



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

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2011-000511
Article Type:	Research
Date Submitted by the Author:	20-Dec-2011
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
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Health services research
Keywords:	Infection control < INFECTIOUS DISEASES, QUALITATIVE RESEARCH, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

[Back to normal](#)

■ Qualitative research review guidelines – RATS

ASK THIS OF THE MANUSCRIPT	THIS SHOULD BE INCLUDED IN THE MANUSCRIPT
<p>R Relevance of study question</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>A Appropriateness of qualitative method</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>T Transparency of procedures</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>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

	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>S Soundness of interpretive approach</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.
2
3
4
5
6
7
8
9
10
11
12
13
14

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

15
16 The RATS guidelines modified for BioMed Central are copyright Jocelyn Clark, BMJ. They can be found in Clark JP: **He**
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
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4 **Barriers and Bridges to Infection Prevention and Control: Results of a Qualitative Case**
5 **Study of a Netherlands' Surgical Unit**
6
7
8

9
10 **ABSTRACT**

11 Objectives:

12
13
14 -To observe the overall work environment including infection prevention and control (IP&C)
15 practices on the target surgical unit;

16
17
18 -To analyze the policies and procedures in the hospital and unit environments;

19
20 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
21 their unit environment; and

22
23
24 -To collect monthly specific IP&C related anonymized data.

25
26 Design:

27
28 In this qualitative case study analysis, a socio-ecological approach on health systems informed
29 the research design and provided a framework to better understand the complexity of
30 implementing effective IP&C.
31

32
33 Setting:

34
35 The study was conducted on a surgical unit at a Netherlands' hospital that reported successful
36 reductions in the prevalence of targeted multidrug-resistant organisms (MDRO).
37

38
39 Methods:

40
41 Research methods included unit observations (n=3), review of relevant policies and procedures,
42 five practitioner-led photo walkabouts of the unit (n=7), three photo elicitation focus groups with
43 practitioners (n=13), and the review of related IP&C data.
44

45
46 Results:

47
48 The findings indicate some conditions and processes present that may influence the low
49 prevalence of MDRO, including the 'search and destroy' active surveillance strategy, low
50 occupancy rates, a centralized bed cleaning system, and the presence of an active grass roots
51 Hygiene in Practice group which engages practitioners in several ongoing activities to promote
52 IP&C on the units.
53

54
55 Conclusions:

56
57 Further research on the benefits of practitioner-led community of practices on IP&C practices
58 such as the Hygiene in Practice group is also recommended. Additional case studies to compare
59
60

1
2
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.
5
6

7 Further data is available by contacting the primary author directly.
8
9

10 11 **SUMMARY**

12
13 Article focus:

- 14
15 -To observe the overall work environment including IP&C practices on the target surgical unit;
- 16
17 -To analyze the policies and procedures aimed at the prevention and minimization of MDRO in
18 the hospital and unit environments;
- 19
20 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
21 their unit environment; and
- 22
23 -To collect monthly specific IP&C related anonymized data.
24
25
26
27
28

29 Key messages:

30
31 The findings indicate some conditions and processes present that may influence the low
32 prevalence of MDRO, including:

- 33
34 -the 'search and destroy' active surveillance strategy, -low occupancy rates
- 35
36 -a centralized bed cleaning system, and
- 37
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.
40
41
42
43

44
45 Strengths and limitations:

- 46
47 -Multiple methods of data collection and a broad socio-ecological system approach to study
48 IP&C on the unit strengthen this research.
- 49
50 -It is possible that staff may have altered their behavior from normal practices during unit
51 observations.
52
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.
56
57
58
59
60

1
2
3 -The focus of this study was on a specific clinical unit of the hospital.
4
5
6
7

8 9 **INTRODUCTION**

10
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.
18
19
20
21
22
23
24
25
26
27

28 In contrast to the North American situation, the “control of MRSA infections [one of the
29 MDRO] is reported to be optimal in the Scandinavian countries [and also in the Netherlands],
30 where strict barrier precautions are in place along with active surveillance culture (ASC)
31 programs”.[5, p.236] Some European countries such as the Netherlands have been recognized as
32 world leaders at minimizing MDRO infection rates, in particular MRSA.[6] Yet, strong evidence
33 on the most effective approaches for achieving good adherence to the simplest measures, such as
34 hand hygiene, remains elusive, and further knowledge of what drives individuals, organizations
35 and health systems towards sustainable IP&C practices does not yet exist in the research
36 literature.[7] To develop a better understanding of what may be shaping the prevention of MRSA
37 and other MDRO, a case study was conducted in April 2008 on a surgical unit at a Netherlands
38 hospital that reported a successful reduction in the prevalence of targeted MDRO and another
39 case study between September and December 2008 on a surgical unit at a Canadian hospital
40 which reported higher rates of targeted MDRO. In this paper, we discuss the key findings of the
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Netherlands hospital case study and offer recommendations for policy, practice and future
4
5 research.
6

7
8 The objectives of the research were:
9

- 10 1. To observe the overall work environment including IP&C practices on the target surgical
11 unit;
12
- 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
18
- 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).
23
24
25
26
27
28
29
30
31
32
33

34 **METHODS**

35
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 21st century societies and their health
43 systems.
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 In this study, a socio-ecological approach on health systems informed this research
4 design and provided a framework to better understand the complexity of implementing effective
5 IP&C. A socio-ecological perspective provides “a framework for understanding the diverse
6 personal and environmental factors and the interrelationships among these factors”, [13, p.45]
7 enabling us to more accurately interpret and manage whole systems change. [14,15] In socio-
8 ecological terms, the term whole systems may be conceptualized as nested cycles of system
9 development, degradation, or restoration. [14,16-18]
10
11
12
13
14
15
16
17
18
19

20 A whole systems’ perspective on IP&C is compatible with the participatory methods of
21 citizen science that engage communities in collectively studying and assessing the socio-
22 ecological conditions of their environments in order to collaboratively design and implement
23 useful, sustainable repairs. [14,18,19] For the purposes of this study, citizen science is
24 conceptualized as a collaborative process between researchers and participants where members
25 of the community are involved in data collection and data analysis to conduct research and
26 generate evidence. [16,19-21] This research approach draws on related work in the fields of
27 ecosystems management and research, [22] economics, [23] restoration management, [24-27] and
28 health systems. [18,19] It involves seeking multiple sources of data and using a variety of
29 methods to develop integrative knowledge about local places as well as the overall system as a
30 whole. [14,18,21,28]
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45

46 Using a socio-ecological perspective and the concept of citizen science as theoretical
47 guideposts, core elements of a proposed socio-ecological framework for studying IP&C were
48 defined, [8,12,15,18] and used to inform the research design and conduct of the study (Appendix
49 1). The framework informed but did not constrain the collection and analysis of the data.
50
51
52
53
54
55
56
57
58
59
60

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.

1
2
3 Aggregated, anonymized IP&C related data were collected including monthly prevalence rates
4
5 for MRSA, VRE, CDI and ESBL (January-December 2008).
6
7

8 Five practitioner-led photo walkabouts and photo narrations (n=7 participants) of their
9
10 perceptions of the concerns and strengths on their unit in relation to infection control were
11
12 conducted. The individuals who participated in separate photo walkabouts included the infection
13
14 control professional (ICP), a unit leader and unit manager, a senior nurse, a physician, and two
15
16 members of the housekeeping staff (n=7). A total of 194 photographs were taken. Following the
17
18 walkabouts, three separate photo elicitation focus groups (n= 13 participants) were conducted to
19
20 review and discuss the images and narratives collected during the walkabout. The three groups
21
22 were management, health professionals and clinical support staff. The participants were asked to
23
24 provide written comments on each photograph and then each group discussed each picture as a
25
26 whole. Informed consent was obtained from all the participants in the photo walkabouts and
27
28 focus group sessions. Field notes were recorded after each photo walkabout and each photo
29
30 elicitation session to note researcher perceptions about the environment at these times of data
31
32 collection as well as participant dynamics during data collection.
33
34
35
36
37
38

39 An iterative data analysis process was conducted to inform data collection and analysis
40
41 throughout successive phases of the research. Atlas.ti version 5.3 software (ATLAS.ti Scientific
42
43 Software Development GmbH, Berlin) was used to support the management and analysis of the
44
45 written and visual data. The qualitative data analysis was initiated first then, as the themes
46
47 became identifiable, the other findings were integrated to better understand the qualitative data.
48
49

50 The rigor of this study was supported by several measures. Observer bias was minimized
51
52 by using multiple methods to gather and verify evidence on the policies, practices and
53
54 surveillance data on IP&C at the study site. Each photo walkabout and focus group session was
55
56
57
58
59
60

1
2
3 audio-taped, transcribed, and then verified to ensure accuracy. Follow-up with local experts
4
5 including some participants, the manager of infection control and a physician-lead in infectious
6
7 diseases, was also executed to ensure accuracy of the data collected. Furthermore, the
8
9 observation field notes, photo walkabout and focus group findings were compared with findings
10
11 from the other data sources of organizational policies, prevalence rates, and other relevant data
12
13 (such as bed occupancy rates) as the iterative data analysis progressed. In addition, a researcher's
14
15 journal was kept to capture reflections on all the research related activities.
16
17
18

19 RESULTS

20
21
22 In the course of the analysis of the case study, six major themes were derived from the
23
24 iterative analysis. Each theme is illustrated with select findings below.
25
26

27 *Considerable IP&C challenges were inherent to the design of the clinical unit*

28
29 The environmental design, which was evidently complex, refers to the features of the
30
31 physical environment or physical space (such as configuration, layout, organization, and other
32
33 attributes) and the organization of the work (the nature, flow and safety of work). Workplace
34
35 design refers to the design of the work environment, the physical space, and the accessibility of
36
37 equipment; the work design is how the staff organizes their work, including the routines and the
38
39 workflow on the unit. Both are central to understanding human factors, which is “the scientific
40
41 discipline concerned with the understanding of interactions among humans and other elements of
42
43 a system, and the profession that applies theory, principles, data and methods to design in order
44
45 to optimize human well-being and overall system performance” (International Ergonomic
46
47 Association, website).
48
49
50
51

52
53 An example of the workplace design is the presence of a sink for staff use at the entrance
54
55 of each room (Figure 1 Hand Hygiene station outside of patient room (MGMT-2)).
56
57
58
59
60

1
2
3 A wall mounted soap dispenser, paper towels, a garbage container with lid, a wall
4
5
6 mounted alcohol-based hand rub (ABHR) dispenser, and gloves in various sizes are present. The
7
8 ABHR dispensers can only be found mounted on the wall near the sinks outside the patient
9
10 rooms, in the dirty utility room and the medication room. There are no additional ABHR
11
12 dispensers on the unit (Observations, P1, 26).

