INFECTIONS AND SOCIETIES
HAJO GRUNDMANN

Hajo Grundmann, born in 1955, studied Sinology, Nursing and Human Medicine at the Universities of Bochum and Freiburg, Germany. He specialised in Clinical Tropical Medicine, Medical Microbiology and Hygiene & Environmental Medicine and received an M.Sc. in Epidemiology of Communicable Diseases at the London School of Hygiene. He worked as a medical doctor at university hospitals in Freiburg, Berlin, and Nottingham and carried out extensive field studies in Taiwan, Venezuela and Tanzania. Currently, he has been appointed Special Professor at the University of Nottingham and holds the Chair for Infectious Diseases Epidemiology at the University of Groningen. He is also the Project Leader of the European Antimicrobial Resistance Surveillance System (EARSS) funded by the European Commission and the Dutch Ministry of Health at the Dutch Institute for Public Health and the Environment. His major research interests are the molecular evolution, epidemiology, and anthropology of antimicrobial resistance and health care associated infections, malaria and tuberculosis. – Address: National Institute for Public Health and the Environment (RIVM), EARSS, Antonie van Leeuwenhoeklaan 9, P.O. Box 1, 3720 BA Bilthoven, The Netherlands.

Outbreaks of epidemic diseases are to public health specialists what earthquakes are to seismologists. Like earthquakes, epidemics are natural events and often disasters, depending on their magnitude and impact on human life. Unlike earthquakes, outbreaks have an ecological dimension and are deeply rooted in the biological and societal properties of human populations, their whereabouts, behaviour and history. In this respect, they are mainly

determined by intrinsic conditions whereas earthquakes, like many other natural disasters, are for the most part extrinsic.

When, in the last decades of the nineteenth century, pioneering microbiologists crushed what was known as the miasma theory (toxic vapours as the origin of epidemic diseases), one of the most revealing explanatory models in contemporary science had won the day. The imprint that the discoveries by Pasteur, Koch and others had on mankind and its understanding was probably only equalled by Darwin's and Wallace's theory of natural selection. In fact Koch's and Henle's postulates on the causation of infections were so persuasive that infectious diseases epidemiology became a victim of its own success.

It was also quickly understood that combating infectious diseases could be accomplished by chemical substances targeted at the causative organisms themselves, and Paul Ehrlich's vision of "magic bullets" became a surprising reality by the successive discovery of sulpha drugs and Fleming's, Florey's, Chain's and Fletcher's work on penicillin. An apparently endless stream of newly identified antimicrobial compounds in the three decades that followed the first successful treatment with penicillin left the impression that humanity had once and for all established superiority over the microbial kingdom. These developments came at a time when chronic diseases epidemiologists were struggling for equally simple solution and, in the absence of such singularities, rapidly developed the field of a whole range of quasi-experimental designs that included cohort and case-control studies, as well as advanced statistical tools necessary for their quantitative analysis.

At the same time, public health efforts to curb infectious diseases relied heavily and successfully on chemotherapy and vaccination, whereby hygiene and sanitation, favoured so much in the century before the contagionists' success, began to fade. Indeed, achievements were impressive. Before the availability of antimicrobial chemotherapy, more than 50% of the overall burden of disease was still caused by infectious diseases in Europe and the US alike. With the advent of antibiotics, disinfectants and pesticides, epidemic infections seemed to melt away like ice in the sunshine. In the late 1960s, after seeing such deadly diseases as smallpox, polio and rheumatic fever tamed by pharmaceutical advances, the United States Surgeon General William H. Steward declared that it was time to close the book on infectious diseases and pay more attention to chronic ailments such as cancer and heart disease. A few evolutionary biologists and social scientists remained, however, sceptical about the sustainability of the pharmaceutical miracle. The former argued that with growing availability of antibiotic compounds, large-scale emergence of resistance would only be a matter of time; and the latter pointed to the fact that demographic transition, as

well as changes in lifestyles that shaped the societies in advanced market communities in the previous hundred years, were equally if not more important than all vaccination, disinfection and antibiotic chemotherapy in reducing infectious diseases and that a reversal of these social improvements would rapidly translate into re-emergence of major epidemics.

Forty years on, we are confronted with a 23-year-old AIDS pandemic that has killed more people than any single epidemic in history. We have to come to terms with Dengue, West Nile-Virus, SARS, and avian influenza. We see multidrug-resistant (MDR) tuberculosis, and malaria (*P. falciparum*), worldwide emergence of multiple antibiotic resistance in major food-borne pathogens that cause epidemic dysentery and typhoid and non-typhoid gut infections (*Shigella* and *Salmonella*). We see new virulence in methicillin-resistant *Staphylococcus aureus* (MRSA) which increasingly spreads through the community and next to complete antibiotic resistance in some notorious hospital pathogens such as *Acinetobacter baumannii* and *Pseudomonas aeruginosa*. At the same time, the once copious supply of new or improved anti-infective compounds has worn thin, as drug development becomes increasingly challenging and pharmaceutical companies invest in more lucrative markets. With this hindsight, it is not surprising that 21st-century infectious diseases consultants and public health specialists have become more modest in their claims to combat infectious diseases as they witness the relentless rise of infectious diseases on the public health agenda.

In the following, I hold the view that

- infectious diseases are biological in their expression but largely socio-culturally determined
- many biomedical approaches make immodest claims of causality
- new explanatory frameworks need to be developed, not only featuring host pathogen relationships, i. e., the molecular/immunological level, but also incorporating ethnography, social sciences, political economy and history
- in the past century "contagionist" models were too dominant and that a reconciliation with more inclusive explanatory models needs to be encouraged in order to improve an understanding of the forces that shape the occurrence of infections and the way societies respond and cope with the perceived risks, and
- a renewed appraisal of behavioural and societal as well as physical approaches is necessary to cope with the predictable onslaught of re-emerging public health threats.

