Reflections from Infection Prevention 2015: beating the bugs, improving the systems and thinking outside the box

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Infection Prevention 2015, the annual conference of IPS, was held in Liverpool this year. The abstracts from the submitted science are published Open Access in the *Journal of Infection Prevention* (2015).

Beating the bugs

The conference kicked off with Professor Andreas Voss. By Andreas' own admission, he was given a curve-ball of a title: 'CRE, VRE, *C. difficile* or MRSA: what should be the priority of infection prevention?' Andreas developed a framework for grading the priority of our microbial threats, accounting for transmissibility, virulence, antibiotic resistance, at-risk patients, feasibility of decolonisation, cost and impact of uncontrolled spread, and the result? Any and all microbes that cause healthcare-associated infection (HCAI) should be a priority of infection prevention. Even those that seem to have less clinical impact (such as VRE) are good indicators of system failure. If we focus too much on one threat, we risk losing sight of the bigger picture.

Next, Dr Jennifer Gardy (Canada) told the story of an outbreak using whole genome sequencing (WGS). I was struck by how far DNA sequencing has come in such a short time frame: to think that you can now sequence a genome in a USB drive on your laptop! The roadblock to its useful application is now not the sequencing *per se*, but the bioinformatics and useful clinical application. But, if that can be solved, WGS offers the potential to turn a 'plate of spaghetti' epidemiological picture into a clear transmission network, and allow you to 'read outbreaks like a book'. Jennifer used the now infamous outbreak of carbapenem-resistant enterobacteriaceae at the National Institutes of Health Clinical Center as an example, which, in reality was really rather small; perhaps that is the point (Palmore and Henderson, 2013). However, the potential applications of WGS go far beyond simple outbreak investigation, encompassing epidemic tracking and metagenomics, and even find a routine application in clinical microbiology (Roach et al., 2015). It was significant that only 8% of the audience had participated in a WGS study; I suspect this will be 98% in 5 years' time.

Carole Fry's guest lecture offered some historical perspective, tracking the introduction of first standard and then transmission based precautions from the early 1990s. Although standard precautions are a great idea in principle, they (ironically) lack standardisation! The Centers for Disease Prevention & Control (CDC) family of precautions

make sense to me, and I remain disturbed by the movement away from contact precautions in some parts of the USA. The reduction in MRSA bacteraemia in the UK has been nothing short of spectacular – but what has effected this miracle (Stone et al., 2012)? And finally, what of developments in surveillance and public reporting? There's good, there's bad and there's ugly – but, on balance, public scrutiny has been a driver for positive change (Horowitz, 2015). And the reduction of MRSA bacteraemia is case in point.

Update on resistant Gram-negatives

Professor Peter Hawkey (Birmingham), Professor Ed Septimus (Texas) and Martin Kiernan (London) provided different aspects of the evolving Gram-negative resistance crisis. Professor Hawkey began with an overview of the epidemiology of multidrug-resistant Gram-negative rods (MDR-GNR), highlighting the gulf in epidemiology between the Enterobacteriaceae and non-fermenters. The sexual promiscuity of Gram-negative bacteria was a theme throughout the conference, resulting in inter and intra-species horizontal gene transfer. Professor Hawkey highlighted disturbing trends of ESBL in India and China (>60%) (Hsueh et al., 2010), and rapid emergence of CPE (overlaid with colistin resistance) in Italy, and Israel (perhaps seeded with KPC by New Yorkers) (Giani et al., 2010; Schawaber et al., 2011). Another threat is contamination of water sources, including effluents from sewage works, which may enrich antibiotic resistant bacteria. The risk to our hospitals is silent transmission of CPE, which will be halted by solid admission screening, accurate surveillance and careful isolation – learning from outbreaks of antibiotic-resistant *Klebsiella* decades earlier (Casewell and Phillips, 1977).

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Professor Septimus was given the tricky task of explaining how to keep CPE at the hospital door. Put simply, carbapenems are the ‘big guns’ and carbapenemases are ‘bigger guns’. The rise of CPE in the USA has been nothing short of meteoric (MMWR, 2013); we are on the road to a crisis and need to change course to succeed in bringing CPE under control. Challenges include medical tourism, queries over how best to detect CPE, regional spread and uncertainty around which interventions are effective. Given this uncertainty, a bundle of interventions is called for – and a bundled approach has been shown to be effective in some parts of the USA. But we need to work closely together to halt the spread of CPE (Hayden et al., 2015).

