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Dress code and traffic flow in the operating room: A multicentre study of staff discipline during surgical procedures.

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Editor-in-Chief
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Nantes, March 22, 2017

Dear Editor,

We are submitting a revised version of the manuscript No. JHI-D-17-00145 entitled "**Dress code and traffic flow in the operating room: A multicentre study of staff discipline during surgical procedures.**" with G. Loison, R. Troughton, F. Raymond, D. Lepelletier, J.C. Lucet, C. Avril, G. Birgand as coauthors. We have followed your advice and shorten the manuscript. Thus, as suggested in your Email, we are resubmitting our work as a "Short report".

We also took reviewers comments in consideration as follow:

- Reviewer #1: There is a flaw in Figure 1. The type font used for the tables is unreadable on printing or on screen as a PDF. I would recommend changing the font and checking it is readable.
We tried to improve the Figure 1 by changing the format.
- Reviewer #2: Page 12, line 12-15: "The mean number was higher during--" This finding was not significant?
The sentence was changed as follow: "The variability in the number of people present was significantly different according to specialties ($p<0.01$), and non-significantly higher during urgent procedures (6.1 vs 5.3, $p=0.09$) and in university hospitals (5.9 vs 5.4 in general hospitals and 5.16 in private, $p=0.22$)."

I hope our work will be considered favourably for publication. If so, I will deal with the prepublication matters and will be the corresponding author.

Sincerely,

Dr. Gabriel Birgand, PharmD PhD

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Dress code and traffic flow in the operating room: A multicentre study of staff discipline during surgical procedures.

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Antimicrobial Resistance at Imperial College London, in partnership with Public Health
England (PHE), and the NIHR Imperial Patient Safety Translational Research Centre.

Abstract

This multicentre study assessed the clothing and traffic flow of operating staff during surgical procedures. Among 1615 surgical attire audited, 56% respected the eight clothing measures. The lack of compliance was due to inappropriate wearing of jewels (26%), and head cover (25%). Among 212 procedures observed, 5 (IQR, 4 – 6) persons were present in median at the incision. The median frequency of entries/exits was 10.6 (6-29) per hour varying from 0-93. Reasons of entries/exits were mainly the lack of material (364, 44.5%). Operating rooms with a low respect of clothing rules seemed to generate a high traffic flow ($p=0.12$).

INTRODUCTION

Surgical-site contamination may originate from the operating room (OR) staff or OR environment, although the transmission mechanisms remain unclear.¹ A correlation between air contamination with microorganisms and wound contamination after total hip or knee surgery has been reported in the past,² and identical *Staphylococcus spp* have been cultured from OR staff skin flora, the OR air, and patient wounds during cardiothoracic surgery.³

Recommendations on OR staff behaviours are mainly based on the surgical attire (wearing a cap and scrub suit) and the restriction of traffic in the OR. These two factors have been advocated as a means to decrease air contamination and wound colonization.⁴ However, recommendations in this field are based on expert advice, as no robust scientific evidence is available to substantiate them.

A recent literature review suggested an impact of surgical team behaviour on the SSI risk and, therefore, opportunities for improvement.⁵ Door openings have been demonstrated to adversely affect air exchange, air quality, and positive pressure in the OR compared with adjacent rooms.⁶ Moreover, studies demonstrated that the traffic flow is a cause of distraction and interruptions for the surgical team and therefore contributes to the risk of adverse events.⁷

The present study assessed the discipline of OR staff represented by measuring clothing and the traffic flow during surgical procedures, and investigated the reasons of non-compliance.

MATERIAL and METHODS

From January to September 2015, 17 health care facilities (HCFs) situated in western France (out of 41 contacted) accepted to participate in the study. Among them, 2 (12%) were university hospitals, 7 (41%) public and 8 (47%) private facilities. Surgeries initially selected were: orthopaedic with hip or knee replacement, gastro-intestinal surgery with hernia, obstetric with caesarean section (CS), gynaecology with hysterectomy and other types of surgery. Some hospitals decided to extend the survey to other specialities: urology, ophthalmology, ears nose throat and cardiovascular surgery. Procedures included were elective or urgent, conventional or laparoscopic surgery, for hospitalised or ambulatory adult patients. All categories of HCPs present in the OR during the period of observation were included for the evaluation of the clothing and the traffic flow.

The compliance with clothing regulations was observed at patient entry in the OR in 17 HCFs among 61 surgical teams, including the following criteria: (1) scrub suit worn, and (2) without ordinary clothes under the suit; (3) surgical caps/hoods worn, (4) completely covering hair, (5) mask worn by “scrubbed and non-scrubbed” staff in the OR, and (6) correctly placed on the mouth and nose; (7) no nail polish or jewellery on hands, (8) specific OR shoes or shoe covers. A score of one point was given for each compliance with individual criteria and the addition of these points gave a final composite score from 1 to 8. A mean score obtained for HCPs belonging to the same OR was then computed to assess the compliance at the team level.

