The infection potential in the home and the role of hygiene: historical and current perspectives

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The control of infection through hygiene has a long erratic history. Personal hygiene and handwashing was less appreciated in the past, since it was not known that invisible organisms could spread from apparently clean hands and surfaces. The role of a hygienic home environment received little attention until the 19th century. Since then, the modern tradition of hygiene has served us well, with improved water and drainage developing alongside vaccination, antibiotics, water purification, improved food production and hygienic food preparation and storage. Two major epidemiological trends are relevant to hygiene perspectives: the decline in the morbidity and mortality from infection, and the transition towards higher levels of chronic or debilitating disease. While mortality from some infections has decreased, communicable disease is no less prevalent. Infectious intestinal disease is still unacceptably high in both developed and developing countries. The control of infection within the home needs to take account of changing epidemiological trends, emphasis on evidence-based approaches and loss of public awareness of the role of hygiene. In earlier eras lack of research on the home environment prevented sufficient attention to infection transmission in the domestic setting. Recent research has demonstrated how microbial contamination can be transmitted by activities in the home. Application of this knowledge could significantly reduce the continuing impact of infectious diseases in our communities.

Keywords: Control of infection; handwashing; morbidity; mortality; communicable disease; home hygiene.

Introduction

Philosophers through the ages have concluded that forgetting the lessons of history can limit progress or, at worst, lead to a repeat of mistakes made in the past. The historical development of attitudes to hygiene provide an understanding of how it is both perceived and practised in our own era, and also provides insights into whether the current focus and guidelines are appropriate.

To our ancestors, hygiene had a broader meaning that affected the person’s whole life, incorporating habits, cleanliness, fresh air, exercise and the general regulation of health. This was partly due to a lack of understanding of the causes of infection and other diseases. Instead, there was a general notion that disease was caused by a number of factors, such as bad air or a ‘miasma’—toxic vapours found near rivers or in poor housing. The poor were thought to have a higher level of disease because they lived in closer proximity to the miasma. Disease was also believed to be caused by an imbalance in ‘humours’ in the body, an idea developed from Arabic and mediaeval medicine.

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This archaic idea of the associations of disease persisted for many centuries and elements of the miasma theory persist today. During the latter half of the 19th century, several of the pioneers of public health and reform, such as Edwin Chadwick, William Farr, Florence Nightingale and John Simon, were ‘miasmatists’ for all or most of their careers. Chadwick believed that intense smells were diagnostic of acute disease, while Simon thought that fevers became epidemic in ‘unhealthy places and among the sickly classes’ (Porter 1997). The microbiological discoveries that established the germ theory gradually, but not entirely, replaced these concepts. Ironically, many of the reforms to sanitation, which made such an enormous impact on infection morbidity and mortality, were prompted by the belief in miasma.

What do people now mean by hygiene?

The current dictionary definition of hygiene refers generally to the promotion of health, but the public health definition of hygiene is rooted more specifically in cleanliness of water, food and the environment. The popular perception of hygiene is still, perhaps, seen as the avoidance of dirt, the killing of germs, or something to do with bathrooms and with hospitals.

Complacency about the contemporary role of hygiene

In the developed world, the media portrayal of hygiene to the general public seems often to draw on outdated concepts of excessive use of disinfectants and attempts to create a germ-free environment, possibly influenced by the stringent methods used to control epidemics in the past, in turn influenced by the fear aroused by infectious diseases such as cholera and diphtheria. Thus, the contemporary media approach questions the need to be so clean, now that pandemics are rare in developed countries, with the underlying assumption that excessive cleanliness is prevalent. People who specialise in hygiene in the home have a different attitude, shaped by an understanding of the continuing prevalence of infection and by observations of the efficiency of hygiene practices. Even health professionals, including doctors and nurses, do not always apply hygiene measures correctly. There is a constant need for education and for application of behavioural science in understanding the values and motivation required for appropriate hygienic practice.

