

Hand washing in operating room: a procedural comparison

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ABSTRACT

Background: Hand washing has been considered a measure of personal hygiene for centuries and it is known that improper hand hygiene among healthcare workers is responsible for about 40% of healthcare-associated infections. Therefore, surgical hand preparation is a critical element for healthcare safety in order to reduce the microbial contamination of surgical wounds in case of a non-detected perforation of a glove. The aim of our study was to evaluate the efficacy of three antiseptics: Povi-iodine scrub, EPG (Ethanol, Hydrogen Peroxide, Glycerol) recommended by WHO and common Marseille soap in a liquid formulation.

Methods: We designed a single-centre pre-post study conducted in the University Hospital of Messina, from January to June 2013. We asked operating room personal to put the fingertips of their right hand (if not left-handed) for one minute on PCA medium, before washing with the three types of antiseptics, and after washing and drying. Drying was completed using sterile gauzes or disposable wipes. We then measured the number of colony forming units per mL (CFU/mL) and calculated the percentage of microbial load reduction. The criteria for inclusion were to be part of a surgical team ready to perform a surgical intervention within 20 minutes of subsequent sampling. The Mann Whitney test was used to verify if the reduction of microbial load was statistically significant for each antiseptic.

Results: 210 samples were considered for statistical analysis. Washing with Marseille soap led to a reduction of microbial load of 64,3% (standard deviation s.d. 25,6), washing with Povi-iodine scrub of 75,9% (s.d. 27,1), washing with EPG of 86,5% (s.d. 20,4). The reduction of the microbial load was statistically significant (p value < 0,01) for each antiseptic.

Conclusions: Although washing with Marseille soap and with Povi-iodine scrub led to a statistically significant reduction of the microbial load of the hands, our study showed that washing with EPG had superior efficacy in CFU reduction. Antiseptic hand washing, however, should not be considered the only measure to reduce infections: the anomaly of some results (initial microbial load lower than after washing) demonstrated that drying is an essential phase in the pre-surgical preparation. Therefore, hand hygiene must be part of a more complex strategy of surveillance and control of healthcare-associated infections.

Key words: hand washing, surgery, healthcare-associated infections.

INTRODUCTION

Hand washing with soap and water has been considered a measure of personal hygiene for centuries [1, 2]. The link between poor hand hygiene and the spread of disease was established two centuries ago: this can be considered as relatively early considering that the discoveries of Pasteur and Lister occurred decades later. The importance of hand hygiene in preventing childbed fever was recognised as early as 1840s by Dr. Oliver Wendell Holmes and in the late 1840's by Dr. Ignaz Semmelweis in reducing maternal mortality in a Vienna hospital [3].

Improper hand hygiene among healthcare workers is responsible for about 40% of healthcare-associated infections [4-6]. Moreover, because of the possibility of glove perforations, various measures have been developed to reduce the risk of surgical site contamination with microorganisms originating from the surgeon's hands. A standard practice for decreasing the microbial bio-burden on the hands of surgeons and other surgical team members is preoperative surgical hand disinfection with an anti-microbial soap (surgical scrub) or an alcohol-based hand disinfectant (surgical rub). Preoperative surgical hand disinfection can reduce, but not eradicate, the resident flora on the surgeon's hands and thus does not totally eliminate the risk of microorganisms transmission into the surgical site in the event of a glove perforation [7-9].

Surgical hand preparation is therefore a critical element for healthcare safety in order to reduce the microbial contamination of a surgical wound in the event of a non-detected break of the glove [10-12].

The World Health Organization (WHO) recommends the use of alcohol-based hand rubs composed of ethanol, glycerol and hydrogen peroxide both for hygienic hand antisepsis and for pre-surgical hand preparation [3].

"EPG" is one of the antiseptic solutions recommended by the World Health Organization: it is composed of ethanol at 80%, hydrogen peroxide 0,125%, glycerol 1,45%. It is necessary to pour 2 ml of this solution on the palm and rub until hands surfaces are dry. The Antimicrobial activity of alcohol is due to its capacity to denature proteins [13], especially at a concentration of 60-80% [14, 15]. Alcohol is not active against spores so it is recommended to wash hands with soap and water before entering the operating room [16]. Alcohol-based hand rubs are known to be the most effective surgical hand antiseptics. They are often preferred to antimicrobial soaps because they are broad-spectrum agents with a high antibacterial effect, they act faster and in a shorter time, they can be easily applied and they are better tolerated by skin [17, 18].

In the surgery units of our hospital Povi-iodine scrub is used for hand antiseptic washing by surgeons. Povi-iodine scrub is an antiseptic with iodine at the

concentration of 7,5%. The scrub must act for 4 minutes. Iodine and iodophors are active against mycobacteria, viruses, mushrooms and they are bactericides against Gram positive, Gram negative bacteria and against some spore-forming bacteria (*Clostridium* spp., *Bacillus* spp.) [19-23].

