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Caring for the Carers of COVID-19

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Lessons from a family used to fighting epidemics since 1854

I have in front of me a letter written on 5 January 1854: "Extracted from the Minutes of the Sanitary Committee of the Parochial Board of Kilwinning by Andrew McCrorie, Inspector of the Poor: The Medical Officers having reported that Cholera had considerably abated in the town and had apparently nearly run its course at the iron works, the Committee are of the opinion that the services of Mr Seaton may now be dispensed with. The Committee hereby express their entire satisfaction with the manner in which that gentleman has discharged his duty, he having exhibited much activity and perseverance in household visitation as well as much skill and success in the treatment of patients under his charge. (Signed) John Service, Preses."

Clinical medicine and epidemiology

James Seaton was the fifth son of a poor handloom weaver and in 1854 was a clinically experienced final year medical student at Anderson's College, Glasgow. The same year, a Yorkshire doctor, John Snow, found himself investigating the cause of the same epidemic in London and was able to attribute it not to miasma but to contamination of drinking water by sewage. His report became famous as one of the origins of epidemiology and public health and exemplifies the principles of that branch of medical science. He investigated the association of the disease in the area with the possible environmental determinants, drew tentative conclusions as to its causation, and then tested them by intervening, in this case by removing the handle of the pump that supplied water to those affected.

Like James Seaton, he had hands-on experience of fighting the disease at the front line, struggling to help people survive when there was no cure available, but he took a step further and used a different form of logical thinking. Instead of the deductive logic of the clinician, using general knowledge of medicine and applying it to the specific circumstances of individual patients to make a diagnosis and apply treatment, he used inductive logic and argued from the specific circumstances across the population and its environment to draw conclusions. These could then be used to make general predictions and to test the usefulness of various interventions. Some doctors think that way and become epidemiologists, but most think deductively and remain clinicians. It is my experience that this frequently leads to them failing to understand each other's thought processes.

Now, 166 years later, two of James Seaton's great-great-grandchildren are in the front line as NHS consultants, looking after patients with COVID-19. They, as he surely was, are struggling in the absence of a cure and with barely adequate facilities to give comfort and help to their patients. Like him, they know that they are putting their lives at risk. But unlike him, they know that there are others who

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follow John Snow's method of thinking and have examined the pandemic and made predictions about its course and the probable consequences of palliative measures. These people include expert committees appointed by Governments. From these committees has come advice, given prominence during press briefings, that a relaxation of the restrictions on the population's activities is dependent on a number called R_0.

What is R_0?

Many have now become familiar with the term 'R naught', a number that we are told must be below one if we can come out of our social isolation. But when the journalists ask how far below one, they don't get a clear answer. If you look it up, you will find a definition: 'the number of cases that are expected to occur on average in a homogeneous population as a result of infection by a single individual, when the population is susceptible at the start of an epidemic'. That sounds clear enough, but then you hear that R_0 keeps changing and that different R_0s seem to be found in different countries and at different times.

It is obvious that it is useful to measure the infectivity of a new and dangerous organism, and that this would in part depend on how efficiently the infection is transmitted to its victims. Counting things like these has long been familiar to medicine and the social sciences. Malthus in the 18th century calculated reproductive rates of human populations in relation to food supply. In the early 20th century, Ronald Ross won his Nobel Prize for the discovery of the mode of transmission of malaria. As professor of tropical medicine in Liverpool, he applied mathematics to understanding how infections spread and to help predict the effectiveness of various preventive measures. Over the century, others in tropical medicine showed the usefulness of these mathematical models and they were widely adopted in studies of the behaviour of other infections, in particular for testing the likely effects of preventive measures. So, that is where the R, the Reproductive number of the organism, came from.

What then is the 0, or naught? This refers to the absence of immunity in the population, so in theory R_0 should not apply, according to the definition, when the proportion of the population with immunity changes, as people get the disease and recover or die. And this turns out to be the case; when they told us that R_0 had fallen they were talking about another number, R_e, the effective reproductive number. This is the number of people in a population who can be infected by an individual at any specific time, and rather obviously depends on local circumstances, notably the proportion of the population in the area in which the disease is circulating who are susceptible to the virus and the reliability of diagnosis of infection there. Thus, R depends not only on the virulence of the organism but also on the susceptibility of the population, the numbers who have been infected and died or become immune, and the numbers who may have natural immunity. And this leads to the thought that it must be difficult to calculate when many of these factors are unknown; assumptions must be made and different methods must lead to different results.