The current complacency towards hygiene in Europe and the USA— that the major dangers are over and measures can be relaxed— is both misplaced and dangerous. While some of the epidemics of the past have been controlled in industrialised countries, new infections have emerged, accompanied by demographic changes such as ageing populations and a rising proportion of chronic illness that increases the susceptibility to infection. Rapid, cheap transport has allowed ever greater numbers of people and food products to travel to more destinations than at any previous time, but the associated globalisation of infection problems is rarely considered. These trends challenge a mindset that assumes the battle for hygiene has been won, and it will only be a matter of time before all other countries follow suit. This may not necessarily be the case. Furthermore, society has changed in other ways that affect hygiene practice. Modern life and jobs outside the home leave little time for hygiene: in Europe, for example, many households in the first half of the 20th century would have had a servant to help in the running and cleaning of their homes. Only a small minority of people today can choose and afford this luxury. As a result, less time is spent on performing hygiene procedures in the home and at a more superficial level.
Another lesson from history is that the hardest time to defeat an enemy is when it is in retreat, because that is when the enemy can re-group and re-emerge. There is a sentimental longing today, particularly in developed countries, that things were better in the past, when food and the environment were more natural: hygiene, both personal and environmental, has thus acquired an undesirably modern connotation, in comparison with eras when there was less need to wash and that perhaps this had its own benefits.

**What has hygiene done for us?**

In general, throughout the world, we are healthier and live longer than any previous generation. This is in part due to improvement in water quality and sanitation, as well as improvements in medicine and nutrition, in the more affluent and industrialised countries. If nostalgic yearnings stir a wish to return to the ‘good old days’ then the associated consequences for health must also be faced. Nevertheless, part of the historical view of hygiene is that it was too generally applied, with insufficient regard to possible environmental effects or side effects on health. The contemporary debate about hygiene, including the ‘hygiene hypothesis’ idea that it has reduced the level of microbial exposure essential to development of a well balanced immune system, has influenced a re-evaluation of hygiene practice both in the home and the outside environment. While available data on microbial exposure appears to counter some of the arguments for the hygiene hypothesis, there has also been insufficient research into infection risks in the home. There is a need to maintain and improve the monitoring of infection within countries and internationally, including examining trends in countries with both a good surveillance system and a long period of improved hygiene and sanitation. In particular, there may be lessons from studies of infection in the home from which evidence can be applied to developing countries.

**Trends and surveillance issues**

An increasingly higher proportion of people now live in cities, with a greater risk of epidemics than in traditional rural living. There is a greater population flux and mobility, and an increased disruption and displacement of people. Refugees can move further away, far from their homelands and often into poverty. In addition, since the events of September 11, 2001, there is an increased fear of the deliberate release of pathogenic micro-organisms.

The rising proportion of people in older age groups is one of the striking trends in developed countries, such as the UK, and also a trend in the more affluent regions of developing countries. Extremes of age—both infancy and old age—are established high-risk periods for infection, so this global demographic trend can be expected to increase the morbidity and mortality from infectious disease. An estimated 10% of the world population will be aged over 65 years by 2025 (World Health Organization 2000); in the UK, the estimate is nearer 24% (Fig. 1). Furthermore, approximately one in six of the European population will be in a high-risk group for infection, either through age or illness.

Surveillance systems worldwide are, in general, biased towards disease outbreaks and epidemics, and thus tend to underestimate small clusters of infection or individual ‘sporadic’ cases, which comprise the majority of cases of infectious disease. Most surveillance systems are also poor at identifying the range of risk factors involved, including the role of infection risks in the home. Such evidence can only be found by conducting detailed and comprehensive studies, outside the scope of regional and national surveillance systems. Ascertainment is also affected by the availability and costs of molecular biological techniques, for example, to identify
Norwalk-like virus (NLV). Such techniques are outside the budget of many developing countries, which contributes to gross underestimation of the impact of these infections.

The surveillance difficulties are not limited to resources: investigating poor hygiene behaviours can be embarrassing. It is difficult to enter an individual’s home and to interrogate them on personal hygiene, such as handwashing, or to inform them they prepared their food badly. Data concerning these personal habits and poor hygiene are rarely featured in national statistics, partly because individuals find it stigmatising and do not want to talk about their experiences. Another surveillance influence, associated with a neglect of home hygiene in epidemiological research, is the emphasis on the effects of vaccines and antibiotics. Successful trials of therapy and vaccines have possibly eclipsed the importance of means of preventing infection through hygiene interventions in the home.

