HUMAN, PHYSICAL AND INTELLECTUAL
RESOURCE GENERATION - PROPOSALS FOR
MONITORING

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1. INTRODUCTION

To perform efficiently health systems require the combination of a large number of properly balanced physical and technical resource inputs. Policy makers must address a number of questions, which include:

- What is the most cost-effective balance between different types of productive resources and how to reach this balance?
- What investment strategy to use (i.e. to train new nurses or to recruit from outside of the country; to build a new hospital or to provide incentives for the private sector to invest in hospitals; etc.)

The main points that need to be emphasized in the discussion on the resource generation function are the following:

- The link between health care resources and population health is not well understood
- Investment decisions have long-term implications for health systems
- Investment decisions in health systems are subject to the political influence of different stakeholders
- There is a significant variation among countries in terms of their investment patterns and resource profiles
- Investment decisions affect the geographic distribution of health care resources and services
- Investment decisions in health systems affect other systems as well

Economists distinguish between capital, investments, and depreciation. Capital refers to the existing stock of productive assets (human resources, physical capital and knowledge). Investment is a flow and refers to additions to capital. Depreciation is also a flow, and refers to subtractions from capital as the value of productive resources decrease over time. The adjustment of capital stock usually occurs slowly over time (2).

The resources are produced by a diverse group of organizations such as universities and other educational institutions, research centres, and companies producing specific technologies such as pharmaceutical products, devices and equipment. Investment decisions are often made outside those organizations (especially if the organizations are public) and involve a variety of stakeholders for whom investment decisions may entail changes in the distribution of financial, technical, and political power (20;33)

The link between health care resources and population health are not well understood. However, it is needless to argue that stock of assets and their composition, as inputs to the production of health, are important elements in the performance of health systems. In the short run, capital stock are sunk costs (fixed inputs) and there is little one can do about them. In the short-run, a deficit in stock can be a real constraint to the delivery of services, while, on the other hand, excess capacities, requiring regular maintenance, can drain financial resource from health systems. In the long run, capital stock become variable inputs, therefore allowing amelioration of current problems in the future through effective investment planning.

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1 For the purposes of this paper the term 'resources' is used synonymously to 'productive assets', and it does not include financial resources.
Investments in human capital and physical capital are usually of a long-term nature. The analysis of the census and Labour Force Survey (1991) in the UK estimated expected working lives of between 19 and 22 year for nurses and 26 and 29 years for doctors. Unfortunately the data on expected working lives (worklife tables) of health care personnel for most countries are not available, which precludes the comprehensive analysis of expected life-time costs associated with human resources, and comparison of such costs across countries. Worklife tables would be also quite useful in the planning of human resource generation and in the comparative cross country analysis of recurrent life-time costs of health care personnel. The life-time of productive assets is an important concept as it has implications for maintenance and operating costs of the assets.

The current efficiency of health systems is often a result of past investment decisions. In Georgia, between 1990 to 1999 public health expenditure as a percent of GDP fell from 3% to 0.5%, an almost six-fold decrease, while the number of physicians per 10,000 population remained almost unchanged - 49, and hospital beds per 10,000 population declined from 9.7 to 4.8, a two-fold reduction. Past investments decisions, responsible for current excess capacities, make it difficult for Georgia to maintain its health systems in the condition of dramatically declining financial resources.

The investment decisions have an impact on the type of services provided, the geographic distribution of services, and also on the political power of the providers - the power and influence of the health care providers who are the direct beneficiaries of investments will increase by investments. On the other hand, the investment decisions themselves are often influenced by the local politics and driven by strong groups of stakeholders. For example, in Kyrgyzstan, the rationalization plan that was put forward in the MANAS National Health Program in 1995, envisaged significant reduction of speciality hospital beds, and, respectively, reduction of public spending on tertiary care. However, due to the strong political power and lobbying of hospitals and professional associations of specialist doctors, the share of the speciality hospitals in the total public health expenditure has grown from 14.5% to 19.3% between 1995 and 1998, while the share of general hospitals fell in the same period from 53.3% to 46.8%. The share of ambulatory curative care and public health services has remained roughly similar, at about 10-11% and 7% respectively.