13
14
15 Another example of workplace design is the garbage cans. One participant described his
16
17 concerns about the garbage bins with lids:

18
19
20 Here, you washed your hands and you throw away the paper towel and you have to touch
21
22 the lid of the dirty waste box again and in fact you have dirty hands again. Afterwards,
23
24 you should use the ABHR. You shouldn't have to touch anything (FG management, P12,
25
26 446).

27
28 This participant clearly recognized that hands can potentially become contaminated when
29
30 opening or closing waste baskets. Overall, the environmental design of the unit provides
31
32 challenges to proper IP&C practices thus leading to many workarounds.

33
34 ***Nurses and other staff employed a wide variety of workarounds to try to adapt to the design of***
35
36 ***their care environment***

37
38 Workarounds are defined by Amalberti and colleagues [33] as the “adaptation of
39
40 procedures by workers to deal with the demands of the work” (p. i67). These procedures are
41
42 often adapted to bypass or avoid a problematic feature of the system that jeopardizes people’s
43
44 chance of completing their work safely within optimal timeframes and resources. Amalberti’s
45
46 theory on workarounds relates to how people naturally migrate to the boundaries of what are
47
48 considered acceptable practices and sometimes violate those boundaries in order to adapt to
49
50 system features that constrain their ability to accomplish their work. According to Amalberti,
51
52 workarounds are an inevitable feature of complex systems, and what we need to do is figure out
53
54 how to facilitate the safest possible adaptations within the context of individual practice and
55
56
57
58
59
60

1
2
3 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the
4
5 boundaries and workarounds that constitute problematic violations of safety principles.
6
7

8 An example of a workaround is the lack of ABHR present at the point of care, requiring
9
10 staff members to go out of the room to clean their hands. During my walkabout with a physician
11
12 participant, the issue of hand hygiene compliance was discussed in relation to non-single patient
13
14 rooms:
15
16

17 The only problem [is] that they have to wash their hands every, every time they care for a
18
19 patient and then go to another. That maybe... that's a risk [of] having more patients in a
20
21 room. If you have one patient in a room then you go out and you wash your hands. If you
22
23 have four patients in a room, you go to one patient then to the other... (PW physician, P8,
24
25 78).

26 During my walkabout with the infection control professional, the participant explained the
27
28 workflow of staff when they enter a single patient room as follows:
29

30 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR
31
32 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other
33
34 things and disinfect your hands again with ABHR. So in fact there should be ABHR at
35
36 this place ... (PW ICP, P6, 383).

37 In these situations, due to system constraints, staff members are required to leave the room to
38
39 clean their hands between patients, in order to avoid the kind of safety violation that Amalberti
40
41 and colleagues [33] discuss.

42 ***Participants viewed organizational and team cultures as integral to the way they enact IP&C***
43
44 ***practices in their workplaces***
45

46 In the first set of national interdisciplinary safety competencies established for Canada,
47
48 Frank et al. [34] contend that the notion of a culture of patient safety is associated with
49
50 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient
51
52 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C
53
54 became evident in the course of the research.
55
56
57
58
59
60

1
2
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:
5
6

7
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).
10

11 During a follow-up, a key informant said:
12

13
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).
16

17 This routine and highly consistent separation of work and street clothing is a notable example of
18 a shared practice, within the group.
19

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:
26
27
28
29
30
31
32

33
34 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).
35

36 This simple activity provides an environment where nurses are encouraged to interact and
37 communicate with each other. It also has a potential impact on infection prevention as it limits
38 staff leaving the unit. A key informant during a follow-up discussion also said:
39
40
41

42
43 ... the evening meals and coffee breaks are used in the lounge on the ward. During lunch
44 all the nurses (and staff) go in two shifts to the restaurant of the hospital (key informant).
45
46

47 Culture is also reflected by the kinds of communication that occur within a team;
48 effective communication is important in order to obtain optimal patient outcomes.[34] During
49 my observations, a clear communication strategy is the isolation card that is found posted
50 underneath the room number. The card reads "barrière-box" isolation with gloves and gowns
51 symbols (Observations, P1, 19). A participant said that:
52
53
54
55
56
57
58
59
60

1
2
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).
5
6

7 As a support staff participant noted:
8

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).
13
14

15 In contrast, an example of ineffective communication was discussed by another
16 participant who stated that:
17
18

19
20 There's not enough information to the staff about infection control measures during a
21 [patient] transport. They wear gowns and gloves when they're in the room but they don't
22 tell the staff what to do during transport, so they're not informed (FG Management, P12,
23 121).
24
25

26 Clear mechanisms to promote effective communication amongst staff therefore need to be in
27 place to minimize the likelihood of adverse events and to ultimately create and support a culture
28 of safety.[34]
29
30
31

32
33 ***Participants who engaged in communal practice activities tended to monitor and support the***
34 ***use of recommended IP&C practices***
35
36

37 In the field of ecological restoration [24-27] and in health systems research, [19,32]
38 engaged practice refers to the vigilance, attentiveness and awareness of one's practices and each
39 other's practices in order to reinforce and actively use what one learns to foster better treatment
40 of each other and the places we share. Within healthcare, the concept of communities of practice,
41 where groups of professionals work on initiatives to create, implement and evaluate evidence-
42 based care improvements, may be thought of as one key forum for engaged practice.
43
44
45
46
47
48
49
50

51
52 A key grass root Hygiene in Practice (HIP) group, which consists of nurse representatives
53 of every surgical unit and an infection control professional, oversees and implements several
54
55
56
57
58
59
60

1
2
3 activities to promote the use of good hygiene precautions in the hospital. During a follow-up
4
5 discussion, key informants said:
6
7

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).
14
15

16 An example of their initiative includes the patient-specific storage box for wound care products
17
18 (Figure 2 Green storage box for patient (MGMT-41)):
19
20

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).
26
27

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***

31
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.
36
37
38
39

40 An example of adaptive learning and growth is the evidence-informed education
41 provided by the grass roots HIP group that is built on current staff knowledge and experience,
42 and is geared to address gaps in practice. All surgical wards have a nurse participating in this
43 group. Many comments were received on the educational poster created by the HIP group
44
45
46
47
48
49
50 (Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:
51
52

53
54 Clear, practical information and pictures, gives good information, better because of the
55 photographs! (FG support staff, written comments, P13, 13).
56
57
58
59
60

1
2
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.
9

10
11
12
13
14
15
16
17
18 ***In the face of numerous system constraints, participants viewed engaged leadership as***
19 ***important for IP&C***
20

21
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.).
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49

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:
53
54
55
56
57
58
59
60

1
2
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).
5
6

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.
17
18
19
20
21
22
23

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.
31
32
33
34
35
36
37
38
39

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.
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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
MRSA	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
VRE	5.0	0	0	0	0	0	0	0	0	1.7	0	0
CDI	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
ESBL	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.

1
2
3 Monthly screenings for VRE were also performed in the intensive care, hematology, and
4 nephrology units. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The CDI
5 prevalence rate ranged from 0-0.8% and although additional screening on high risk patients for
6 ESBLs was performed, the monthly ESBL prevalence rate was somewhat higher, 0.98%-4.27%.
7
8 Although MRSA, VRE and CDI rates may be below 1%, other pathogens such as ESBL may not
9 appear to be as controlled. A comprehensive infection prevention control program for all MDRO
10 should focus on the control of many pathogens simultaneously, including those pathogens that
11 have not yet been identified.
12
13
14
15
16
17
18
19
20
21

22 Another factor that can have an impact on the rate of MDRO is the occupancy rate which
23 was reported as approximately 80%. Studies have shown that lower occupancy rates are linked to
24 lower infection rates (National Audit Office, 2004). In a study in Northern Ireland, the bed
25 occupancy rate was found to have a significant positive correlation with MRSA rates in
26 hospitals.[39] Also, another study by Borg [40] found a significant correlation between the bed
27 occupancy rate and the MRSA infection rates. Similarly, Borg and colleagues [41] concluded
28 that periods of high occupancy levels were associated with higher MRSA incidence rates. In
29 another study by the Department of Health in the UK,[42] concluded that hospitals with higher
30 than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with
31 occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public
32 Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good
33 control of infections”.[43, p.1401] Thus, the results of our case study support the notion that the
34 bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the
35 prevalence of MDRO infections.
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
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.

27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
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.

43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
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

1
2
3 have proper access to soap and water or an ABHR.[45,46] In this case study, the ABHR
4
5 dispensers were only located outside the patient rooms. According to the WHO Guidelines on
6
7 Hand Hygiene in Health Care (2009), the ABHR dispensers should be located in the patient
8
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]
12
13

14
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
18
19 toilets, and lack of storage space. It is likely that similar design issues abound in most acute care
20
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.
30
31
32
33

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.
43
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
47
48 providers, as it may also include the amount of product used by visitors and/or patients (World
49
50 Health Organization, 2009).
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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

1
2
3 practices to other acute care hospital around the world would be a valuable way to better
4
5 understand what IP&C programs are most effective in which contexts, and for what reasons.
6
7
8
9
10

11 **DATA SHARING**

12
13
14 Supplementary data is available by contacting the primary author.
15

16 **COMPETING INTERESTS**

17
18 None.
19

20 **FUNDING**

21
22
23 The project was funded in part by the Canadian Patient Safety Institute, the University of Alberta
24 Mary Louise Imrie Graduate Award (2008) and the Registered Nurses' Foundation of Ontario
25 Award (Rolling Stones/CPI Award) for the Advancement of Professional Practice in Infection
26 Control (2008).
27
28

29 **CONTRIBUTORSHIP**

30
31
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.
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

References

- 1 Brooklyn Antibiotic Resistance Task Force. The cost of antibiotic resistance: Effect of
2 resistance among *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and
3 *Pseudomonas aeruginosa* on length of hospital stay. *Infect Control Hosp Epidemiol*
4 2002;**23**(2):106-108.
- 5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
- 2 Song X, Srinivasan A, Plaut D et al. Effect of nosocomial vancomycin-resistant enterococcal
bacteremia on mortality, length of stay and costs. *Infect Control Hosp Epidemiol*
2003;**24**(4):251-256.
- 3 Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes:
mortality, length of hospital stay and health care costs. *CID* 2006;**42**(Suppl 2):S82-S89.
- 4 Zoutman DE, Ford BD. The relationship between hospital infection surveillance and control
activities and antibiotic-resistant pathogen rates. *Am J Infect Control* 2005;**33**:1-5.
- 5 West TE, Guerry C, Hiott M et al. Effect of targeted surveillance for control of methicillin-
resistant *Staphylococcus aureus* in a community hospital system. *Infect Control Hosp Epidemiol*
2006;**27**(3):233-238.
- 6 Vriens M, Blok H, Fluit A et al. Costs associated with a strict policy to eradicate methicillin-
resistant *Staphylococcus aureus* in a Dutch university medical center: A 10-year survey. *Eur J*
Clin Microbiol Infect Dis 2002;**21**:782-786.
- 7 Backman C, Zoutman DE, Marck PB. An integrative review of the current evidence on the
relationship between hand hygiene interventions and the incidence of healthcare associated
infections. *Am J Infect Control* 2008;**36**(5):333-348.
- 8 Struelens MJ (1998). The epidemiology of antimicrobial resistance in hospital acquired
infections: problems and possible solutions. *BMJ* 1998;**317**:652-653.
- 9 Ali SH. A socio-ecological autopsy of the E. Coli O157:H7 outbreak in Walkerton, Ontario,
Canada. *Soc Sci Med* 2004;**58**(12):2601-2612.
- 10 Gloubeman S. Walkerton water and complex adaptive systems. *Hospital Quarterly*
2001;**4**:28-31.
- 11 Macdonald MT. From SARS to strategic actions reframing systems. *J Adv Nurs*
2004;**47**(5):544-550.
- 12 Waldvogel FA. Infectious diseases in the 21st century: Old challenges and new opportunities.
Int J Infect Dis 2004;**8**:5-12.
- 13 Edwards N, Mill J, Kothari AR. Multiple intervention research programs in community
health. *Can J Nurs Res* 2004;**36**(1):40-54.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

14 Edwards N, Marck P, Virani T et al. Whole systems change in health care: Implications for evidence-informed nursing service delivery models. University of Ottawa, Canada 2007;1- 115.

