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Two centuries of immunisation in the United Kingdom (Part I)

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Summary

The impact of immunisation is best understood through a historical lens, since so many of the diseases which placed a burden on our population have been eliminated or controlled through immunisation. The United Kingdom (UK) National Health Service (NHS), which celebrated its 70th birthday in 2018, is responsible for delivering the highly successful universal national immunisation programme. However, the first vaccines used in the UK were not part of a centrally coordinated programme until the 1960s. Resources that summarise the first 200 years of immunisation in the UK are not readily accessible.

Here we provide a two part chronological insight into the history of the UK immunisation programme from primary sources. In Part 1, we highlight the importance of wartime conditions, unprecedented vaccine development, and the polio outbreaks in the 1950s in driving developments in immunisation and discuss subsequent changes in the use of the original vaccines of the immunisation programme, namely, diphtheria, tetanus, pertussis, and polio. In Part 2, we discuss the formation of the Joint Committee on Vaccination and Immunisation and its role, working with public health agencies and advising the UK Governments on vaccine policy, to bring a comprehensive programme to defend the health of the population against serious infectious diseases, highlighting the importance of programme organisation and leadership.

Introduction

In the United Kingdom (UK), the National Health Service immunisation programme is a cornerstone of public health policy protecting the population against serious infectious diseases throughout life. We describe the use of vaccines in the United Kingdom from the time of Edward Jenner, to recent times noting the polio crisis which led to the development of a centrally

coordinated NHS programme and the formation of the Joint Committee on Vaccination and Immunisation (JCVI) in 1963; which has overseen many changes over five decades of advice to the UK Governments (see Table 1).¹⁻

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Vaccination against smallpox

Smallpox vaccine was first available from the early 1800s following publication of Jenner's monograph on the first use of vaccination.⁶⁶ By 1825, it was estimated that 50% of children living in large English towns had been vaccinated against smallpox.⁶⁶ However, large epidemics of smallpox continued and the first Vaccination Act was passed in 1840, formalising use of the vaccine and outlawing variolation; a practice that had been introduced in England in the 18th century and aimed to stimulate immunity in individuals by the practice of rubbing material from smallpox pustules or scabs into scratches in the skin to induce immunity.⁶⁶ The practice was outlawed because the illness induced by variolation was not always mild, and severe cases and deaths were reported.⁶⁶ Further Vaccination Acts were passed and amended over the next 70 years, including compulsory vaccination of infants from 1853. The challenges and controversies of these Acts and programme are described elsewhere.⁶⁶⁻⁶⁸

By the end of the 19th century, up to 85% of children were vaccinated against smallpox and the annual smallpox death rate had declined from 300-400/100,000 in the pre-vaccination era to 1·3 /100,000.⁶⁶ During the early 20th century, smallpox incidence continued to decline; compulsory vaccination was abolished in 1948.⁶⁶ Vaccination of infants continued through the 1950s and '60s, despite low disease incidence, because of the continued risk of imported smallpox.⁶⁶ Routine vaccination stopped in 1971, prior to the declaration of global smallpox eradication in 1980.^{15,69}

Local authority and Ministry of Health (MoH) roles

Significant progress in vaccine development in the early 20th century led to further vaccines being available for use by the 1930s and '40s, including diphtheria, tetanus and pertussis vaccines. At this time, the design and delivery of non-smallpox immunisation programmes was locally led, resulting in a variation in which different vaccines were available in different localities.

In England, Medical Officers of Health, based in Local Health Authorities (LHAs), were responsible for providing immunisation clinics and collaborating with general practitioners who also offered immunisations. Permission for LHAs to run immunisation schemes had to be obtained from the MoH under the Public Health Act 1936, (section 177 (1) /204) and from 1948 section 26 of the NHS Act 1946. Programmatic decisions were the responsibility of the LHA; the MoH provided guidance on how vaccines could be used or made recommendations that a programme should be implemented.

Tetanus vaccine was the first vaccine after smallpox to be used on a routine basis, in the armed forces.