The traffic flow was assessed in 15 HCFs and 43 surgical teams. This traffic was estimated by the number and reason for entries/exits during the period from incision to wound closure including every HCP categories. The number of persons present in the OR was recorded at the cutaneous incision.

Direct observations were performed by either nurses of the surgical team or infection control team members, and HCPs were informed of the audit. Univariate comparisons used a Chi-square tests or a Mann–Whitney U-test, as appropriate. These analyses were performed using Stata release 10.0 (Stata Corp LP, College Station, TX).

RESULTS

Among the 295 operations included in the evaluation clothing, 26 (9%) were in university hospitals, 125 (42%) in public and 144 (49%) in private hospitals. Orthopaedic surgery accounted for 102 (35%) procedures, 72 (24%) were gastro-intestinal, 54 (18%) gynaecology, 19 (64%) obstetric, and the 48 remaining in the five others specialties. The surgery was elective in 260 (88 %) situations, urgent in 14 (4%) others and the 7% remaining were not recorded. Among the 1615 professionals observed, 295 (18%) were surgeons, 445 (27%) anaesthetists, 566 (35%) nurses and 309 (19%) belonged to other categories.

When aggregating the eight criteria, 56% (n=904) of the 1615 HCPs observed fully complied with clothing regulations. The mean score for the compliance with clothing was 7.4 among the 8 indicators assessed. The analysis by subcategories showed increased clothing compliance for HCPs working in orthopaedic surgery (mean score: 7.45, $p<0.01$) compared to other specialties and for surgeons and nurses in comparison to anaesthetists and other HCPs categories (mean score: 7.5 and 7.6 vs 6.9 and 7.3; $p<0.01$).

For HCPs complying with only 6 criteria or less, the lack of compliance was due to either the position of the head cover (56 to 79%), the presence of hand jewellery (69 to 86%), or the face mask position (19 to 59%).

The traffic flow of HCPs estimated by entries/exits was observed during 212 operations: 66 (31%) in orthopaedic surgery (25 hip replacement, 14 knee replacement and 27 others), 64 (30%) in obstetrics and gynaecology (17 CS, 9 hysteroscopy, 7 hysterectomy, 6 tumorectomy, 25 others), 57 (27%) in gastrointestinal (28 hernia repairs, 10 cholecystectomies), 11 cataract operations, 9 cardiovascular surgery, two urology, and one each of dermatology and ENT. Among the 212 procedures, 200 (94%) were elective surgery and 12 (9%) were urgent procedures. The median turnaround time of procedures from wound incision to closure was 37 minutes (IQR: 22-61).

The median number of persons at wound incision and the median frequencies of entries/exits from incision to closure are displayed in Table 1. The variability in the number of people present was significantly different according to specialties ($p<0.01$), and non-significantly higher during urgent procedures (6.1 vs 5.3, $p=0.09$) and in university hospitals (5.9 vs 5.4 in general hospitals and 5.16 in private, $p=0.22$).

Among the 212 procedures observed from wound incision to closure, a median of 10.6 (IQR: 6-20) entries/exits were observed per hour and varied from 0 to 93 per hour. This median frequency varied from 9/h (IQR: 5-16, Min-Max: 0-93) in private hospitals to 20/h (IQR: 11-27, Min-Max: 7-67) in university hospitals ($p<0.01$).

During THR and TKR, the frequency varied from 0 to 51/h ($p=0.01$) across ORs and from 9 to 51/h in a same OR. A significant increase of entries/exits was observed during CS with a median of 29/h (20-39) rising to a maximum of 93 entries/exits per hour.

The anaesthesia team generated 4 (IQR: 0-9, Min: 0, Max: 82) doors openings per hour, nurses 1/h (IQR: 0-7, Min: 0, Max: 40), surgeons 0/h (IQR: 0-0, Min: 0, Max: 16) and 0/h (IQR: 0-1, Min: 0, Max: 39) ($p<0.01$) for persons from other categories. The rate of entries/exits per hour was significantly correlated with the number of people in the OR ($r=0.22$, $p<0.01$).

1 A total of 817 reasons of entries/exits were recorded. Among them, 364 (44.5%)
2 corresponded to the need for equipment, 113 (13.8%) for communication and 107 (13.1%)
3 were linked to staffing (the switch of team members in 72 situations (8.8%), lunch or coffee
4 breaks in 21 (2.6%) situations). The 233 remaining reasons were not classifiable. A non-
5 significant elevated traffic flow was observed in ORs with HCFs poorly complying with
6 clothing rules ($r = -0.09$, $p = 0.3$).
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16 **DISCUSSION**