15 Stokols D. Translating social ecological theory into guidelines for community health promotion. *Am J Health Promot* 1996;**10**(4):282-298.

16 Gunderson L, Holling CS. *Panarchy: understanding transformations in human and natural systems*. Washington, DC: Island Press 2002.

17 Holling, CS. Two cultures of ecology. *Conservation Ecology* 1998;**2**(2):4.

18 Marck PB, Higgs ES, Edwards N et al. Generating adaptive health systems: An emerging framework of research and restoration for a safer world. Social Science and Humanities Research Council Working Paper Series: Paper #1 2006. Retrieved on June 3, 2007 from <http://www.nursing.ualberta.ca/SaferSystems/projects.htm>

19 Marck PB, Kwan JA, Preville B et al. Building safer systems by ecological design: using restoration science to develop a medication safety intervention. *Qual Saf Health Care* 2006;**15**:92-97.

20 Irwin A. *Citizen science. A study of people, expertise and sustainable development*. Routledge Taylor & Francis Group, New York, 1995;202.

21 Rhemtulla JM, Hall RJ, Higgs ES et al. Eighty years of change: vegetation in the montane ecoregion of Jasper National Park, Alberta, Canada. *Can J For Res* 2002;**32**:2010-2021.

22 Gunderson LH, Holling, CS, Light, SS. *Barriers and bridges to the renewal of ecosystems and institutions*. New York: Columbia University Press 1995.

23 Ostrom E. *Not just one best system: The diversity of institutions for coping with the commons* in Researching the culture in agri-culture: Social research for international agricultural development, Ed. Michael Cernea and Amir Kassam, Cambridge, MA: CABI Publishing, 2006;329–360.

24 Higgs ES. A quantity of engaging work to be done: Ecological restoration and morality in a technological culture. *Restoration and Management Notes* 1991;**9**(2):97-103.

25 Higgs ES. What is good ecological restoration? *Conversation Biology* 1997;**11**(2):338-348.

26 Higgs E. The Bear in the kitchen. Ecological restoration in Jasper Park raises questions about wilderness in the Disney age. *Alternatives Journal* 1999;**25**(2):30-35.

27 Higgs E. *Nature by design: People, natural process, and ecological restoration*. Cambridge, MIT Press 2003.

- 1
2
3 28 Gunderson L, Folke C, Lee M et al. In memory of Mavericks. *Conservation Ecology*
4 2001;**6**(2):19.
5
6
7 29 Muto CA, Jernigan JA, Ostrowsky BE et al. SHEA guideline for preventing nosocomial
8 transmission of multidrug-resistant strains for *Staphylococcus aureus* and *Enterococcus*. *Infect*
9 *Control Hosp Epidemiol* 2003;**24**:362-386.
10
11
12 30 Yin RK. *Case study research design and methods, Third edition*. Sage Publications,
13 Thousand Oaks 2003;175.
14
15 31 Tellis W. Application of a case study methodology. *The Qualitative Report* 1997;**3**(3)
16 Retrieved September 1, 2007 from <http://www.nova.edu/ssss/QR/QR3-3/tellis2.html>
17
18
19 32 Marck PB, Higgs ES, Vieira ER et al. Through the eyes of practitioners: Adapting visual
20 research methods from ecological restoration to integrate the ethics, science, and practice of
21 safety in health care. *Health Care Systems Ergonomics & Patient Safety International*
22 *Conference Papers* 2008. Retrieved from
23 http://www.heps2008.org/abstract/data/PDF/Marck_Patricia.pdf.
24
25
26 33 Amalberti R, Vincent C, Auroy Y et al. Violations and migrations in health care: a framework
27 for understanding and management. *Qual Saf Health Care* 2006;**15**:66-71.
28
29
30 34 Frank JR, Brien S (Editors) on behalf of The Safety Competencies Steering Committee. The
31 safety competencies Enhancing patient safety across the health professions. Ottawa, ON:
32 Canadian Patient Safety Institute 2008.
33
34
35 35 Walker B, Carpenter SR, Anderies JM et al. Resilience management in social ecological
36 systems: A working hypothesis for a participatory approach. *Conservation Ecology* 2002;**6**:14.
37
38
39 36 Verhoef J, Beaujean D, Blok H et al. A Dutch approach to methicillin-resistant
40 *Staphylococcus aureus*. *Eur J Clin Microbiol Infect Dis* 1999;**18**:461-466.
41
42
43 37 Wertheim HFL, Vos MC, Boelens HAM et al. Low prevalence of methicillin-resistant
44 *Staphylococcus aureus* (MRSA) at hospital admission in the Netherlands: the value of search and
45 destroy and restrictive antibiotic use. *J Hosp Infect* 2004;**56**(4):321-325.
46
47
48 38 Vos MC, Behrendt MD, Melles DC et al. 5 years of experience implementing a methicillin-
49 resistant *Staphylococcus aureus* search and destroy policy at the largest university medical center
50 in the Netherlands. *Infect Control Hosp Epidemiol* 2009;**30**(10):977-984.
51
52
53 39 Cunningham JB, Kernohan WG, Sowney R. Bed occupancy and turnover interval as
54 determinant factors in MRSA infections in acute settings in Northern Ireland: 1 April 2001 to 31
55 March 2003. *J Hosp Infect* 2005;**61**:189-193.
56
57
58 40 Borg MA. Bed occupancy and overcrowding as determinant factors in the incidence of
59 MRSA infections within general ward settings. *J Hosp Infect* 2003;**54**:316-318.
60

1
2
3
4 41 Borg MA, Suda D, Scicluna E. Time-series analysis of the impact of bed occupancy rates on
5 the incidence of methicillin-resistant *Staphylococcus aureus* infection in overcrowded general
6 wards. *Infect Control Hosp Epidemiol* 2008;**29**(6):496-502.
7

8
9 42 Department of Health (UK). Hospital organisation, specialty mix and MRSA. Report no
10 9163. 2007.
11

12
13 43 Orendi, J. (2008). Health-care organisation, hospital-bed occupancy, and MRSA. *The Lancet*
14 2008;**371**:1401-1402.
15

16
17 44 Farrow TS, Black SM. Infection prevention and control in the design of healthcare facilities,
18 *HealthcarePapers* 2009;**9**(3):32-37.
19

20
21 45 Haas J, Larson E. Compliance with hand hygiene guidelines: Where are we in 2008? *Am J*
22 *Nurs* 2008;**108**(8): 40-44.
23

24
25 46 Pittet D, Hugonnet S, Harbarth S et al. Effectiveness of a hospital-wide program to improve
26 compliance with hand hygiene. *The Lancet* 2000;**356**(9238):1307-1312.
27

28
29 47 Creedon SA. Healthcare workers' hand decontamination practices: compliance with
30 recommended guidelines. *J Adv Nurs* 2005;**51**(3):208-216.
31

32
33 48 Suresh G, Cahill J. How "user friendly" is the hospital for practicing hand hygiene? An
34 ergonomic evaluation. *Journal of Quality and Patient Safety* 2007;**33**(3):171-179.
35

36
37 49 Harbarth S, Pittet D, Grady L et al. Interventional study to evaluate the impact of an alcohol-
38 based hand gel in improving hand hygiene compliance. *Pediatr Infect Dis J* 2001;**21**:489-495.
39

40
41 50 Rathert C, Ishqaidef G, May DR. Improving work environments in health care: Test of a
42 theoretical framework, *Health Care Manage Rev* 2009;**34**(4):334-343.
43

44
45 51 Struelens M. Multidisciplinary antimicrobial management teams: The way forward to control
46 antimicrobial resistance in hospitals. *Curr Opin Infect Dis* 2003;**16**(4):305-307.
47

48
49 52 Backman C, Marck PB, Krogman N et al. Barriers and Bridges to Infection Prevention and
50 Control: Results of a Case Study of a Canadian Surgical Unit, *CJIC* 2011: 233-242.
51

52
53 53 Buell L. *The environmental imagination: Thoreau, nature writing, and the formation of*
54 *American culture*. Cambridge, MA: Belknap Press of Harvard University Press 1995.
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only



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

Journal:	<i>BMJ Open</i>
Manuscript ID:	bmjopen-2011-000511.R1
Article Type:	Research
Date Submitted by the Author:	08-Feb-2012
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
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Health services research
Keywords:	Infection control < INFECTIOUS DISEASES, QUALITATIVE RESEARCH, HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™
Manuscripts

[Back to normal](#)

■ Qualitative research review guidelines – RATS

ASK THIS OF THE MANUSCRIPT	THIS SHOULD BE INCLUDED IN THE MANUSCRIPT
<p>R Relevance of study question</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>A Appropriateness of qualitative method</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>T Transparency of procedures</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>

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

	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>S Soundness of interpretive approach</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.
2
3
4
5
6
7
8
9
10
11
12
13
14

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

15
16 The RATS guidelines modified for BioMed Central are copyright Jocelyn Clark, BMJ. They can be found in Clark JP: **He**
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
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12
13 **Barriers and Bridges to Infection Prevention and Control: Results of a Qualitative Case**
14 **Study of a Netherlands' Surgical Unit**
15
16
17

18
19 **ABSTRACT**

20 Objectives:

21
22
23 -To observe the overall work environment including infection prevention and control (IP&C)
24 practices on the target surgical unit;

25
26 -To analyze the policies and procedures in the hospital and unit environments;

27
28 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
29 their unit environment; and

30
31 -To collect monthly specific IP&C related anonymized data.
32
33

34 Design:

35
36 In this qualitative case study analysis, a socio-ecological approach on health systems informed
37 the research design and provided a framework to better understand the complexity of
38 implementing effective IP&C.
39
40

41 Setting:

42
43 The study was conducted on a surgical unit at a Netherlands' hospital that reported successful
44 reductions in the prevalence of targeted multidrug-resistant organisms (MDRO).
45
46

47 Methods:

48
49 Research methods included unit observations (n=3), review of relevant policies and procedures,
50 five practitioner-led photo walkabouts of the unit (n=7), three photo elicitation focus groups with
51 practitioners (n=13), and the review of related IP&C data.
52

53 Results:

54
55 The findings indicate some conditions and processes present that may influence the low
56 prevalence of MDRO, including the 'search and destroy' active surveillance strategy, low
57 occupancy rates, a centralized bed cleaning system, and the presence of an active grass roots
58 Hygiene in Practice group which engages practitioners in several ongoing activities to promote
59 IP&C on the units.
60

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

Conclusions:

1
2
3
4
5
6
7
8
9
10
11
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.