The aim of our study was to evaluate the efficacy of three antiseptics: Povi-iodine scrub, EPG (Ethanol, Hydrogen Peroxide, Glycerol) and common Marseille soap in a liquid formulation.

MATERIALS AND METHODS

Our study was designed as a single-centre pre-post study conducted in the University Hospital of Messina, from January to June 2013, after preventive authorisation by the hospital administration. Participation in the study was voluntary. The criteria for inclusion were to be a member (effective member or doctor in training) of a surgical team ready to perform a surgical intervention planned within 20 minutes after sampling. It was decided to exclude the subjects who did not belong to the professional profiles mentioned above or who did not perform surgical interventions within 20 minutes of sampling. We measured the number of colony forming units per mL (CFU/mL) in Petri dishes of Plate Count Agar medium (PCA, Oxoid Ltd, Milan, Italy), collecting samples from the hands of operators who washed their hands with the three types of antiseptics.

Samples were collected in scrub rooms adjacent to the operating room, before surgery. Antiseptic hand washing was carried out following WHO guidelines.

Operators were asked to put the fingertips of their right hand (if not left-handed) for one minute on the PCA medium, before washing with the three types of antiseptics, and after washing and drying. Drying was completed using sterile gauzes or disposable wipes. Antisepsis with EPG was not followed by rinsing and drying because of its high evaporation power. Plates of PCA were incubated at 37° C and a colony count was made after 24 and 48 hours.

In the first phase of the study, 253 samples before and after washing were collected: 99 with Povi-iodine scrub, 105 with EPG, 49 with Marseille soap. It was not always possible to collect three samples from the same health care worker. The samples were collected from the hands of surgeons who followed routine hand washing procedures in scrub rooms adjacent to the operating rooms. For these samples we calculated the percentage of microbial load reduction and the standard deviation. The Shapiro Wilk test was performed to assess the non normal distribution of the data. So we decided to use The Mann Whitney test to verify if the reduction of microbial load was statistically significant for each antiseptic.

RESULTS

210 samples were considered for statistical analysis: in 42 samples, in fact, the initial microbial load was lower than after washing. Table 1 shows the mean CFU before and after washing, and the percentage of microbial load reduction.

Washing with Marseille soap led to a reduction of microbial load of 64,3% (standard deviation s.d. 25,6), washing with Povi-iodine scrub of 75,9% (s.d. 27,1), washing with EPG of 86,5% (s.d. 20,4). The reduction of the microbial load was statistically significant (p value < 0,01) for each antiseptic.

DISCUSSION

The anomaly of some results, namely the initial microbial load lower than after washing, was probably

due to poor hand drying or a hasty washing, or to the stress of the pre-surgical phase aggravated by the presence of personnel assigned to the execution of sample collecting, and demonstrates that drying is an essential phase in the pre-surgical preparation, where attention is needed to avoid contamination. As other studies report, wet hands represent a damp environment which offer more favourable conditions for microbial survival and transmission [24]. It was decided to collect only 50 samples from operating rooms after washing with Marseille soap because results were not satisfactory since the beginning of the analysis. In fact Marseille soap is a detergent, composed by surfactants and complementary substances that facilitate the removal of dirt from hands or other surfaces [3].

The percentage of microbial load reduction demonstrated that EPG was an excellent antiseptic for pre-surgical preparation. This is in line with another study conducted in Germany, which demonstrated the

**TABLE 1. Efficacy in microbial load reduction of the three examined antiseptics
1a - EPG**

MEAN CFU BEFORE WASHING	MEAN CFU AFTER WASHING	DIFFERENCE	% MICROBIAL LOAD REDUCTION
69,4	0	69,4	100,00
81	0,6	80,4	99,26
29	1	28	96,55
16,2	0	16,2	100,00
9	0	9	100,00
14	2	12	85,71
12	0,2	11,8	98,33
31,2	3,8	27,4	87,82
62,6	7,6	55	87,86
6,6	0	6,6	100,00
21,4	0	21,4	100,00
22	0	22	100,00
22,6	0,6	22	97,35
76,6	5,2	71,4	93,21
110	23,8	86,2	78,36
14,8	4	10,8	72,97
14,6	6,4	8,2	56,16
19,2	9	10,2	53,13
74,6	26,2	48,4	64,88
11,8	2,4	9,4	79,66
10,4	5,8	4,6	44,23
4	0,8	3,2	80,00
53,2	0,8	52,4	98,50
11,8	0	11,8	100,00
19,8	11,4	8,4	42,42
10,4	6	4,4	42,31
20,2	6,8	13,4	66,34
5,4	3,4	2	37,04
27,4	0	27,4	100,00
79	1	78	98,73
5,8	0	5,8	100,00
59,6	0	59,6	100,00
3,4	0	3,4	100,00
51,2	0,6	50,6	98,83
140	0	140	100,00
28,6	8,6	20	69,93
44	2,6	41,4	94,09
20,4	2	18,4	90,20
25,6	0	25,6	100,00
160	0	160	100,00
150	56,4	93,6	62,40
25	0	25	100,00
19,8	1	18,8	94,95
19,8	0	19,8	100,00
7,8	2,2	5,6	71,79

