



## Research Paper

# Mapping pneumonia research: A systematic analysis of UK investments and published outputs 1997–2013



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## ABSTRACT

**Background:** The burden of pneumonia continues to be substantial, particularly among the poorest in global society. We describe here the trends for UK pneumonia R&D investment and published outputs, and correlate with 2013 global mortality.

**Methods:** Data related to awards to UK institutions for pneumonia research from 1997 to 2013 were systematically sourced and categorised by disease area and type of science. Investment was compared to mortality figures in 2010 and 2013 for pneumonia, tuberculosis and influenza. Investment was also compared to publication data. **Results:** Of all infectious disease research between 2011 and 2013 (£917.0 million), £28.8 million (3.1%) was for pneumonia. This was an absolute and proportionate increase from previous time periods. Translational pneumonia research (33.3%) received increased funding compared with 1997–2010 where funding was almost entirely preclinical (87.5%, here 30.9%), but high-burden areas such as paediatrics, elderly care and antimicrobial resistance received little investment. Annual investment remains volatile; publication temporal trends show a consistent increase. When comparing investment to global burden with a novel ‘investment by mortality observed’ metric, tuberculosis (£48.36) and influenza (£484.21) receive relatively more funding than pneumonia (£43.08), despite investment for pneumonia greatly increasing in 2013 compared to 2010 (£7.39). Limitations include a lack of private sector data and the need for careful interpretation of the comparisons with burden, plus categorisation is subjective.

**Conclusions:** There has been a welcome increase for pneumonia funding awarded to UK institutions in 2011–2013 compared with 1997–2010, along with increases for more translational research. Published outputs relating to pneumonia rose steadily from 1997 to 2013. Investment relative to mortality for pneumonia has increased, but it remains low compared to other respiratory infections and clear inequities remain. Analyses that measure investments in pneumonia can provide an insight into funding trends and research gaps.

**Research in context:** Pneumonia continues to be a high-burden illness around the globe. This paper shows that although research funding is increasing in the UK (between 1997 and 2013), it remains poorly funded compared to other important respiratory infectious diseases such as tuberculosis and influenza. Publications about pneumonia have been steadily increasing over time, indicating continuing academic and clinical interest in the topic. Though global mortality of pneumonia is declining, it should still be an area of high priority for funders, policymakers and researchers.

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## 1. Introduction

Despite documented complexities with epidemiological definitions and clinical diagnosis (Scott et al., 2012), the global burden of pneumonia,

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including healthcare-associated and ventilator-associated pneumonia, clearly remains significant. Estimates from the Global Burden of Disease Study 2013 (GBD 2013) suggested that although mortality from the main pneumonia-causing pathogens was decreasing worldwide, there were still at least 785,000 deaths globally from pneumococcal pneumonia, respiratory syncytial virus and *Haemophilus influenzae* pneumonia in 2013 with much of this burden in low- and middle-income countries (GBD 2013 Mortality and Causes of Death Collaborators, 2014), although other analyses considered mortality to be greater (Kovacs et al., 2015). In GBD 2013 figures, there were a further 105,000 deaths from influenza, where pneumonia is a significant secondary complication from primary infection, and an estimated 2 million deaths from lower respiratory tract infections of unknown aetiology (GBD 2013 Mortality and Causes of Death Collaborators, 2014). The GBD study also attributed 76.7 million disability-adjusted life-years (DALYs) to pneumonia and pneumococcal disease in 2010, again with the poorest sectors of society bearing the majority of this burden (Murray et al., 2012). Though there is an increasing prevalence of non-communicable disease and injuries in middle and lower-income countries (GBD 2013 Mortality and Causes of Death Collaborators, 2014), projections from the World Health Organization (WHO) estimate deaths from lower respiratory tract infections will remain among the top 4 leading causes of deaths in 2015 and 2030 (World Health Organization, 2013a).