14
15 Further data is available by contacting the primary author directly.
16
17

18 19 20 **SUMMARY**

21 Article focus:

22
23 -To observe the overall work environment including IP&C practices on the target surgical unit;

24
25 -To analyze the policies and procedures aimed at the prevention and minimization of MDRO in
26
27 the hospital and unit environments;

28
29 -To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
30
31 their unit environment; and
32
33

34
35 -To collect monthly specific IP&C related anonymized data.
36

37 Key messages:

38
39 The findings indicate some conditions and processes present that may influence the low
40
41 prevalence of MDRO, including:

42
43 -the 'search and destroy' active surveillance strategy, -low occupancy rates
44
45

46
47 -a centralized bed cleaning system, and

48
49 -the presence of an active grass roots Hygiene in Practice group which engages practitioners in
50
51 several ongoing activities to promote IP&C on the units.
52

53 Strengths and limitations:

54
55 -Multiple methods of data collection and a broad socio-ecological system approach to study
56

57 IP&C on the unit strengthen this research.

58
59 -It is possible that staff may have altered their behavior from normal practices during unit
60
61 observations. [For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml](http://bmjopen.bmj.com/site/about/guidelines.xhtml)

-The prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage

1
2
3
4
5
6
7
8
9
10
11
12 limiting the ability to assess the rigor of data collection.

13
14 -The focus of this study was on a specific clinical unit of the hospital.

17 INTRODUCTION

19
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

38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>
findings of the Netherlands hospital case study and offer recommendations for policy, practice

1
2
3
4
5
6
7
8
9
10
11
12 The objectives of the research were:

- 14 1. To observe the overall work environment including IP&C practices on the target surgical
15 unit;
- 16 2. To critically review the policies and procedures aimed at the prevention and minimization of
17 MDRO in the hospital and unit environments;
- 18 3. To analyze the barriers and bridges to IP&C that practitioners identify in visual narratives of
19 their unit environment; and
- 20 4. To collect monthly specific IP&C related anonymized data on the target surgical unit and in
21 the facility overall for a duration of 12 months, and the prevalence rates of methicillin-
22 resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *enterococci* (VRE),
23 extended spectrum beta-lactamases (ESBLs) and *Clostridium difficile* infections (CDI).
24
25
26
27
28
29
30
31
32
33
34
35
36

37 38 **METHODS**

39
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 21st century societies and their health
47 systems.
48
49
50
51
52
53
54
55
56
57
58

59 In this study, a socio-ecological approach on health systems informed this research
60 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

1
2
3
4
5
6
7
8
9
10
11
12 personal and environmental factors and the interrelationships among these factors”,[13, p.45]
13
14 enabling us to more accurately interpret and manage whole systems change.[14,15] In socio-
15
16 ecological terms, the term whole systems may be conceptualized as nested cycles of system
17
18 development, degradation, or restoration.[14,16-18]
19

20
21 A whole systems’ perspective on IP&C is compatible with the participatory methods of
22
23 citizen science that engage communities in collectively studying and assessing the socio-
24
25 ecological conditions of their environments in order to collaboratively design and implement
26
27 useful, sustainable repairs.[14,18,19] For the purposes of this study, citizen science is
28
29 conceptualized as a collaborative process between researchers and participants where members
30
31 of the community are involved in data collection and data analysis to conduct research and
32
33 generate evidence.[16,19-21] This research approach draws on related work in the fields of
34
35 ecosystems management and research,[22] economics,[23] restoration management,[24-27] and
36
37 health systems.[18,19] It involves seeking multiple sources of data and using a variety of
38
39 methods to develop integrative knowledge about local places as well as the overall system as a
40
41 whole.[14,18,21,28]
42
43
44
45
46

47 Using a socio-ecological perspective and the concept of citizen science as theoretical
48
49 guideposts, core elements of a proposed socio-ecological framework for studying IP&C were
50
51 defined,[8,12,15,18] and used to inform the research design and conduct of the study (Appendix
52
53 1). The framework informed but did not constrain the collection and analysis of the data.
54
55

56 57 **Setting**

58
59 The hospital is a 1042-bed tertiary care major teaching and referral center in The
60
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

1
2
3
4
5
6
7
8
9
10
11 room visits and over 336,000 outpatient visits. The patient average length of stay was 7.7 days.
12 The hospital occupancy rate was about 80% at any given time. There were 10,668 employees in
13 2008 including 2,560 nurses. This hospital was chosen because it reported less than 1% MDRO
14 prevalence rates.[29] The case study was conducted on a 34-bed unit, with 6 (18%) single-bed
15 rooms, comprising mainly of orthopedic, cosmetic, urology and general surgery patients. Ethical
16 approval was obtained through the University of Alberta Health Ethics Review Board and the
17 study hospital's Medical Ethics Review Committee.
18
19
20
21
22
23
24
25
26
27
28
29
30

31 **Data Collection and Analysis**

32
33 Data were collected and analyzed from multiple sources to gain an in-depth
34 understanding of the case [30,31] from a socio-ecological perspective on health systems. The
35 photographic research methods used, which were adapted from previous work in ecological
36 restoration [27] and health systems research [19,32] consisted of practitioner-led audio-taped
37 photo walkabouts with photo narration and communal photo elicitation forums. Participant
38 guided ecological tours of the hospital helped to foster community participation, local expertise
39 and indigenous ecological knowledge that practitioners have about the places where they work.
40 Unit observation sessions (n=3) were also performed by one of the authors (CB) and field notes
41 were recorded on the work environment of the unit to gain an initial perspective of the overall
42 environment and IP&C practices. Nursing, medical, housekeeping and other hospital personnel
43 on the unit were informed that the study was taking place and that the observations collected
44 would be shared with them, and with the hospital in aggregate form only. The first author made it
45 clear that the specific findings would not be linked to any individuals. In addition, policies and
46 procedures relevant to IP&C practices (n=11) were collected in order to gain a better
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12 understanding of the existing practices. Aggregated, anonymized IP&C related data were
13
14 collected including monthly prevalence rates for MRSA, VRE, CDI and ESBL (January-
15
16 December 2008).
17

18
19 Five practitioner-led photo walkabouts and photo narrations (n=7 participants) of their
20
21 perceived concerns and strengths on their unit in relation to IP&C were conducted. The
22
23 individuals who participated in separate photo walkabouts included the infection control
24
25 professional (ICP), a unit leader and unit manager, a senior nurse, a physician, and two members
26
27 of the housekeeping staff (n=7). A total of 194 photographs were taken. Following the
28
29 walkabouts, three separate photo elicitation focus groups (n= 13 participants) were conducted to
30
31 review and discuss the images and narratives collected during the walkabout. The three groups
32
33 were management, health professionals and clinical support staff. The participants were asked to
34
35 provide written comments on each photograph and then each group discussed each picture as a
36
37 whole. Informed consent was obtained from all the participants in the photo walkabouts and
38
39 focus group sessions. Field notes were recorded after each photo walkabout and each photo
40
41 elicitation session to note researcher perceptions about the environment at these times of data
42
43 collection as well as participant dynamics during data collection.
44
45
46
47
48

49
50 An iterative data analysis process was conducted to inform data collection and analysis
51
52 throughout successive phases of the research. Atlas.ti version 5.3 software (ATLAS.ti Scientific
53
54 Software Development GmbH, Berlin) was used to support the management and analysis of the
55
56 written and visual data. The qualitative data was coded into thematic categories. These categories
57
58 were compared and contrasted in relation to the patterns identified that relate to IP&C. As
59
60 coding, comparing, and contrasting within the qualitative data progressed in iterative cycles of
data collection and data analysis, potential links between various groupings of coded visual and

1
2
3
4
5
6
7
8
9
10
11
12 textual data, related emerging theory and research literature were identified and discussed within
13
14 the research team. Our analysis was sensitive to the policies and procedures, prevalence rates,
15
16 and other hospital documents that helped contextualize these specific findings.
17

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
36
37 kept to capture reflections on all the research related activities.
38
39
40
41

42 RESULTS

43
44
45 In the course of the analysis of the case study, six major themes were derived from the
46
47 iterative analysis. Each theme is illustrated with select findings below.
48

49 *Considerable IP&C challenges were inherent to the design of the clinical unit*

50
51
52 The environmental design consists of both workplace and work design. Workplace design
53
54 refers to the design of the work environment, the physical space, and the accessibility of
55
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
59
60 discipline concerned with the understanding of interactions among humans and other elements of
a system, and the profession that applies theory, principles, data and methods to design in order

1
2
3
4
5
6
7
8
9
10
11
12 to optimize human well-being and overall system performance” (International Ergonomic
13 Association, website).

14
15
16
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)).

19
20
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).

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

30
31
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).

37
38
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.

