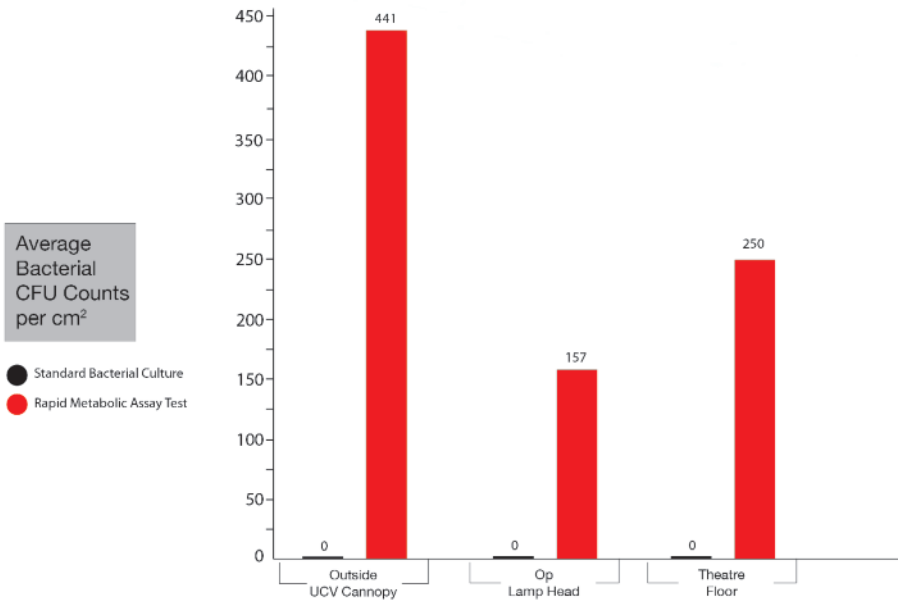
Prevention is better than cure

Dr Andrew Kemp, PhD, group CEO at Q Technologies Group provides an insight into how technological innovations are being used to help us re-think the role that surfaces and skin play in primary and cross infection.

In the 21st century it is difficult to think of many areas of science, where we use technologies that are over 100 years old to test new technologies for efficacy. Culture media and techniques have remained almost unchanged in all that time. The same can be said for the chemicals that we use to kill bacteria on skin and surfaces. As a scientist, I have to wonder why these have remained unchallenged in an age of constant technical improvements in almost every other area of healthcare. The increasing availability of polymerases chain reaction (PCR) testing to help identify species has increased the speed at which we can now make decisions over many aspects of the care of our patients. However, its use to determine levels of bio burden on surfaces is limited to say the least. As a global society, we have spent trillions of dollars on infection control and prevention, mostly on the "cure" rather than the "prevention" side of the equation.

We have researched the use of air handling systems, producing prescribed filtration methods, air pressures and numbers of air changes per hour. We use many different materials in our healthcare facilities, using metals such as silver and copper to create an environment that is hostile to bacteria, yet still we have a significant number of healthcare acquired infections to deal with.

Surfaces for the most part have been ignored as a significant area of research as testing has generally shown only potential links to primary infections and cross infection. In fact, there is no current healthcare technical memorandum for surface cleaning, with little guidance of any value being offered in respect to testing for surface contamination; leaving little in respect to choice and frequency of use of chemicals to clean and disinfect our healthcare facilities.



Graph 1: Comparison of standard bacterial culture results vs rapid metabolic assay test.

Using BSRMA

Until now, we have not been able to accurately assess low numbers of bacteria on surfaces or skin, as culture requires the ability to grow enough bacteria from a sample to become visible on the chosen media plate. Although PCR potentially reduces this time to a matter of hours, it is not widely available yet, and its use in reliably giving CFU counts is yet to be proven to be of use in clinical settings. In September 2015, a Bacteria Specific Rapid Metabolic Assay (BSRMA) originally developed for battlefield testing of biological weapons, was released for sale outside the military environment. Results using this newly available test on surfaces and skin have been incredibly revealing.