The estimation of R numbers is thus complex and depends partly on assumptions and partly on observations. It includes the rate of new infections, the number of susceptible people and the rate of removal from the susceptible population by recovery or death. The original calculations of R_0 were made in China and the Diamond Princess early in the pandemic, when the entire population was effectively uniformly susceptible, and gave a figure of around 2.5. Any number greater than one means that the infection rate accelerates, increases exponentially, and the higher the number, the more people are infected more rapidly. Subsequent calculations, as one would expect, have varied quite widely but still average around 2.5, and this number was used to predict two things: that herd immunity would require at least 65% of the population to be infected or immunised, and that without dramatic preventive measures this would lead to over 80% of us being infected, with half a million or more deaths in the UK during the current pandemic. Nevertheless, the R_0 estimates suggested that even strict isolation measures might still only limit the numbers of deaths to somewhere below 50,000. Our reaction, described as 'the right action at the right time' was later than it might have been, and the UK death rate so far is

among the highest in the world, at 28,313 or 425 per million of the population and rising. It is likely that the political responses to these early calculations have saved us from an even worse fate but that the 50,000 may not prove far wide of the mark.

Making decisions on coming out

Ultimately, the politicians must balance costs and benefits; they must make judgements based partly on scientific advice and partly on economic considerations, and they have a big one to make now in relation to coming out of isolation. What we have done is delay and probably reduce the effects of the virus by shepherding the population into a safe but unsustainable haven. It is likely that most people who are now isolated, other than young children, are susceptible to the virus, some more susceptible than others, and that the virus itself has effectively been confined to the NHS, care home populations and other groups of essential workers and their families who have been unable to isolate. This is where new cases of infection are now predominantly being seen and where R_0 presumably applies, at about 2.5. The infection now lurks in the very places where the sick and disabled themselves seek help. Elsewhere in the nations of the UK, in our homes, R_e is presumably well below 1.

There is no single R number that applies to the whole population. It is important to question whether a continuing fixation on overall R_0 is still relevant or whether it is a distraction from what is beginning to be realised; that there is another more clinical side to epidemic control, complementary to predicting risks and developing new strategies for their reduction. This side is what is sometimes called shoe leather epidemiology, going around to find cases, isolating them, tracing their contacts, and isolating these in turn. This is the only way to starve the virus of its nourishment by reducing its chances of finding enough people to infect and in whom to reproduce. It is possible to embark on this early in an epidemic or when there are few enough people falling ill in the population, and it is easier when the distribution of the disease is relatively confined. It is not dependent on mobile phone technology, though this could help.

Test, trace and isolate

This brings me to the 100,000 tests a day saga, an apparent pledge by the UK Government issued on the spur of the moment without consideration of what tests were being offered, or even why. This has caused us to focus on the number, rather than the purpose of the tests, leading to them being regarded as a means of diagnosing infections in ill patients and allowing those unaffected to get back to work, rather than as a means of controlling the pandemic. However, whether or not the target was reached, it is of significance only in that the ability to do many more tests was urgently needed to allow their use in a prevention strategy. And this strategy is what will allow the politicians to judge that the time has come to release us from isolation. That time will be when R_e is less than 1 in the current refuges of the virus: hospitals, care homes, prisons and other places where isolation has not been possible. The national R, however calculated, is irrelevant to the situation in these reservoirs of infection.

When the decision is made, release must be gradual, as inevitably more non-immune people moving into the at-risk population will raise the general R_e and more new cases will occur. Continuing distancing and hygiene measures will be essential for all and wearing of simple masks in public places highly desirable. Coughs and colds should be a reason for staying at home. Outdoor work will be safer than indoor work and workplaces will have to take account of infective risks in the way they are becoming accustomed to. A renewed system of population surveillance for infection, isolation and contact tracing will need to continue. Political judgements at this time should be assisted by experienced public and occupational health specialists. Medical history has provided salutary lessons on the role of hospitals in spreading infection, including the old story of childbirth fever and the recent story of antibiotic resistance.

The family heritage

John Snow went on to give Queen Victoria chloroform during childbirth and broke the religious taboo on pain relief in labour. One of the most in-

fluential doctors in the history of medicine, he died of a stroke aged 45. James Seaton became a surgeon and President of the then new Leeds School of Medicine before dying of an infection acquired from a patient. His surgeon son, my grandfather, caught septicaemia in his work and was lucky to survive with only a destroyed knee joint.

My father, working in tropical medicine during the war, caught typhus from his laboratory work on the disease but fortunately survived. My son and a nephew are NHS consultants looking after patients with COVID-19. I spent a large part of my career investigating causes of disease and how to prevent and, in the case of tuberculosis, cure them. You will understand why I feel strongly about the need to protect those who care for others.

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