42
43
44
45
46
47
48
49
50
51 ***Nurses and other staff employed a wide variety of workarounds to try to adapt to the design of***
52 ***their care environment***

53
54
55 Workarounds are defined by Amalberti and colleagues [33] as the “adaptation of
56 procedures by workers to deal with the demands of the work” (p. i67). These procedures are
57 often adapted to bypass or avoid a problematic feature of the system that jeopardizes people’s
58 chance of completing their work safely within optimal timeframes and resources. Amalberti’s
59
60

1
2
3
4
5
6
7
8
9
10
11
12 considered acceptable practices and sometimes violate those boundaries in order to adapt to
13 system features that constrain their ability to accomplish their work. According to Amalberti,
14 workarounds are an inevitable feature of complex systems, and what we need to do is figure out
15 how to facilitate the safest possible adaptations within the context of individual practice and
16 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the
17 boundaries and workarounds that constitute problematic violations of safety principles.
18
19
20
21
22
23
24

25
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:
30
31
32
33
34

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).
40
41

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:
44
45

46 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR
47 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other
48 things and disinfect your hands again with ABHR. So in fact there should be ABHR at
49 this place ... (PW ICP, P6, 383).
50
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.
56
57
58
59
60

*Participants viewed organizational and team cultures as integral to the way they enact IP&C
practices in their workplaces*
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

1
2
3
4
5
6
7
8
9
10
11
12 In the first set of national interdisciplinary safety competencies established for Canada,
13
14 Frank et al. [34] contend that the notion of a culture of patient safety is associated with
15
16 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient
17
18 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C
19
20 became evident in the course of the research. For example, during the photo walkabout with a
21
22 participating physician and ICP, they explained that there is a change room on the unit where
23
24 staff can:
25
26

27
28 ... put on, [and] take off their own clothes and put on their hospital [uniform] before they
29
30 start working (PW physician and ICP, P8, 456).
31

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
36 occurrence. Most nurses change uniforms in the hospital (key informant).
37

38 This routine and highly consistent separation of work and street clothing is a notable example of
39
40 a shared practice that supports effective IP & C within the group. Another shared practice with
41
42 potential positive impact on IP&C that was observed is the unit team’s regular engagement in
43
44 shared breaks and evening meals in a staff lounge located on the unit (Observations, P1, 18).
45
46

47 During the photo walkabout with the physician, he explained that:
48

49 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).
50
51

52 This simple activity provides an environment where nurses are encouraged to interact and
53
54 communicate with each other. It also has a potential impact on IP&C as it limits staff leaving the
55
56 unit.
57
58

59
60 Culture is also reflected by the kinds of communication that occur within a team;
For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>
effective communication is important in order to obtain optimal patient outcomes.[34] During

1
2
3
4
5
6
7
8
9
10
11
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:

15
16
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:

21
22
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:

31
32
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).

36
37
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]

43
44
45 ***Participants who engaged in communal practice activities tended to monitor and support the***
46
47 ***use of recommended IP&C practices***

48
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.
60

1
2
3
4
5
6
7
8
9
10
11
12 A key grass root Hygiene in Practice (HIP) group, which consists of nurse representatives
13
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
27

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
39

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
49

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
54
55
56
57
58
59
60

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.html>

(Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:

1
2
3
4
5
6
7
8
9
10
11
12 Clear, practical information and pictures, gives good information, better because of the
13 photographs! (FG support staff, written comments, P13, 13).
14

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.
19
20 These comments brought forward by staff themselves are important to the development of
21 sustainable solutions.
22
23
24
25
26
27
28

29
30 ***In the face of numerous system constraints, participants viewed engaged leadership as***
31 ***important for IP&C***
32
33

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.).
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
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:
15
16

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.
34
35
36
37
38

39
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.
47
48
49
50
51
52
53
54

55
56 Overall, the hospital reports a prevalence count of patients identified with MRSA, VRE,
57 CDI, and ESBL isolates per month. The hospital does not regularly calculate infection rates for
58 these organisms. Thus, the estimated prevalence rates were calculated by using the proportion of
59
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
MRSA	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
VRE	5.0	0	0	0	0	0	0	0	0	1.7	0	0
CDI	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
ESBL	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,

1
2
3
4
5
6
7
8
9
10
11
12 environmental cleaning. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The
13
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
19
20 MDRO should focus on the control of many pathogens simultaneously, including those
21
22 pathogens that have not yet been identified.
23
24

25
26 Another factor that can have an impact on the rate of MDRO is the occupancy rate which
27
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
31
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
37
38 that periods of high occupancy levels were associated with higher MRSA incidence rates. In
39
40 another study by the Department of Health in the UK,[42] concluded that hospitals with higher
41
42 than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with
43
44 occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public
45
46 Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good
47
48 control of infections”. [43, p.1401] Thus, the results of our case study support the notion that the
49
50 bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the
51
52 prevalence of MDRO infections.
53
54
55
56
57
58

59
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

1
2
3
4
5
6
7
8
9
10
11
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.
19
20
21
22
23
24
25
26
27

28 Another support for IP&C in the study site that bears further scrutiny is the high level of
29 environmental cleaning. This includes the central bed washing system which consists of the
30 thorough washing of all hospital beds after patient discharge. According to the Dutch Working
31 Party on Infection Prevention Bed and Accessories guidelines (2007), “machine cleaning is
32 preferred to manual cleaning” because of the consistency in the cleaning procedure, the high
33 temperatures for washing and rinsing, the heavy work of manually washing a bed and the better
34 tracking mechanism of clean beds throughout the hospital. It would be worthwhile to study the
35 costs and benefits of this practice at the study site and in other contexts in further detail.
36
37
38
39
40
41
42
43
44
45
46

47 Despite the number of recommended practices in place, some barriers to sound IP&C
48 practices were also evident. For instance, specific environmental design challenges promoted
49 problematic workarounds, which are often developed by staff to adapt to the limitations of their
50 care environments.[44] As Amalberti and colleagues [33] argue, practitioners naturally migrate
51 to the boundaries of and even violate acceptable practices as they attempt to adapt to conflicting
52 work demands in complex health care systems. For example, practitioners, are less likely to
53 clean their hands if they do not have proper access to soap and water or an ABR, [45,46] and it
54 is recommended that dispensers should be placed in many convenient and accessible locations
55
56
57
58
59
60

1
2
3
4
5
6
7
8
9
10
11
12 for staff.[47-49] Furthermore, according to the WHO Guidelines on Hand Hygiene in Health
13
14 Care (2009), the ABHR dispensers should be located in the patient rooms at point of care.
15
16 However, on the study unit, the ABHR dispensers were only located outside the patient rooms.
17
18

19 Other environmental design issues that pose barriers to IP&C were also observable, such
20
21 as garbage bins that require handling to open. It is likely that similar design issues abound in
22
23 most acute care hospitals. Rathert and colleagues [50] recommend that organizations examine
24
25 how the implementation of policies and procedures influence the work and work environment of
26
27 nurses in order to avoid unfavourable workarounds. It is a tribute to the empowerment and
28
29 ingenuity of the staff that they innovate workarounds to try to deal with these systemic barriers
30
31 and support effective control of MDRO.
32
33
34

35 Another deficit at the study site was the calculation of unit-based consumption of ABHR
36
37 to monitor adherence to hand hygiene practices. There are no recommendations on how to
38
39 monitor compliance of hand hygiene in the Dutch guideline of hand hygiene for staff (Dutch
40
41 Working Party on Infection Prevention, 2007). However, the recommended method to monitor
42
43 hand hygiene compliance, according to the WHO Guidelines on Hand Hygiene in Health Care, is
44
45 by direct observations. Product consumption monitoring cannot determine if hand hygiene is
46
47 performed correctly and at appropriate times. It may also not properly reflect the overall product
48
49 consumption by healthcare providers, as it may also include the amount of product used by
50
51 visitors and/or patients (World Health Organization, 2009).
52
53
54
55

56 Furthermore, although a report of the antibiotic usage by physician is provided by the
57
58 pharmacy department on an annual basis, physicians are permitted to prescribe antibiotics at their
59
60 discretion. This may limit the efficacy of the process. More stringent guidelines on the
For peer review only: <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

1
2
3
4
5
6
7
8
9
10
11
12 restrictive use of antibiotics are needed as there is a trend for hospital pathogens to become more
13
14 resistant in the future.[51]

15
16
17 There were several limitations to this study. It is possible, for instance, that staff may
18
19 have altered their behavior from normal practices during unit observations. Furthermore, the
20
21 prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage and
22
23 antibiotic data were collected by hospital personnel not supervised by the researcher, limiting the
24
25 ability to assess the rigor of data collection. In addition, the focus of this study was on a specific
26
27 clinical unit of the hospital. These limitations were addressed by incorporating multiple methods
28
29 of data collection and by taking a broad socio-ecological system approach to study IP&C on the
30
31 unit. However, if feasible, it would be preferable in future case studies to collect all data across
32
33 sites through one researcher and study entire organizations or perhaps even regions to obtain a
34
35 more comprehensive picture of some aspects of the complex phenomena of IP&C.
36
37
38
39

40 CONCLUSION

41
42 This case study provided in-depth knowledge of the socio-ecological conditions present
43
44 on a surgical unit at a Netherlands hospital that reported rates of MDRO below 1%. These
45
46 findings suggest there is merit in further exploring the potential benefits of such health system
47
48 practices for optimal prevention and control of MDRO in modern hospital environments. Further
49
50 research on the benefits of practitioner-led community of practices on IP&C practices such as the
51
52 Hygiene in Practice group is also recommended. Additional case studies to compare these
53
54 practices to other acute care hospitals in a variety of countries would be a valuable way to better
55
56 understand what IP&C programs are most effective in which contexts, and for what reasons.
57
58
59
60

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

1
2
3
4
5
6
7
8
9
10
11
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.
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

References

- 1 Brooklyn Antibiotic Resistance Task Force. The cost of antibiotic resistance: Effect of
2 resistance among *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and
3 *Pseudomonas aeruginosa* on length of hospital stay. *Infect Control Hosp Epidemiol*
4 2002;**23**(2):106-108.
- 5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
2 Song X, Srinivasan A, Plaut D et al. Effect of nosocomial vancomycin-resistant enterococcal
bacteremia on mortality, length of stay and costs. *Infect Control Hosp Epidemiol*
2003;**24**(4):251-256.
- 3 Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes:
mortality, length of hospital stay and health care costs. *CID* 2006;**42**(Suppl 2):S82-S89.
- 4 Zoutman DE, Ford BD. The relationship between hospital infection surveillance and control
activities and antibiotic-resistant pathogen rates. *Am J Infect Control* 2005;**33**:1-5.
- 5 West TE, Guerry C, Hiott M et al. Effect of targeted surveillance for control of methicillin-
resistant *Staphylococcus aureus* in a community hospital system. *Infect Control Hosp Epidemiol*
2006;**27**(3):233-238.
- 6 Vriens M, Blok H, Fluit A et al. Costs associated with a strict policy to eradicate methicillin-
resistant *Staphylococcus aureus* in a Dutch university medical center: A 10-year survey. *Eur J*
Clin Microbiol Infect Dis 2002;**21**:782-786.
- 7 Backman C, Zoutman DE, Marck PB. An integrative review of the current evidence on the
relationship between hand hygiene interventions and the incidence of healthcare associated
infections. *Am J Infect Control* 2008;**36**(5):333-348.
- 8 Struelens MJ (1998). The epidemiology of antimicrobial resistance in hospital acquired
infections: problems and possible solutions. *BMJ* 1998;**317**:652-653.
- 9 Ali SH. A socio-ecological autopsy of the E. Coli O157:H7 outbreak in Walkerton, Ontario,
Canada. *Soc Sci Med* 2004;**58**(12):2601-2612.
- 10 Gloubeman S. Walkerton water and complex adaptive systems. *Hospital Quarterly*
2001;**4**:28-31.
- 11 Macdonald MT. From SARS to strategic actions reframing systems. *J Adv Nurs*
2004;**47**(5):544-550.
- 12 Waldvogel FA. Infectious diseases in the 21st century: Old challenges and new opportunities.
Int J Infect Dis 2004;**8**:5-12.
- 13 Edwards N, Mill J, Kothari AR. Multiple intervention research programs in community

1
2
3
4
5
6
7
8
9
10
11
12
13 14 Edwards N, Marck P, Virani T et al. Whole systems change in health care: Implications for
14 evidence-informed nursing service delivery models. University of Ottawa, Canada 2007;1- 115.