Tetanus

Tetanus was a major cause of morbidity in the British Army prior to the First World War (1914-18).⁷⁰ The incidence of tetanus fell significantly during World War 1 when passive immunisation with tetanus anti-toxin was introduced for routine treatment of wounded soldiers.⁷⁰ In 1938, Major J Boyd undertook trials of tetanus toxoid vaccine in army troops and demonstrated the vaccine's effectiveness. Tetanus toxoid vaccination was introduced routinely for all troops that same year.¹

The incidence of tetanus reduced significantly further during World War II (1939-45) and this was attributed to active immunisation with tetanus toxoid vaccine.¹ The army discontinued the tetanus vaccination programme at the end of WWII before its re-introduction in 1949, due to increasing international tensions.⁶⁷

The use of passive and active immunisation against tetanus during the Second World war led to an increased interest in prevention of tetanus.⁶⁷ Both active and passive immunisation were being used to treat tetanus prone wounds in civilians during the early 1950s but there was no routine vaccination programme. The MoH stated in 1954 that the incidence of tetanus was insufficient to justify the introduction of routine vaccination.⁷¹

Despite MoH advice that routine use of tetanus vaccine was not required, LHAs began to request permission to introduce vaccination programmes for infants from 1955.⁵ By 1960, eighty-six of 146 LHAs had approved schemes, six others were known to be providing tetanus vaccine without approval and pressure was applied to the Ministry to introduce a routine programme.⁷² Vaccination against tetanus was officially recommended as part of the routine infant and childhood immunisation schedules in 1961.⁹

Routine immunisation programmes in the UK from 1940

Since 1961 the UK immunisation programme has expanded to prevent a large number of important infectious diseases. Table 2 presents the impact of some of the vaccines on disease incidence. Diphtheria was the first vaccine to be introduced in a universal immunisation programme in the UK after smallpox.

Diphtheria

Diphtheria immunisation was used sporadically in England from 1921, for nurses working in diphtheria wards and for children in residential care.⁷³ In 1932 the MoH published a memorandum on the production of artificial immunity against diphtheria. This detailed the methods agreed at the first immunisation committee that met in 1932 and in accordance with findings from a conference of experts held in 1931 (the Health Committee of the League of Nations).⁷³ The memorandum aimed to encourage rather than instruct immunisation with the aim of reducing the 60,000 annual notifications of diphtheria and 3000 deaths.⁷⁴ The introduction of diphtheria immunisation campaigns was slower in the UK than in some other countries. In Toronto,

Canada, available vaccines were being utilised to successfully control diphtheria outbreaks with intensive immunisation campaigns from 1926-29.⁷⁵

By 1940, war conditions and population movement from urban to rural areas led the MoH to take a more direct approach. In January 1940, the MoH recommended that all LHAs apply to run diphtheria toxoid immunisation programmes and published a new memorandum on vaccination.⁷⁶ In December, the Ministry provided approval proactively to all LHAs to expedite the implementation of the programme.⁷⁷ The aims were firstly to eliminate diphtheria and secondly to prevent a resurgence of disease due to war conditions.

The programme initially focused on children aged five to 15 years; from 1943, one to four year olds were targeted and the under ones from 1945.⁷⁸ Implementation of the programme was very slow: by the end of 1941, 37% of school aged children had been vaccinated.^{67,79} Promotion of the national campaign increased from 1942 and the MoH took a central role in developing a range of materials (posters, films and broadcasts from the Chief Medical Officer). The factors that led to the success of this programme during the war years included: leadership from central government, fear of a familiar disease during wartime living conditions and population movement and freely available vaccine.⁸⁰

By 1957, 44% of one year old children were immunised and the incidence of diphtheria had decreased significantly.⁷⁹ 1959 was the first year in which no diphtheria related deaths were recorded.⁶⁷

From 1968, the schedule for diphtheria immunisation was three doses in infancy with a fourth pre-school booster dose.¹³ Diphtheria remained a four dose schedule until 1994 when a fifth dose in adolescence was introduced owing to the waning of immunity in adults and epidemics in Eastern Europe.²⁰

Tuberculosis: BCG immunisation

From August 1949, BCG vaccine was available for chest physicians to use for contacts of TB cases and was also offered to all hospital nursing staff and medical students following a negative Mantoux test.^{3,81}

