Immersed in a microbial sea

Hugh Pennington

It cannot be denied that the public has a deep and abiding interest in microbes. The viewing figures of TV programmes on killer viruses (even if they are really bacteria) and the response to food scares – to take two typical and topical examples – prove the point. A particular concern of many is what one can call the 'clean dirt' hypothesis. It is that because we are so cosseted and hygienic these days our immune systems are not being properly challenged, thus leading to a decline in our resistance and a consequentially bad response when we actually meet a pathogen for the first time. Its proponents believe that there was a golden age in the past when the dirt we consumed at our mother's knee provided a protective stimulus that we now lack.

Certainly, some immunologically mediated diseases, like asthma, have become much commoner in recent years. Whether this has anything to do with people taking baths more often, the frequency of deodorant use or having whiter teeth is, of course, uncertain. It could equally be due to more houses having more mites because of fitted carpets. Whatever, we can be sure that the dirt that our forebears ate and drank as children was not innocuous or benign. It killed them like flies. Go into any churchyard and look at 19th century tombstones. Many babies in most families never made it because of infection. These factors underpinned my response to John Humphries when he challenged me on the BBC Radio *Today* programme recently about cleanliness predisposing us to disease. I felt obliged to use that fine old Scottish word '*bollocks*'.

Despite the massive lengthenings of lifespan that have coincided with increases in cleanliness, as microbiologists we know that despite regular and frequent showers, clean drinking water and pasteurized milk we still live immersed in a richly diverse microbial sea. The bacteria living on our skin and in our throats and bowels are constantly challenging our defences and keeping our immunology very busy. We all carry potential pathogens like *Staphylococcus aureus*, *Streptococcus pyogenes* and *Neisseria meningitidis* from time to time – some of us for long periods – but resist some of them much more effectively than in the past and cope with all of them at least as well. Indeed, for organisms like *S. aureus* a strong case can be made that because our nutritional state is no longer defective, our immune systems now work at optimal levels, in contrast with the 19th century when systemic staphylococcal diseases like osteomyelitis were common. Our major *S. aureus* problem just now is quite a different one. We can only blame ourselves for MRSA, not just doctors for inappropriate overprescription of antibiotics and patients for shouting for them too loudly, but as microbiologists for forgetting about evolution and failing to remind everybody often enough about its power, its inevitability and its unforgiving nature.

Rather than immunological inexperience accounting for the current levels of disease, the present day incidence of infection provides overwhelming evidence that there is still plenty of dirt about. The landmark and massive Infectious Intestinal Disease Study in England, the biggest and most detailed of its kind conducted to date anywhere in the world, has just published its final report. It showed that 9·5 million cases occur annually, of which 1·5 million see a general practitioner and half a million have stools sent for microbiological examination. Only a small fraction of these cases require any specific treatment and even fewer need to go to hospital or suffer complications. The vast majority of victims recover without intervention because their immune responses and other antimicrobial defences are in fine fettle.

The real problem is posed by those micro-organisms that cause nasty diseases not because our immune defences have been enfeebled by clean living, but because the causative bacteria and viruses have evolved in ways that assist their evasion of our responses, even when these are working at their best. These are the organisms on which we have concentrated our efforts to develop preventive and therapeutic measures. Not only can we be proud of our microbiological successes against them, we can claim to be responsible for a significant proportion of the most important and effective preventive measures in current medical practice. For surgeons to operate on people without regularly killing a significant proportion there is an utter dependence on aseptic technique. We have eradicated smallpox by vaccination and polio will follow soon. Measles, diphtheria, whooping cough and *Haemophilus influenzae* meningitis have moved from being common killers to rare diseases because of this approach.

Nevertheless, and despite all these successes, there is much unfinished business. It is one thing to interrupt the spread of bacteria in operating theatres designed for the purpose by using elaborate rituals applied with an obsessional attention to detail. But the application of the same aseptic principles in the other parts of hospitals is scandalously defective. Despite the principles being fully worked out for more than a century and in spite of the training of doctors and nurses in basic microbiology, the Comptroller and Auditor General pointed out in a report to the House of Commons in February of this year that 1 in 11 hospital patients at any one time has an infection caught in hospital, which apart from causing pain, permanent disability and death, costs the NHS as much as £1,000 million every year. If things are this bad in hospitals, which have as their mission statement Florence Nightingale's dictum '*to do the sick no harm*', goodness only knows what they are like in kitchens in homes and restaurants.

The success of vaccines has raised expectations that existing problems can be solved by them – even those like malaria that have a rather intractable air about them and those against influenza and pneumococcal infections that have been around a long time, without inducing the hoped for step-change in prevention. Success brings its

own difficulties. When the infections they effectively prevent become rare, a very low incidence of vaccination complications – or the suggestion of one – becomes a problem in itself.

As if these difficulties were not enough, it is salutary to remember that our failures to prevent disease do not come just from an inability to apply known principles. There is still a lot of microbiological ignorance about. Take two topical examples, *Escherichia coli* O157 on farms and the winter surge of influenza. Wouldn't it be nice to know how to eradicate the first from cattle and how to stop the second. So much important work remains to be done. The articles that follow show us the way.

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