15 16 Stokols D. Translating social ecological theory into guidelines for community health
17 promotion. *Am J Health Promot* 1996;**10**(4):282-298.

18 19 20 Gunderson L, Holling CS. *Panarchy: understanding transformations in human and natural*
21 *systems*. Washington, DC: Island Press 2002.

22 23 24 Holling, CS. Two cultures of ecology. *Conservation Ecology* 1998;**2**(2):4.

25 26 27 28 29 30 31 Marck PB, Higgs ES, Edwards N et al. Generating adaptive health systems: An emerging
32 framework of research and restoration for a safer world. Social Science and Humanities Research
33 Council Working Paper Series: Paper #1 2006. Retrieved on June 3, 2007 from
34 <http://www.nursing.ualberta.ca/SaferSystems/projects.htm>

35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 19 Marck PB, Kwan JA, Preville B et al. Building safer systems by ecological design: using
restoration science to develop a medication safety intervention. *Qual Saf Health Care*
2006;**15**:92-97.

20 Irwin A. *Citizen science. A study of people, expertise and sustainable development*. Routledge
Taylor & Francis Group, New York, 1995;202.

21 Rhemtulla JM, Hall RJ, Higgs ES et al. Eighty years of change: vegetation in the montane
ecoregion of Jasper National Park, Alberta, Canada. *Can J For Res* 2002;**32**:2010-2021.

22 Gunderson LH, Holling, CS, Light, SS. *Barriers and bridges to the renewal of ecosystems*
and institutions. New York: Columbia University Press 1995.

23 Ostrom E. *Not just one best system: The diversity of institutions for coping with the commons*
in *Researching the culture in agri-culture: Social research for international agricultural*
development, Ed. Michael Cernea and Amir Kassam, Cambridge, MA: CABI Publishing,
2006;329-360.

24 Higgs ES. A quantity of engaging work to be done: Ecological restoration and morality in a
technological culture. *Restoration and Management Notes* 1991;**9**(2):97-103.

25 Higgs ES. What is good ecological restoration? *Conversation Biology* 1997;**11**(2):338-348.

26 Higgs E. The Bear in the kitchen. Ecological restoration in Jasper Park raises questions about
wilderness in the Disney age. *Alternatives Journal* 1999;**25**(2):30-35.

For peer review only - <http://bmjopen.bmj.com/site/about/guidelines.xhtml>

27 Higgs E. *Nature by design: People, natural process, and ecological restoration*. Cambridge,
MIT Press 2003.

1
2
3
4
5
6
7
8
9
10
11
12 28 Gunderson L, Folke C, Lee M et al. In memory of Mavericks. *Conservation Ecology*
13 2001;**6**(2):19.

14
15
16 29 Muto CA, Jernigan JA, Ostrowsky BE et al. SHEA guideline for preventing nosocomial
17 transmission of multidrug-resistant strains for *Staphylococcus aureus* and *Enterococcus*. *Infect*
18 *Control Hosp Epidemiol* 2003;**24**:362-386.

19
20 30 Yin RK. *Case study research design and methods, Third edition*. Sage Publications,
21 Thousand Oaks 2003;175.

22
23
24 31 Tellis W. Application of a case study methodology. *The Qualitative Report* 1997;**3**(3)
25 Retrieved September 1, 2007 from <http://www.nova.edu/ssss/QR/QR3-3/tellis2.html>

26
27 32 Marck PB, Higgs ES, Vieira ER et al. Through the eyes of practitioners: Adapting visual
28 research methods from ecological restoration to integrate the ethics, science, and practice of
29 safety in health care. *Health Care Systems Ergonomics & Patient Safety International*
30 *Conference Papers* 2008. Retrieved from
31 http://www.heps2008.org/abstract/data/PDF/Marck_Patricia.pdf.

32
33
34 33 Amalberti R, Vincent C, Auroy Y et al. Violations and migrations in health care: a framework
35 for understanding and management. *Qual Saf Health Care* 2006;**15**:66-71.

36
37
38 34 Frank JR, Brien S (Editors) on behalf of The Safety Competencies Steering Committee. The
39 safety competencies Enhancing patient safety across the health professions. Ottawa, ON:
40 Canadian Patient Safety Institute 2008.

41
42
43 35 Walker B, Carpenter SR, Anderies JM et al. Resilience management in social
44 ecological systems: A working hypothesis for a participatory approach. *Conservation Ecology*
45 2002;**6**:14.

46
47
48 36 Verhoef J, Beaujean D, Blok H et al. A Dutch approach to methicillin-resistant
49 *Staphylococcus aureus*. *Eur J Clin Microbiol Infect Dis* 1999;**18**:461-466.

50
51
52 37 Wertheim HFL, Vos MC, Boelens HAM et al. Low prevalence of methicillin-resistant
53 *Staphylococcus aureus* (MRSA) at hospital admission in the Netherlands: the value of search and
54 destroy and restrictive antibiotic use. *J Hosp Infect* 2004;**56**(4):321-325.

55
56
57 38 Vos MC, Behrendt MD, Melles DC et al. 5 years of experience implementing a methicillin-
58 resistant *Staphylococcus aureus* search and destroy policy at the largest university medical center
59 in the Netherlands. *Infect Control Hosp Epidemiol* 2009;**30**(10):977-984.

60
39 Cunningham JB, Kernohan WG, Sowney R. Bed occupancy and turnover interval as
determinant factors in MRSA infections in acute settings in Northern Ireland: 1 April 2001 to 31
March 2003. *J Hosp Infect* 2005;**61**:189-193.

1
2
3
4
5
6
7
8
9
10
11
12 40 Borg MA. Bed occupancy and overcrowding as determinant factors in the incidence of
13 MRSA infections within general ward settings. *J Hosp Infect* 2003;**54**:316-318.

14
15
16 41 Borg MA, Suda D, Scicluna E. Time-series analysis of the impact of bed occupancy rates on
17 the incidence of methicillin-resistant *Staphylococcus aureus* infection in overcrowded general
18 wards. *Infect Control Hosp Epidemiol* 2008;**29**(6):496-502.

19
20
21 42 Department of Health (UK). Hospital organisation, specialty mix and MRSA. Report no
22 9163. 2007.

23
24 43 Orendi, J. (2008). Health-care organisation, hospital-bed occupancy, and MRSA. *The Lancet*
25 2008;**371**:1401-1402.

26
27
28 44 Farrow TS, Black SM. Infection prevention and control in the design of healthcare facilities,
29 *Healthcare Papers* 2009;**9**(3):32-37.

30
31 45 Haas J, Larson E. Compliance with hand hygiene guidelines: Where are we in 2008? *Am J*
32 *Nurs* 2008;**108**(8): 40-44.

33
34
35 46 Pittet D, Hugonnet S, Harbarth S et al. Effectiveness of a hospital-wide program to improve
36 compliance with hand hygiene. *The Lancet* 2000;**356**(9238):1307-1312.

37
38 47 Creedon SA. Healthcare workers' hand decontamination practices: compliance with
39 recommended guidelines. *J Adv Nurs* 2005;**51**(3):208-216.

40
41
42 48 Suresh G, Cahill J. How "user friendly" is the hospital for practicing hand hygiene? An
43 ergonomic evaluation. *Journal of Quality and Patient Safety* 2007;**33**(3):171-179.

44
45
46 49 Harbarth S, Pittet D, Grady L et al. Interventional study to evaluate the impact of an alcohol-
47 based hand gel in improving hand hygiene compliance. *Pediatr Infect Dis J* 2001;**21**:489-495.

48
49
50 50 Rathert C, Ishqaidef G, May DR. Improving work environments in health care: Test of a
51 theoretical framework, *Health Care Manage Rev* 2009;**34**(4):334-343.

52
53 51 Struelens M. Multidisciplinary antimicrobial management teams: The way forward to control
54 antimicrobial resistance in hospitals. *Curr Opin Infect Dis* 2003;**16**(4):305-307.

55
56 52 Backman C, Marck PB, Krogman N et al. Barriers and Bridges to Infection Prevention and
57 Control: Results of a Case Study of a Canadian Surgical Unit, *CJIC* 2011: 233-242.

58
59 53 Buell L. *The environmental imagination: Thoreau, nature writing, and the formation of*
60 *American culture*. Cambridge, MA: Belknap Press of Harvard University Press 1995.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60



327x219mm (300 x 300 DPI)

Review only

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.

1
2
3 The objectives of the research were:
4

- 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 21st century societies and their health
44
45 systems.
46
47
48
49

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
56
57
58
59
60

1
2
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]
10
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]
34
35
36
37

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
55
56
57
58
59
60

1
2
3 room visits and over 336,000 outpatient visits. The patient average length of stay was 7.7 days.
4
5 The hospital occupancy rate was about 80% at any given time. There were 10,668 employees in
6
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.**
16
17
18
19
20
21

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
51
52
53
54
55
56
57
58
59
60

1
2
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
9

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.
36
37
38
39

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
54
55
56
57
58
59
60**

1
2
3 **groupings of coded visual and textual data, related emerging theory and research literature**
4
5 **were identified and discussed within the research team. Our analysis was sensitive to the**
6
7 **policies and procedures, prevalence rates, and other hospital documents that helped**
8
9 **contextualize these specific findings.**
10
11

12
13 The rigor of this study was supported by several measures. Observer bias was minimized
14
15 by using multiple methods to gather and verify evidence on the policies, practices and
16
17 surveillance data on IP&C at the study site. Each photo walkabout and focus group session was
18
19 audio-taped, transcribed, and then verified to ensure accuracy. Follow-up with local experts
20
21 including some participants, the manager of **IP&C** and a physician lead in infectious diseases,
22
23 was also executed to ensure accuracy of the data collected. Furthermore, the observation field
24
25 notes, photo walkabout and focus group findings were compared with findings from the other
26
27 data sources of organizational policies, prevalence rates, and other relevant data (such as bed
28
29 occupancy rates) as the iterative data analysis progressed. In addition, a researcher's journal was
30
31 kept to capture reflections on all the research related activities.
32
33
34
35