In November 1953, the MoH encouraged local authorities to introduce BCG vaccination for children aged 13 to 14 years. The incidence of TB had begun to decline to 18.6/100,000 in 1953 but the Ministry wanted to protect older children before they entered the age group when a rapid rise in incidence occurred.⁴ The decision to introduce BCG vaccine was left to the LHAs. In 1956, following publication of a report from the Medical Research Council's Committee on Tuberculosis Vaccine, the MoH urged those LHAs who had not commenced a programme to re-consider.⁸²

Significant variation existed in local policy for the universal adolescent BCG programme across England. Some areas had discontinued the programme long before 2005 when the universal adolescent programme was replaced with a selective programme.^{36,83}

Pertussis

Pertussis vaccination was introduced routinely in 1957 to prevent the 53,607—157,835 cases reported each year.^{7,84} In many LHAs its use predates this, as pertussis vaccines were produced and available in England from the 1940s.^{7,66} Between 1946 and 1959 the Medical Research Council conducted large studies of pertussis vaccination. These trials determined standards for the production of pertussis vaccines and safety data.⁸⁵

Prior to 1957, MoH policy was to approve LHA's pertussis vaccination schemes on the condition that the local Medical Officer of Health selected which vaccine to use and maintained accurate records. Records from the Ministry of Health show that 43% (60 of 139) of LHAs had schemes in 1949 rising to 73% (108 of 146) in 1954.^{71,86}

Cases of pertussis decreased following the introduction of routine immunisation. In 1966 the potency of the British vaccine was increased in line with the World Health Organization (WHO) international standard for pertussis vaccine.⁹⁷ By 1972/3, the annual incidence of pertussis was around 2000 notifications and vaccine uptake was about 80%.^{84,88}

The pertussis vaccination programme suffered a major setback from 1974, when uptake dropped greatly due to vaccine safety concerns. The media reported the concerns of an influential paediatrician of an association between neurological conditions and pertussis vaccination. Opinion became divided in both the public and the medical profession.⁸⁸ Parents refused to vaccinate their infants and some medical professionals offered DT vaccine in place of DTP.⁸⁸ Within three years a large pertussis outbreak occurred.⁸⁸ From 1977-1979 there were around 5000 hospital admissions and 38 deaths.^{89,90}

Despite Joint Committee on Vaccination and Immunisation (JCVI) support (see Part 2) and a large surveillance study of children which confirmed there was no safety issue, confidence in the programme took a number of years to be restored.⁸⁷ By the early 1990s the incidence of pertussis had decreased substantially.⁸⁴

However despite high uptake of whole cell vaccine in infancy, pertussis continued to cause significant morbidity and mortality in children too young to be fully protected by vaccination, and concerns continued about the association of the vaccine with hypotonic hypo-responsive episodes and prolonged crying and fever.

A pre-school booster of acellular pertussis (aP) vaccine was introduced in 2001 to protect older children and reduce transmission to infants.²⁷ In 2004 the infant schedule switched from whole cell pertussis (wP) to the less reactogenic acellular pertussis vaccine with the aim of providing the same level of protection from disease but with fewer associated adverse reactions.³³ The change to inactivated polio vaccine and acellular pertussis vaccine was undertaken both to reduce the risk of vaccine-associated poliomyelitis (VAPP)

and to avoid adverse events associated with whole cell pertussis vaccine, which had already declined with the switch to the accelerated, 2,3,4 month schedule. There was no available whole cell pertussis vaccine which contained inactivated polio vaccine.

In 2011 the incidence of pertussis was 2 per 100,000 population; this had increased to 18 per 100,000 in 2012.⁹¹ The outbreak likely arose as a result of reduced protection noted in a number of countries following the adoption of acellular pertussis vaccine.⁹² In August 2012, in response to HPA data showing increases in pertussis cases and deaths in children too young to be vaccinated, Departments of Health (DH) decided to vaccinate pregnant women as an emergency measure. The approach was supported by the JCVI and the programme commenced in October 2012. Deaths subsequently declined and PHE surveillance demonstrated high effectiveness.⁹³

