to  
12 system features that constrain their ability to accomplish their work. According to Amalberti,  
13 workarounds are an inevitable feature of complex systems, and what we need to do is figure out  
14 how to facilitate the safest possible adaptations within the context of individual practice and  
15 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the  
16 boundaries and workarounds that constitute problematic violations of safety principles.  
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26 An example of a workaround is the lack of ABHR present at the point of care, requiring  
27 staff members to go out of the room to clean their hands. During the photo walkabout with a  
28 physician participant, the issue of hand hygiene compliance was discussed in relation to non-  
29 single patient rooms:  
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35 The only problem [is] that they have to wash their hands every, every time they care for a  
36 patient and then go to another. That maybe... that's a risk [of] having more patients in a  
37 room. If you have one patient in a room then you go out and you wash your hands. If you  
38 have four patients in a room, you go to one patient then to the other... (PW physician, P8,  
39 78).  
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42 During the photo walkabout with the ICP, the participant explained the workflow of staff when  
43 they enter a single patient room as follows:  
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47 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR  
48 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other  
49 things and disinfect your hands again with ABHR. So in fact there should be ABHR at  
50 this place ... (PW ICP, P6, 383).  
51  
52

53 In these situations, due to system constraints, staff members are required to leave the room to  
54 clean their hands between patients, in order to avoid the kind of safety violation that Amalberti  
55 and colleagues [33] discuss.  
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***Participants viewed organizational and team cultures as integral to the way they enact IP&C  
practices in their workplaces***  
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12 In the first set of national interdisciplinary safety competencies established for Canada,  
13 Frank et al. [34] contend that the notion of a culture of patient safety is associated with  
14 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient  
15 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C  
16 became evident in the course of the research. For example, during the photo walkabout with a  
17 participating physician and ICP, they explained that there is a change room on the unit where  
18 staff can:  
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28 ... put on, [and] take off their own clothes and put on their hospital [uniform] before they  
29 start working (PW physician and ICP, P8, 456).  
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32 During a follow-up interview, a key informant said:  
33

34 Only a few staff members (<5%) wear their uniform outside the hospital. It’s a rare  
35 occurrence. Most nurses change uniforms in the hospital (key informant).  
36  
37

38 This routine and highly consistent separation of work and street clothing is a notable example of  
39 a shared practice that supports effective IP & C within the group. Another shared practice with  
40 potential positive impact on IP&C that was observed is the unit team’s regular engagement in  
41 shared breaks and evening meals in a staff lounge located on the unit (Observations, P1, 18).  
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47 During the photo walkabout with the physician, he explained that:  
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49 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).  
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51

52 This simple activity provides an environment where nurses are encouraged to interact and  
53 communicate with each other. It also has a potential impact on IP&C as it limits staff leaving the  
54 unit.  
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Culture is also reflected by the kinds of communication that occur within a team;  
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effective communication is important in order to obtain optimal patient outcomes.[34] During

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12 that is found posted underneath the room number. The card reads “barrière-box” isolation with  
13  
14 gloves and gowns symbols (Observations, P1, 19). A participant said that:

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17 ... with the isolation room you have this card so everybody who enters the room knows  
18 that this is happening and what you have to wear (PW housekeeping staff, P5, 95).

19  
20 As a support staff participant noted:

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23 ... it's too complex; there are too many different kinds of situations, so we always go to  
24 the nurse. [We ask] the nursing people in the hospital which things we have to do. And  
25 they tell us, we have to wear gloves, you have to put a mask on, or whatever ... (FG  
26 support staff, P10, 1199).

27  
28 In contrast, an example of ineffective communication was discussed by another  
29  
30 participant who stated that:

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33 There's not enough information to the staff about IP&C measures during a [patient]  
34 transport. They wear gowns and gloves when they're in the room but they don't tell the  
35 staff what to do during transport, so they're not informed (FG Management, P12, 121).

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38 Clear mechanisms to promote effective communication amongst staff therefore need to be in  
39  
40 place to minimize the likelihood of adverse events and to ultimately create and support a culture  
41  
42 of safety.[34]

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45 ***Participants who engaged in communal practice activities tended to monitor and support the***  
46  
47 ***use of recommended IP&C practices***

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49 In the field of ecological restoration [24-27] and in health systems research, [19,32]  
50  
51 engaged practice refers to the vigilance, attentiveness and awareness of one's practices and each  
52  
53 other's practices in order to reinforce and actively use what one learns to foster better treatment  
54  
55 of each other and the places we share. Within healthcare, the concept of communities of practice,  
56  
57 where groups of professionals work on initiatives to create, implement and evaluate evidence-  
58  
59 based care improvements, may be thought of as one key forum for engaged practice.  
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12 A key grass root Hygiene in Practice (HIP) group, which consists of nurse representatives  
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14 of every surgical unit and an ICP, oversees and implements several activities to promote the use  
15  
16 of good hygiene precautions in the hospital. During a follow-up discussion, key informants noted  
17  
18 that:  
19

20  
21 The HIP group is an initiative of the surgical units and the ICP. The ICP attends the  
22 meetings of the HIP group every month and together they make plans on activities and  
23 education. It has great value because of the cooperation (key informant #1). Local  
24 initiatives are stimulated by the working group. They learn to look at their working  
25 procedures through the eyes of an ICP (key informant #2).  
26  
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28 An example of a HIP initiative is the patient-specific storage box for wound care products  
29  
30 (Figure 2 Green storage box for patient (MGMT-41)):  
31

32  
33 This is a box in use. Personal wound products for the patient and they're stored in  
34 here...(PW management, P7, 1138). So every patient when they need a lot of bandage  
35 gets a...green box (PW management, P7, 704). I like this very much; material needed for  
36 one patient is stored in a closed box. The box can be disinfected. No cart is necessary in  
37 the room (FG management, written comments, P20, 16).  
38  
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40 This is an example of a simple yet vital HIP initiative to support IP&C practices.  
41

### 42 ***The use of knowledge about IP&C supported adaptive learning and growth***

43  
44 The theme of adaptive knowledge use refers to the development and translation of  
45 knowledge into lessons for individuals, teams, organizations and systems to drive sustainable  
46 change.[16,18,22,25,27,35] This adaptive knowledge is critically linked to the ongoing  
47 education, training and feedback that are necessary to encourage IP&C within healthcare.  
48  
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50 An example of adaptive learning and growth is the evidence-informed education  
51 provided by the grass roots HIP group that is built on current staff knowledge and experience,  
52 and is geared to address gaps in practice. All surgical wards have a nurse participating in this  
53 group. Many comments were received on the educational poster created by the HIP group  
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(Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:

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12 Clear, practical information and pictures, gives good information, better because of the  
13 photographs! (FG support staff, written comments, P13, 13).  
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15 Training and education on hand hygiene is provided to units upon request by the unit  
16 manager or the IP&C department. There were no hospital-wide hand hygiene programs or  
17 campaigns underway in the hospital during the study period. Monitoring of hand hygiene  
18 compliance was calculated based on product consumption and not on hand hygiene observations.  
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20 These comments brought forward by staff themselves are important to the development of  
21 sustainable solutions.  
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30 ***In the face of numerous system constraints, participants viewed engaged leadership as***  
31 ***important for IP&C***  
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34 The concept of engaged leadership as a critical form of IP&C governance emerged as a  
35 key study finding in a variety of ways. At the Netherlands hospital, the IP&C department,  
36 consisting of 1.32 FTEs per 250 beds, supports the overall IP&C activities of the hospital. The  
37 IP&C program reports to the Infection Control Committee who advises the Board of Directors on  
38 the IP&C policies. This committee meets every two months and discusses all IP&C-related  
39 issues. If necessary, the IP&C policies are reviewed and revised accordingly. The Infection  
40 Control Committee then reports the changes to the Board of Directors for endorsement. Twice a  
41 year a prevalence rate of nosocomial infections is calculated. These results are provided to the  
42 management teams of each specialty involved, and to the Board of Directors. Furthermore, the  
43 Board of Directors receives a copy of the annual report of the IP&C department (which includes  
44 all the work completed by the IP&C department in the last year and details such as any outbreaks  
45 that have occurred, etc.).  
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12 An example of a health system level policy in place at the Netherlands hospital is the  
13 central process used for bed cleaning to reduce the risk of bacteria survival on bed surfaces. A  
14 physician participant pointed out:  
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17  
18 ... a bed that's going off the unit to be cleaned... It's going to be washed... in this  
19 building; it's like a car wash ... (PW physician, P8, 272).  
20  
21

22 As another participant noted:  
23

24  
25 What a good system...beds are cleaned well at the central bed cleaning department (FG  
26 health professionals, written comments, P26, 08).  
27

28  
29 Also, a yearly report of the antibiotic usage by specialty is provided by pharmacy. The  
30 hospital also provides a booklet consisting of guidelines on antibiotic usage for physicians. The  
31 microbiologists act as consultants to all the physicians in the hospital. However, physicians are  
32 free to prescribe antibiotics at their discretion, which ultimately affects the efficacy of the  
33 process.  
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40 Another health system level policy supported by management is the 'search and destroy'  
41 active surveillance strategy for MRSA. The 'search and destroy' strategy for MRSA is a  
42 screening strategy that is aimed at high risk patients only, defined as patients who come from  
43 foreign countries or patients who have been in contact with pigs or cattle. These patients are  
44 screened on admission for carriage of MRSA (Dutch Working Party on Infection Prevention,  
45 2007). Patients are automatically placed on isolation precautions until the test results are  
46 available.  
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57 Overall, the hospital reports a prevalence count of patients identified with MRSA, VRE,  
58 CDI, and ESBL isolates per month. The hospital does not regularly calculate infection rates for  
59 these organisms. Thus, the estimated prevalence rates were calculated by using the proportion of  
60

cases or prevalence count of patients, over the total population at a given time. The prevalence rates are outlined in Table 1.

**Table 1: Hospital- and Community-Acquired MRSA, VRE, CDI and ESBL Prevalence Rates (per 1,000 patient days) (colonized and infected cases) (Jan-Dec 2008)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>MRSA</b>	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
<b>VRE</b>	5.0	0	0	0	0	0	0	0	0	1.7	0	0
<b>CDI</b>	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
<b>ESBL</b>	25	9.76	16.9	18.2	21.2	16.6	22.6	32.9	23.4	42.7	28.4	33.3

## DISCUSSION

The findings indicate that there are considerable IP&C challenges inherent to the complexity of the hospital environment. Staff employed a wide variety of workarounds or used temporary fixes to adapt to these challenges, and organizational and team cultures were integral to the way that practices were enacted within the workplace. Staff who engaged in the unit's practice activities tended to monitor and support the use of recommended practices, and there were several exemplars of using knowledge about IP&C to support adaptive learning and growth. In the face of numerous system constraints, participants viewed engaged leadership as important for IP&C.

Findings in the study support the search and destroy strategy for MRSA well documented in the literature [36-38] as one of the major bridges or facilitators to IP&C. In the case study, the monthly MRSA prevalence rate for 2008 ranged from 0-0.67% which is consistent with the rate of less than 1% [29] published in the literature. The control measures in the search and destroy strategy included preemptive isolation of patients, repeated screening of staff for MRSA,

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12 environmental cleaning. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The  
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14 CDI prevalence rate ranged from 0-0.8% and the monthly ESBL prevalence rate was somewhat  
15  
16 higher, 0.98%-4.27%. Although MRSA, VRE and CDI rates may be below 1%, other pathogens  
17  
18 such as ESBL may not appear to be as controlled. A comprehensive IP&C program for all  
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20 MDRO should focus on the control of many pathogens simultaneously, including those  
21  
22 pathogens that have not yet been identified.  
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26 Another factor that can have an impact on the rate of MDRO is the occupancy rate which  
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28 was reported as approximately 80%. Studies have shown that lower occupancy rates are linked to  
29  
30 lower infection rates (National Audit Office, 2004). In a study in Northern Ireland, the bed  
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32 occupancy rate was found to have a significant positive correlation with MRSA rates in  
33  
34 hospitals.[39] Also, another study by Borg [40] found a significant correlation between the bed  
35  
36 occupancy rate and the MRSA infection rates. Similarly, Borg and colleagues [41] concluded  
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38 that periods of high occupancy levels were associated with higher MRSA incidence rates. In  
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40 another study by the Department of Health in the UK,[42] concluded that hospitals with higher  
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42 than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with  
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44 occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public  
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46 Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good  
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48 control of infections”. [43, p.1401] Thus, the results of our case study support the notion that the  
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50 bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the  
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52 prevalence of MDRO infections.  
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60 Another bridge to IP&C is the support provided by management for the Hygiene in  
Practice (HIP) group. This grassroots group incorporates sound IP&C practices into the  
workplace. The group also provides support amongst individuals to value IP&C in the



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12 workplace, thus fostering the organizational and team culture of safety by promoting group  
13 norms in favor of good practice. Furthermore, the group promotes adaptive learning and growth  
14 by developing and translating knowledge to minimize poor IP&C practices. According to a study  
15 by the Plexus Institute (2009), healthcare workers who take ownership of the IP&C issues on a  
16 unit can significantly improve MDRO rates. While we are well aware of the benefits of the  
17 support from IP&C experts, it is worth exploring which kind of community of practice (e.g. unit-  
18 based practitioner-led or IP&C-led) have a greater influence on IP&C practices.