Other trends evident in the UK include the continuing rise in, for instance, viral gastroenteritis and also in emerging infections, such as Campylobacter and Helicobacter, where there is insufficient information about causes to prevent them. Campylobacter enteritis is now the most common bacterial infection in the UK, with evidence to suggest that it is also common in any country with good surveillance (Fig. 2). Campylobacter has been recently identified also as an emerging infection issue in developing countries (Coker et al. 2002).

For some infections, such as chicken pox, measles and polio, the age at which a person first becomes infected is also changing. While infection is no longer a major cause of mortality in infancy in developed countries, delayed exposure can result in a more severe form of the illness. The chronic after effects of infection include arthritis, infertility and heart disease, with some evidence that the age at exposure influences the outcome (Lindsay 1997).
Gastrointestinal disease

The overall upward trend in gastrointestinal infection in England and Wales in the last few decades is due mainly to viral gastroenteritis and campylobacter enteritis. The trend in salmonella infections has levelled off since more stringent controls of poultry and egg production were instituted in the 1990s. *Shigella sonnei* dysentery has also become less frequent, although, as with most infections, this is linked to a cyclical trend associated in part with herd immunity. There is little or no evidence that improvements in home hygiene have made a major impact on the level of gastrointestinal infections: the proportion of outbreaks attributed to a cause within the home has remained much the same according to the reports from the Communicable Disease Surveillance Centre of the Public Health Laboratory Service in England and Wales (Evans *et al.* 1998).

Over a third of the infectious intestinal disease episodes (IID) reported in England and Wales are due to viruses, only a small proportion of which are associated with food poisoning: most are spread in home and community environments. Many of these infections are not ascertained by national statistics, as demonstrated by a detailed study of IID in England and Wales by Wheeler *et al.* (1999). This study produced an estimate of nine million episodes of IID annually, as compared with about 100,000 cases reported to national surveillance. Self-treatment, or illnesses not considered notifiable, accounts for a large proportion of this under-ascertainment. So the estimate from national statistics that only around 3% of IID are acquired in the home is
likely to be a considerable underestimate: the actual proportion is probably nearer to 75% in most European countries.

What proportion of these infections occurs in the home?

Because of the known under-ascertainment of infectious diseases, there are varying estimates of the frequency of IID acquired in the home, although most sources suggest a high proportion throughout the European region (Schmidt 1998). A detailed study of salmonella infections in England and Wales produced an estimate of 86% home-acquired salmonellosis (Socket et al. 1993), while estimates across Europe range from 50% to 80%; for example, Scuderi et al. (1996) estimated that 74% of salmonella cases in Italy could be linked to infection within the home. The emphasis, therefore, has shifted away from regarding food poisoning as a restaurant-acquired infection, and this pattern seems to be repeated in many parts of Europe. Surveillance systems are biased towards the food poisoning component of IID, partly because food poisoning is statutorily notifiable in many countries; yet detailed studies have demonstrated that much of IID is not associated with a recognised food poisoning incident (Wheeler et al. 1999; Le Baigue et al. 2000).

Food hygiene is nevertheless an important component of preventing infection within the home. The Food Standards Agency, a relatively new agency in the UK, estimates that up to 50% of cases of infection are foodborne (Food Standards Agency 2002). The hygiene significance is emphasised by studies demonstrating the persistence of salmonella in a kitchen environment long after the food has been prepared (Humphrey et al. 1994; Cogan et al. 1999). Inappropriate hygiene practice—such as failure to wash hands or to clean high-risk areas—has also been identified as a contributing factor to outbreaks. For example, in a study of sporadic infections of Escherichia coli O157 due to homemade hamburgers in the USA, it was estimated that hand hygiene could have prevented 34% of the infections, in addition to the proportion preventable by cleaning work surfaces (Mead et al. 1997).

Other sources of infection

Domesticated pets are a source of pathogen-acquired infection. For example, cats are often portrayed as clean because they are always washing and preening their fur. In fact their fur may be heavily contaminated with salmonella and other micro-organisms (Bruner and Gillespie 1966; Morse 1976; Moreno et al. 1993; Cefai et al. 1994): cats and other domestic pets also excrete Campylobacter (Harrison 2000). Pet-handlers often forget that animals are a reservoir of infection and that their pets are the cause of infections in the home, particularly during high-risk activities, such as cleaning up pet faeces, when hygiene precautions are essential.

