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Infectious disease research investments: Systematic analysis of immunology and vaccine research funding in the UK☆

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ABSTRACT

Financing for global health is a critical element of research and development. Innovations in new vaccines are critically dependent on research funding given the large sums required, however estimates of global research investments are lacking. We evaluate infectious disease research investments, focusing on immunology and vaccine research by UK research funding organisations. In 1997–2010, £2.6 billion were spent by public and philanthropic organisations, with £590 million allocated to immunology and vaccine research. Preclinical studies received the largest funding amount £505 million accounting for 85.6% of total investment. In terms of specific infection, "the big three" infections dominated funding: HIV received £127 million (21.5% of total), malaria received £59 million (10.0% of total) and tuberculosis received £36 million (6.0% of total). We excluded industry funding from our analysis, as open-access data were unavailable. A global investment surveillance system is needed to map and monitor funding and guide allocation of scarce resources.

1. Introduction

Vaccines are the most cost-effective health intervention for the prevention of disease [1]. Since their invention, vaccines have been administered to billions of individuals with significant health and economic benefits, particularly to people in low- and middle-income countries [2,3].

Public funders, philanthropic institutions, pharmaceutical companies and biotech companies all play a role in the research and development (R&D) of new vaccines. A WHO–UNICEF analysis estimated that US$76 billion was required for immunisation strategies for 2006 to 2015 among 117 low- and middle-income countries alone [4]. Although, since 2000, international financing of global health has increased substantially [5]; the Global Immunisation Vision and Strategy for 2006–2015 is under funded by US$11–15 billion [6,7].

Since 2007, R&D expenditures have been estimated for global neglected diseases [8]. A recent study, which reviewed 6170 studies accounting for £2.6 billion of investments, documented for the first time in detail research investments for infectious diseases in the UK or for the UK institutions and the global partners involved in infectious disease research [9]. However, annual expenditures on vaccine research have not been estimated [10]. The United Kingdom (UK) is the second largest investor in global health; however, there are no analyses of R&D funding allocated to vaccine research and delivery. Investments by the UK pharmaceutical industry are also poorly documented, primarily due to commercial sensitivity of the data on R&D funding.

In this study, we systematically analyse the financing for vaccine research and immunology of infectious diseases.

2. Methods

We systematically searched databases and websites for information on research investments for the period 1997–2010. We identified 325,922 studies for screening and included 6165 studies in the final analysis (supplementary figure 1). We created a comprehensive database of open-access infectious disease research projects and categories studies and funding by disease, cross-cutting research theme, and categories along the R&D value chain [9]. The R&D categories included: pre-clinical research; phase 1, 2 or 3 trials; product development; and implementation research.

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Preclinical research refers to all basic science studies. Clinical trials included phase 1, phase 2 and phase 3 studies. Product development research included new product trials, phase 4 studies and post-marketing research. Implementation research includes all operational, epidemiological, social science and health economics studies. A specific analysis of immunology and vaccine research is presented in this paper due to the significant relevance of host-pathogen interactions to new vaccine development. Further information on detailed methodology is available online (http://researchinvestments.org/data) and published elsewhere [9].

Variables collected included the study title, abstract, funding awarded to the study, lead institution, principal investigator, and the year of award. We included all immunology and vaccine-related studies for infectious diseases where the lead institution was based in the UK. We excluded immunology and vaccine studies not immediately relevant to infectious diseases. Veterinary infectious disease research was excluded unless there was a clear zoonotic component. We excluded open-access data from the pharmaceutical industry, due to paucity of publically available data. All grant funding amounts were adjusted for inflation and reported in 2010 UK pounds. Grants were not modified according to levels of overheads applied to the award. Grants awarded in a currency other than pounds were converted to UK pounds using the mean exchange rate in the year of award.

A team of researchers and the authors sourced data for the study over 3 years (September 2007 to December 2010). Data were categorised between December 2010 and April 2012 and analysed in two steps: between October 2011 and May 2012, and in July 2013. Microsoft Excel software was used for data categorisation. We used fold differences and statistical tests (nonparametric Mann-Whitney rank sum test, K-sample test and nonparametric Wilcoxon signed-rank test) to compare total investment, number of studies, mean grant, and median grant according to specific infection, disease system, funding organisation, and cross-cutting categories. Statistical analysis and generation of figures and graphs were performed using Stata software (v11).

Table 1

3. Results

We identified a total research investment of £590 million across 1276 studies for immunology and vaccine research, accounting for 22.7% of total research investment in infectious diseases, which was £2.6 billion. Funding explicitly for vaccine research amounted to £235 million across 368 studies (9.0% of total).