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29 Another support for IP&C in the study site that bears further scrutiny is the high level of  
30 environmental cleaning. This includes the central bed washing system which consists of the  
31 thorough washing of all hospital beds after patient discharge. According to the Dutch Working  
32 Party on Infection Prevention Bed and Accessories guidelines (2007), “machine cleaning is  
33 preferred to manual cleaning” because of the consistency in the cleaning procedure, the high  
34 temperatures for washing and rinsing, the heavy work of manually washing a bed and the better  
35 tracking mechanism of clean beds throughout the hospital. It would be worthwhile to study the  
36 costs and benefits of this practice at the study site and in other contexts in further detail.

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Despite the number of recommended practices in place, some barriers to sound IP&C practices were also evident. For instance, specific environmental design challenges promoted problematic workarounds, which are often developed by staff to adapt to the limitations of their care environments.[44] As Amalberti and colleagues [33] argue, practitioners naturally migrate to the boundaries of and even violate acceptable practices as they attempt to adapt to conflicting work demands in complex health care systems. For example, practitioners, are less likely to clean their hands if they do not have proper access to soap and water or an ABR, [45,46] and it is recommended that dispensers should be placed in many convenient and accessible locations

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12 for staff.[47-49] Furthermore, according to the WHO Guidelines on Hand Hygiene in Health  
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14 Care (2009), the ABHR dispensers should be located in the patient rooms at point of care.  
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16 However, on the study unit, the ABHR dispensers were only located outside the patient rooms.  
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19 Other environmental design issues that pose barriers to IP&C were also observable, such  
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21 as garbage bins that require handling to open. It is likely that similar design issues abound in  
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23 most acute care hospitals. Rathert and colleagues [50] recommend that organizations examine  
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25 how the implementation of policies and procedures influence the work and work environment of  
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27 nurses in order to avoid unfavourable workarounds. It is a tribute to the empowerment and  
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29 ingenuity of the staff that they innovate workarounds to try to deal with these systemic barriers  
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31 and support effective control of MDRO.  
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35 Another deficit at the study site was the calculation of unit-based consumption of ABHR  
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37 to monitor adherence to hand hygiene practices. There are no recommendations on how to  
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39 monitor compliance of hand hygiene in the Dutch guideline of hand hygiene for staff (Dutch  
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41 Working Party on Infection Prevention, 2007). However, the recommended method to monitor  
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43 hand hygiene compliance, according to the WHO Guidelines on Hand Hygiene in Health Care, is  
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45 by direct observations. Product consumption monitoring cannot determine if hand hygiene is  
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47 performed correctly and at appropriate times. It may also not properly reflect the overall product  
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49 consumption by healthcare providers, as it may also include the amount of product used by  
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51 visitors and/or patients (World Health Organization, 2009).  
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56 Furthermore, although a report of the antibiotic usage by physician is provided by the  
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58 pharmacy department on an annual basis, physicians are permitted to prescribe antibiotics at their  
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60 discretion. This may limit the efficacy of the process. More stringent guidelines on the  
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12 restrictive use of antibiotics are needed as there is a trend for hospital pathogens to become more  
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14 resistant in the future.[51]

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17 There were several limitations to this study. It is possible, for instance, that staff may  
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19 have altered their behavior from normal practices during unit observations. Furthermore, the  
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21 prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage and  
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23 antibiotic data were collected by hospital personnel not supervised by the researcher, limiting the  
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25 ability to assess the rigor of data collection. In addition, the focus of this study was on a specific  
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27 clinical unit of the hospital. These limitations were addressed by incorporating multiple methods  
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29 of data collection and by taking a broad socio-ecological system approach to study IP&C on the  
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31 unit. However, if feasible, it would be preferable in future case studies to collect all data across  
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33 sites through one researcher and study entire organizations or perhaps even regions to obtain a  
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35 more comprehensive picture of some aspects of the complex phenomena of IP&C.  
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## 40 CONCLUSION

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43 This case study provided in-depth knowledge of the socio-ecological conditions present  
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45 on a surgical unit at a Netherlands hospital that reported rates of MDRO below 1%. These  
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47 findings suggest there is merit in further exploring the potential benefits of such health system  
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49 practices for optimal prevention and control of MDRO in modern hospital environments. Further  
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51 research on the benefits of practitioner-led community of practices on IP&C practices such as the  
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53 Hygiene in Practice group is also recommended. Additional case studies to compare these  
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55 practices to other acute care hospitals in a variety of countries would be a valuable way to better  
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57 understand what IP&C programs are most effective in which contexts, and for what reasons.  
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Furthermore, findings from this research can inform current and future efforts to provide

infection prevention and control programs and strategies that are socio-ecologically sound. The

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12 findings also support that current initiatives underway to promote system-wide improvements in  
13 infection prevention and control should engage local practitioners in designing and implementing  
14 interventions that can be adapted to their specific clinical environment. Finally, this research  
15 suggests that qualitative research can reveal embedded and taken-for-granted daily and ritualized  
16 social practices that contribute to infection prevention and control.  
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**Appendix 1: Core elements of a proposed socio-ecological framework for studying IP&C**  
(Table reprinted from Backman et al. [52])

Core Elements	Definitions
Citizen science	The notion of citizen science refers to individuals working collaboratively with communities, governing bodies and others to conduct research and generate evidence.[14,18,19]. This includes using a participatory and collaborative approach to the design, conduct and analysis of IP&C research, involving members of the community in data collection and data analysis wherever feasible and appropriate and seeking multiple sources of data (including sources of indigenous or local knowledge) and using a variety of methods to develop integrative knowledge about local places as well as the larger system.[16,19-21]
Place ethic	According to Lawrence Buell [53] and Higgs,[26,27] a place ethic is shown in the ways that individuals treat and support each other and the places they share. Place ethic refers to the importance of fostering a deep understanding of and respect for the history, culture, knowledge and rituals of communities. In this research, thinking about place ethic includes inquiring about what people see as important in the care of each other and their environment, how they reinforce and support each other to value IP&C, and whether respect for historical knowledge informs how a place functions over time.
Engaged practice	The concept of engaged practice refers to the creation, implementation and evaluation of sound practices that are evidence-informed.[18,24-27] This includes self monitoring and adjustment of daily IP&C practices (e.g.: audits, equipment checks), using local feedback processes to continually improve workflow, work design, and processes at the individual, team, and healthcare community levels.
Adaptive learning and growth	The idea of adaptive learning and growth refers to the development and use of knowledge translation strategies that disseminate learnings across individuals, teams, organizations and system levels to drive sustainable changes.[16,18,22,25,27,35] This includes evidenced-informed management of MDRO, screening policies, resource allocation decisions about patient care staffing, housekeeping, availability of equipment and supplies, staff and public education policies and funding.

