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Airborne bacterial dispersal during and after dressing and bed changes on burns patients

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ABSTRACT

Background: It is acknowledged that activities such as dressing changes and bed sheet changes are high-risk events; creating surges in levels of airborne bacteria. Burns patients are particularly high dispersers of pathogens; due to their large, often contaminated, wound areas. Prevention of nosocomial cross-contamination is therefore one of the major challenges faced by the burns team. In order to assess the contribution of airborne spread of bacteria, air samples were taken repeatedly throughout and following these events, to quantify levels of airborne bacteria.

Methods: Air samples were taken at 3-min intervals before, during and after a dressing and bed change on a burns patient using a sieve impaction method. Following incubation, bacterial colonies were enumerated to calculate bacterial colony forming units per m^3 (cfu/m^3) at each time point. Statistical analysis was performed, whereby the period before the high-risk event took place acted as a control period. The periods during and after the dressing and bed sheet changes were examined for significant differences in airborne bacterial levels relative to the control period. The study was carried out four times, on three patients with burns between 35% total burn surface area (TBSA) and 51% TBSA.

Results: There were significant increases in airborne bacteria levels, regardless of whether the dressing change or bed sheet change took place first. Of particular note, is the finding that significantly high levels (up to 2614 cfu/m^3) of airborne bacteria were shown to persist for up to approximately 1 h after these activities ended.

Discussion: This is the most accurate picture to date of the rapidly changing levels of airborne bacteria within the room of a burns patient undergoing a dressing change and bed change. The novel demonstration of a significant increase in the airborne bacterial load during these events has implications for infection control on burns units. Furthermore, as these increased levels remained for approximately 1 h afterwards, persons entering the room both during and after such events may act as vectors of transmission of infection. It is suggested that appropriate personal protective equipment should be worn by anyone entering the room, and that rooms should be quarantined for a period of time following these events.

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Conclusion: Airborne bacteria significantly increase during dressing and sheet changes on moderate size burns, and remain elevated for up to an hour following their cessation.

1. Introduction

The primary modes of cross-contamination of pathogens between burns patients are believed to be direct and indirect contact either from the hospital environment and equipment, or via staff [1]: the contribution of the airborne route is less well defined. When a burns patient is at rest in bed, the dispersal of bacteria from their wounds is likely to be negligible. On the instigation of activity however, a proliferation of bacteria are released into the air, and onto surrounding surfaces, after travelling a distance of up to 2 m from whence they came [2]. Certain events have been identified as high-risk periods of bacterial liberation. Bed sheet changes are one such event creating enhanced bacterial dispersion. Mean counts of airborne methicillin resistant Staphylococcus aureus (MRSA) from infected patients have been shown to be 4.7 colony forming units per m^3 (cfu/m^3) during rest periods, rising to 116 cfu/m^3 during bed sheet changes. Levels were shown to remain elevated for at least 15 min after activities ceased [3]. Dressing changes are a further event shown to liberate bacteria from even small non-burn wounds [4].

The contribution of the airborne route can be difficult to quantify, as ''it is a characteristic of the airborne route...that whenever there is the possibility of aerial transfer there is almost always the possibility of transfer by other routes'' [5]. A true airborne route is one in which particles remain suspended in the air almost indefinitely as they are so small, and are transmitted over long distances. Bacteria may be dispersed as clusters without associated cells or liquid, or carried on skin cells, mucus or saliva, which evaporate leaving smaller, more truly airborne, droplet nuclei [6].

Of particular relevance to burns patients are studies of the airborne spread of staphylococci. Samples taken within burns units using settle plates (agar plates exposed within the room for passive collection of airborne microorganisms) demonstrated that burns patients generate high levels of infectious S. aureus aerosols [7]. Epidemics of S. aureus on burns units have been linked to individual heavy dispersers and a consequential increase in positive air samples [8].

Evidence for airborne bacteria settling and contaminating surrounding surfaces includes a study of sterile operating trays, open but untouched in an operating theatre. Within 4 h, 30% of trays were contaminated, with 44% of isolates being coagulase negative staphylococci [9]. Further work has demonstrated positive air and environmental surface contamination in the vicinity of patients and staff who are carriers of MRSA, indicating an airborne route of dispersal [10,11]. One study showed that 33% of air samples taken in the vicinity of medical and surgical patient carriers of MRSA were positive for the pathogen [10]. The airborne route has previously been attributed to 98% of bacteria found in wounds during clean operations: approximately 30% of these being directly precipitated from the air, with the majority being transferred indirectly via the environment or staff [11]. Further reports exist of healthy S. aureus dispersers causing wound infections in nearby patients [12,13]. However, studies comparing the relative contributions to airborne bacteria made by both nasal carriers and patients with wounds colonised with staphylococci have emphasised the importance of friction on the skin and agitation caused by bed making [5,14].

Near ubiquitous colonisation of burns wounds means that burns patients may be expected to release higher levels of airborne bacteria than non-burns patients. In the 1970s, one study attempted to link the size of a burn and the airborne dispersal of S. aureus during a dressing change: a correlation was demonstrated between the size of the burn and the number of bacteria precipitated onto settle plates over a period of days [7]. More recently, the aerosolisation of MRSA has been demonstrated during 32% (11/35) of dressing changes on MRSA positive burns patients using a laminar flow air sampler [15].

These two papers begin to tackle the issue of airborne dispersal of bacteria during dressing changes, however they have significant limitations. Settle plates left exposed for several days have the potential to collect bacteria from a plethora of sources. Furthermore their use is limited due to the agar in the settle plates drying out when uncovered for prolonged periods [7]. An air sampler is therefore a preferred sampling tool. However, the authors of the paper using the laminar flow air sampler did not report the point at which sampling was started, nor how long after the dressing change was complete that post-dressing change samples were taken [15]. The experimental methods described below were therefore developed to more accurately evaluate the airborne bacterial dispersal during dressing and bed changes.

2. Materials and methods

2.1. *Sampling methods and rationale*

A sieve impaction method was chosen for collection of air samples, using a Surface Air System (SAS) Super 180 air sampler (Cherwell Laboratories Ltd., Bicester, UK). Air is aspirated at a fixed velocity for a variable time through a perforated cover. Particles from the air are impacted onto the surface of 90 mm tryptone soya agar (TSA) plate for recovery: a non-selective, nutrient rich medium. The SAS Super 180 air sampler can sample the air for a variable amount of time, thus sampling variable volumes, but with relatively short sampling times, enabling multiple samples to be taken within a short time frame. Furthermore, it has a rechargeable battery and is small and portable enough to be used in an inpatient isolation room. It was easily cleaned between studies using detergent wipes. It is an established method for measuring air contamination. In contrast, the Anderson air sampler, which separates particles according to size, was found during preliminary work to be too large and cumbersome for