36 **RESULTS**

37
38 In the course of the analysis of the case study, six major themes were derived from the
39
40 iterative analysis. Each theme is illustrated with select findings below.
41
42

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
47 refers to the design of the work environment, the physical space, and the accessibility of
48
49 equipment; the work design is how the staff organizes their work, including the routines and the
50
51 workflow on the unit. Both are central to understanding human factors, which is “the scientific
52
53 discipline concerned with the understanding of interactions among humans and other elements of
54
55
56
57
58
59
60

1
2
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

27 Another example of workplace design is the garbage cans. One participant described his
28
29 concerns about the garbage bins with lids:
30
31

32 Here, you washed your hands and you throw away the paper towel and you have to touch
33
34 the lid of the dirty waste box again and in fact you have dirty hands again. Afterwards,
35
36 you should use the ABHR. You shouldn't have to touch anything (FG management, P12,
37
38 446).
39

40 This participant clearly recognized that hands can potentially become contaminated when
41
42 opening or closing waste baskets. Overall, the environmental design of the unit provides
43
44 challenges to proper IP&C practices thus leading to many workarounds.
45

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

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
56
57
58
59
60

1
2
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
5 system features that constrain their ability to accomplish their work. According to Amalberti,
6
7
8 workarounds are an inevitable feature of complex systems, and what we need to do is figure out
9
10
11 how to facilitate the safest possible adaptations within the context of individual practice and
12
13
14 evolving system constraints. Amalberti also distinguishes between adaptive workarounds at the
15
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
23 staff members to go out of the room to clean their hands. During the photo walkabout with a
24
25
26 physician participant, the issue of hand hygiene compliance was discussed in relation to non-
27
28
29 single patient rooms:

30 The only problem [is] that they have to wash their hands every, every time they care for a
31
32
33 patient and then go to another. That maybe... that's a risk [of] having more patients in a
34
35
36 room. If you have one patient in a room then you go out and you wash your hands. If you
37
38
39 have four patients in a room, you go to one patient then to the other... (PW physician, P8,
40
41
42 78).

43
44 During the photo walkabout with the ICP, the participant explained the workflow of staff when
45
46
47 they enter a single patient room as follows:

48 ... it should be in fact because you have to wash here; take off your gloves, put on ABHR
49
50
51 but there's no ABHR here [chuckles]; go out to the sluice (anteroom); take off the other
52
53
54 things and disinfect your hands again with ABHR. So in fact there should be ABHR at
55
56
57 this place ... (PW ICP, P6, 383).

58
59 In these situations, due to system constraints, staff members are required to leave the room to
60
clean their hands between patients, in order to avoid the kind of safety violation that Amalberti
and colleagues [33] discuss.

Participants viewed organizational and team cultures as integral to the way they enact IP&C practices in their workplaces

1
2
3
4 In the first set of national interdisciplinary safety competencies established for Canada,
5 Frank et al. [34] contend that the notion of a culture of patient safety is associated with
6 “attitudes, activities and enduring ethical values that are conducive to the safe delivery of patient
7 care” (p. 5). Several exemplars of organizational and team culture that were relevant to IP&C
8 became evident in the course of the research. For example, during the photo walkabout with a
9 participating physician and ICP, they explained that there is a change room on the unit where
10 staff can:
11
12
13
14
15
16
17
18
19

20 ... put on, [and] take off their own clothes and put on their hospital [uniform] before they
21 start working (PW physician and ICP, P8, 456).
22

23 During a follow-up interview, a key informant said:
24

25 Only a few staff members (<5%) wear their uniform outside the hospital. It’s a rare
26 occurrence. Most nurses change uniforms in the hospital (key informant).
27
28

29 This routine and highly consistent separation of work and street clothing is a notable example of
30 a shared practice that supports effective IP & C within the group. Another shared practice with
31 potential positive impact on **IP&C** that was observed is the unit team’s regular engagement in
32 shared breaks and evening meals in a staff lounge located on the unit (Observations, P1, 18).
33
34
35
36
37
38

39 During the photo walkabout with the physician, he explained that:
40

41 ... this is where the nurses...drink their coffee, [the] lounge (PW physician, P8, 354).
42
43

44 This simple activity provides an environment where nurses are encouraged to interact and
45 communicate with each other. It also has a potential impact on **IP&C** as it limits staff leaving the
46 unit.
47
48
49

50
51 Culture is also reflected by the kinds of communication that occur within a team;
52 effective communication is important in order to obtain optimal patient outcomes.[34] During
53 observations, a visible clear communication strategy that was identified was the isolation card
54
55
56
57
58
59
60

1
2
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
33
34
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
41 In the field of ecological restoration [24-27] and in health systems research, [19,32]
42 engaged practice refers to the vigilance, attentiveness and awareness of one's practices and each
43 other's practices in order to reinforce and actively use what one learns to foster better treatment
44 of each other and the places we share. Within healthcare, the concept of communities of practice,
45 where groups of professionals work on initiatives to create, implement and evaluate evidence-
46 based care improvements, may be thought of as one key forum for engaged practice.
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
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).
30

31
32 This is an example of a simple yet vital HIP initiative to support IP&C practices.
33

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

35
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.
40
41
42
43
44

45
46 An example of adaptive learning and growth is the evidence-informed education
47 provided by the grass roots HIP group that is built on current staff knowledge and experience,
48 and is geared to address gaps in practice. All surgical wards have a nurse participating in this
49 group. Many comments were received on the educational poster created by the HIP group
50
51 (Figure 3 Poster (HIP group) (NURS-19)). For example, a comment included:
52
53
54
55
56
57
58
59
60

1
2
3 Clear, practical information and pictures, gives good information, better because of the
4 photographs! (FG support staff, written comments, P13, 13).
5
6

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.
13
14
15
16
17
18
19

20
21 ***In the face of numerous system constraints, participants viewed engaged leadership as***
22 ***important for IP&C***
23
24

25
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.).
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
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
5
6 physician participant pointed out:
7
8

9
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).
12
13

14 As another participant noted:

15
16 What a good system...beds are cleaned well at the central bed cleaning department (FG
17 health professionals, written comments, P26, 08).
18
19

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.
25
26
27
28
29
30

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.
38
39
40
41
42
43
44
45
46
47

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
51
52
53
54
55
56
57
58
59
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
MRSA	5.01	3.25	1.69	1.66	1.77	1.66	1.74	1.94	3.60	0	6.69	1.67
VRE	5.0	0	0	0	0	0	0	0	0	1.7	0	0
CDI	5.0	8.13	3.37	3.32	5.31	3.32	0	1.94	5.40	5.12	1.67	8.33
ESBL	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

1
2
3 environmental cleaning. The monthly VRE prevalence rate in 2008 ranged from 0-0.5%. The
4
5 CDI prevalence rate ranged from 0-0.8% and the monthly ESBL prevalence rate was somewhat
6
7 higher, 0.98%-4.27%. Although MRSA, VRE and CDI rates may be below 1%, other pathogens
8
9 such as ESBL may not appear to be as controlled. A comprehensive **IP&C** program for all
10
11 MDRO should focus on the control of many pathogens simultaneously, including those
12
13 pathogens that have not yet been identified.
14
15

16
17
18 Another factor that can have an impact on the rate of MDRO is the occupancy rate which
19
20 was reported as approximately 80%. Studies have shown that lower occupancy rates are linked to
21
22 lower infection rates (National Audit Office, 2004). In a study in Northern Ireland, the bed
23
24 occupancy rate was found to have a significant positive correlation with MRSA rates in
25
26 hospitals.[39] Also, another study by Borg [40] found a significant correlation between the bed
27
28 occupancy rate and the MRSA infection rates. Similarly, Borg and colleagues [41] concluded
29
30 that periods of high occupancy levels were associated with higher MRSA incidence rates. In
31
32 another study by the Department of Health in the UK,[42] concluded that hospitals with higher
33
34 than 90% occupancy rates had a 10.3% greater incidence of MRSA infection than those with
35
36 occupancies below 85%. Furthermore, “in the UK, the House of Commons Committee of Public
37
38 Accounts has repeatedly noted that high levels of bed occupancy are not consistent with good
39
40 control of infections”. [43, p.1401] Thus, the results of our case study support the notion that the
41
42 bed occupancy rate can provide a useful measure of a hospital's ability to prevent and control the
43
44 prevalence of MDRO infections.
45
46
47
48
49

50
51 Another bridge to IP&C is the support provided by management for the Hygiene in
52
53 Practice (HIP) group. This grassroots group incorporates sound IP&C practices into the
54
55 workplace. The group also provides support amongst individuals to value IP&C in the
56
57
58
59
60

1
2
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.

10
11
12
13
14
15
16
17
18
19
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.

28
29
30
31
32
33
34
35
36
37
38
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
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
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.
5
6

7
8 However, on the study unit, the ABHR dispensers were only located outside the patient rooms.
9

10
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.
18
19
20
21
22
23
24
25
26

27
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).
37
38
39
40
41
42
43
44
45
46
47

48
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
52
53
54
55
56
57
58
59
60

1
2
3 restrictive use of antibiotics are needed as there is a trend for hospital pathogens to become more
4
5 resistant in the future.[51]
6

7
8 There were several limitations to this study. It is possible, for instance, that staff may
9
10 have altered their behavior from normal practices during unit observations. Furthermore, the
11
12 prevalence counts of MRSA, VRE, CDI and ESBL, the rates of hand hygiene product usage and
13
14 antibiotic data were collected by hospital personnel not supervised by the researcher, limiting the
15
16 ability to assess the rigor of data collection. In addition, the focus of this study was on a specific
17
18 clinical unit of the hospital. These limitations were addressed by incorporating multiple methods
19
20 of data collection and by taking a broad socio-ecological system approach to study IP&C on the
21
22 unit. However, if feasible, it would be preferable in future case studies to collect all data across
23
24 sites through one researcher and study entire organizations or perhaps even regions to obtain a
25
26 more comprehensive picture of some aspects of the complex phenomena of IP&C.
27
28
29
30

31 CONCLUSION

32
33
34 This case study provided in-depth knowledge of the socio-ecological conditions present
35
36 on a surgical unit at a Netherlands hospital that reported rates of MDRO below 1%. These
37
38 findings suggest there is merit in further exploring the potential benefits of such health system
39
40 practices for optimal prevention and control of MDRO in modern hospital environments. Further
41
42 research on the benefits of practitioner-led community of practices on IP&C practices such as the
43
44 Hygiene in Practice group is also recommended. Additional case studies to compare these
45
46 practices to other acute care hospitals in a variety of countries would be a valuable way to better
47
48 understand what IP&C programs are most effective in which contexts, and for what reasons.
49
50

51
52
53 **Furthermore, findings from this research can inform current and future efforts to provide**
54
55 **infection prevention and control programs and strategies that are socio-ecologically sound.**
56
57
58
59
60

1
2
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.**
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

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.

