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## Use of a Steam Generator for Disinfection of Hospital Ward Room Surfaces

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author SDL managed the analyses of the study and performed the statistical analysis. Author GS wrote the first and the final draft of the manuscript. Author GF designed the study and wrote the protocol. Author PC managed the literature searches. All authors read and approved the final manuscript.*

Research Article

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### ABSTRACT

**Objectives:** The present work examines the ability of a method — based on saturated overheated dry steam — to decontaminate surfaces in patient rooms in a surgery ward.

**Study Design:** An experimental study.

**Place and Duration of Study:** The investigation was carried out in two rooms of a surgical ward at the Villa Erbosa health care facility in Bologna (Italy) over a period of three weeks.

**Methodology:** Samples, using 24 cm diameter contact plates containing an agar-base medium, were taken before and after steam decontamination obtained using a professional steam generator.

**Results:** After steam treatment, the number of CFU (colony forming unit) present on the surfaces analyzed was reduced by 88.41%.

**Conclusion:** These results are significant and indicate that the use of steam provides good results in terms of decontamination of the surfaces in ward rooms.

Furthermore steam not leaves residues that could be the source of subsequent chemical contamination of the surfaces.

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## 1. INTRODUCTION

If the surfaces of hospital ward rooms are not effectively decontaminated, they can be colonized by a number of highly pathogenic microorganisms that cause hospital-acquired infections. In fact, it is well known that many microorganisms survive for a long time on surfaces [1] and play a major role in the transmission of pathogenic microorganisms between individuals [2]. In the hospital environment, widespread use of chemical microbicidal solutions has become the norm in decontaminating surfaces. However, such methods do have limits and contraindications:

1. To be effective they may require relatively long contact times (5-10 minutes);
2. Their vapors can be toxic for the operators, irritating the skin, eyes and airways;
3. Chemical products can be deactivated by organic substances present in the dirt which may explain a protective action on the bacterial flora [3];

The biocide capacity of high temperature steam has long been known: just think of the autoclave. However, its use for disinfection of environmental surfaces has been relatively limited since steam dispensers were too bulky and thus not very mobile. Technological advances have now made it possible to build small scale steam generators that can easily be moved around and used to clean and disinfect room surfaces. Dry steam, generated under pressure, is used for cleaning purposes. Since it is entirely composed of water vapor at a much higher temperature, saturated overheated dry steam is much drier and therefore suitable for disinfection. Moreover, the latter feature — its dryness — means that it can be applied on electrical and electronic equipment as long as it is unplugged. Additionally, overheated dry steam disinfection can even be performed when patients are present and can reach points that are not readily accessible to more common methods. This work examines the ability of a new “steam method” — based on the use of steam appliances with accessories — to decontaminate the surfaces in patient rooms of a surgical ward at the “Villa Erbosa” clinic in Bologna, Italy.

## 2. METHODOLOGY

The investigation, involving two rooms in a surgery ward, was conducted over a period of three weeks. Samples were taken twice a week before and after decontamination operations. In both rooms, samples were taken — both before and after steam decontamination — at the most critical points:

- 3 points on the table.
- 2 points on the chair.
- 3 points on the dresser.
- 6 points on the surface of two overbed tables (3+3).

Throughout the entire investigation, a total of 84 points were sampled in the ward room. The examined surfaces were smooth, undamaged and made of plastic laminate. The samples were taken using 24 cm diameter contact plates containing an agar-base medium (tryptic soy agar). After incubation at  $36\pm 1^{\circ}\text{C}$  (optimum temperature for growth of the potential pathogens) for 24 and 48h, the colonies that had developed were counted, the reduction in

bacterial load evaluated and then the results were analyzed for statistical significance. The results of this study refer to the CFU developed after 48 hours of incubation. The steam generator unit consists of a professional steam generator (MONDIAL VAP 4500; Polti - Bulgarograsso, Como, Italy) with AISI316 steel boiler that reaches a pressure of 6 bar. Decontamination operations were performed by a nozzle with controlled-expansion chamber connected to the steam generator with saturated steam at 180°C with a contact time of about 30 seconds/m<sup>2</sup>.

During all research period the cleaning of surfaces in hospital rooms was performed through the use of non-woven cloths mops (80% polyester-20% polyamide) moistened with tap water. In this way it is prevented the risk that possible residues of chemicals could interfere on the growth of bacterial colonies.

Samplings were performed by the same operator using a Rodac-Weight (International pbi S.p.a. – Novara, Milano, Italy), which applies the same pressure — equivalent to a standard weight of 500 gr — on the contact plate. The time of application was 10 sec. Sample points on the various surfaces were random performed before and after the use of steam, being careful not to overlap the same areas of contact.

### **3. RESULTS AND DISCUSSIONS**

It can be seen that, before treatment, the ward room presented a mean value and standard error of 94.39±11.90 cfu/24cm<sup>2</sup> while, after treatment, the number of colonies was 10.94±1.41 cfu/24cm<sup>2</sup>; this means that, for the investigation as a whole, there was an overall 88.41% reduction of CFU values (approximately 1 log<sub>10</sub> microbial reduction) while the inter-day variability ranged between 79.97 and 93.67% (Table 1). The statistical significance of the results was analyzed using the Student t-Test. The t value was 9.96 with *P*<.001. This t value is significant.

Analysis of the results obtained shows that use of saturated steam results in fast, effective decontamination of the surfaces in the rooms of a hospital surgical ward. It must be pointed out that the cfu values found after sanitation were always lower than those proposed by either Dancer [4] (≤5 cfu/cm<sup>2</sup>) or Malik et al. [5] (≤ 2.5 cfu/cm<sup>2</sup>). Analysis of the percentage of sampling points that exceeded these values throughout the entire investigation shows that, before steam decontamination of the ward rooms, 21% of the surfaces exceed the values proposed by Dancer [4] and 58% were deemed acceptable by Malik. After sanitation, however, 100% of the points examined revealed microbial loads below the Dancer limit and only one point exceeded the limit proposed by Malik [5]. Given the low residual load found after treatment with steam, the presence of pathogens would appear highly unlikely as stated by Dancer [4]. Moreover, similar research, performed using saturated steam dispensers, has shown that this method is effective in decontaminating surfaces, both those experimentally contaminated with high concentrations of pathogenic microorganisms [6] and those found in long-term care facilities [7].

**Table 1. Number of CFU/hospital room, averages and standard error before and after treatment with steam, in individual hospital rooms and for the whole experiment**

	First week				Second week				Third week				Total experience data	
	Room 1		Room 2		Room 1		Room 2		Room 1		Room 2		Before	After
	Before	After	Before	After	Before	After	Before	After	Before	After				
<b>CFU/ room</b>	2005	220	1816	202	799	91	1004	201	1236	128	1026	65	7929	919
<b>Average</b>	146,29	16,57	129,71	14,43	57,07	6,50	71,71	14,36	88,29	9,14	73,29	4,64	94,39	10,94
<b>Std. Error</b>	61,57	3,78	18,49	3,34	9,21	2,43	14,47	5,38	17,94	2,47	14,08	1,50	11,90	1,41

#### 4. CONCLUSIONS

The results obtained indicate that the use of the steam generated system provides a reduction by approximately 1 log<sub>10</sub> in terms of contamination of the surfaces in ward rooms.

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#### COMPETING INTERESTS

All authors declare that no competing interests exist.

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