In one example, after the annual deep cleaning of an orthopaedic operating room, multiple samples were taken from various areas within the room. Samples were then taken to a tier one laboratory for culture, with the same number being tested on site using the BSRMA test. Results from the BSRMA in five minutes showed approximately 588 million live bacteria were still present. Contrasting with zero growth using culture at 48 hours (see graph 1).

These conflicting results may be one of the main reasons there has been little innovation or move to improve in disinfection chemistry and its application. Moreover, if we believe our surfaces to be completely clean due to the chemicals and techniques we currently use, then why change?

Why improve on perfection? Except that ▶

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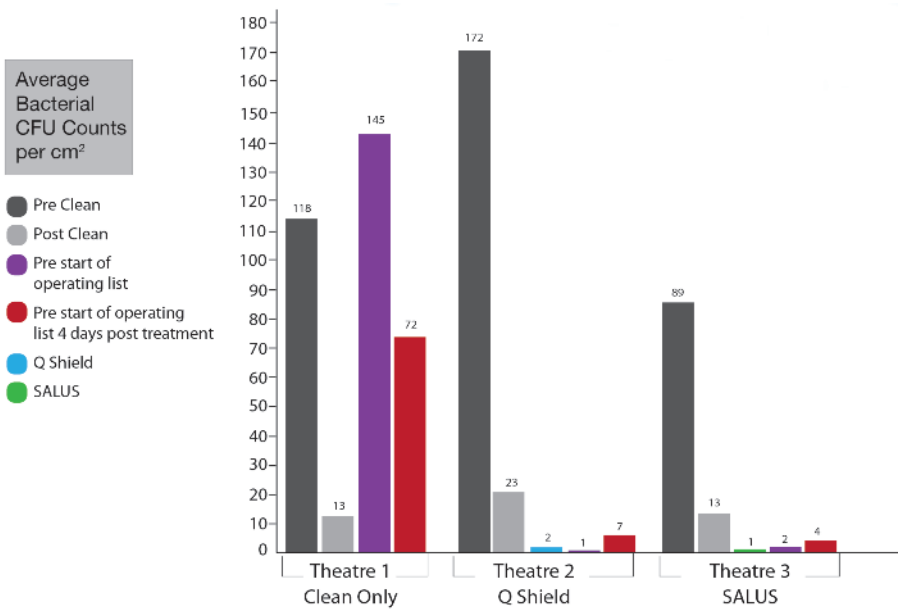
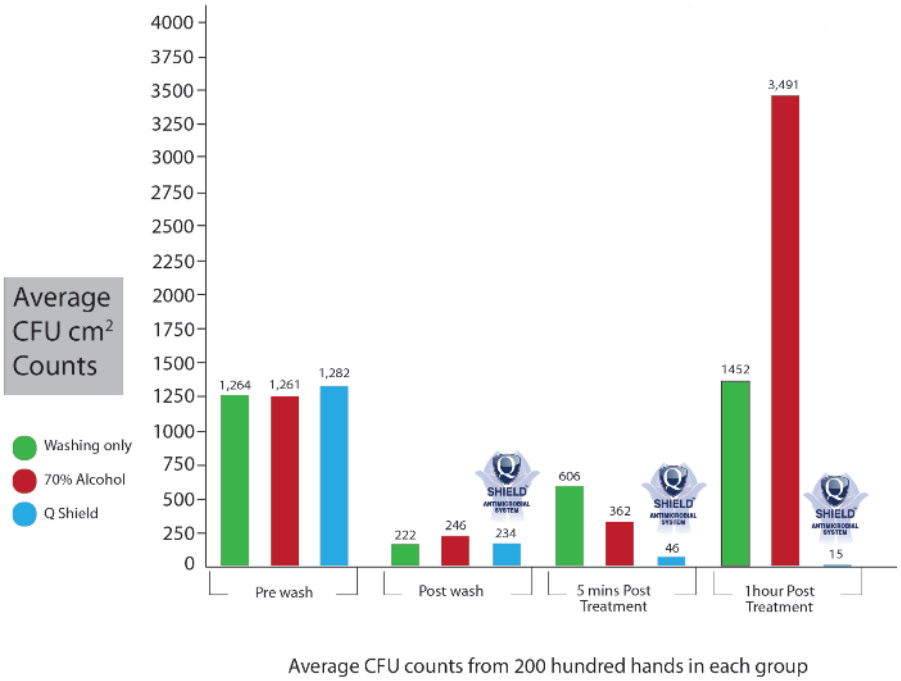
the results clearly demonstrate the lack of sensitivity of culture testing in comparison to the BSRMA. What could possibly produce a better result than zero? Today, most healthcare facilities around the world don't routinely test surfaces for bioburden for this reason, plus if we have to wait two days for a result, what would be the point? When the result arrives back it is of no value to the reader, as it cannot be assumed that the surface has that same level of contamination now.