Polio

Polio became a notifiable disease in England in 1912 and records confirm that small-scale epidemics occurred most years.⁹⁴ The first large polio epidemic in England occurred in 1947 with over 7,000 cases and 688 deaths; large summer outbreaks continued into the 1950s.⁹⁴

In 1955, the Central Health Services Council in England and the Scottish Health Services Council appointed a Joint Committee on Poliomyelitis Vaccine, to advise on the use of polio vaccine for mass immunisation and to respond to Ministerial questions.⁹⁵ The committee included members of both Health Councils and other external experts under the chairmanship of Lord Cohen of Birkenhead. The committee had access to information on the use of polio vaccines in other countries, particularly the safety issues surrounding the use of polio vaccine in the United States of America during 1955.⁶⁶ The Central Health Services Council reported in 1955 that it accepted a plan for vaccination as drawn up by the Medical Research Council's Committee on Clinical Trials of Poliomyelitis Vaccine.⁹⁵ Inactivated Polio Vaccine (IPV) was to be produced in the UK, subject to strict safety standards and batch testing

prior to use. A surveillance scheme to detect 'inoculation poliomyelitis' was introduced.⁹⁶

In January 1956, the MoH recommended a two-dose polio vaccination programme for children aged two to nine years.⁶ Vaccine supply in 1956 was limited and vaccine use was restricted to the months prior to the peak polio season that occurred between July and November.

In May 1957, the Joint Committee on Polio Vaccination revised guidance enabling programmes to run throughout the year.⁹⁷ Eligibility for vaccination was extended to include children aged six months to 15 years and pregnant women.⁹⁸ The programme was extended further in 1958 to young adults aged 16 -25 years.⁹⁹ The 1959 death from polio of a Birmingham City football team member, Jeff Hall, resulted in increased uptake of the vaccine.¹⁰⁰

In 1958, a third polio dose was added to the schedule, to be administered no more than seven months after the first dose.⁹⁹ A pre-school, fourth dose, was added in 1961 and from 1968 one further dose was scheduled for school leavers aged between 15 and 19 years.^{13,101}

Until 1962, only inactivated polio vaccine (IPV) was available in the UK. Oral 'Sabin' polio vaccine (OPV) became available in 1962 and the MoH recommended this as the vaccine of choice.¹¹ IPV replaced OPV in 2004 to coincide with the introduction of acellular pertussis vaccine.³³ IPV avoided the risk of vaccine associated paralytic polio cases .³³

Polio vaccine remains part of the routine immunisation schedule and will do so, at least, until the global eradication of polio is achieved. There were 33 cases globally in 2018¹⁰² Post-eradication, it remains unclear whether or when security of containment of polio virus against accidental or deliberate release would allow vaccination to cease.

Conclusion

In this article we have considered the introduction of vaccines against smallpox, diphtheria, tetanus, pertussis and polio, which have controlled these disease across the UK, showing the potential for public health interventions to drive an unprecedented and measurable impact on children health. These vaccines provided the backbone for immunisation in the NHS, which was overseen through the formation of the Joint Committee on Vaccination and Immunisation which is considered in Part 2.

Conflicts of interest

Sarah Lang, Sarah Loving, Noel McCarthy and Mary Ramsay: we declare that we have no conflicts of interest.

David Salisbury: reports personal fees from vaccine manufacturers, outside the submitted work.

Andrew Pollard is Chair of UK Dept. Health's Joint Committee on Vaccination & Immunisation & the EMA scientific advisory group, on vaccines and is a member of the WHO's SAGE.

Contributors

Sarah Lang: Conceived idea of immunisation timeline, completed literature searches, sources and analysed available literature, designed, drafted and revised paper (and the immunisation timeline).

Sarah Loving: Revised draft papers and advised on design of the paper. Approved final version.

Noel McCarthy: Initiated collaborative timeline project. Advised on design of paper, revised draft paper. Approved final version

Mary Ramsay: Drafted sections of the paper, critically revised draft papers. Approved final version

David Salisbury: Critically revised draft papers, advised on interpretation of data. Approved final version.

Andrew Pollard: Initiated collaborative timeline project. Advised on design of paper, drafted sections of paper, critically revised draft papers. Approved final version.