**TABLE 1. Efficacy in microbial load reduction of the three examined antiseptics
1a - EPG**

MEAN CFU BEFORE WASHING	MEAN CFU AFTER WASHING	DIFFERENCE	% MICROBIAL LOAD REDUCTION
46,8	7,6	39,2	83,76
8	0	8	100,00
18	0,2	17,8	98,89
53,6	0,4	53,2	99,25
222	0,2	221,8	99,91
67,8	0	67,8	100,00
33,8	32,8	1	2,96
4,2	0	4,2	100,00
83	0,2	82,8	99,76
15,8	3	12,8	81,01
16,4	1,8	14,6	89,02
53,2	3,2	50	93,98
80,6	0	80,6	100,00
35,4	0,8	34,6	97,74
7,6	0	7,6	100,00
39,6	0,8	38,8	97,98
34,8	2,8	32	91,95
4,8	0	4,8	100,00
2,6	0	2,6	100,00
106,4	10,4	96	90,23
58,6	5,4	53,2	90,78
31	13,2	17,8	57,42
14,6	2	12,6	86,30
25,6	1	24,6	96,09
45,8	0,4	45,4	99,13
2,2	0,4	1,8	81,82
7,4	0,6	6,8	91,89
23	3,4	19,6	85,22
0,6	0,6	0	0,00
42,6	2,2	40,4	94,84
20	2,4	17,6	88,00
10,2	0	10,2	100,00
167,2	0,4	166,8	99,76
72	12,2	59,8	83,06
85,8	3	82,8	96,50
30,6	0,6	30	98,04
84,4	25,8	58,6	69,43
8,4	0,6	7,8	92,86
24,6	3,4	21,2	86,18
33	9,8	23,2	70,30
25,2	1,8	23,4	92,86
6,6	0	6,6	100,00
5,6	0,2	5,4	96,43
17	0	17	100,00
7,4	0,2	7,2	97,30
34,4	17	17,4	50,58

efficacy of alcohol-based hand rubs, tested after 30 seconds of drying [25]. However it is important to remember that the efficacy of alcohol based antiseptics depends on the concentration of alcohol, as it was demonstrated in another study which showed that hand rubs based on 70% ethanol used as recommended are not suitable to ensure complete coverage of both hands and a satisfactory antiseptics [26]. Moreover, although hand rubs based on ethanol are very effective against bacteria, they are not generally recommended to control non enveloped RNA virus infections, which are an important cause of healthcare-associated infections [27]. However its disinfectant power and its practicality make EPG an excellent alternative to classic antiseptics with iodine, as the World Health Organization recommends. The economic cost of this kind of antiseptics is higher, but the decreased time dedicated to hand washing, cited in another study [28], and the lower incidence of healthcare-associated

infections make them more cost effective.

Povi-iodine scrub is also a good antiseptic: it leads to a good microbial load reduction, even if it is dependent on the accuracy of washing and good hand drying. Its efficacy is demonstrated in other studies, but the alcohol-based hand rub has always demonstrated superior efficacy in CFU reduction and maintenance compared to Povi-iodine scrub [29, 30].

CONCLUSIONS

Although washing with Marseille soap and with Povi-iodine scrub led to a statistically significant reduction of the microbial load of the hands, our study showed that washing hands with EPG has a superior efficacy in CFU reduction. Antiseptic hand washing, however, cannot be considered the only measure to reduce infections: it is important, in fact, to pay attention