We therefore have to rely on the original data from their development testing and expect it to reflect current efficacy for both chemical and UVC surface disinfection in use. These internationally agreed standard tests are designed to show the log reduction score produced by a chemical or the UVC light only in the first five minutes after application. Now that we have discovered that culture is a poor method of counting bacteria numbers present we need to retest, which should also go beyond the five minutes. We need to re-test with the more specific and sensitive test to show that what we thought was clean, remains so. Currently recommended disinfectants are short acting and have no lasting effect which is why these tests were developed in the way they were. However, as leading opinion is that any bacteria surviving initial disinfection proliferate using the dead bacteria as a food source, efficacy testing of all disinfection methods should perhaps include the current time periods, but they should be extended, in some cases for many hours.



Graph 2: Comparison of operating theatre, standard cleaning vs Q shield only vs SALUS system over four days.



Graph 3: Comparison test over time, hand washing only vs alcohol gel vs Q Shield.

A proven track record

To steal a term from management training manuals: "If you can measure it, you can improve it". The origins of all current disinfecting chemistries are at least 60 years old. Perhaps we are at an epiphany now in infection control terms, as big as the earth was known to be flat, and then proven to be round. Although the BSRMA test is new to healthcare, its proven track record in the military demands our attention and discussion as to the relevance of the data the test is providing. There are some current draw backs in that it does not currently identify species. However, if we look at high risk areas in healthcare facilities i.e. the operating theatre, numbers of bacteria may be of at least the same importance in that area as the species of bacteria, the BSRMA test can therefore be deemed to be of use for testing here. As the test does not require the sample taken to grow more bacteria in order to give a result, this test gives a result within five minutes of sampling. There are many potential uses for such a rapid test, it may for instance help to reduce environmental bio burden by allowing clinical staff the opportunity of re-cleaning high risk areas after suspected contamination. It could also be used to identify areas where high bio burden is apparent, and therefore if bacterial species is important, it can show areas of high contamination where culture sampling is most likely to get a result. Species specific assays are already in development and are expected at any time, but they will be very specific and only four or five major groups will be identifiable at the start.

It is a fact that using chemical with a log five kill (99.999%), it takes a bacterial species that is able to divide every 15 minutes a little over four hours to go from 10 million to 100 and then back up to 13 million. A chemical with a persistent log five kill, repeats that level of kill every five minutes and therefore has a totally different outcome. Using the same maths, using a chemical that is persistent with the same log five kill rate every five minutes until it is removed from the surface, the 10 million become 100 in five minutes as before, but this time the bacteria never has the opportunity to divide again as the remainder are killed over the next five minutes. This efficacy is demonstrated in a side by side test using two orthopaedic operating theatres (see graph 2).

