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Innovation and the Burden of Disease: Retrospective Observational Study of New and Emerging Health Technologies Reported by the EuroScan Network from 2000 to 2009

Orsolina I. Martino, PhD[1,], Derek J. Ward, MPH, MD[1], Claire Packer, BMBS, FFPH[1], Sue Simpson, PhD[1], Andrew Stevens, MA, MSc, FFPH[2]*

[1]*National Horizon Scanning Centre, University of Birmingham, Edgbaston, Birmingham, UK;* [2]*Public Health, Epidemiology and Biostatistics, University of Birmingham, Edgbaston, Birmingham, UK*

ABSTRACT

Objectives: Medical innovation in developed countries has been linked to burden of disease, with more innovation in areas representing greater investment return. This study used horizon scanning or early awareness and alert activity as a novel measure of innovation to determine whether new and emerging health technologies reported by international horizon scanning agencies reflected diseases constituting the greatest burden. **Methods:** This was a retrospective observational study of the 20 member agencies of EuroScan (the International Information Network on New and Emerging Health Technologies), representing 17 developed countries. Burden of disease was defined as disability-adjusted life-years, taken from the 2004 World Health Organization Global Burden of Disease estimates. This analysis focused on 102 specific diseases within 21 broader groups. Horizon scanning output was measured as the number of technologies reported by EuroScan member agencies between 2000 and 2009. **Results:** At best there was a weak association between innovation and burden of disease. An apparent high-level association was dependent on just three high-prevalence disease groups: malignant neoplasms, neuropsychiatric conditions, and cardiovascular disease. Disaggregating broader groups into specific diseases further weakened the association. Innovation is disproportionately strong in cancer and nonischemic heart disease and disproportionately weak in mental health. **Conclusions:** Innovations reported by early awareness and alert systems do not always reflect conditions accounting for the highest morbidity and mortality. The results do not support previous reports of a positive relationship between burden of disease and innovation, but accord with evidence of notable discrepancies among key groups. Factors other than disease burden drive innovation.

Keywords: burden of illness, epidemiology, health services, innovation.

Introduction

In developed countries the main disease burden is from noncommunicable conditions, most notably cardiovascular disease, cancer, and neuropsychiatric conditions [1,2]. The development of new health technologies might be expected to focus on diseases with high morbidity and mortality, to reflect areas of greater burden. However, because the innovation process is long, costly [3,4], often unsuccessful, and largely commercially driven, innovation typically reflects all the factors influencing investment return, of which burden of disease is just one [5–7].

The existing evidence of a positive relationship between burden of disease and innovation is based mainly on input measures of innovation such as public and charitable research and development (R&D) funding [8,9]. This association may be a reflection of health-care policy, in particular calls to address the burden of specific diseases including cancer and dementia [10–13]. There are concerns, however, that some disease areas are underfunded. A recent report by the UK Clinical Research Collaboration found that although research spending in the United Kingdom broadly corresponded to burden of disease, cancer attracted a disproportionately high level of funding whereas blood system disorders, cardiovascular diseases, and stroke received comparatively little funding [9]. Furthermore, separating neuropsychiatric conditions into neurological and mental health conditions revealed disproportionately low funding in mental health compared with the related disease burden [14]. This corroborates concerns over a lack of investment in dementia research and services [15–17]. Only Lichtenberg [18] used output measures of innovation and found a positive relationship among developed countries. This was based primarily on pharmaceuticals launched; drugs currently on sale and relevant published articles were used as innovation outcomes in additional analyses, but these were limited to the United States and cancer, respectively.

Horizon scanning or early awareness and alert systems have been implemented in many developed countries to identify new and emerging health technologies, with the aim of managing their introduction into resource-limited health-care systems. One facet of their work is to anticipate technologies that will have a significant, positive impact on patients and systems, and those with

* *Address correspondence to:* Orsolina I. Martino, National Horizon Scanning Centre, University of Birmingham, 90 Vincent Drive, Edgbaston, Birmingham B15 2SP, UK.

E-mail: o.i.martino@bham.ac.uk.

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Table 1 – Reported technologies, DALYs, and deaths for level 1 categories.

Level 1 group	Reported technologies, n(%)	DALYs ('000s)	Deaths ('000s)
I: Communicable, maternal, perinatal, and nutritional conditions	102 (6.9)	2346 (4.6)	196 (5.0)
II: Noncommunicable diseases	1367 (92.4)	45,051 (88.1)	3460 (89.9)
III: Injuries	10 (0.7)	3712 (7.3)	191 (5.0)
Total	*1479 (100)*	*51,109 (100)*	*3847 (100)*

DALYs, disability-adjusted life-years.

potentially negative impacts. The results of horizon scanning activity may be considered an ideal proxy measure for innovation, because it attempts to capture all important new interventions and products relevant to health-care services. This study examines the relationship between disease burden and the reporting of health innovations among the 20 member agencies of EuroScan (the International Information Network on New and Emerging Health Technologies) [19]. We compare health technologies reported by EuroScan from 2000 to 2009 with burden of disease (World Health Organization [WHO]: WHO 2004 estimates) [2] in the 17 developed countries represented, at different levels of disaggregation.

