

# What is material compatibility?

## Why should we worry about material compatibility?

Adequate surface decontamination is essential to prevent the spread of healthcare-associated infections (HCAIs)<sup>1-5</sup>. As evidence for decontamination of environmental surfaces has grown, surfaces in healthcare settings are being exposed to disinfectants more frequently in the fight against HCAs.

Alerts from both UK and Australian regulatory bodies, highlighted increased risk of damage to plastic surfaces if compatible disinfectants are not used<sup>6-8</sup>. The focus of these alerts is primarily on disinfectants and use but the materials used in construction of these surfaces have a huge role to play. Incompatibility of detergent and disinfectant wipes with plastic surfaces has been reported on a number of healthcare surfaces and equipment including tympanic thermometers, patient monitors, and infusion pumps<sup>7</sup>.

Healthcare practitioners are now disinfecting more surfaces than ever before but, at the same time, manufacturers increasingly tend towards utilising cheaper polymers in construction of healthcare equipment<sup>9</sup>. The change in infection

prevention techniques has led to more rigorous cleaning of items that were not designed for exposure to disinfectants in the same way as products designed solely for healthcare use. These include light switches, plug sockets and phone handsets, made from less durable polymers that may experience premature failure following frequent disinfection.

When surface materials are incompatible with the disinfectants used to clean them, it can lead to lasting damage and premature failure: they can react in a way that breaks down the plasticity and causes them to become brittle and crack – this is known as environmental stress cracking<sup>10</sup>. In addition to loss of function, damaged surfaces can become increasingly hard to disinfect and can, therefore, harbour microorganisms.

In the UK, the burden of responsibility falls upon the equipment manufacturers to provide accurate compatibility data for their materials. Worldwide, the picture is mixed: regulators are struggling to develop policies to deal with the growing

problem of incompatibility. Material compatibility can complicate the procurement of both healthcare equipment and disinfectants; manufacturers of both will need to collaborate to develop products that keep patients safe, but operate for a long functional life. Until that time, understanding material compatibility issues between common surfaces and disinfectants is essential for informing effective infection prevention and control practices.

**Material incompatibility leads to premature failure, increases costs and compromises patient safety.**

## What causes material incompatibility?

There are two primary factors that have led to an increase in environmental stress cracking throughout healthcare: practitioners are disinfecting more surfaces than ever before and equipment manufacturers are moving away from durable metals and plastics towards cheaper polymers<sup>9</sup>. These cheaper polymers are susceptible to environmental stress cracking caused by repeated exposure to the chemical disinfectants used to help prevent healthcare-associated infections.

Disinfectants are required to adhere to strict standards of efficacy, stability and safety before regulators will allow products to enter the market. These same standards do not apply to materials selected for construction of healthcare equipment – particularly of plastic surfaces commonly found in domestic environments, such as plugs and power sockets.

**There is no standard testing method to compare exposure to all surface disinfectants – allowing plastic manufacturers to set their own success criteria.**

Environmental stress cracking has been observed in many different plastics – including those traditionally considered highly chemically resistant<sup>11</sup> – upon exposure to many different types of disinfectants. These issues will not be resolved until there is development of standardised compatibility tests between plastics and healthcare disinfectants, and manufacturers of healthcare equipment act upon this data to improve material selection. Until then, it falls to healthcare procurement teams to be diligent when considering new equipment for their facility.

## How to prevent issues of material incompatibility

---

The best way to prevent material incompatibility is to have a systematic approach to equipment procurement. We've put together a checklist of questions [here](http://gamahealthcare.com/compatibility) (<http://gamahealthcare.com/compatibility>) to ask manufacturers to ensure they have provided adequate decontamination instructions.

These are important questions for a manufacturer to answer: evidence-based infection prevention practices are vital to ensure patient safety, you should not be forced to compromise your environmental cleaning practice because equipment manufacturers have failed to perform compatibility testing.

If you're in the UK, the MHRA requires that equipment manufacturers provide this information; if you feel it is not forthcoming, raise concerns with both the manufacturer and the MHRA. Elsewhere, local regulatory bodies differ in the amount of compatibility data they require from equipment manufacturers; if you're unsure what the manufacturers are obliged to provide, contact your regulator.

## The role of disinfectant

---

Whilst the onus is largely on equipment manufacturers to select appropriate polymers, it's important to select disinfectant products with both a strong evidence base and robust compatibility data. Whilst Australia's medical device regulator, the TGA, has issued an alert on the use of Quaternary Ammonium Compounds (QACs), evidence suggests the causative agents are more likely to be amines – hydrocarbon derivatives of ammonia.

We have seen that some healthcare environmental plastics, often electrical outlets, are now made from polycarbonates. Polycarbonates are easily damaged by amines – through a mechanism called aminolysis – leading to cracking of the plastic<sup>12</sup>. The ability of amines to breakdown polycarbonate is so great that they have been studied as a potential method for recycling plastics<sup>13</sup>. Amines are sub-classified as primary, secondary and tertiary based on the degree of hydrocarbon substitution – it's this substitution that interacts with plastic surfaces. This issue is not limited to polycarbonates: amines have been found to cause chemical weakening of PET, PVC and rubber<sup>14</sup>.