Martin Kiernan delved into the depths of the hospital environment to explore the potential role of surfaces in the transmission of Gram-negative rods. Martin conjured a picture of complex transmission networks, involving multiple contacts with contaminated hands and surfaces, rather than linear transmission pathways. But since Gram-negative bacteria can survive on dry surfaces for longer than you may expect, are not reliably removed by conventional methods, and admission to a room previously occupied by a patient with resistant *A. baumannii* and *P. aeruginosa* increases the risk of acquisition, we discount the role of contaminated surfaces in the transmission of Gram-negative bacteria at our peril.

Pandemic viruses: MERS and Ebola

Professor Ziad Memish (Saudi Arabia) provided an update on MERS, focusing on the infection prevention and control implications. Outbreaks in Jeddah, Saudi Arabia and South Korea are most likely explained by simple breakdowns in basic infection control. As to where the virus originated, camels carry the can, but this should be shared with bats, and probably other animal reservoirs, and we can expect to see more MERS-like viruses emerging in future as wild animals ‘urbanise’.

Ronald Kremer provided a unique insight into the Médecins Sans Frontières response to Ebola in West Africa. Challenges were almost innumerable but included: patient transport; lack of transparency and fear in contact tracing; clinical challenges; “Ebola deniers”; and safe burial practices. Ronald alluded to a day in the life of a front-line local Ebola fighter: you care for a sick colleague (blood everywhere); your wife won’t sleep with you; and your landlord evicts you. I felt a keen sense of contrast between the conditions faced in West Africa and the preparedness plans laid in the UK: the high-tech High Level Isolation Unit at the Royal Free Hospital in London is a far cry from West Africa.

Group Captain Andy Green (Ministry of Defence) added further unique insights from the perspective of the UK response. As Ebola raged out of control in West Africa, the UK were busy building treatment facilities, and preparing

for worst-case scenarios in the UK. The Ebola response required unprecedented civilian, military, government and Non-Government Organisation collaboration. Captain Green concluded in the words of Churchill: ‘Never in the field of human conflict was so much owed by so many to so few’. So it seems fitting that the military IPC team won the Team of the Year Award at IPS, and Ebola Fighters were made *Time Magazine*’s Person of the Year.

Improving the systems

The economics of HCAI is going to become increasingly important as the NHS – and healthcare systems worldwide – continue to ‘seek efficiency savings’ (aka ‘demand more for less’). So the overview of HCAI economics from Dr Nick Graves (Australia) was timely. There is something rather uncomfortable about setting an ‘acceptable’ level of HCAI, or putting a value in pounds that we would be prepared pay to save a life, but this is exactly what we have to do to manage the demands of scarcity. Dr Graves presented some useful worked examples to illustrate his point, around coated catheters, hip replacements, hand hygiene improvement and MRSA screening (Halton et al., 2009; Zheng et al., 2014). In most cases, there comes a point where a health benefit is too expensive to ‘purchase’, which is an uncomfortable but very real choice across all areas of healthcare (e.g. cancer drugs).

Dr Jennie Wilson (London) gave a helpful ‘meet the experts’ session on Surgical Site Infection (SSI). For somebody fairly new to SSI surveillance (like me!) it was invaluable. SSI causes considerable increased morbidity and mortality, and yet we capture only a fraction of SSIs in most existing surveillance approaches (Wilson, 2013). Furthermore, it seems that the harder you look for SSIs, the more you identify (aka ‘seek and ye shall find’). Especially when you add robust post-discharge surveillance (Koek et al., 2013). So, how can we improve? A recognition that surveillance definitions are not the same as clinical definitions will help, but we need to explore new ways of identifying SSIs.

Dr Nikki Maran (Scotland) explored the importance of human factors in infection prevention and control. Healthcare is dangerous when you compare it with peer activities. Why is this? Because healthcare workers are lazy and don’t care about causing harm? Absolutely not. Humans have heroic capacities: compassion, empathy, care, knowledge, resilience... but they tend to be more Clark Kent than Superman (although patients tend to expect the latter!). Mistakes happen (especially when staff are tired, stressed or, interestingly, insulted)! Also, are we setting achievable targets? Careful observation of an anaesthetist (like Dr Maran) at work identifies so many hand contacts and so little time! This calls for a modified procedure to make it achievable for human beings. So how can we improve? Knowledge and expertise doesn’t really affect the likelihood of error and, while rules can be helpful, we’re all

like toddlers and like to push the boundaries. We need to develop a safety culture, exploring and harnessing human factors to improve our delivery of safe, effective healthcare.