Diagnostics research accounted for £100.3 million across 407 studies (3.8%) and therapeutics accounted for £408.5 million across 526 studies (15.7%) of total funding of £2.6 billion.

Research with a clear global focus or performed with a partner organisation accounted for £170 million across 264 studies (28.8% of the £590 million for immunology and vaccine research). Figure 1 shows total investment for immunology of infectious diseases and vaccine research studies over time without a clear long-term pattern, with peaks in funding in the years 2000, 2005, 2006 and 2008.

Figure 2 shows total investment for immunology of infectious diseases and vaccine research studies by specific infection. HIV research received the most investment for immunological research with £126.6 million (21.5% of total), followed by malaria with £58.8 million (10.0%) and tuberculosis (TB) with £35.6 million (6.0%). Only 16 out of 45 major infectious diseases (35.6%) included in this analysis received over £1 million funding over the 14-year study period. Pathogens attracting low investment for vaccine research from public and philanthropic funders included Dengue virus, Norovirus, *Clostridium difficile*, *Escherichia coli*, *Neisseria Gonorrhoea*, and *Staphylococci spp.*

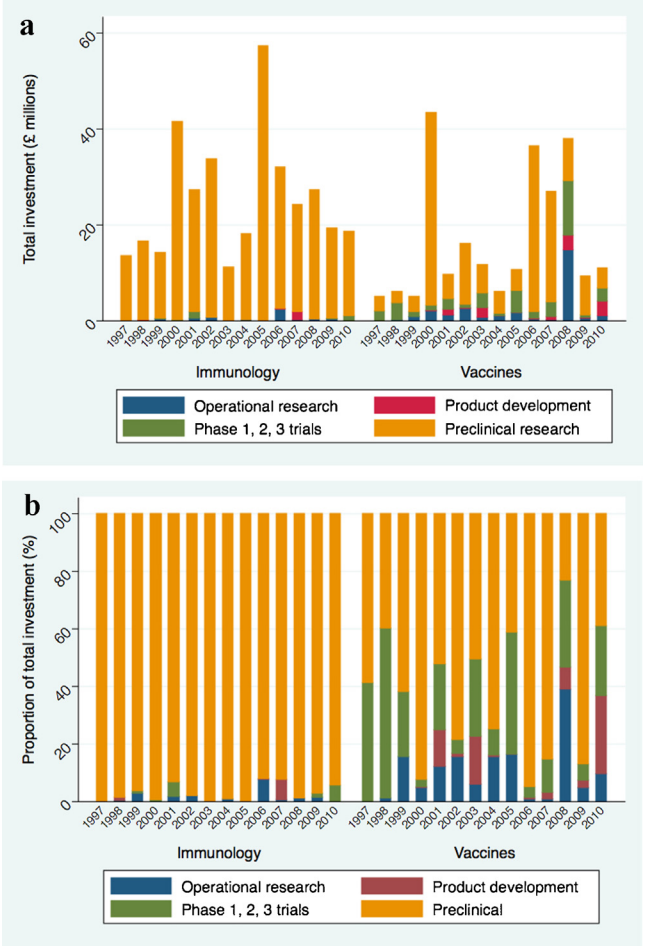

Fig. 1. Bar graph showing: A) total investment in immunology and vaccine research over time by R&D pipeline and B) proportion of investment over time by R&D pipeline.

According to the type of research along the R&D value chain, preclinical research attracted the most investment with £505.1 million (85.6%) followed by phase 1, 2, 3 trials with £41.2 million (7.0%) and implementation research with £31.6 million (5.4%). Product development was the least well-funded type of immunology and vaccine research with £12.5 million (2.1%).

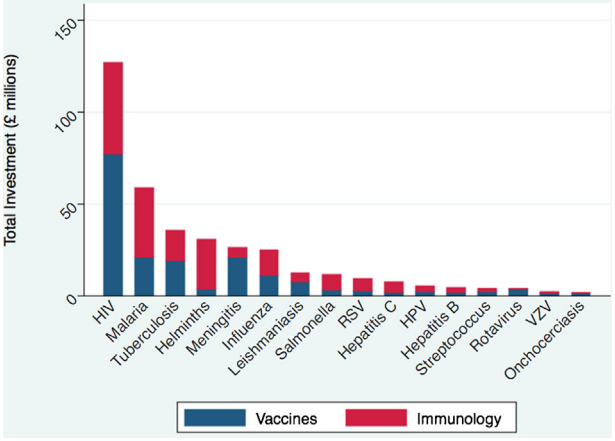

Fig. 2. Bar graph showing total investment in vaccine research by specific infection (for infections with > £1 million research expenditure).