Methods

Innovation: Horizon scanning output

Horizon scanning output was measured as the number of unique technologies uploaded onto the EuroScan database between 2000 and 2009, both inclusive. EuroScan member agencies are all noncommercial, nonprofit organizations operating in relation to regional or national government, representing the following countries: Australia, Austria, Canada, Denmark, England, Finland, France, Germany, Ireland, Israel, Italy, the Netherlands, New Zealand, Norway, Spain (incorporating autonomous regional early awareness and alert systems in Andalucía and the Basque Country), Sweden, and Switzerland (see http://www.euroscan.org.uk). Technologies include drugs, devices, diagnostics, interventions (e.g., surgery), programs (e.g., screening programs), and organizational changes to the delivery of health care (e.g., delivery in different settings) [19].

Burden of disease

Burden of disease was measured as disability-adjusted life-years (DALYs) and deaths for 2004 for countries within EuroScan (updated WHO Global Burden of Disease estimates) [2]. The 2004 estimates were the most up-to-date available. These were summed to generate composite DALYs and deaths for countries represented within EuroScan. Bivariate Pearson's correlations were performed to determine the extent to which DALYs for specific diseases (N = 102; see "Classification of Diseases" section below) were correlated between countries. This was repeated for deaths. A high degree of linear association between all countries for both DALYs and deaths indicated similar distributions of disease burden (DALYs: $r \geq 0.8$, N = 102, $P < 0.001$; deaths: $r \geq 0.8$, N = 102, $P < 0.001$ for all comparisons).

Classification of diseases

Diseases (or causes) are grouped in the first three levels of the four-stage hierarchy used in the WHO Global Burden of Disease studies [1,2]. At the first level, there are three main categories: communicable, maternal, perinatal, and nutritional conditions; noncommunicable diseases; and injuries. At the second level, these categories are broken down into 21 disease groups; for example, "noncommunicable diseases" consists of 14 groups, including malignant neoplasms and diabetes mellitus. At the third level, some of these groups are broken down further into specific diseases; for example, "malignant neoplasms" consists of 17 specific types of cancer. This level also includes "other" categories (e.g., "other malignant neoplasms" includes less common forms of cancer, such as sarcoma and glioma). There are 102 specific diseases at the third level. We created an additional third-level category for "all malignant neoplasms" to take into account technologies that covered multiple types of cancer or were nonspecific. This category is included within the broader "malignant neoplasms" group for analysis at the second level, but not otherwise at the third level.

Assigning disease classification to reported technologies

Of all the technologies uploaded onto the EuroScan database between 2000 and 2009, 45% were drugs, 23% devices, 14% procedures, 12% diagnostics, 3% programs, and <1% settings. The remainder were unspecified. We assigned disease classification codes to technologies in stages. At the first stage, we assigned codes to all entries with an indication clearly specified within the title (e.g., "vaccine for herpes zoster"). Approximately 70% of technologies were coded in this way. At the second stage, we scrutinized the full database records for entries without a clear indication in the title and extracted the information where possible. Technologies that could not be coded included those with vague or very broad indications (e.g., "cancer"), those with no specific indication, and those whose indications could not be linked to specific diseases (e.g., contraception, smoking cessation, and general wound care). Coding did not discriminate between different stages of the same disease; for example, a drug for metastatic melanoma indicated for both stages III and IV disease would be coded only once as melanoma. Technologies with more than one indication received separate codes for each disease.

Statistical analysis

The association between horizon scanning output and burden of disease (DALYs and deaths) was analyzed by using bivariate Pearson's correlations in SPSS Statistics 17.0 (IBM, New York, USA). Fisher's z transformation was used to calculate 95% confidence intervals for each value of r. The analysis was repeated for both broader disease groups (level 2) and specific diseases (level 3).

Results

Of 1451 unique technologies entered on the EuroScan database between 2000 and 2009, 80 (5.5%) could not be coded and were therefore excluded from the analysis. This left 1371 unique technologies with 1479 individual indications. At the first level, noncommunicable diseases accounted for approximately 90% of technologies, DALYs, and deaths (Table 1).

At the second level, three disease groups predominated (Fig. 1). Neuropsychiatric conditions had the most DALYs but dispropor-