Dr Jason Tetro ('the Germ Guy') began with the infectiousness of infection prevention enthusiasm (although, disappointingly, he gave no estimation of the basic reproduction number, R_0). Jason gave an overview of the cornerstones of effective science communication: education, enrichment, engagement and entertainment. His talk got me thinking about whether we should consider paying for professional marketers to launch our IPC campaigns?

Mark Gallagher, a Formula 1 executive, drew a series of thoughtful comparisons between F1 and healthcare. The priorities of F1 and healthcare are closely aligned: (1) great performance; (2) robust, reliable systems; and (3) safety. The history of safety in F1 is chequered, to say the least. F1 used to kill at least one driver per year and if you drove for five seasons before 1960, you had a 25% chance of death (not including the countless fans and race marshals also killed). The safety culture in F1 was driven by public scrutiny from televised races in the 1990s. How similar then that our own safety culture is being driven by the scrutiny of public reporting. Mark detailed a watershed race weekend in 1994 when two drivers were killed (Roland Ratzenberger and Ayrton Senna). In both cases, human factors contributed: Senna's team made modifications to his steering without reference to the due process, and Ratzenberger ignored the protocol to return to the pits for a once-over of his car following an accident. F1 has learnt much from these tragedies; the question for us is do we learn enough from our daily tragedies of transmission? Mark spent most of his time talking about high performance team work. An F1 team has a huge range of skills, experience and paygrade in the same team, and the natural hierarchy arising from this situation can be damaging, with fear of recrimination (or actual recrimination) silencing junior team members. It's the same situation in the operating theatre or resus room. Not only can a flag from a junior team member avert a disaster, it can also be an unexpected source for innovation (if we listen). Team leadership is crucial, and the ability to inspire their team is what sets a great driver apart from a good driver. Michael Schumacher was the greatest in Mark's view, whose mantra was: 'Once something is a passion, the motivation is there'. Finally, Mark considered the similarity of pit stops to a clinical team in full flow – and I was struck by the similarity of Mark's videos of pit stops with Dr Maran's videos of an anaesthetic team at work! We watched a video of a 23 s pit stop from the 1980s – slow, chaotic and dangerous. F1 has improved the process and safety around pit stops dramatically: times have plummeted from 23 s to <2 s (slightly skewed by no refuelling these days), with improved safety. The infamous pit stop fire engulfing Jos Verstappen is case in point (again caused by human factors). Although dramatic, nobody was injured. Wouldn't it be helpful if a patient was engulfed in

harmless flames whenever they acquired a line infection? The team who was responsible would be much less likely to make the same mistake again! So, F1 systems are robust and configured to allow team members to make mistakes, with checklists and buddy systems in place. Do we have enough flex in our systems to allow for 'to err is human'?

Thinking outside the box

New technology to improve hand and environmental hygiene

One way to get more realistic compliance data is through automated approaches to hand hygiene compliance (Dawson and Mackrill, 2014). Drs Dawson and Mackrill considered issues around product usage, self-reporting, direct observation, perceptions of technology (often viewed, unhelpfully, as a 'silver bullet') and staff perceptions of need and benefit. They divided the technology into those that monitored product usage, surveillance systems that monitored individual performance, and systems that monitored both product usage and individual performance. Although automated surveillance systems will always be imperfect and involve a degree of inference, would you rather monitor the five moments sporadically/badly or have robust measurements of a smaller number of moments? Automated surveillance methods will not replace manual audits – at least for now – but it's time to take a long hard look at what is available.

As if to reinforce my new-found enthusiasm for automated monitoring of hand hygiene compliance, Pat Cattini (London) presented work from the Royal Brompton hospital on her experience with an automated hand hygiene monitoring system. The 'HANDS' study (JIP, Abstract ID: 3730) is a randomised evaluation of a radio frequency identification (RFID) based compliance system, with the feedback modality randomised: a real-time vibration reminder provided the most powerful driver for compliance. Surprisingly, hand hygiene compliance was higher among doctors (47%) than nurses (38%) – and this was from a huge sample of >325,000 observations. How long would it take to reach that number of observations with a paper-based audit? Some fascinating aspects of the study emerged around encouraging staff to embrace the technology as an opportunity for personal performance monitoring and improvement, rather than fearing 'Big Brother'; sweets were useful to this end.

