An investigation into the microbial contamination levels of non-invasive ventilation (NIV) devices used in adults with cystic fibrosis (CF)

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Introduction
Non-invasive ventilation (NIV) is commonly used in CF patients with hypercapnic respiratory failure, as well as an adjunct to improve sputum clearance (1). The re-use of NIV devices for different patients in secondary care is a cost-effective measure but must be safe (2). Bacterial cross-infection from NIV devices has been discussed as a potential risk (3) but data is limited (2, 4). We are not aware of any previous studies investigating bacterial contamination of NIV devices used by CF patients.

A wide variety of NIV devices are used in CF care worldwide but all have similar basic conformations. Devices draw in room air through inlet ports, with replaceable air filters that prevent dirt/dust entering the machine. Positive pressure is generated and transmitted to the patient via a tube and an interface which is connected to an outlet port. Outlet bacterial/viral filters assist in minimising the chance of pathogens being transmitted from device to patient and from patient to device (4).

Background
Prior to this study, the NIV infection control procedure in our centre had been to:

- clean and disinfect external surfaces of NIV devices between patients
- use a single-patient use outlet bacterial/viral filter (when no integral NIV humidifier used)

In addition, our practice was to send NIV devices to the Trust Central Sterile Services Department (CSSD) for internal Ethylene Oxide (ETO) sterilisation in between use by CF adults, if:

- the last patient to use a device had a significant airway infection besides Pseudomonas aeruginosa (PsA) e.g. Burkholderia cepacia complex (BCC)
- use of an outlet bacterial/viral filter was not feasible (if an integral NIV humidifier used)

Changes in CSSD protocol meant that the continued practice of ETO sterilisation was less feasible. Concerns were that without ETO sterilisation, any pathogens on the internal surfaces of a device could be transmitted to the next CF patient using the device, particularly if an outlet filter was not used.

Objective
- To investigate the extent and nature of microbial contamination of: the patient environment: • NIV devices used in our CF centre in patients with persistent infection • To inform the need for ETO sterilisation

Methods

A prospective quality improvement study was conducted.

1. Environmental Sampling
   - Performed during airway clearance in the hospital rooms of 2 CF in-patients with known persistent infection:
     - 1 with PsA
     - 1 with BCC
   a) Air sampling was performed at two points (one close to the patient’s bedside and the other at a distance of 0.5m) using the MAS-100 Ecolab air sampling device and Blood Agar plates.
   b) Three sets of culture settle plates (Rose Bengal, Cystine Lactose Electrolyte Depletive [CLED] and Plate Count Agar [PCA] plates) were left at various places in the 2 patients’ rooms for an hour following airway clearance. They were collected and incubated for 5 days but no growth was observed.

2. Device Sampling
   - 7 NIV machines recently used by different CF patients:
     - 5 had been sent for ETO sterilisation following use by CF patients. Table 1 describes the patient characteristics and NIV devices investigated in this study.

Machines were carefully disassembled by a specialist NIV medical engineer in a clean side room in an autoclave bag. Individuals were aprons and gloves and took precautions to avoid environmental contamination. Each device was swabbed in 7 areas as detailed in Table 2.

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Results

1. Environmental Sampling
   - Significant growth occurred on the air sampler plates collected during airway clearance
   - Some organisms were present in the air as demonstrated by settle plates
   - Selective BCC medium had been used on some swabs from Machine numbers 5 and 6 and incubated for 5 days but no growth was observed
   - No common CF pathogens were isolated during environmental sampling

2. Device Sampling
   - There was no growth or insignificant growth on most of the plates of the swabs from the NIV machines
   - The insignificant growth varied from 1-4 colonies of Bacillus, Micrococcus, yeast or environmental gram negative rods

The only exceptions were the following:

- No common CF pathogens were isolated
- Contaminating micro-organisms were all normal environmental flora

Conclusion

This study investigates evidence of bacterial contamination of NIV devices used by CF patients. Extensive swabbing of 7 machines at our centre only yielded insignificant growth from 1 out of the 7 swab sites in 2 machines. The contaminating micro-organisms were all normal environmental flora and no common CF pathogens were isolated. In this small study, microbial contamination of NIV devices was noted to be minimal and there was no evidence that ETO “sterilisation” was effective in reducing bacterial contamination. The continued practice of ETO “sterilisation” was therefore considered unnecessary.

Recommendations

Based on the results of this small study, the following recommendations were made by the Birmingham Health Protection Agency regarding the hygienic re-use of NIV devices within the West Midlands Regional Adult CF Centre:

1. Surface cleaning and disinfection of the external surfaces of devices between patients should continue
2. All NIV circuit components (outlet tubing and interfaces) should be single-patient use
3. Appropriate single-patient use outlet bacterial/viral filters should always be used
4. Inlet filters must be replaced between patients
5. No need to continue the practice of ETO “sterilisation”

Addtional changes to practice

Due to the recommendation that outlet bacterial/viral filters should always be used, single use non-integral humidifiers are now used within the NIV circuit if required. Despite the lack of evidence of contamination of NIV devices with pathogenic bacteria in this study, we use separate devices for patients infected with BCC organisms.

Acknowledgements

Staff at the following institutions based within the Heart of England NHS Foundation Trust at Birmingham Heartlands Hospital: Research and Development Laboratory and Food & Water Laboratory at the Microbiology Laboratory, Birmingham Health Protection Agency Laboratory, West Midlands Regional Adult CF Centre.

References


Table 1. Details of NIV machines investigated

<table>
<thead>
<tr>
<th>Machine no.</th>
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<tr>
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</tr>
<tr>
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Table 3. Swab sites for each NIV machine

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