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## Barriers and Bridges to Infection Prevention and Control: Results of a Qualitative Case Study of a Netherlands' Surgical Unit

### INTRODUCTION

**Infection prevention and control (IP&C)** in the acute care environment is one of the most important issues in modern healthcare. Healthcare-associated infections (HAI) are not only a potential burden on patients in terms of increased morbidity and length of stay but also an economic burden on the healthcare system.[1-3] However, although the importance of **IP&C** is well recognized and numerous research studies and best practice guidelines have been published on this topic, infection rates of multidrug-resistant organisms (MDRO) are on the rise in Canada and in the United States,[4] and IP&C remains a challenge. In contrast to the North American situation, the “control of MRSA infections [one of the MDRO] is reported to be optimal in the Scandinavian countries [and also in the Netherlands], where strict barrier precautions are in place along with active surveillance culture (ASC) programs”. [5, p.236] Some European countries such as the Netherlands have been recognized as world leaders at minimizing MDRO infection rates, in particular MRSA.[6] Yet, strong evidence on the most effective approaches for achieving good adherence to the simplest measures, such as hand hygiene, remains elusive, and further knowledge of what drives individuals, organizations and health systems towards sustainable IP&C practices does not yet exist in the research literature.[7] To develop a better understanding of what may be shaping the prevention of MRSA and other MDRO, a case study was conducted in April 2008 on a surgical unit at a Netherlands hospital that reported a successful reduction in the prevalence of targeted MDRO. In this paper, we discuss the key findings of the Netherlands hospital case study and offer recommendations for policy, practice and future research.



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3 The objectives of the research were:  
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- 5  
6 1. To observe the overall work environment including IP&C practices on the target surgical  
7  
8 unit;  
9  
10 2. To **critically review** the policies and procedures aimed at the prevention and minimization of  
11  
12 MDRO in the hospital and unit environments;  
13  
14 3. To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of  
15  
16 their unit environment; and  
17  
18 4. To collect monthly specific IP&C related anonymized data on the target surgical unit and in  
19  
20 the facility overall for a duration of 12 months, and the prevalence rates of methicillin-  
21  
22 resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE),  
23  
24 resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE),  
25  
26 extended spectrum beta-lactamases (ESBLs) and *Clostridium difficile* infections (CDI).  
27  
28

## 29 **METHODS**

30  
31 The need for more theoretically driven research in IP&C in order to strengthen the rigor  
32  
33 and usefulness of evidence for IP&C has been recognized in the literature.[7-12] One promising  
34  
35 theoretical line of inquiry is supported by Struelens'[8] recommendation to take a broad socio-  
36  
37 ecological approach to the study and management of IP&C. This socio-ecological perspective is  
38  
39 well supported by others including Ali,[9] Gloubeman,[10] Macdonald,[11] and Waldvogel,[12]  
40  
41 who all argue that a host of inter-related social and environmental factors play a critical role in  
42  
43 the emergence and trajectory of infectious diseases in 21<sup>st</sup> century societies and their health  
44  
45 systems.  
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50  
51 In this study, a socio-ecological approach on health systems informed this research  
52  
53 design and provided a framework to better understand the complexity of implementing effective  
54  
55 IP&C. A socio-ecological perspective provides “a framework for understanding the diverse  
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3 personal and environmental factors and the interrelationships among these factors”,[13, p.45]  
4  
5 enabling us to more accurately interpret and manage whole systems change.[14,15] In socio-  
6  
7 ecological terms, the term whole systems may be conceptualized as nested cycles of system  
8  
9 development, degradation, or restoration.[14,16-18]  
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11

12  
13 A whole systems’ perspective on IP&C is compatible with the participatory methods of  
14  
15 citizen science that engage communities in collectively studying and assessing the socio-  
16  
17 ecological conditions of their environments in order to collaboratively design and implement  
18  
19 useful, sustainable repairs.[14,18,19] For the purposes of this study, citizen science is  
20  
21 conceptualized as a collaborative process between researchers and participants where members  
22  
23 of the community are involved in data collection and data analysis to conduct research and  
24  
25 generate evidence.[16,19-21] This research approach draws on related work in the fields of  
26  
27 ecosystems management and research,[22] economics,[23] restoration management,[24-27] and  
28  
29 health systems.[18,19] It involves seeking multiple sources of data and using a variety of  
30  
31 methods to develop integrative knowledge about local places as well as the overall system as a  
32  
33 whole.[14,18,21,28]  
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38  
39 Using a socio-ecological perspective and the concept of citizen science as theoretical  
40  
41 guideposts, core elements of a proposed socio-ecological framework for studying IP&C were  
42  
43 defined,[8,12,15,18] and used to inform the research design and conduct of the study (Appendix  
44  
45 1). The framework informed but did not constrain the collection and analysis of the data.  
46  
47

## 48 **Setting**

49  
50 The hospital is a 1042-bed tertiary care major teaching and referral center in The  
51  
52 Netherlands providing general and specialized services for the population of its city and the  
53  
54 surrounding area. In 2008, the hospital had approximately 31,420 admissions, 22,564 emergency  
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3 room visits and over 336,000 outpatient visits. The patient average length of stay was 7.7 days.  
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5 The hospital occupancy rate was about 80% at any given time. There were 10,668 employees in  
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7 2008 including 2,560 nurses. This hospital was chosen because it reported less than 1% MDRO  
8  
9 prevalence rates.[29] The case study was conducted on a 34-bed unit, with 6 (18%) single-bed  
10  
11 rooms, comprising mainly of orthopedic, cosmetic, urology and general surgery patients. **Ethical**  
12  
13 **approval was obtained through the University of Alberta Health Ethics Review Board and**  
14  
15 **the study hospital's Medical Ethics Review Committee.**  
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### 22 **Data Collection and Analysis**