Amines with four hydrocarbon substituents are positively charged and exist as 'permanent cations' – referred to as QACs – this makes QACs morphologically and functionally distinct from primary, secondary and tertiary amines. The reactivity of amines depends upon the presence of a free electron pair on the nitrogen; QACs do not have these and therefore do not undergo aminolysis reactions in the same way.

### Quaternary Ammonium Compounds are comparatively unreactive and have good surface compatibility compared with other disinfectants<sup>15</sup>.

Additionally, because they exist as permanent cations, they act as detergents, as well as disinfectants, and do not diffuse readily across biological membranes – making them ideal for human and animal disinfection<sup>16</sup>.

The most likely source of amines in a hospital environment is not from use of QACs, but from chlorine-based disinfectants: reactions between chlorine-based disinfectants and organic matter produce, amongst other things, chloramines<sup>17</sup>. Chloramines are highly reactive amines which can be responsible for aminolysis of plastic surfaces.

In addition, some disinfectant manufacturers use amines to supplement the disinfectant activity of their QAC-based formulations. GAMA Universal-range surface disinfection products are QAC-based and have a comparatively neutral pH, making them compatible with a broad range of surfaces. Third-party testing carried out, on both the Universal and Sporidical Wipes, showed they do not produce amines in their eluate and so do not cause environmental stress cracking through aminolysis. You should always be aware of the active biocides in your disinfectant formulations and ensure there are no 'hidden' agents that may cause surface compatibility issues.

GAMA Healthcare collaborates with manufacturers of healthcare equipment to test compatibility, produce decontamination procedures, and inform polymer choice for new products; you can find a list of equipment for which GAMA products are approved for use [here](http://gamahealthcare.com/compatibility) (<http://gamahealthcare.com/compatibility>).

Regulatory body recommendations, such as those issued by Australia's TGA, have the potential to influence Infection Prevention and Control (IPC) policies. Changing disinfectant products with inadequate scientific evidence can lead to sub-optimal cleaning – placing patients, staff and visitors at risk. Reducing incidence of healthcare-associated infections should always be priority; clear evidence to support claims of clinical efficacy, is essential before any IPC policy is changed.



## References

1. Dancer SJ. The role of environmental cleaning in the control of hospital-acquired infection. *J Hospital Infect.* 2009;73(4):378-85.
2. Rutala WA, Weber DJ. Role of the hospital environment in disease transmission, with a focus on *Clostridium difficile*. *Healthcare Infection.* 2013;18(1):14.
3. Wilson AP, Hayman S, Folan P, Ostro PT, Birkett A, Batson S, et al. Computer keyboards and the spread of MRSA. *J Hosp Infect.* 2006;62(3):390-2.
4. Weber DJ, Anderson DJ, Sexton DJ, Rutala WA. Role of the environment in the transmission of *Clostridium difficile* in health care facilities. *Am J Infect Control.* 2013;41(5 Suppl):S105-10.
5. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care-associated pathogens: norovirus, *Clostridium difficile*, and *Acinetobacter* species. *Am J Infect Control.* 2010;38(5 Suppl 1):S25-33.
6. Medicines and Healthcare products Regulatory Agency. Ensure detergent and disinfectant wipes are compatible with the device. MD/2013/019. In: MHRA, editor. London 2013.
7. Medicines and Healthcare products Regulatory Agency. Medical devices in general and non-medical products. MDA/2010/001. In: MHRA, editor. London 2010.
8. Victorian Managed Insurance Authority. Disinfectant wipes and detergent used on reusable medical devices with plastic surfaces. In: Authority VMI, editor. Melbourne 2017.
9. Pomager J. 5 Big Trends Affecting Polymer Material and Process Selection For Medical Devices 2014.
10. PolyOne. Medical Plastics Help Designers and Manufacturers Meet Changing Requirements. Ohio 2015.
11. Klein RJ, Gibler MJ, Jacobs RM, Sell EL, Lince SD. Environmental Stress Cracking of Medical Thermoplastics: Assessing Lifetime of High Performance Amorphous Resins in Presence of Hospital Cleaners. SPE ANTEC; 23-5 May; Indianapolis, IN; USA 2016.
12. Maia J, Cruz JM, Sendón R, Bustos J, Cirugeda ME, Sanchez JJ, et al. Effect of amines in the release of bisphenol A from polycarbonate baby bottles. *Food Research International.* 2010;43(5):1283-8.
13. Hata S, Goto H, Yamada E, Oku A. Chemical conversion of poly (carbonate) to 1, 3-dimethyl-2-imidazolidinone (DMI) and bisphenol A: a practical approach to the chemical recycling of plastic wastes. *Polymer.* 2002;43(7):2109-16.
14. Scheirs J. Chemical Attack of Polymers. Compositional and failure analysis of polymers: a practical approach: John Wiley & Sons; 2000.
15. Rutala WA, Weber DJ. Disinfection and sterilization: an overview. *Am J Infect Control.* 2013;41(5 Suppl):S2-5.
16. Zhang C, Cui F, Zeng G-m, Jiang M, Yang Z-z, Yu Z-g, et al. Quaternary ammonium compounds (QACs): A review on occurrence, fate and toxicity in the environment. *Science of the Total Environment.* 2015;518:352-62.
17. Lahl U, Bötjer K, Düszein J, Gabel B, Stachel B, Thiemann W. Distribution and balance of volatile halogenated hydrocarbons in the water and air of covered swimming pools using chlorine for water disinfection. *Water Research.* 1981;15(7):803-14.



JBN190390