Drs Alan Beswick (Health & Safety Laboratory) and Tim Boswell (Nottingham) presented back-to-back talks on automated room decontamination (ARD) systems. Dr Beswick considered three 'classes' of ARD: 'fumigants', 'UV' and 'air purification'. There is a lack of universal test methodology for all three of these classes, but safety should be paramount in their application. One clear piece of advice was that fumigants (such as hydrogen peroxide vapour) should be deployed in conjunction with a hand-held device

to ensure that the room is safe for room re-entry. Currently, it is not clear how these systems should be validated – and even less clear how they should be regulated. So, for now, it is up to the end users to develop appropriate test methods to ensure that products are fit for purpose. Dr Boswell offered a user perspective, challenging the appropriateness of the highly concentrated challenges used to evaluate ARD systems in some studies, arguing that a lower level of contamination is sufficient and a better model of real hospital surface contamination. Tim went on to review the accumulating evidence that various ARD systems – including those based on hydrogen peroxide and UVC – are associated with reduced transmission of pathogens.

Microbiome modulation for health

A fascinating and fast moving areas of research is around our evolving understanding of the importance of a happy, healthy gut microbiota in our general state of health (or otherwise). Professor Neil Woodford (Public Health England) introduced the importance of the gut as a ‘ginormous resistance reservoir’. The gut weighs around 2 kg, contains 10 times more cells than in our entire body, has a unique composition (like an ever-changing fingerprint) and is fundamental to health (Gillings et al., 2015). As we develop our understanding of the gut microbiome, it is becoming increasingly apparent that antibiotics are like ‘A bombs’, which drastically reduce the diversity and alter the composition of our gut microbiota, making us more susceptible to disease. How many resistance genes are in the gut? Somebody is trying to count: but it’s a bit like counting the stars! Part of the problem is the sexual promiscuity of bacteria – especially the Gram-negatives. And it’s not just in your gut – bacteria can ‘traffick’ resistance genes through the hospital environment. One easy way to introduce resistant bacteria into your gut microbiota is to go on holiday abroad. So choose your holiday destination carefully: it will influence which type of antibiotic resistant bacteria you are colonised with when you return (von Wintersdorff et al., 2014)! Perhaps we are now at the point where ethnicity and holiday destination should be used to guide antibiotic therapy?

Dr Jonathan Sutton (Ysbyty Gwynedd) punned his way through faecal microbiota transplantation: ‘from me... to poo’. It’s difficult to over-emphasise just how spectacularly effective faecal matter transplantation (FMT) is for recurrent *C. difficile* infection (CDI) (van Nood et al., 2013). So much so, that it remains a mystery to me why the very successful early FMT experiments from the 1950s were not followed up. Perhaps a deceptively successful golden half century of antibiotic use is to blame! It’s important to explore patient attitudes to FMT although patients are generally supportive. The safety of FMT is important and careful donor selection a key factor. Using companies such as ‘OpenBiome’ provides a useful source of reliable material for faecal transplant. But we can never be certain that we aren’t transmitting what we don’t yet know about!

Dr Clifford McDonald (CDC) and Professor Jan Kluytmans (Netherlands) debated whether we should be using ‘selective digestive decontamination’ (SDD) of the gut. (SDD = is the prophylactic use of antibiotics to eradicate pathogenic microorganisms from the gastrointestinal tract, in order to reduce the incidence of infections and mortality in critically ill patients.) The initial vote before the debate identified just 5% of the audience in favour of SDD. Jan presented the case for SDD, reviewing large, randomised studies showing that SDD works: it reduces mortality, length of stay, transmission – and is not associated with increased antibiotic resistance (de Smet et al., 2011). Clifford presented the case against SDD, accepting that SDD works in reducing mortality, etc., but that there is evidence that it increases the level of antibiotic resistance, especially in Gram-negative bacteria (Oostdijk et al., 2010). Particularly, indiscriminate use of colistin in SDD protocols cannot help with our already crumbling last line of defence against CPE. Furthermore, antibiotic exposure disrupts our microbiome, which makes us less resistant to colonisation with antibiotic resistant bacteria, and has knock-on effects in other areas of health. Instead of SDD, we should focus on microbiome-sparing therapies. And the result of the debate? A swing towards SDD in the audience, but still an overwhelming majority against SDD! So let’s call it an honourable draw.

Final reflections

I enjoyed Infection Prevention 2015 as much as ever. This report only covers a fraction of the material that was presented. I could only write about the sessions I attended – and there were a lot of good presentations that I missed. Also, and perhaps most importantly, I have made virtually no reference to the 150 or so high-quality posters and oral presentations that went on during the conference. These are the life-blood of these conferences and I’m delighted to say that the abstracts are published Open Access in the *Journal of Infection Prevention*. So huge thanks to all who contributed.

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