Panel: Search strategy and selection criteria

The search strategy initially focused on sourcing primary references for the immunisation timeline (table 1) before being expanded to support the analysis of programme introductions and changes. A catalogue of immunisation related circulars was not available to facilitate these searches.

Available web based materials were searched on the Department of Health Website including Chief Medical Officer (CMO) letters on immunisation, Immunisation Against Infectious Diseases (2006) and current and historical JCVI minutes. All CMO letters from 1995 were available on-line.

To identify primary references from 1938 to 1994 Google Scholar and Medline were searched for “immunisation programmes” and “vaccination programmes”. Results were searched to identify published circulars and further searches made to source these.

Further searches were necessary to access pre-1993 circulars. All available Ministry of Health Circulars (1919–1968) held at the Radcliffe Camera Library (Oxford) were accessed and reviewed. Internal government documents were examined; all open Ministry of Health, DHSS & War Office files pertaining to immunisation or vaccination programmes from 1920s onwards held at the National Archives, Kew, were searched and reviewed, including minutes of meetings, notes and published circulars. Searches at the National Archives were conducted over three days. Where circulars were not accessible, data in other primary references were cross-referenced.

JH Parish’s publications, *A History of Immunisation* (1965) and *Victory with Vaccines* (1968) ^{66, 67}, provided further historical insights and additional primary references were identified from these publications.

Limitation of historical methods. This work used written records accessible through tracing references from key resources and systematic extensive searches in both the National Archive at Kew and the University of Oxford library ensuring good coverage of DH and JCVI documents. We have not

used any oral history approaches to supplement this work nor attempted to access less structured archives such as those describing policy development and disease surveillance work undertaken to inform the decisions and decision making discussions summarised in the DH statements and JCVI minutes that we have reviewed but which are outside the scope of this work.

Table 1 Immunisation timeline 1938 to 2017

Routine and selective vaccination programmes, introductions and changes, 1938-2017