Investments in capital such as a new hospital could have a significant impact on the economy in the area where the hospital is to be located. Local politicians, professional groups, and unions all will have their own interests in such decisions. Once built, hospitals are difficult to close. The public often associates with institutions in their area and views the potential loss of those institutions as the loss of personal and community good.

Countries differ significantly in terms of the availability of different resources, which reflects their investment patterns. For example, in 1991, Denmark had 2.5 MRI units per million population, the UK - 1.1, and the USA - 10.1. In the same year, the USA had almost 5 times as many CT scanners per a million population than Denmark. The graph below (Fig. 1) demonstrates the differences in

\[ E = \sum q_i \left[ p_{fti} Y_{fti} + p_{pti} Y_{pti} \right] \left( 1 - m_i \right), \]

where \( q_i \) is the proportion of professionals qualified by age \( i \), \( p_{fti} \) is the proportion of professionals in full-time work at age \( i \), \( p_{pti} \) is the proportion of professionals in part-time work at age \( i \), \( Y_{pti} \) is the expected part-time working year at age \( i \), \( Y_{fti} \) is the number of full-time working years in age group \( i \), and \( m_i \) is the probability of dying between the age of qualification and age \( i \).

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1 The approach for estimating expected working life is similar to worklife tables produced to predict labour force participation and lost earnings capacity. The expected working life is the sum of the full- and part-time year over the entire working life adjusted for mortality, emigration, and proportion of people qualified at different ages. The following formula is used for the estimation of working life:

\[ E = \sum q_i \left[ p_{fti} Y_{fti} + p_{pti} Y_{pti} \right] \left( 1 - m_i \right), \]

where \( q_i \) is the proportion of professionals qualified by age \( i \), \( p_{fti} \) is the proportion of professionals in full-time work at age \( i \), \( p_{pti} \) is the proportion of professionals in part-time work at age \( i \), \( Y_{pti} \) is the expected part-time working year at age \( i \), \( Y_{fti} \) is the number of full-time working years in age group \( i \), and \( m_i \) is the probability of dying between the age of qualification and age \( i \).
resource profiles of different OECD countries based on hospital beds per 1,000 population, MRI units and CT scanners per 1 mln. population according to the data from 1997 (28):

**Figure 1**

![Availability of health technology(1997)](source:image)

(Source: OECD Health Database (28))

The next graph (Fig. 2) shows the variation of the total health employment per 1,000 population in different OECD countries (28):

**Figure 2**

![Total Health Employment per 1,000 Population (1997)](source:image)

(Source: OECD Health Database)

Countries show significant variations also in terms of the amount of investments they make in their health systems. The following two graphs (Fig. 3, 4) represent the comparison of different OECD countries in terms of total health expenditure (THE) as a % of GDP and the total investment in medical facilities as a % of THE (28):
Human, physical and intellectual resource generation – proposals for monitoring

Comparison of the Total Health Expenditures and the Total Investment in Medical Facilities (1998)

As it can be seen on these graphs OECD countries with lower total health expenditure as % of their GDP invest more in medical facilities as a % of their total health expenditure.

Unfortunately the data on resource profiles and investments in health systems is hardly available from developing countries, despite the importance of such data for policy decisions.

Strong public stewardship is necessary to guide investment in health systems. Policy makers and managers require tools to assist them in monitoring the impact of investment decisions on the delivery of health services and the performance of the health system.

Resource generation function is closely linked with service provision. The boundaries between these two functions might not be always clear. The following chart (Fig. 5) schematically represents the relationship between resource generation and service provision function:
Figure 5. The link between resource generation and service provision functions

The products of the resource generation function become inputs in the process of service provision.

2. HUMAN RESOURCES FOR HEALTH

As stated in the World Health Report 2000, human resources are the “most important of the health system’s inputs” (44). Drawing from the wider definition of health systems from the World Health Report 2000, human resources can be defined as the stock of all individuals engaged in the promotion, protection, or improvement of health of population. This would include both private and public sectors, and different domains of health systems such as personal curative and preventive care, non-personal public health interventions, health promotion and disease prevention.