References

- 1 Brooklyn Antibiotic Resistance Task Force. The cost of antibiotic resistance: Effect of resistance among *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* on length of hospital stay. *Infect Control Hosp Epidemiol* 2002;**23**(2):106-108.
- 2 Song X, Srinivasan A, Plaut D et al. Effect of nosocomial vancomycin-resistant enterococcal bacteremia on mortality, length of stay and costs. *Infect Control Hosp Epidemiol* 2003;**24**(4):251-256.
- 3 Cosgrove SE. The relationship between antimicrobial resistance and patient outcomes: mortality, length of hospital stay and health care costs. *CID* 2006;**42**(Suppl 2):S82-S89.
- 4 Zoutman DE, Ford BD. The relationship between hospital infection surveillance and control activities and antibiotic-resistant pathogen rates. *Am J Infect Control* 2005;**33**:1-5.
- 5 West TE, Guerry C, Hiott M et al. Effect of targeted surveillance for control of methicillin-resistant *Staphylococcus aureus* in a community hospital system. *Infect Control Hosp Epidemiol* 2006;**27**(3):233-238.
- 6 Vriens M, Blok H, Fluit A et al. Costs associated with a strict policy to eradicate methicillin-resistant *Staphylococcus aureus* in a Dutch university medical center: A 10-year survey. *Eur J Clin Microbiol Infect Dis* 2002;**21**:782-786.
- 7 Backman C, Zoutman DE, Marck PB. An integrative review of the current evidence on the relationship between hand hygiene interventions and the incidence of healthcare associated infections. *Am J Infect Control* 2008;**36**(5):333-348.
- 8 Struelens MJ (1998). The epidemiology of antimicrobial resistance in hospital acquired infections: problems and possible solutions. *BMJ* 1998;**317**:652-653.
- 9 Ali SH. A socio-ecological autopsy of the E. Coli O157:H7 outbreak in Walkerton, Ontario, Canada. *Soc Sci Med* 2004;**58**(12):2601-2612.
- 10 Gloubeman S. Walkerton water and complex adaptive systems. *Hospital Quarterly* 2001;**4**:28-31.
- 11 Macdonald MT. From SARS to strategic actions reframing systems. *J Adv Nurs* 2004;**47**(5):544-550.
- 12 Waldvogel FA. Infectious diseases in the 21st century: Old challenges and new opportunities. *Int J Infect Dis* 2004;**8**:5-12.
- 13 Edwards N, Mill J, Kothari AR. Multiple intervention research programs in community health. *Can J Nurs Res* 2004;**36**(1):40-54.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

14 Edwards N, Marck P, Virani T et al. Whole systems change in health care: Implications for evidence-informed nursing service delivery models. University of Ottawa, Canada 2007;1- 115.

15 Stokols D. Translating social ecological theory into guidelines for community health promotion. *Am J Health Promot* 1996;**10**(4):282-298.

16 Gunderson L, Holling CS. *Panarchy: understanding transformations in human and natural systems*. Washington, DC: Island Press 2002.

17 Holling, CS. Two cultures of ecology. *Conservation Ecology* 1998;**2**(2):4.

18 Marck PB, Higgs ES, Edwards N et al. Generating adaptive health systems: An emerging framework of research and restoration for a safer world. Social Science and Humanities Research Council Working Paper Series: Paper #1 2006. Retrieved on June 3, 2007 from <http://www.nursing.ualberta.ca/SaferSystems/projects.htm>

19 Marck PB, Kwan JA, Preville B et al. Building safer systems by ecological design: using restoration science to develop a medication safety intervention. *Qual Saf Health Care* 2006;**15**:92-97.

20 Irwin A. *Citizen science. A study of people, expertise and sustainable development*. Routledge Taylor & Francis Group, New York, 1995;202.

21 Rhemtulla JM, Hall RJ, Higgs ES et al. Eighty years of change: vegetation in the montane ecoregion of Jasper National Park, Alberta, Canada. *Can J For Res* 2002;**32**:2010-2021.

22 Gunderson LH, Holling, CS, Light, SS. *Barriers and bridges to the renewal of ecosystems and institutions*. New York: Columbia University Press 1995.

23 Ostrom E. *Not just one best system: The diversity of institutions for coping with the commons* in Researching the culture in agri-culture: Social research for international agricultural development, Ed. Michael Cernea and Amir Kassam, Cambridge, MA: CABI Publishing, 2006;329–360.

24 Higgs ES. A quantity of engaging work to be done: Ecological restoration and morality in a technological culture. *Restoration and Management Notes* 1991;**9**(2):97-103.

25 Higgs ES. What is good ecological restoration? *Conversation Biology* 1997;**11**(2):338-348.

26 Higgs E. The Bear in the kitchen. Ecological restoration in Jasper Park raises questions about wilderness in the Disney age. *Alternatives Journal* 1999;**25**(2):30-35.

27 Higgs E. *Nature by design: People, natural process, and ecological restoration*. Cambridge, MIT Press 2003.

- 1
2
3 28 Gunderson L, Folke C, Lee M et al. In memory of Mavericks. *Conservation Ecology*
4 2001;**6**(2):19.
5
6
7 29 Muto CA, Jernigan JA, Ostrowsky BE et al. SHEA guideline for preventing nosocomial
8 transmission of multidrug-resistant strains for *Staphylococcus aureus* and *Enterococcus*. *Infect*
9 *Control Hosp Epidemiol* 2003;**24**:362-386.
10
11 30 Yin RK. *Case study research design and methods, Third edition*. Sage Publications,
12 Thousand Oaks 2003;175.
13
14 31 Tellis W. Application of a case study methodology. *The Qualitative Report* 1997;**3**(3)
15 Retrieved September 1, 2007 from <http://www.nova.edu/ssss/QR/QR3-3/tellis2.html>
16
17
18 32 Marck PB, Higgs ES, Vieira ER et al. Through the eyes of practitioners: Adapting visual
19 research methods from ecological restoration to integrate the ethics, science, and practice of
20 safety in health care. *Health Care Systems Ergonomics & Patient Safety International*
21 *Conference Papers* 2008. Retrieved from
22 http://www.heps2008.org/abstract/data/PDF/Marck_Patricia.pdf.
23
24
25 33 Amalberti R, Vincent C, Auroy Y et al. Violations and migrations in health care: a framework
26 for understanding and management. *Qual Saf Health Care* 2006;**15**:66-71.
27
28
29 34 Frank JR, Brien S (Editors) on behalf of The Safety Competencies Steering Committee. The
30 safety competencies Enhancing patient safety across the health professions. Ottawa, ON:
31 Canadian Patient Safety Institute 2008.
32
33
34 35 Walker B, Carpenter SR, Anderies JM et al. Resilience management in social ecological
35 systems: A working hypothesis for a participatory approach. *Conservation Ecology* 2002;**6**:14.
36
37
38 36 Verhoef J, Beaujean D, Blok H et al. A Dutch approach to methicillin-resistant
39 *Staphylococcus aureus*. *Eur J Clin Microbiol Infect Dis* 1999;**18**:461-466.
40
41
42 37 Wertheim HFL, Vos MC, Boelens HAM et al. Low prevalence of methicillin-resistant
43 *Staphylococcus aureus* (MRSA) at hospital admission in the Netherlands: the value of search and
44 destroy and restrictive antibiotic use. *J Hosp Infect* 2004;**56**(4):321-325.
45
46
47 38 Vos MC, Behrendt MD, Melles DC et al. 5 years of experience implementing a methicillin-
48 resistant *Staphylococcus aureus* search and destroy policy at the largest university medical center
49 in the Netherlands. *Infect Control Hosp Epidemiol* 2009;**30**(10):977-984.
50
51
52 39 Cunningham JB, Kernohan WG, Sowney R. Bed occupancy and turnover interval as
53 determinant factors in MRSA infections in acute settings in Northern Ireland: 1 April 2001 to 31
54 March 2003. *J Hosp Infect* 2005;**61**:189-193.
55
56
57 40 Borg MA. Bed occupancy and overcrowding as determinant factors in the incidence of
58 MRSA infections within general ward settings. *J Hosp Infect* 2003;**54**:316-318.
59
60

1
2
3
4 41 Borg MA, Suda D, Scicluna E. Time-series analysis of the impact of bed occupancy rates on
5 the incidence of methicillin-resistant *Staphylococcus aureus* infection in overcrowded general
6 wards. *Infect Control Hosp Epidemiol* 2008;**29**(6):496-502.
7

8
9 42 Department of Health (UK). Hospital organisation, specialty mix and MRSA. Report no
10 9163. 2007.
11

12
13 43 Orendi, J. (2008). Health-care organisation, hospital-bed occupancy, and MRSA. *The Lancet*
14 2008;**371**:1401-1402.
15

16
17 44 Farrow TS, Black SM. Infection prevention and control in the design of healthcare facilities,
18 *HealthcarePapers* 2009;**9**(3):32-37.
19

20
21 45 Haas J, Larson E. Compliance with hand hygiene guidelines: Where are we in 2008? *Am J*
22 *Nurs* 2008;**108**(8): 40-44.
23

24
25 46 Pittet D, Hugonnet S, Harbarth S et al. Effectiveness of a hospital-wide program to improve
26 compliance with hand hygiene. *The Lancet* 2000;**356**(9238):1307-1312.
27

28
29 47 Creedon SA. Healthcare workers' hand decontamination practices: compliance with
30 recommended guidelines. *J Adv Nurs* 2005;**51**(3):208-216.
31

32
33 48 Suresh G, Cahill J. How "user friendly" is the hospital for practicing hand hygiene? An
34 ergonomic evaluation. *Journal of Quality and Patient Safety* 2007;**33**(3):171-179.
35

36
37 49 Harbarth S, Pittet D, Grady L et al. Interventional study to evaluate the impact of an alcohol-
38 based hand gel in improving hand hygiene compliance. *Pediatr Infect Dis J* 2001;**21**:489-495.
39

40
41 50 Rathert C, Ishqaidef G, May DR. Improving work environments in health care: Test of a
42 theoretical framework, *Health Care Manage Rev* 2009;**34**(4):334-343.
43

44
45 51 Struelens M. Multidisciplinary antimicrobial management teams: The way forward to control
46 antimicrobial resistance in hospitals. *Curr Opin Infect Dis* 2003;**16**(4):305-307.
47

48
49 52 Backman C, Marck PB, Krogman N et al. Barriers and Bridges to Infection Prevention and
50 Control: Results of a Case Study of a Canadian Surgical Unit, *CJIC* 2011: 233-242.
51

52
53 53 Buell L. *The environmental imagination: Thoreau, nature writing, and the formation of*
54 *American culture*. Cambridge, MA: Belknap Press of Harvard University Press 1995.
55
56
57
58
59
60