23  
24 Data were collected and analyzed from multiple sources to gain an in-depth  
25  
26 understanding of the case [30,31] from a socio-ecological perspective on health systems. The  
27  
28 photographic research methods used, which were adapted from previous work in ecological  
29  
30 restoration [27] and health systems research [19,32] consisted of practitioner-led audio-taped  
31  
32 photo walkabouts with photo narration and communal photo elicitation forums. Participant  
33  
34 guided ecological tours of the hospital helped to foster community participation, local expertise  
35  
36 and indigenous ecological knowledge that practitioners have about the places where they work.  
37  
38 Unit observation sessions (n=3) were also performed by one of the authors (CB) and field notes  
39  
40 were recorded on the work environment of the unit to gain an initial perspective of the overall  
41  
42 environment and IP&C practices. **Nursing, medical, housekeeping and other hospital**  
43  
44 **personnel on the unit were informed that the study was taking place and that the**  
45  
46 **observations collected would be shared with them, and with the hospital in aggregate form**  
47  
48 **only. The first author made it clear that the specific findings would not be linked to any**  
49  
50 **individuals.** In addition, policies and procedures relevant to IP&C practices (n=11) were  
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3 collected in order to gain a better understanding of the existing practices. Aggregated,  
4  
5 anonymized IP&C related data were collected including monthly prevalence rates for MRSA,  
6  
7 VRE, CDI and ESBL (January-December 2008).  
8  
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10  
11 Five practitioner-led photo walkabouts and photo narrations (n=7 participants) of their  
12  
13 perceived concerns and strengths on their unit in relation to **IP&C** were conducted. The  
14  
15 individuals who participated in separate photo walkabouts included the infection control  
16  
17 professional (ICP), a unit leader and unit manager, a senior nurse, a physician, and two members  
18  
19 of the housekeeping staff (n=7). A total of 194 photographs were taken. Following the  
20  
21 walkabouts, three separate photo elicitation focus groups (n= 13 participants) were conducted to  
22  
23 review and discuss the images and narratives collected during the walkabout. The three groups  
24  
25 were management, health professionals and clinical support staff. The participants were asked to  
26  
27 provide written comments on each photograph and then each group discussed each picture as a  
28  
29 whole. Informed consent was obtained from all the participants in the photo walkabouts and  
30  
31 focus group sessions. Field notes were recorded after each photo walkabout and each photo  
32  
33 elicitation session to note researcher perceptions about the environment at these times of data  
34  
35 collection as well as participant dynamics during data collection.  
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40  
41 An iterative data analysis process was conducted to inform data collection and analysis  
42  
43 throughout successive phases of the research. Atlas.ti version 5.3 software (ATLAS.ti Scientific  
44  
45 Software Development GmbH, Berlin) was used to support the management and analysis of the  
46  
47 written and visual data. **The qualitative data was coded into thematic categories. These  
48  
49 categories were compared and contrasted in relation to the patterns identified that relate to  
50  
51 IP&C. As coding, comparing, and contrasting within the qualitative data progressed in  
52  
53 iterative cycles of data collection and data analysis, potential links between various  
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3 **groupings of coded visual and textual data, related emerging theory and research literature**  
4 **were identified and discussed within the research team. Our analysis was sensitive to the**  
5 **policies and procedures, prevalence rates, and other hospital documents that helped**  
6 **contextualize these specific findings.**  
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12 The rigor of this study was supported by several measures. Observer bias was minimized  
13 by using multiple methods to gather and verify evidence on the policies, practices and  
14 surveillance data on IP&C at the study site. Each photo walkabout and focus group session was  
15 audio-taped, transcribed, and then verified to ensure accuracy. Follow-up with local experts  
16 including some participants, the manager of **IP&C** and a physician lead in infectious diseases,  
17 was also executed to ensure accuracy of the data collected. Furthermore, the observation field  
18 notes, photo walkabout and focus group findings were compared with findings from the other  
19 data sources of organizational policies, prevalence rates, and other relevant data (such as bed  
20 occupancy rates) as the iterative data analysis progressed. In addition, a researcher's journal was  
21 kept to capture reflections on all the research related activities.  
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## 36 RESULTS

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38 In the course of the analysis of the case study, six major themes were derived from the  
39 iterative analysis. Each theme is illustrated with select findings below.  
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### 43 *Considerable IP&C challenges were inherent to the design of the clinical unit*

44  
45 The environmental design consists of both workplace and work design. Workplace design  
46 refers to the design of the work environment, the physical space, and the accessibility of  
47 equipment; the work design is how the staff organizes their work, including the routines and the  
48 workflow on the unit. Both are central to understanding human factors, which is “the scientific  
49 discipline concerned with the understanding of interactions among humans and other elements of  
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3 a system, and the profession that applies theory, principles, data and methods to design in order  
4  
5 to optimize human well-being and overall system performance” (International Ergonomic  
6  
7 Association, website).  
8  
9

10 An example of the workplace design is the presence of a sink for staff use at the entrance  
11  
12 of each room (Figure 1 Hand Hygiene station outside of patient room (MGMT-2)).  
13

14 A wall mounted soap dispenser, paper towels, a garbage container with lid, a wall  
15  
16 mounted alcohol-based hand rub (ABHR) dispenser, and gloves in various sizes are present. The  
17  
18 ABHR dispensers can only be found mounted on the wall near the sinks outside the patient  
19  
20 rooms, in the dirty utility room and the medication room. There are no additional ABHR  
21  
22 dispensers on the unit (Observations, P1, 26).  
23  
24  
25

26 Another example of workplace design is the garbage cans. One participant described his  
27  
28 concerns about the garbage bins with lids:  
29  
30

31 Here, you washed your hands and you throw away the paper towel and you have to touch  
32  
33 the lid of the dirty waste box again and in fact you have dirty hands again. Afterwards,  
34  
35 you should use the ABHR. You shouldn't have to touch anything (FG management, P12,  
36  
37 446).  
38

39 This participant clearly recognized that hands can potentially become contaminated when  
40  
41 opening or closing waste baskets. Overall, the environmental design of the unit provides  
42  
43 challenges to proper IP&C practices thus leading to many workarounds.  
44

45 ***Nurses and other staff employed a wide variety of workarounds to try to adapt to the design of***  
46  
47 ***their care environment***  
48

49 Workarounds are defined by Amalberti and colleagues [33] as the “adaptation of  
50  
51 procedures by workers to deal with the demands of the work” (p. i67). These procedures are  
52  
53 often adapted to bypass or avoid a problematic feature of the system that jeopardizes people's  
54  
55 chance of completing their work safely within optimal timeframes and resources. Amalberti's  
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3 theory on workarounds relates to how people naturally migrate to the boundaries of what are  
4 considered acceptable practices and sometimes violate those boundaries in order to adapt to  
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8 system features that constrain their ability to accomplish their work. According to Amalberti,  
9  
10  
11 workarounds are an inevitable feature of complex systems, and what we need to do is figure out  
12  
13 how to facilitate the safest possible adaptations within the context of individual practice and  
14  
15 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the  
16  
17 boundaries and workarounds that constitute problematic violations of safety principles.  
18  
19

20 An example of a workaround is the lack of ABHR present at the point of care, requiring  
21  
22 staff members to go out of the room to clean their hands. During the photo walkabout with a  
23  
24 physician participant, the issue of hand hygiene compliance was discussed in relation to non-  
25  
26 single patient rooms:  
27  
28

29 The only problem [is] that they have to wash their hands every, every time they care for a  
30  
31 patient and then go to another. That maybe... that's a risk [of] having more patients in a  
32  
33 room. If you have one patient in a room then you go out and you wash your hands. If you  
34  
35 have four patients in a room, you go to one patient then to the other... (PW physician, P8,  
36  
37 78).