This broad definition of human resources is supported and accepted both in management science and practice, and in the literature relating to health systems assessment (10;12). However, considering different elements of planning, production, retention and recruitment of health personnel for the health systems workforce, a more sophisticated typology of human resources is desirable. The table below (Table 1) sets out two types of human resources, their description, and the current challenges which Member States face in human resource generation and provision:
Table 1. Classification of human resources for health systems

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health professionals</strong></td>
<td>Health professionals generated by the health care system in either full or part. Includes doctors, nurses, midwives, psychologists, pharmacists, dentists, and others.</td>
<td>The health system expects to employ 90% of the health care providers, which it generates. If this expectation is not met, shortages will follow. Competition for health care providers may be external – migration from developing to developed countries for example, or internal – from the public to the private sector.</td>
</tr>
<tr>
<td><strong>Non health professionals</strong></td>
<td>Those workers of health care system who are not health professionals.</td>
<td>The health system must compete in the wider labour market to employ non-health professionals. In the UK, for example, managers were recruited to the health services from industry but to do so required a substantial raise in the salary levels of managers, in order to compete with salaries in other sectors.</td>
</tr>
</tbody>
</table>

The classification of human resources is based on the primary intent of their professional education and training. Those human resources who are actually engaged in health system can be referred to as health system workforce or health workforce, including both health professionals and non-health professionals.

The issue of human resources concerns both the resource generation and service provision functions. The production of human resources (education); maintenance of their quality and productivity through continuous education and training; determination of the size and composition of the workforce at the macro level; regulation of the education of health care providers, and regulation of professional practices (licensing, accreditation, etc.) can be considered as elements of the resource generation function.

Deployment of human resources, selection of an appropriate skill mix for the production of health services, distribution of the work force between different levels of the health service provision system, setting up incentives structures for health personnel, and human resources management can be considered as elements of service provision function. In this case, human resources could be regarded as inputs into the health production function.

Three types of costs are associated with human resources for health systems: (a) investment costs spent on their production (capital expenditures on educational facilities, expenditures on training and education), (b) maintenance costs (continuing education), and (c) salaries and other benefits paid or offered to human resources. According to the accounting norms, maintenance costs of all types of productive assets together with operating costs (salaries and other benefits in the case of human resources) constitute the recurrent costs. The division between continuing education (above referred to as maintenance) and salaries is proposed by us only for delineating resource generation and service provision functions for the assessment and monitoring purposes, and therefore such division is artificial. We suggest including continuing education (maintenance of human resources) in the assessment and monitoring of the resource generation function on the premise that continuing education is a means of maintaining productivity and quality of human resources. Salaries are the cost of the utilization of human resources as inputs in the service provision process.
Therefore, we suggest looking at the salaries and other incentives for human resources within the scopes of services provision function. There are a variety of levels and points at which the costs of human resources can be measured. In order to annuitize the costs of education and training for health care personnel, Netten and Knight (1998) suggest measuring the costs of the initial investment in training and then estimating the return on investment over time using the number of full time equivalent years that a health professional produces over the course of their employment, but also taking into account the costs of career breaks and early retirement (24). According to estimation of Netten et al. Equivalent Annual Costs (investment cost) of full-time equivalent nurse and doctor in the UK are £4,735 and £21,215 respectively.

Dahlén and Bolmsjö include a variety of additional costs that need to be factored into the total cost of employment. Among those are the cost of recruiting the employee, the costs associated with the initial training period for any employee to learn the system in which they work, the cost of health benefits and any other payments that may be mandated on the part of the employer (11). Absenteeism, illness and rehabilitation are additional costs of employment that Dahlén and Bolmsjö suggest need to be taken into consideration. Another approach to estimating the cost of producing human resources could be the computation of the cycle cost index (25). The cycle cost index takes into account the total training effort invested to produce a single graduate, and is given as: \( N/M \). In this notation \( N \) is a weighted sum of all students who participated in the training (including those who did not successfully complete the program), and the weight for each student is how long he/she spent in the program. \( M \) is the number of graduates multiplied by the nominal length of the program. The index is a measure of the efficiency of the program in producing graduates - the greater its value, the less efficient the training program (1.0 implies 100 per cent efficiency). Although this was not devised by the authors, Ngu and Kwankam use this indicator to compute, and compare, the cost of training programs at the University of Yaounde, Cameroon (25).