The graph shows the results of testing using the BSRMA. Cleaning was undertaken every evening from 10pm each evening by a dedicated, well trained and motivated cleaning team. Theatre one was cleaned using standard cleaning techniques, the chemical of choice was sodium hypochlorite. Although cleaning appears to have been very effective initially, bacterial surface contamination was back to pre-cleaning levels prior to the following

day's operating list starting. Theatre two was on day one initially cleaned using standard techniques but was then subsequently treated on day one only, with a persistent disinfectant. The results showed that prior to commencement of the operating lists each morning it had continued to keep surface bio burden to a minimum.

The results of testing long term efficacy of alcohol gels on hands have also been as revealing as those of surface disinfectants (see graph 3). In this study, hands were tested into three groups of office workers. All three groups were tested using the BSRMA tests. All three groups were tested prior to washing their hands under supervision. They were then re-tested immediately after drying. One group then had no further interventions and went back to work to be re-tested after five minutes and one hour. The second group were treated with a leading brand alcohol gel, and re-tested after five minutes and one hour after application. The third group had a persistent hand sanitizer applied. No other sanitary interventions were allowed in either group. The significant increase in bacterial bio burden in the alcohol gel group is again due to the live bacteria feeding on the dead bacteria plus the residue of glycine gel left on the skin which as a sugar also provides an excellent food source for the surviving bacteria.

The Lincoln MSc group also felt that during hand washing the dead bacteria would be washed from the surface with water and friction, both of which do not occur when using a hand gel. They felt that this would reduce the chances of any residue holding the dead bacteria being left on the skin. Although this was not tested, it is worth considering as another potential benefit of hand washing. It also demonstrates the benefit over time that the persistent antimicrobial has over both non-persistent interventions.

Fighting bacteria

The ever increasing numbers of antibiotic resistant bacteria are of more concern today than ever before. For the first time, we are recognising significant bacterial strains that we have no treatment for. The pharmaceutical industry has significantly reduced its activity in researching new types of antibiotics, with far less new types of antibiotic being produced now than at any time since the 1960s. Phage's, whilst in use in Russia since WW2, are still not in widespread use anywhere else yet. There are many reasons for this, not least the difficulties in gaining a return on the investment in the time and money it takes to bring any new drug to market today. A completely new antibiotic produced on a bench top today would not be ready for market until sometime in the latter part of the 2020s, and it will have cost around $2bn to research, test, trial and bring to market. If successful, it is highly likely that the medical profession will want to hold its use back for exceptional cases in the hope that they will stave off resistance for as long as possible. A new analgesic is unlikely to be treated in this way and it is therefore easy to understand why it's much more profitable at least in the early days after launch.

Two very old sayings spring to mind: "Persistence pays" and "prevention is better than cure". BSRMA testing on both surfaces and skin has now opened our eyes to levels of bacterial contamination we were previously blind to. The clinical consequences of these findings are potentially enormous and only further research will bring this to light when many of our current procedures and pathways in infection control are based on what has now to be considered questionable evidence. How safe can we assume that evidence is now?

Will our new ability to view levels of surface contamination stimulate clinicians to call for industry to develop new eco-friendly disinfectants that are long lasting and where we see no resistance to their efficacy? In order to understand the true nature and effect of bioburden on surfaces and skin, perhaps we should now say: "Now we can test it, we can improve it".

Is the infection control world flat or round? Perhaps, at the very least the distance to our horizon is changing so we can see more of the curvature? For this scientist, it's probably the most interesting and exciting time of my career. CSJ

About the author

Dr Andrew Kemp's career in infection prevention began whilst studying biological warfare during his military service. Working in acute surgical trauma, his interest in all aspects of infection control led him to a PhD (Bio) in surface disinfection and decontamination. As part of the UK's special interest group in environmental contamination, he is a main contributor to the surface cleaning and decontamination guidance document, which will be presented to the Department of Health. He is the principle scientific research officer at the Q Technologies Group based at the University of Lincoln.