38 During the photo walkabout with the ICP, the participant explained the workflow of staff when  
39  
40 they enter a single patient room as follows:

41 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR  
42  
43 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other  
44  
45 things and disinfect your hands again with ABHR. So in fact there should be ABHR at  
46  
47 this place ... (PW ICP, P6, 383).

48 In these situations, due to system constraints, staff members are required to leave the room to  
49  
50 clean their hands between patients, in order to avoid the kind of safety violation that Amalberti  
51  
52 and colleagues [33] discuss.  
53

54 ***Participants viewed organizational and team cultures as integral to the way they enact IP&C***  
55  
56 ***practices in their workplaces***  
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3 In the first set of national interdisciplinary safety competencies established for Canada,  
4 Frank et al. [34] contend that the notion of a culture of patient safety is associated with  
5 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient  
6 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C  
7 became evident in the course of the research. For example, during the photo walkabout with a  
8 participating physician and ICP, they explained that there is a change room on the unit where  
9 staff can:

10  
11  
12 ... put on, [and] take off their own clothes and put on their hospital [uniform] before they  
13 start working (PW physician and ICP, P8, 456).

14  
15 During a follow-up interview, a key informant said:

16  
17 Only a few staff members (<5%) wear their uniform outside the hospital. It’s a rare  
18 occurrence. Most nurses change uniforms in the hospital (key informant).

19  
20 This routine and highly consistent separation of work and street clothing is a notable example of  
21 a shared practice that supports effective IP & C within the group. Another shared practice with  
22 potential positive impact on **IP&C** that was observed is the unit team’s regular engagement in  
23 shared breaks and evening meals in a staff lounge located on the unit (Observations, P1, 18).

24  
25 During the photo walkabout with the physician, he explained that:

26  
27 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).

28  
29 This simple activity provides an environment where nurses are encouraged to interact and  
30 communicate with each other. It also has a potential impact on **IP&C** as it limits staff leaving the  
31 unit.

32  
33 Culture is also reflected by the kinds of communication that occur within a team;  
34 effective communication is important in order to obtain optimal patient outcomes.[34] During  
35 observations, a visible clear communication strategy that was identified was the isolation card  
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3 that is found posted underneath the room number. The card reads “barrière-box” isolation with  
4  
5 gloves and gowns symbols (Observations, P1, 19). A participant said that:  
6  
7

8 ... with the isolation room you have this card so everybody who enters the room knows  
9 that this is happening and what you have to wear (PW housekeeping staff, P5, 95).  
10

11 As a support staff participant noted:  
12

13  
14 ... it’s too complex; there are too many different kinds of situations, so we always go to  
15 the nurse. [We ask] the nursing people in the hospital which things we have to do. And  
16 they tell us, we have to wear gloves, you have to put a mask on, or whatever ... (FG  
17 support staff, P10, 1199).  
18  
19

20 In contrast, an example of ineffective communication was discussed by another  
21 participant who stated that:  
22  
23

24 There’s not enough information to the staff about IP&C measures during a [patient]  
25 transport. They wear gowns and gloves when they’re in the room but they don’t tell the  
26 staff what to do during transport, so they’re not informed (FG Management, P12, 121).  
27  
28

29 Clear mechanisms to promote effective communication amongst staff therefore need to be in  
30 place to minimize the likelihood of adverse events and to ultimately create and support a culture  
31 of safety.[34]  
32  
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35  
36 ***Participants who engaged in communal practice activities tended to monitor and support the***  
37  
38 ***use of recommended IP&C practices***  
39

40 In the field of ecological restoration [24-27] and in health systems research, [19,32]  
41 engaged practice refers to the vigilance, attentiveness and awareness of one’s practices and each  
42 other’s practices in order to reinforce and actively use what one learns to foster better treatment  
43 of each other and the places we share. Within healthcare, the concept of communities of practice,  
44 where groups of professionals work on initiatives to create, implement and evaluate evidence-  
45 based care improvements, may be thought of as one key forum for engaged practice.  
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3 A key grass root Hygiene in Practice (HIP) group, which consists of nurse representatives  
4 of every surgical unit and an ICP, oversees and implements several activities to promote the use  
5  
6 of good hygiene precautions in the hospital. During a follow-up discussion, key informants noted  
7  
8 that:  
9  
10

11  
12 The HIP group is an initiative of the surgical units and the ICP. The ICP attends the  
13 meetings of the HIP group every month and together they make plans on activities and  
14 education. It has great value because of the cooperation (key informant #1). Local  
15 initiatives are stimulated by the working group. They learn to look at their working  
16 procedures through the eyes of an ICP (key informant #2).  
17  
18

19  
20 An example of a HIP initiative is the patient-specific storage box for wound care products  
21  
22 (Figure 2 Green storage box for patient (MGMT-41)):  
23

24  
25 This is a box in use. Personal wound products for the patient and they're stored in  
26 here...(PW management, P7, 1138). So every patient when they need a lot of bandage  
27 gets a...green box (PW management, P7, 704). I like this very much; material needed for  
28 one patient is stored in a closed box. The box can be disinfected. No cart is necessary in  
29 the room (FG management, written comments, P20, 16).  
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32 This is an example of a simple yet vital HIP initiative to support IP&C practices.  
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### 34 ***The use of knowledge about IP&C supported adaptive learning and growth***