**TABLE 1. Efficacy in microbial load reduction of the three examined antiseptics
1b - Povi-Iodine Scrub**

MEAN CFU BEFORE WASHING	MEAN CFU AFTER WASHING	DIFFERENCE	% MICROBIAL LOAD REDUCTION
56	2,4	53,6	95,71
34	7,6	26,4	77,65
86	10,8	75,2	87,44
58,2	10,2	48	82,47
125,6	107,8	17,8	14,17
120	4,2	115,8	96,50
64,2	51,2	13	20,25
189,8	37,2	152,6	80,40
102,4	11,8	90,6	88,48
145	47,6	97,4	67,17
232	43,2	188,8	81,38
66,2	24,8	41,4	62,54
40,2	11,4	28,8	71,64
9,2	0,8	8,4	91,30
43	39,2	3,8	8,84
95,4	13,8	81,6	85,53
67,6	7,6	60	88,76
75	5,2	69,8	93,07
88	2,2	85,8	97,50
0	0	0	100,00
19,8	0	19,8	100,00
24,8	10,4	14,4	58,06
54,2	42,4	11,8	21,77
44	21,8	22,2	50,45
93,6	37,2	56,4	60,26
14,6	0,8	13,8	94,52
7,4	0,2	7,2	97,30
0,6	0,2	0,4	66,67
22	0	22	100,00
19	0,4	18,6	97,89
32,4	0	32,4	100,00
75,8	8,6	67,2	88,65
48,4	11,8	36,6	75,62
44	15,4	28,6	65,00
52,8	0,4	52,4	99,24
34,4	28,8	5,6	16,28
24,4	23	1,4	5,74
40,4	4	36,4	90,10
58	7,8	50,2	86,55
24,8	11,4	13,4	54,03
30	4	26	86,67
51,6	1	50,6	98,06
202	38,6	163,4	80,89
107	84,8	22,2	20,75
116	47,4	68,6	59,14
21,4	2,2	19,2	89,72
37,6	4,6	33	87,77
277	4,4	272,6	98,41
108,4	16,8	91,6	84,50
40	0,8	39,2	98,00
11,2	0,2	11	98,21
25,6	2,6	23	89,84
37	0,2	36,8	99,46
70,6	33,4	37,2	52,69
221	3	218	98,64
107,8	14,8	93	86,27
138	2,2	135,8	98,41
70,2	3,2	67	95,44
33,4	2,8	30,6	91,62
33,6	7,6	26	77,38
42,4	4	38,4	90,57
20	1,2	18,8	94,00
103,6	11,2	92,4	89,19
58,8	2,6	56,2	95,58
161,8	4	157,8	97,53
22,6	0,6	22	97,35
6	0,2	5,8	96,67
58,8	11	47,8	81,29
60,8	0,8	60	98,68
26,2	0,4	25,8	98,47
13,4	0	13,4	100,00
4,4	2,6	1,8	40,91
5,2	2,4	2,8	53,85
18,8	8	10,8	57,45

**TABLE 1. Efficacy in microbial load reduction of the three examined antiseptics
1b - Povi-Iodine Scrub**

MEAN CFU BEFORE WASHING	MEAN CFU AFTER WASHING	DIFFERENCE	% MICROBIAL LOAD REDUCTION
35,8	7,8	28	78,21
24,6	20	4,6	18,70
8	8	0	0,00
23,4	8	15,4	65,81
12	0,6	11,4	95,00
15,6	11,6	4	25,64
58	26,2	31,8	54,83
101,6	36	65,6	64,57
7,6	0	7,6	100,00
39,8	14	25,8	64,82
14,2	0	14,2	100,00
54,4	0,2	54,2	99,63
53,8	8,2	45,6	84,76
16,2	12	4,2	25,93

**TABLE 1. Efficacy in microbial load reduction of the three examined antiseptics
1c - Marseille Soap**

MEAN CFU BEFORE WASHING	MEAN CFU AFTER WASHING	DIFFERENCE	% MICROBIAL LOAD REDUCTION
36,8	2	34,8	94,57
68	6,2	61,8	90,88
37,6	16,8	20,8	55,32
31,4	18	13,4	42,68
31,8	7,6	24,2	76,10
8,2	5,8	2,4	29,27
31,8	12	19,8	62,26
84,6	21,4	63,2	74,70
262	3,6	258,4	98,63
89,6	37,2	52,4	58,48
69,2	37,6	31,6	45,66
3,4	2,4	1	29,41
6,8	2	4,8	70,59
22	12,2	9,8	44,55
18,4	1,8	16,6	90,22
97,6	68,2	29,4	30,12
79,4	3	76,4	96,22
10,6	8,4	2,2	20,75
9,8	6,4	3,4	34,69
9,8	3,4	6,4	65,31
67,2	32,4	34,8	51,79
21,6	11,6	10	46,30
81,2	0	81,2	100,00
68,2	5,8	62,4	91,50
5,4	0	5,4	100,00
26,8	4,4	22,4	83,58
38,4	28	10,4	27,08
37	13,2	23,8	64,32
32,4	6,4	26	80,25
53,8	2,2	51,6	95,91
24,2	13,8	10,4	42,98

to other factors such as environmental hygiene, control of crowding and staff education. Therefore, hand hygiene must be part of a more complex strategy of surveillance and control of healthcare-associated infections.

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