EXPLORING ANTIMOCROBIAL COATINGS FOR ENDOSCOPES

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INTRODUCTION

Hospital-acquired Infections (HAIs) have been a continuous burden on the NHS and have been estimated to cost £2 billion per year (Guest *et al*., 2020). Endoscopy-related infections, through cross contamination between patients, have been a contributing factor to this burden.

Bacterial biofilms are a layer of several microbes that adhere to the surface of instruments (Luo *et al*., 2020). They are associated with a range of HAIs, as they usually contain several pathogenic microbes (Luo *et al*., 2020). More than 60% of endoscopic infections are a result of biofilms on their surface (Coenye & Nelis, 2010). A large number of studies have shown that after sterilisation, biofilms are still found on endoscope surfaces, proving the inefficiency of current cleaning practices (Nelson, 2005).

Current Problems

- Biofilm Formation: Endoscopes may have biofilms, which are populations of bacteria enclosed in a protective matrix. Biofilms are extremely resistant to disinfection and can act as reservoirs for ongoing contamination.
- Problems with current cleaning: Harsh cleaning or sterilisation methods can harm endoscopes, diminishing their efficiency and perhaps causing them to fail during treatments.
- Cross-Contamination: Improper handling or cleaning of endoscopes can cause cross-contamination among patients. Residual biological material left on the endoscope from one patient could transfer to the next, increasing the risk of infection.

Possible antimicrobial/antifouling techniques for endoscope coatings:

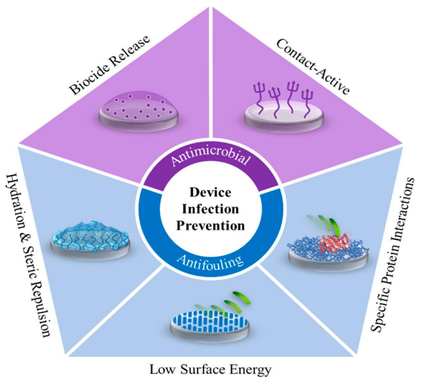
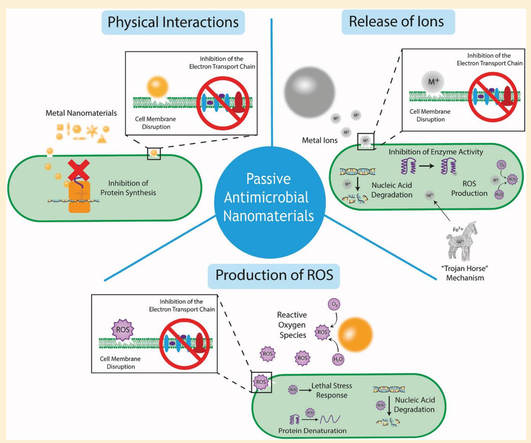
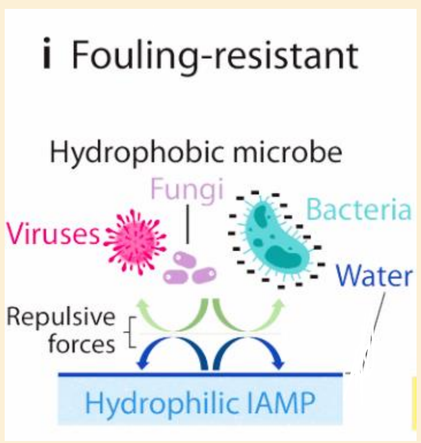


Figure 1: Possible antimicrobial/antifouling techniques for endoscope coatings adapted from Zander & Becker (2017)

RESULTS

	METAL NANOPARTICLES	INTRINSICALLY ANTIMICROBIAL POLYMERS (IAMPS)
Overview	For centuries, metals have been used in different industries due to their antimicrobial nature. This properties has adopted their use in healthcare as antimicrobial coatings (Cheeseman *et al*., 2020). Metals are condensed into nanoparticles, to enhance their activity and increase their surface area (Palza *et al.*, 2022). When interacting with microbes, they either release metal ions or reactive oxygen species that affects the microbes cell wall, membrane-bound proteins or inhibit protein synthesis (Cheeseman *et al*., 2020). This is summarised in **Figure 2.**	According to Palza *et al*, IAMPs present inherent pathogen growth inhibition or elimination without releasing any antimicrobial agent (2022). They are therefore more advantageous compared to metal ions as they avoid microbial cell bursting and potential release of toxic agents. Passive IAMPs have a fouling resistant mechanism which prevents the formation of biofilms (Zander & Becker, 2017). The membrane structure of microbes are formed of lipids with a hydrophobic character. IAMPs which are inherently hydrophilic are coated on device surfaces forming a repulsive barrier to the microbes as seen in **Figure 3.**
Mechanism of Action		
	Figure 2: Showing mechanism of action of metal nanoparticles adapted from Palza *et al.* (2022)	**Figure 3:** Showing mechanism of action of hydrophilic IAMPs adapted from Palza *et al*. (2022)
Examples	Silver (Au), Gold (Ag)	Polyethene Glycol (PEG)
Biocompatibility	Release of metal ions from metal nanoparticle coatings poses a risk of cytotoxicity to cells that line the endothelium where endoscopes enter (Li *et al*, 2012). Potential risk may arise from interactions of the metal particles with microbes, resulting in microbe bursting and release of toxins which may affect endothelial cells (Palza *et al*, 2022).	Although the biocompatibility of a PEG layer as a microbial coating has not been investigated in endoscopes, it has been investigated in medical implants. In a study by Rodriguez *et al*, PEG demonstrated biocompatibility greater than 80% (2022).
Method of Application	• Encapsulation in phospholipid bilayers • Polymer matrices • Graphene matrices • Laser etching	• Laser etching • Hydrogel coating • Covalent bonding

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DISCUSSION

Limitations of our research

- Despite the extensive research on the antimicrobial activity of both coatings, neither has currently been applied to endoscopes
- The lack of research on antimicrobial endoscopy coatings posed a challenge to us during our research

Recommendation

- Endoscopes come in contact with multiple patient's microbiome and pose a risk of possible transfer of pathogenic microbes between patients
- The current cleaning protocols for endoscopes do not sufficiently eradicate microbes on their surface, increasing the risk of endoscopy-related infections
- To decrease the occurrence of endoscopy-related infections it would be advantageous to apply antimicrobial coatings that prevent microbial biofilm formation on the surfaces of the endoscope
- Metal nanoparticles and IAMPs present significant advancements to the discovery of potential coatings that can be used on endoscopes
- However, IAMPs such as PEG, hold the upper hand as they have greater biocompatibility and less cytotoxicity making them potentially more suitable in endoscopy

REFRENCES