Part of the solution to overcoming these challenges is to invest in research. The UK is consistently rated among the top three investors in neglected disease research (Policy Cures, 2014a), and UK-based authors are generally prolific at contributing to the published evidence base (Yao et al., 2014). Thus the activity of UK institutions is likely to be of significant national and international importance. The Research Investments in Global Health study (ResIn, [www.researchinvestments.org](http://www.researchinvestments.org)) has previously reported on infectious disease research investments awarded to UK institutions between 1997 and 2010 (Head et al., 2013), also specifically highlighting the limited and fractured nature of pneumonia and pneumococcal research (Head et al., 2014a,b). There is a paucity in the systematic tracking of global investments in health research and development (R&D), with noted mismatches between the global burden of pneumonia and research investment (Rudan et al., 2011), and only one study of limited scope highlighting product and technology-related R&D of bacterial pneumonia in low-income settings (Policy Cures, 2014b).

We present an update to the ResIn study, covering awards for pneumonia and pneumococcal-research from 2011 to 2013, with reference to previously published data from 1997 to 2010 for context. We highlight the trends in both total investment and temporal drift in funding by type of science. Furthermore, we compare investment against global mortality of disease and describe bibliometrics trends for pneumonia-related publications as a surrogate of research output. We discuss some clear challenges and evidence gaps, and review potential ways forward.

## 2. Methods

Our methods for the analysis covering 1997–2010 are described in detail elsewhere (Head et al., 2013, 2014b), and have been updated for the 2011–2013 analyses.

### 2.1. Data collection

We systematically sourced information on funding decisions from the major public and philanthropic funding bodies for infectious disease research (<http://researchinvestments.org/about-the-study/study-methodology/>). Private sector investment is not included due to insufficient information in the public domain. Data was obtained either by searching online for the institution's portfolio of awards, or requested directly from the funder.

### 2.2. Data categorisation and handling

The study team identified the infection-related awards led by a UK institution and categorised them by disease area, by specific pathogen and by type of science according to their position along the R&D value chain. R&D categories were: preclinical research, phase I–III trials, intervention and product development studies, translational (previously referred to as implementation and operational research), and cross-disciplinary awards. The cross-disciplinary category has been newly created for the 2011–2013 analysis, reflecting the notable increase in the number of studies with significant components covering two distinct types of science. We have not yet retrospectively applied this new category to the 1997–2010 dataset though do not anticipate revisions to greatly impact on observed trends in investment. Further detail on data categorisation is available on the study website, alongside the full list of included funders and the search keywords used. Information collected on each award included study title and abstract (where available), the lead institution and principal investigator, funder, year of award and total funding awarded. As per previous analyses (Head et al., 2013), and similar to approaches recommended by others (Young et al., 2015), awards originating from an international funder were converted to UK pounds using the mean exchange rate in the year of the award. All awards were adjusted for inflation and reported in 2013 UK pounds.

Each study was categorised by author MGH. Awards for pneumonia and pneumococcal-related research are included here. There were random checks by at least two other individuals on 20% samples of the data to reduce observer error, with differences reported and corrected, and any remaining differences settled by consensus. Datasets were also sent out to all authors for review and comment.

### 2.3. Data analysis

Burden data was sourced from the GBD study (GBD 2013 Mortality and Causes of Death Collaborators, 2014; Lozano et al., 2012). UK investment and global mortality for pneumonia, tuberculosis and influenza was analysed by comparing the sum funding across 2005–2009 with 2010 burden, and funding across 2008–2012 with 2013 burden. Findings were reported as an 'investment by mortality observed' metric. The dataset was assembled in Microsoft Excel 2013 and Stata (V13) was used for further statistical analysis. Spearman's rank correlation coefficient ( $\rho$ ) was used to assess correlation.

### 2.4. Bibliometrics

The publications database Scopus® (<http://www.scopus.com/>) was used to search for publications incorporating the keywords 'pneumonia' or 'pneumococcal', published between 1997 and 2013 and including at least one author affiliated to a UK institution. Search results were exported and conditional formatting equations used to identify papers with a UK individual listed as first or last author; this was a proxy measure for significant involvement from the UK and thus used to compare with funding trends. Since most awards in our dataset are either less than one year, or between two and three years in duration, a likely publication yield for each year of investment was calculated by using the total publications in the four years after the award, and this produced an 'investment per publication' metric. Temporal trends, citation numbers and type of publication were also considered. Microsoft Excel 2013 and 2011 was used to assemble the bibliometrics dataset, and Graphpad Prism 6 (<http://www.graphpad.com/scientific-software/prism/>) produced the figures.

## 3. Results

Total research funding for all infectious diseases awarded to UK institutions between 2011 and 2013 was £917.0 million across 1232

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