The Biological Level

The success of microorganisms that cause infectious diseases is largely a result of their fast reproduction and large population sizes. Combined with high mutability and an astonishing rate of genetic information exchange, evolution keeps pathogens ahead of the small- and large-scale ecological changes under which they are forced to exist. Disease-causing microorganisms in humans heavily depend on society, which sets the conditions for exposure and transmission. Societies provide the very fabric of interpersonal relations as well as macro-economic structures and create the ecological opportunities that infectious agents seize and exploit. In this way, societies themselves unwittingly shape the pattern of the infections they confront, causing the decline and disappearance of some but at the same time the emergence and perpetuation of others.

Current examples in advanced market communities are the emergence of bovine spongiform encephalopathy (BSE) and avian influenza (bird flu). The success of intensive animal-rearing practices comes at a price. In BSE, ruminant feeds (meat and bone meal) that contain protein agents called prions were unwittingly transmitted through the food chain, resulting in BSE in cattle and eventually fatal variant Creutzfeldt Jacob's disease in humans. Bird flu is brought about by a genetic variant of influenza virus that easily spreads between poultry flocks and occasionally causes infections in humans. There is a worry that repeated human infections could increase the chance for the emergence of a novel strain adapted to human transmission, causing pandemic spread in a population immunologically naïve and thus highly susceptible to this new variant strain.

Whereas influenza virus fulfils Koch's postulates as a causative agent of flu, prions present a conceptual difficulty, simply because prions are not microorganisms. They are not alive, not even in a broad sense that could encompass virus particles. Prions are mere protein molecules. Inoculating prions in susceptible animals brings about a conformational change of a neuronal protein within the host. Importantly, this conformational change is replicative, i. e., it multiplies, leading to a slow but steady degeneration of the central nervous system. In essence, prion molecules convey conformational information and this information has the propensity for multiplication. After all, it is the capacity for multiplication that is essential for any type of information. We know from the media that the more replicative and transmissible information is, the better it sells. Its contagiousness depends on emotions in the recipients, joy when listening to jokes, concern when confronted with news and imagination when marvelling over tales. In a way, information has much in common

with infection and the ecological context in which information evolves is the collective mindset of its audience.

The Societal Level

Few scientists doubt that vCJD is a transmissible disease, but the emergence of vCJD, BSE and likewise bird flu can hardly be explained on the basis of biomedical paradigms such as exposure and transmission alone. The explanation requires a historical, cultural and socio-economic context. By invoking Koch's postulates as the sole criterion for causation of infectious diseases, biomedical sciences make immodest claims of causality. They are immodest because they distract attention from deliberate market decisions that modify biological outcomes. Food production (incl. use of antibiotics as growth promoters), travel patterns, life styles, recreational adventures and intensive care medicine in hospitals are the frame in which affluent societies are currently experiencing emerging or re-emerging infectious diseases.

Economies in developing countries create different ecological constraints. It is the mantra of experts in international public health that poverty and the resulting inequalities are the driving force of infections; and there is no doubt that poverty reduces access to health facilities, schooling and education and that it generally creates life conditions that undermine the ability of humans to make choices. Yet, it seems that it is not the absolute level of poverty that drives many epidemics in less developed countries (especially HIV/AIDS and TB), but rather the degree of economic and gender inequality, as well as the speed with which the social landscapes change. Given that societal success becomes more and more epitomised by financial wealth and that concepts cherished in market societies such as individualism, youth and entrepreneurship – by themselves alien to traditional rural communities – are increasingly conveyed through the media, the sustainability of resources and stabilising customs are left behind for quick gain, giving way to an economic boom and bust dynamic, which creates the inequality between the rich and destitute, the divide between those who choose and those who are left with no choice. It is under these circumstances where infections like HIV and TB thrive, where the risk of acquiring HIV depends not only on the knowledge of how the virus is transmitted. Indeed, economic landslide changes are by far the most important contributors to the dissemination of HIV and TB, rather than ignorance of the modes of transmission or harmful "cultural beliefs and prac-

tices". It has been shown that many who acquire HIV infections do so in spite of having enough information to protect themselves.

The Task

At the Wissenschaftskolleg, my initiative centred on an effort to develop a conceptual framework and improve a model of causation that goes beyond germ theory and Koch's postulates, accepting the fact that the transmission of infectious particles is only the necessary part of an entire set of other components that constitute a sufficient cause for infection and frequently premature death by AIDS, TB or multi-resistant pathogens. This model allows the determination of a set of alternative sufficient causes made up of various components for different scenarios or cultural contexts and includes conceptual attempts to quantify them. The stance taken here was to critically recast some of the doubts shared by enemies of the "virus-only hypothesis", a rejection that, for the AIDS epidemic, has proven to have disastrous consequences when appealing to politicians (like President Thabo Mbeki of South Africa) in their endeavour to deny a sexual contagion. Conversely, the model allows for a reconciliation of the purely biomedical "contagionist" point of view with (what in analogy to nineteenth-century terminology was tentatively termed) the "miasmic" point of view. Miasma in this case, however, is not understood as a gaseous toxic emanation but in a much broader sense (as, in fact, Pettenkofer and Virchow already did) as an epidemiological collective, which includes the recipient as well as the donor of the infectious agent, *and* the historic conditions, value systems and socio-economical dependencies in which donor and recipient coexist.

With a better understanding of societal determinants for the emergence and transmission of infectious diseases comes a reflection on appropriate and acceptable interventions. In the light of this more comprehensive etiological understanding, we may reappraise health traditions that may provide a new emphasis on controlling infectious diseases by a mix of behavioural and physical approaches that embody a concept that seems to have long come of age: hygiene.