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Key Note Lecture

Science and society: vaccines and public health[☆]

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ABSTRACT

Most public health research is devoted to the measurement of disease burdens and of the costs and effectiveness of control measures. The history of immunization provides many colourful examples of various ways in which such measurements are made, of how they have influenced policies, and of the importance of public perception of the magnitudes of the various burdens, benefits and risks. Improving the public's ability to evaluate evidence is itself an important aspect of public health.

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One might liken public health to a set of scales, weighing the magnitudes and costs of various 'problems' on one side, and balancing these against the effectiveness and costs of various 'control interventions' on the other. Everyone in public health is involved somewhere in this spectrum of relating problems to solutions, and insofar as we are doing it scientifically, this means quantifying them in various ways. It may be appropriate to actually go out and measure them, and a lot of the public health workforce does that. But sometimes you cannot measure – it is just too expensive, or it would take too long, or it is not known how. So sometimes estimation is used, and this often means modelling; it often means assumptions have to be made.

It is also important to consider the importance of public perceptions of the magnitude or cost of a problem, and of the intervention being developed, implemented or evaluated. This review looks at measuring, estimating and perceiving the magnitude of burdens and costs with reference to

immunization, as illustrative of many of the issues which confront public health.

Smallpox

It all started with smallpox. In terms of burden, before the nineteenth century it was the number one cause of mortality. It is said that a third of the population of Iceland died from smallpox, that there were 40,000 smallpox deaths in Paris in 1723, and that 90% of the Aztec population died from smallpox. The numbers are staggering, as we know from the Bills of Mortality, which collected parish records, starting during the plague period of the seventeenth century. Over 150 years, between 7% and 10% of all deaths in these bills were attributed to smallpox. That is a measurement, the best they could do at that time.

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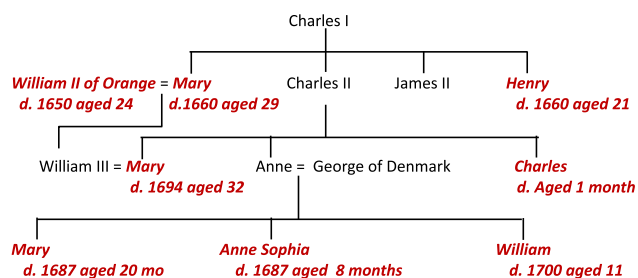


Fig. 1 – Family Tree showing smallpox deaths in the Stuart family. Smallpox deaths in red italics. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Family records are available of various royal families from ages past, including causes of death, as exemplified in the fragment of the Stuart Royal family tree shown in Fig. 1. These families knew their pedigrees, and they knew who died of smallpox. They feared it, and this had implications.

Variolation

So what was done about it? It had been recognized for centuries, by many people around the world, that you got this disease only once. If you survived it, you never got it again and need not fear it – in effect it was recognized to be both a contagious and an immunizing disease. There must have been a variety of folk practices to combat this disease, and one turns out to have been particularly important, a technique later known as variolation – variola being the medical term for smallpox. It is thought this originated in East Asia, perhaps 2000 years ago, when someone developed a technique of taking material from lesions of mild cases – vesicular fluid, or scab, or pus – and inoculating it in a variety of ways – into the nose, or scratching it into the skin. The intention was to induce a mild case, which would immunize. This was variolation.

Mary Montagu

How did variolation get here?¹ A key figure was Lady Mary Wortley Montagu, a colourful lady, who did not like her family's intentions for her life, and so she ran away when she was a teenager, with the ambassador to the Sultan of Turkey. She contracted smallpox herself, but noticed that there was a community in Turkey that escaped the disease. She made enquiries and found out that they were practising variolation. Being concerned about her own children, she had one of them variolated in Turkey. This was done by a Turkish woman, and it was witnessed by the physician of the embassy, Charles Maitland. She came back to this country in about 1720 and had her second child variolated here by Maitland. That procedure was witnessed by an interesting man: Hans Sloane, one of the towering figures of the enlightenment – the man whose collections are the foundation of the British Museum.

Sloane had close connections with the royal court, and knew Carolyn, the Princess of Wales. Carolyn and one of her

children had had smallpox, and she heard through Hans Sloane about the procedure that Mary Montagu had brought back from Turkey. She wanted to know if it would work on her children – so let us read what Sloane wrote: ‘To secure her other children, and for the common good, she begged the lives of six condemned criminals who had not had the smallpox in order to try the experiment of inoculation upon them’. Maybe this was one of the first experiments, the first formal evaluation of a vaccine. At least one of those condemned criminals was then made to sleep in the same bed as an active smallpox case, to expose him. It was not the last time that convicts were used for evaluating things in public health, but that is another story. That is the way variation made it into the Palace of Westminster and this country.

Use of variolation

There are very few data available about the practice, but variolation was very widely used – hundreds of thousands of people throughout Europe, let alone large numbers of people in Asia, over hundreds of years. In the West, some variolators set themselves up in business, and some of them became very well-known, such as Thomas Sutton who had a variolation franchise in 40 cities of Europe. Such a practice was not without risk: scraping pus, vesicular fluid, and scabs from one individual and inoculating them into another is not a procedure one would encourage today. Data are not available, but a good many other things must have been transmitted as well. Some of the variolators advertised that only 1% of their subjects died!

Despite such problems the practice spread rapidly in Europe. A particularly interesting example relates to Catherine the Great of Russia, who paid for an English physician, Dr Thomas Dimsdale, to variolate her family. When news of this arrived in France, it prompted none other than François-Marie Arouet de Voltaire to write to Catherine: ‘Oh Madam – what a lesson your majesty is giving to our ridiculous Sorbonne and to the argumentative charlatans in our medical schools. You have been inoculated with less fuss than a nun taking an enema. We French can hardly be inoculated at all, except by decree of parliament’.

Daniel Bernoulli

Voltaire was referring in this letter to debates in France over variolation, which ultimately led the French Royal Academy to address the issue. To do this, they turned to one of great intellects of the eighteenth century: Daniel Bernoulli, famed in particular for his work in mathematics and physics. He was invited to examine the smallpox vs variolation problem, and produced a remarkable report: ‘an Attempted and New Analysis of the Mortality Caused by Smallpox, and the Advantages of Inoculation to Prevent It’.²

In doing this, Bernoulli made another of his many contributions, this time to demography: he developed what is known as the double decrement life table, which is a method for tracing mortality from two different causes. The first life table had been developed by Edmund Halley – the astronomer – in the seventeenth century, on the basis of

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