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22 This study suggests an overall good respect of the dress code and a suboptimal
23 discipline of OR staff regarding the traffic flow during surgical procedures.
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29 Despite the singularity of the high risk environment represented by the OR, actors are
30 sometimes omitting basic rules of discipline as a matter of routine, even in presence of clear
31 national/local guidelines. The lack of awareness and knowledge of regulations may explain
32 the relatively low compliance with the dress code observed in the present study. Moreover,
33 the low level of evidence regarding the impact of surgical attire on the infectious risk is
34 controversial among both experts and OR staff, contributing to the establishment of traditions
35 or rituals.⁸
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48 Movement of OR staff compromises the efficiency of ventilation systems.⁹
49 Additionally, the number of staff in the OR and their subsequent entries/exits may increase
50 the level of noise, distract or interrupt the surgical team during procedures, increasing the risk
51 of post-operative complications.⁵ Efforts in this field may improve the quality of cares and
52 patient safety. The pooled 11,713 doors openings from five studies (the present results added
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of those from four previous studies), suggest that 30% (Min-Max: 15-44) of entries/exits are due to a lack of equipment, 15% (1-24) for lunch/coffee breaks/shift change, and 14% (7-27) for scrubbed team activities.⁵ No explanation was given for 21% (8-47) of entries/exits. Thus, a large part of entries/exits may be avoided. Several interventional studies mainly based on processes/skills training and education of surgical staff led up to 50% reduction of doors openings.¹⁰

The traffic flow in the present study was significantly higher in university hospitals and within the anaesthesia team, and was correlated with the number of people present at the incision. Public HCFs are responsible for the education and training of staff, which may explain this difference. For some procedures, the anaesthesia team manages several patients at the same time, or special cares can be implemented (e.g. new-born management after CS) contributing to an increase of traffic flow.

To our knowledge, this is the first multicentre study simultaneously assessing the dress code and traffic flow in a large number of procedures, from a diverse panel of surgical specialties. A trend was observed between the compliance with clothing regulations and traffic flow suggesting that the discipline in the OR can be seen as an overall factor influencing patient safety. Data were collected by direct observations and were probably subject to the Hawthorne effect. This potential bias may emphasize the finding that despite a potential effort of OR staff, practice remains weak with much room for improvement.

CONCLUSION

This study suggests a potential room for improvement in the respect of the dress code of operating staff and a suboptimal traffic flow in OR mainly due to a lack of material and communication during interventions.

Acknowledgements

This research was partially funded by the National Institute for Health Research (NIHR) Health Protection Research Unit in Healthcare Associated Infection and Antimicrobial Resistance at Imperial College London, in partnership with Public Health England (PHE), and the NIHR Imperial Patient Safety Translational Research Centre. The views expressed are those of the author(s) and not necessarily those of the National Health Service (NHS), the NIHR, the Department of Health, or PHE. The authors also acknowledge the UK Clinical Research Collaboration Centre for Infection Prevention and Management, Imperial College Healthcare NHS Trust, and the NIHR Imperial Biomedical Research Centre.

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Table 1: Description and comparison of the number of persons at wound incision and the traffic flow from incision to closure in ORs.

At wound incision	Number of persons			p	Frequency of entries/exits per hour			p
	Mean	Median (IQR)	Min-Max		Mean	Median (IQR)	Min-Max	
Overall	5.3	5 (4-6)	2-10		14.9	10 (6-20)	0-93	
Type of hospital				0.22				<0.01
University hospital	5.9	6 (4-7)	2-10		24	20 (11-27)	7-67	
Public hospitals	5.4	5 (4-6)	3-10		17	14 (8-23)	0-78	
Private hospitals	5.16	5 (4-6)	2-10		13	9 (5-16)	0-93	
Type of surgery				<0.01				<0.01
Orthopaedic	5.5	5 (4-6)	3-10	0.03	12	9 (4-15)	0-78	0.06
THR	5.7	6 (5-6)	3-9		9	7 (3-12)	0-51	
TKR	6.1	6 (5-7)	3-9		8	8 (5-10)	0-18	

Other procedures	5	5 (4-6)	3-8		17	12 (7-22)	0-78	
Gynecology/ Obstetric	5.5	5 (4-7)	2-10	<0.01	20	13 (8-25)	0-93	<0.01
C-section	7.1	7 (6-8)	5-10		30	29 (20-39)	10-42	
Other procedures	4.9	5 (4-6)	2-10		16	12 (7-20)	0-93	
Gastro-intestinal	5.3	5 (4-6)	3-10	0.81	14	9 (6-19)	0-67	0.14
Hernia repair	5.3	5 (4-7)	3-8		12	8 (5-16)	0-67	
Other procedures	5.2	5 (4-6)	3-10		15	13 (7-21)	0-62	
Others	3.9	4 (4-4)	2-5		13	11 (5-20)	0-48	
Type of procedure				0.1				0.36
Elective	5	5 (4-6)	2-10		15	11 (6-20)	0-93	
Urgent	6	6 (4.5-7.5)	4-9		22	13 (7-29)	0-78	

Abbreviations: IQR, intra quartile range; THR, total hip replacement; TKR, total knee replacement

Figure