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36 The theme of adaptive knowledge use refers to the development and translation of  
37 knowledge into lessons for individuals, teams, organizations and systems to drive sustainable  
38 change.[16,18,22,25,27,35] This adaptive knowledge is critically linked to the ongoing  
39 education, training and feedback that are necessary to encourage IP&C within healthcare.  
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43 An example of adaptive learning and growth is the evidence-informed education  
44 provided by the grass roots HIP group that is built on current staff knowledge and experience,  
45 and is geared to address gaps in practice. All surgical wards have a nurse participating in this  
46 group. Many comments were received on the educational poster created by the HIP group  
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48 (Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:  
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3 Clear, practical information and pictures, gives good information, better because of the  
4 photographs! (FG support staff, written comments, P13, 13).  
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7 Training and education on hand hygiene is provided to units upon request by the unit  
8 manager or the **IP&C** department. There were no hospital-wide hand hygiene programs or  
9 campaigns underway in the hospital during the study period. Monitoring of hand hygiene  
10 compliance was calculated based on product consumption and not on hand hygiene observations.  
11 These comments brought forward by staff themselves are important to the development of  
12 sustainable solutions.  
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21 ***In the face of numerous system constraints, participants viewed engaged leadership as***  
22 ***important for IP&C***  
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26 The concept of engaged leadership as a critical form of IP&C governance emerged as a  
27 key study finding in a variety of ways. At the Netherlands hospital, the **IP&C** department,  
28 consisting of 1.32 FTEs per 250 beds, supports the overall IP&C activities of the hospital. The  
29 IP&C program reports to the Infection Control Committee who advises the Board of Directors on  
30 the **IP&C** policies. This committee meets every two months and discusses all **IP&C**-related  
31 issues. If necessary, the IP&C policies are reviewed and revised accordingly. The Infection  
32 Control Committee then reports the changes to the Board of Directors for endorsement. Twice a  
33 year a prevalence rate of nosocomial infections is calculated. These results are provided to the  
34 management teams of each specialty involved, and to the Board of Directors. Furthermore, the  
35 Board of Directors receives a copy of the annual report of the IP&C department (which includes  
36 all the work completed by the IP&C department in the last year and details such as any outbreaks  
37 that have occurred, etc.).  
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3 An example of a health system level policy in place at the Netherlands hospital is the  
4 central process used for bed cleaning to reduce the risk of bacteria survival on bed surfaces. A  
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8 physician participant pointed out:  
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10 ... a bed that's going off the unit to be cleaned... It's going to be washed... in this  
11 building; it's like a car wash ... (PW physician, P8, 272).  
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14 As another participant noted:  
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16 What a good system...beds are cleaned well at the central bed cleaning department (FG  
17 health professionals, written comments, P26, 08).  
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20 Also, a yearly report of the antibiotic usage by specialty is provided by pharmacy. The  
21 hospital also provides a booklet consisting of guidelines on antibiotic usage for physicians. The  
22 microbiologists act as consultants to all the physicians in the hospital. However, physicians are  
23 free to prescribe antibiotics at their discretion, which ultimately affects the efficacy of the  
24 process.  
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31 Another health system level policy supported by management is the 'search and destroy'  
32 active surveillance strategy for MRSA. The 'search and destroy' strategy for MRSA is a  
33 screening strategy that is aimed at high risk patients only, defined as patients who come from  
34 foreign countries or patients who have been in contact with pigs or cattle. These patients are  
35 screened on admission for carriage of MRSA (Dutch Working Party on Infection Prevention,  
36 2007). Patients are automatically placed on isolation precautions until the test results are  
37 available.  
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48 Overall, the hospital reports a prevalence count of patients identified with MRSA, VRE,  
49 CDI, and ESBL isolates per month. The hospital does not regularly calculate infection rates for  
50 these organisms. Thus, the estimated prevalence rates were calculated by using the proportion of  
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cases or prevalence count of patients, over the total population at a given time. The prevalence rates are outlined in Table 1.

**Table 1: Hospital- and Community-Acquired MRSA, VRE, CDI and ESBL Prevalence Rates (per 1,000 patient days) (colonized and infected cases) (Jan-Dec 2008)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>MRSA</b>	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
<b>VRE</b>	5.0	0	0	0	0	0	0	0	0	1.7	0	0
<b>CDI</b>	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
<b>ESBL</b>	25	9.76	16.9	18.2	21.2	16.6	22.6	32.9	23.4	42.7	28.4	33.3

## DISCUSSION

The findings indicate that there are considerable IP&C challenges inherent to the complexity of the hospital environment. Staff employed a wide variety of workarounds or used temporary fixes to adapt to these challenges, and organizational and team cultures were integral to the way that practices were enacted within the workplace. Staff who engaged in the unit's practice activities tended to monitor and support the use of recommended practices, and there were several exemplars of using knowledge about IP&C to support adaptive learning and growth. In the face of numerous system constraints, participants viewed engaged leadership as important for IP&C.

Findings in the study support the search and destroy strategy for MRSA well documented in the literature [36-38] as one of the major bridges or facilitators to IP&C. In the case study, the monthly MRSA prevalence rate for 2008 ranged from 0-0.67% which is consistent with the rate of less than 1% [29] published in the literature. The control measures in the search and destroy strategy included preemptive isolation of patients, repeated screening of staff for MRSA, repeated attempts at decolonization of MRSA positive patients and staff and high levels of

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3 environmental cleaning. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The  
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5 CDI prevalence rate ranged from 0-0.8% and the monthly ESBL prevalence rate was somewhat  
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7 higher, 0.98%-4.27%. Although MRSA, VRE and CDI rates may be below 1%, other pathogens  
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9 such as ESBL may not appear to be as controlled. A comprehensive **IP&C** program for all  
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11 MDRO should focus on the control of many pathogens simultaneously, including those  
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13 pathogens that have not yet been identified.  
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18 Another factor that can have an impact on the rate of MDRO is the occupancy rate which  
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20 was reported as approximately 80%. Studies have shown that lower occupancy rates are linked to  
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22 lower infection rates (National Audit Office, 2004). In a study in Northern Ireland, the bed  
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24 occupancy rate was found to have a significant positive correlation with MRSA rates in  
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26 hospitals.[39] Also, another study by Borg [40] found a significant correlation between the bed  
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28 occupancy rate and the MRSA infection rates. Similarly, Borg and colleagues [41] concluded  
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30 that periods of high occupancy levels were associated with higher MRSA incidence rates. In  
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32 another study by the Department of Health in the UK,[42] concluded that hospitals with higher  
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34 than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with  
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36 occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public  
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38 Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good  
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40 control of infections”. [43, p.1401] Thus, the results of our case study support the notion that the  
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42 bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the  
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44 prevalence of MDRO infections.  
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51 Another bridge to IP&C is the support provided by management for the Hygiene in  
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53 Practice (HIP) group. This grassroots group incorporates sound IP&C practices into the  
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55 workplace. The group also provides support amongst individuals to value IP&C in the  
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3 workplace, thus fostering the organizational and team culture of safety by promoting group  
4 norms in favor of good practice. Furthermore, the group promotes adaptive learning and growth  
5 by developing and translating knowledge to minimize poor IP&C practices. According to a study  
6 by the Plexus Institute (2009), healthcare workers who take ownership of the **IP&C** issues on a  
7 unit can significantly improve MDRO rates. While we are well aware of the benefits of the  
8 support from IP&C experts, it is worth exploring which kind of community of practice (e.g. unit-  
9 based practitioner-led or IP&C-led) have a greater influence on IP&C practices.

