A prospective study into biofilms and bacteriology cultures in different tracheostomy tubes used in laryngotracheal reconstruction

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Introduction

Patients requiring tracheostomies are often unwell and potentially have increased vulnerability to infection.¹ Therefore, any indwelling non-organic material that may reduce the bioburden, could have a potential benefit to improve survival.

What are Biofilms?

Biofilms are three-dimensional matrices in which microorganisms are able to evade host immunity via a range of mechanisms living symbiotically in dormant sessile states intolerant to anti-microbial treatments.^{2,3} Biofilms are a common problem associated with indwelling medical devices, which can be present on 90% of tracheostomy tubes seven days after their insertion.¹ The implication of their presence and long term effects is not fully understood, but has been implicated in ventilator acquired pneumonia, other forms of sepsis and chronic laryngitis.⁴ There is even speculation that it may potentially contribute to oncogenic transformation of epithelial cells through inflammatory mediators.⁴ Anecdotally, it is known that granulation tissue can often be associated with the tracheostomy site.

Environmental studies have demonstrated that bacteria frequently exist in biofilms. This can take the form of slime which is an exopolysaccharide matrix created by the bacteria which helps them evade host immunity and environmental hazards.^{5,6}

Aim

Laryngotracheal reconstruction (LTR) often requires a covering tracheostomy tube. The aim of our prospective study was to identify the biofilms present in patients post LTR and identify any relation to the type of tracheostomy tube used, with a view to helping to prevent infection.

Methodology

Patients undergoing LTR were given a variety of tracheostomy tubes. At two weeks following LTR the tracheostomy tubes were removed and examined for the presence of biofilms and microorganisms.

Procedure

Inner and outer tubes were separated and placed into universal containers filled with mucolyse, which is a solution that breaks up biofilms after 10 minutes of agitation. Tubes were removed and the resultant microbial mucolyse mix concentrated down to precisely 1.0ml. Serial concentrations of this base mixture were then cultured onto a variety of selective and non-selective agar. The resultant colonies were enumerated and identified using a combination of MALDI-TOF and traditional identification methods.

Results

Isolate name	# Isolates	Number
Corynebacterium species	11	288,992,470
Staphylococcus aureus	2	71,400,000
Coagulase negative Staphylococcus	12	24,411,600
Pseudomonas aeruginosa	4	23,100,000
Streptococcus agalactiae	1	18,700,000
Proteus mirabilis	1	16,700,000
Micrococcus luteus	2	8,800,000
Streptococcus anginosus	9	3,947,000
Streptococcus oralis	11	1,090,900
Serratia marscens	3	1,090,000
Lactobacillus species	6	423,300
Streptococcus pneumoniae	1	230,000
Actinomyces species	4	154,000
Stenotrophomonas maltophilia	2	150,000
Rhodococcus species	1	140,000
Rothia mucilaginosa	2	80,000
Candida albicans	6	65,400
Candida glabrata	1	60,000
Prevotella species	2	12,000
Bifidobacterium species	1	5,000
Enterococcus faecium	1	100
Escherichia coli	2	100

Table 1: Organisms and concentrations collected from all tracheostomy tubes

	Total CFU/ml
Tube 1	1,420,000
Tube 2	13,880,000
Tube 3	75,000,000
Tube 4	1,260,000
Tube 5	86,000,000
Tube 6	64,200,000
Tube 7 Inner	5,000
Tube 7 Outer	260,000
Tube 8 Outer	4,223,300
Tube 9 Inner	32,000,300
Tube 9 Outer	2,800,200
Tube 10 Inner	4,300
Tube 10 Outer	430,200
Tube 11 Inner	26,108,000
Tube 11 Outer	53,604,200
Tube 12 Inner	10,400,300
Tube 12 Outer	85,000,600
Tube 13 Inner	2,900,000
Tube 13 Outer	55,470

Table 2: Total organism counts per millilitre of concentrated biofilm deposit for each tracheostomy tube
Tubes 1-10 Blueline Ultra
Tubes 11-13 Bivona Silicone

Conclusions

- Standard latex tubes have a reasonable mixture of normal oral/throat flora. However, there is a notable variations in concentrations of organisms and total counts.
- Teflon tubes do not show a clear change in the normal flora or a reduction in concentration of organisms or total counts.
- Most organisms that constitute normal flora in the mouth and throat are potential biofilm formers.
- Almost all of the organisms found – viridans Streptococci (oralis/mitis/perioris/salivarius etc), Staphylococci (S.aureus & S.epidermidis) and the Corynebacteria are known to form biofilms on artificial and plastic surfaces in the right conditions. The same goes for the yeast and anaerobes.

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