Universal routine programmes	Year	Selective or catch up programmes
	1938	Tetanus: armed forces personnel ¹
Diphtheria ²	1940	
	1949	BCG: hospital nurses/medical students ³
Adolescent BCG ⁴	1953	
	1955	Tetanus: use begins in some local authorities ⁵
Polio: inactivated "Salk" vaccine (IPV) ⁶	1956	
Pertussis ⁷	1957	Influenza: healthcare workers – this year only ⁸
First national childhood immunisation schedules Diphtheria, tetanus and pertussis (DTP) ⁹	1961	Influenza: clinical risk groups ¹⁰
Polio: oral 'Sabin' introduced in preference to IPV ¹¹	1962	
Measles (in 2 nd year of life) ¹²	1968	Measles: all children up to 15 years of age ¹²
Childhood schedule revised (DTP/polio timings altered) ¹³		
Rubella: girls aged 11-14 years ¹⁴	1970	
Smallpox: programme discontinued ¹⁵	1971	Rabies for those at occupational risk ¹⁶
MMR: at 13 months of age ¹⁷	1988	
Primary course schedule accelerated: 2,3,4months ¹⁸	1990	
Hib: at 2,3,4 months ¹⁹	1992	Hib catch up: 13 - 48 month olds ¹⁹ PPV: clinical risk groups ¹⁹
Diphtheria: added to school leaver booster (Td) ²⁰	1994	Measles/Rubella: catch up - 5 -16 years of age ²¹
MMR: 2 nd dose scheduled with pre-school booster ²²	1996	MMR: catch up - born after 01.01.1990 ²²
Hib: combined with DTaP ²³		
Influenza: aged 75 years and above ²⁴	1998	
MenC: at 2,3,4 months ²⁵	1999	Men C: catch up <18 yrs ²⁵
Influenza: aged 65 years and above ²⁶	2000	
Pertussis: (acellular-aP) added to pre school booster ²⁷	2001	
Tetanus: single antigen replaced with Td ²⁸	2002	Men C: catch up - all 20-24 year olds ²⁹ Pneumococcal conjugate vaccine (PCV7): <2yrs of age in clinical risk group ²⁹
Pneumococcal Polysaccharide Vaccine (PPV): aged 80 years and above ³⁰	2003	Varicella: non immune HCW ³¹ Hib: catch up - >6 months to < 4 years old ³²
Polio: switched from oral to IPV ³³ Pertussis: switched from whole cell to acellular ³³ Childhood/adolescent vaccines changed to combined: 5 in 1 DTaP/IPV/Hib at 2,3,4 mths, dTaP/IPV at pre-school booster & Td/IPV at school leaver booster ³³ PPV: aged 75 years and above ³⁴ PPV: aged 65 years and above ³⁵	2004	Pneumococcal conjugate vaccine (PCV7): <5yrs of age in clinical risk group ³⁴
Men C: primary schedule reduced to two doses ³⁷	2006	BCG: changed from universal to selective programme ³⁶ PCV: catch up: children - <2yrs age on 01/09/06 ³⁷ Influenza: Health care workers with direct patient contact ³⁸
Hib/Men C: booster at 12 months ³⁷ PCV7: at 2, 4 & 13 months ³⁷		
	2007	Hib: catch up - children born Sept 07- Mar 09 ³⁹
HPV: Girls in school year 8 (aged 12/13yrs) ⁴⁰	2008	HPV catch up - girls aged 17/18 years ⁴¹ MMR catch up - children and adolescents ⁴²
	2009	HPV catch up: girls aged 13-17 years ⁴³ Pandemic influenza vaccine ⁴⁴
PCV7 replaced with PCV13 ⁴⁵ Hib/MenC, PCV & MMR scheduled together 12/13 mths ⁴⁶	2010	Influenza: extension to all pregnant women ⁴⁷
	2012	Pertussis: pregnant women (28-32 weeks gestation) ⁴⁸
Rotavirus: at 2,3 months of age ⁴⁹ Men C: adolescent booster ⁵¹ Men C: infant schedule reduced to one dose ⁵¹ Shingles: aged 70 (1 st September to 31 st August) ⁵² Influenza: aged 2 & 3 (on 1 st September) ⁵³ Influenza: extended to 4 year olds (on 1 st September) ⁵⁴	2013	MMR: catch up due to measles outbreak ⁵⁰ Shingles: catch up - born 2/9/33 to 01/09/34 ⁵²
MenB: 2, 4 & 12 months of age (born on after 01/07/15) ⁵⁶ MenC adolescent booster switched to MenACWY ⁵⁷ Influenza: extended to school years 1 & 2 ⁵⁸	2015	Men B: catch up - born 01/05/15 to 30/06/15 ⁵⁶ Men ACWY: catch up (2 cohorts) 1. Aug 15 to Mar 16 - born 01/09/96 to 31/08/97 2. Sept 15 to July 16 - born 01/09/99 to 31/08/00 ⁵⁷ Men ACWY: replaced Men C in freshers programme ⁵⁷ Shingles: catch up - born 2/9/36 to 1/9/37 ⁵⁹
Influenza: extended to school year 3 (from September) ⁶⁰ Men C: infant dose removed (1 st July) ⁶¹	2016	Men ACWY: catch up (2 cohorts) 1. Apr 16 to Mar 17 – born 01/09/97 to 31/08/98 2. Sept 16 to July 17 - born 01/09/00 to 31/08/01 ⁵⁷ Shingles: catch up – born 2/9/37 to 1/9/38 ⁶² Pertussis: from 16 weeks gestation (pregnant women) ⁶³

Influenza: extended to school year 4 (from September) ⁶⁴ Hepatitis B: 2,3,4 months (6 in1 vaccine) ⁶⁵	2017	Men ACWY: catch up (April 2017 – March 2018) born 01/09/98 to 31/08/99 ⁵⁷
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Table 2

Disease notifications (year before routine immunisation introduced) ⁸⁶	Routine immunisation commences	2017 Confirmed cases ⁸⁶
47,343 (1939)	Diphtheria 1940	18
6,331 (1955)	Polio 1956	0
92,410 (1956)	Pertussis 1957	4341
460,407 (1967)	Measles 1968	277
849 confirmed (1992)	Hib 1992	12 (2014) ¹⁰⁸
1509 (1998)	Meningococcal Septicaemia 1999	200

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