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20 Another support for IP&C in the study site that bears further scrutiny is the high level of  
21 environmental cleaning. This includes the central bed washing system which consists of the  
22 thorough washing of all hospital beds after patient discharge. According to the Dutch Working  
23 Party on Infection Prevention Bed and Accessories guidelines (2007), “machine cleaning is  
24 preferred to manual cleaning” because of the consistency in the cleaning procedure, the high  
25 temperatures for washing and rinsing, the heavy work of manually washing a bed and the better  
26 tracking mechanism of clean beds throughout the hospital. It would be worthwhile to study the  
27 costs and benefits of this practice at the study site and in other contexts in further detail.

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39 Despite the number of recommended practices in place, some barriers to sound IP&C  
40 practices were also evident. For instance, specific environmental design challenges promoted  
41 problematic workarounds, which are often developed by staff to adapt to the limitations of their  
42 care environments.[44] As Amalberti and colleagues [33] argue, practitioners naturally migrate  
43 to the boundaries of and even violate acceptable practices as they attempt to adapt to conflicting  
44 work demands in complex health care systems. For example, practitioners, are less likely to  
45 clean their hands if they do not have proper access to soap and water or an ABHR, [45,46] and it  
46 is recommended that dispensers should be placed in many convenient and accessible locations  
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3 for staff.[47-49] Furthermore, according to the WHO Guidelines on Hand Hygiene in Health  
4 Care (2009), the ABHR dispensers should be located in the patient rooms at point of care.  
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8 However, on the study unit, the ABHR dispensers were only located outside the patient rooms.  
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11 Other environmental design issues that pose barriers to IP&C were also observable, such  
12 as garbage bins that require handling to open. It is likely that similar design issues abound in  
13 most acute care hospitals. Rathert and colleagues [50] recommend that organizations examine  
14 how the implementation of policies and procedures influence the work and work environment of  
15 nurses in order to avoid unfavourable workarounds. It is a tribute to the empowerment and  
16 ingenuity of the staff that they innovate workarounds to try to deal with these systemic barriers  
17 and support effective control of MDRO.  
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28 Another deficit at the study site was the calculation of unit-based consumption of ABHR  
29 to monitor adherence to hand hygiene practices. There are no recommendations on how to  
30 monitor compliance of hand hygiene in the Dutch guideline of hand hygiene for staff (Dutch  
31 Working Party on Infection Prevention, 2007). However, the recommended method to monitor  
32 hand hygiene compliance, according to the WHO Guidelines on Hand Hygiene in Health Care, is  
33 by direct observations. Product consumption monitoring cannot determine if hand hygiene is  
34 performed correctly and at appropriate times. It may also not properly reflect the overall product  
35 consumption by healthcare providers, as it may also include the amount of product used by  
36 visitors and/or patients (World Health Organization, 2009).  
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49 Furthermore, although a report of the antibiotic usage by physician is provided by the  
50 pharmacy department on an annual basis, physicians are permitted to prescribe antibiotics at their  
51 discretion. This may limit the efficacy of the process. More stringent guidelines on the  
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3 restrictive use of antibiotics are needed as there is a trend for hospital pathogens to become more  
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5 resistant in the future.[51]  
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8         There were several limitations to this study. It is possible, for instance, that staff may  
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10 have altered their behavior from normal practices during unit observations. Furthermore, the  
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12 prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage and  
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14 antibiotic data were collected by hospital personnel not supervised by the researcher, limiting the  
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16 ability to assess the rigor of data collection. In addition, the focus of this study was on a specific  
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18 clinical unit of the hospital. These limitations were addressed by incorporating multiple methods  
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20 of data collection and by taking a broad socio-ecological system approach to study IP&C on the  
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22 unit. However, if feasible, it would be preferable in future case studies to collect all data across  
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24 sites through one researcher and study entire organizations or perhaps even regions to obtain a  
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26 more comprehensive picture of some aspects of the complex phenomena of IP&C.  
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### 31 **CONCLUSION**

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34         This case study provided in-depth knowledge of the socio-ecological conditions present  
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36 on a surgical unit at a Netherlands hospital that reported rates of MDRO below 1%. These  
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38 findings suggest there is merit in further exploring the potential benefits of such health system  
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40 practices for optimal prevention and control of MDRO in modern hospital environments. Further  
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42 research on the benefits of practitioner-led community of practices on IP&C practices such as the  
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44 Hygiene in Practice group is also recommended. Additional case studies to compare these  
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46 practices to other acute care hospitals in a variety of countries would be a valuable way to better  
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48 understand what IP&C programs are most effective in which contexts, and for what reasons.  
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53 **Furthermore, findings from this research can inform current and future efforts to provide**  
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55 **infection prevention and control programs and strategies that are socio-ecologically sound.**  
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3 **The findings also support that current initiatives underway to promote system-wide**  
4 **improvements in infection prevention and control should engage local practitioners in**  
5 **designing and implementing interventions that can be adapted to their specific clinical**  
6 **environment. Finally, this research suggests that qualitative research can reveal embedded**  
7 **and taken-for-granted daily and ritualized social practices that contribute to infection**  
8 **prevention and control.**  
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**Appendix 1: Core elements of a proposed socio-ecological framework for studying IP&C**  
(Table reprinted from Backman et al. [52])

Core Elements	Definitions
Citizen science	The notion of citizen science refers to individuals working collaboratively with communities, governing bodies and others to conduct research and generate evidence.[14,18,19]. This includes using a participatory and collaborative approach to the design, conduct and analysis of IP&C research, involving members of the community in data collection and data analysis wherever feasible and appropriate and seeking multiple sources of data (including sources of indigenous or local knowledge) and using a variety of methods to develop integrative knowledge about local places as well as the larger system.[16,19-21]
Place ethic	According to Lawrence Buell [53] and Higgs,[26,27] a place ethic is shown in the ways that individuals treat and support each other and the places they share. Place ethic refers to the importance of fostering a deep understanding of and respect for the history, culture, knowledge and rituals of communities. In this research, thinking about place ethic includes inquiring about what people see as important in the care of each other and their environment, how they reinforce and support each other to value IP&C, and whether respect for historical knowledge informs how a place functions over time.
Engaged practice	The concept of engaged practice refers to the creation, implementation and evaluation of sound practices that are evidence-informed.[18,24-27] This includes self monitoring and adjustment of daily IP&C practices (e.g.: audits, equipment checks), using local feedback processes to continually improve workflow, work design, and processes at the individual, team, and healthcare community levels.
Adaptive learning and growth	The idea of adaptive learning and growth refers to the development and use of knowledge translation strategies that disseminate learnings across individuals, teams, organizations and system levels to drive sustainable changes.[16,18,22,25,27,35] This includes evidenced-informed management of MDRO, screening policies, resource allocation decisions about patient care staffing, housekeeping, availability of equipment and supplies, staff and public education policies and funding.

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