In the home, viruses are also a cause of concern. Viruses are shed in very large numbers by those infected, and only a few viral particles may be needed to produce infection. For example, the projectile vomiting associated with NLV infection can potentially infect everyone in the immediate environment: survival of the virus on carpets and other surfaces has been shown to cause outbreaks in people exposed to the environment long after the vomiting episode. Known as ‘winter vomiting’ in temperate countries, the Norwalk-like agent was recently implicated as the cause of a disruptive outbreak in troops in Afghanistan, and research suggests that over 1500 more cases occur than are recorded in national statistics in England (Cowden 2002). Respiratory infections, such as colds and influenza, also have a hygiene element in their spread: in a recent study of naval recruits in the USA, a controlled handwashing regime was estimated
to have prevented 45% of upper respiratory tract infections in those following the regime (Ryan et al. 2001). Individuals can easily inoculate themselves, and others through transfer of viruses sneezed or coughed into their hands as well as into the general environment. Sustaining handwashing programmes in hospitals, as well as in community settings such as day nurseries, is a contemporary challenge, with no evidence that people have become overzealous in this regard in recent decades, as has been suggested in some media critiques of hygiene.

Finally, flies and other insects remain an important source of infection transmission, and studies have demonstrated that fly control can reduce the incidence of diarrhoea in warm climates (Cohen et al. 1991; Chavasse et al. 1999; Emerson et al. 1999). Research studies focusing on the home now provide a better understanding of how, and to what extent, infectious disease agents are spread. Although such data come largely from typical home settings in developed countries, the principles are applicable to all home environments.

Hygiene is a shared responsibility

Globally, escalating treatment costs and growing awareness of the unpredictable nature of microbes suggest that hygiene may be the most economically sustainable prevention strategy. While provision of good quality water and efficient sanitation are vital factors, it is now recognised that the health gains will only be commensurate with investment if steps are taken also to improve standards of hygiene practice within the community. This depends primarily on the development of effective guidelines for home hygiene, in turn dependent upon an understanding of the infection potential within the home. To be effective, ‘Home Hygiene’ must cover all aspects of intestinal disease prevention, including food and water hygiene, personal hygiene, general hygiene and hygiene related to the care of preventable groups. In developing countries, guidelines for home hygiene must also address peri-domestic sanitation and disposal of human excreta and other waste.

The current media coverage of hygiene is generally negative, linking a presumed over-enthusiasm with hygiene with rising trends of eczema, hayfever and asthma. Suggestions that hygiene and cleanliness can be relaxed are a powerful influence, associated with the idea that the exposures in a traditional rustic life – such as close exposure to farm animals and mud – are needed for robust immune systems. The hygiene hypothesis is still being investigated, with research being carried out into the other possible influences on allergy, such as diet and reduced exercise. Meanwhile, there is no doubt that the media coverage has undermined confidence in hygiene practice and education on avoidance of infection.

The hygiene debate has helped to show that there is a need for an evidence base to demonstrate when and where particular hygiene practices are needed. The evidence base must include further study of infection in the home environment, as well as trials of specific interventions. Most of these interventions are inexpensive and simple, with the principles of eliminating pathogens well established for over a century. The fact that infectious disease is still a major problem in both developed and developing countries demonstrates that the lessons of history are quickly forgotten. Educational initiatives need to take account of modern perspectives, lifestyles and behaviours: the responsibility for this must be shared between governments, health agencies and individuals. A hygienic home is an achievable aim without damaging the overall microbial environment, if the focus is re-directed to where hygiene needs are currently unmet or not specifically targeted. The changing patterns in demography and chronic disease suggest that appropriate use of hygiene is an urgent worldwide priority. Two and a half thousand years ago, Hippocrates wrote that:
“Whoever wishes to investigate medicine properly should proceed thus . . . When he comes into a strange city, he ought to consider its situation, how it lies to the wind, the sun and the waters which the inhabitants use . . . and the mode in which the inhabitants live . . .”

(translated by Adams 1939)

Some lessons from history bear the test of time and of scientific advances: the importance of environmental and social context described by Hippocrates has been rediscovered in public health and in gene–environment interactions in our times: let us also continue to remember, and to build on, the historic role of hygiene in preventing infection.

References