The total stock and composition of human resources reflect the trends in the development of health systems. In 1950s and early 1960s, the main human resource concern in Sub-Saharan Africa was to train a cadre of senior professionals to staff the new "centres of excellence". Auxiliary health workers were neglected. By the late 1960s and early 1970s, concern shifted to preventive health care and access to rural health services. This created a need for more nurses and auxiliary health workers. However, despite the shift of the emphasis from hospitals to health centres, hospitals and physicians retained their central and dominant roles and even expended their share of national health budgets (41).

Comparison of different regions and countries show striking differences in the stock and the composition of human resources. For instance, in 1995 in Sub-Saharan Africa the average number of physicians per 1,000 population was 0.3, while in OECD Member European countries - 2.9 (28;31). The following graph (Fig. 6) represents the comparison of some European and African countries in terms of the availability of doctors and nurses per 100,000 population:
This graph shows that in Europe the number of doctors and nurses per 100,000 population is much higher than in Africa.

The data on the profile of the stock of human resources in developing countries is hardly available, calling for intensive work to generate such data. It is expected that there is a huge variation in the availability of different types of human resources. However, the evidence on the effect of different composition of human resources on health system performance is not yet available. The following graph (Fig. 7) shows the availability of different types of health care personnel per 100,000 population in some African countries for which the data was available in WHO, HFA database:

(Source: WHO, HFA database)
As we can see the availability of doctors and midwives in these African countries varies significantly. While generally more nurses are available than doctors, the variation in the availability of nurses is higher (standard deviation values for nurses, doctors, and midwives are 100.9, 79.18, and 86.25 respectively).

The similar data for some European countries are displayed on the next graph (Fig. 8):

![Comparison of Physicians, Nurses, and Midwives among Some European Countries (1998)](image)

The graph reveals the greatest variation in the nurse-population ratio (standard deviation values for nurses, doctors and midwives are 474.38, 106.09, and 68.91 respectively). The difference in the availability of doctors and nurses is better represented in the next graph (Fig. 9).

Migration of human resources is becoming an issue of increasing importance for many countries. Migration refers to the flow of health workers from one work location to another, though it does not necessarily imply from one country to another. Migration of health staff from rural to urban areas, for example, is an issue of concern in many developing countries (29). There are mixed views on the effects of migration on countries, depending on whose perspectives are studied – that of the donor country, the recipient country or the migrating individual. It is impossible to assess the impact of migration objectively without clear evidence, of which there is little currently available. The effect which migration has on a country is related to the relative needs and loss of health personnel in that country, the impact being greatest where needs and loss are both high -
such as in Zimbabwe, where there are high vacancy rates in nursing positions, and nurses from Zimbabwe are being actively recruited to the UK, USA, Canada and New Zealand (22).

Migration of health workforce from developing countries to developed once can be viewed as a growing problem exacerbating the shortages and producing a disproportionate adverse impact on developing countries with relatively poor health status and few economic resources (14). Ojo (1990) explored the detrimental effects of migration of health personnel from sub-Saharan Africa (29). He calculated the cost of emigration of physicians from Nigeria by estimating the resources invested to produce a medical university graduate. He included in the costs 1) living cost 2) educational fees, regardless of who paid them and 3) earnings foregone while in school. He calculated that the cost of producing a medical graduate in 1988 in Nigeria was US$30,000, and that the cost of losing 400 graduates a year was therefore $12,000,000. Although he did not do so, he suggested that in addition their future earnings, equal to the value of their output, is also lost to Nigeria. Ojo does not calculate remittances returning to the country, and does not explain how he arrives at his figures. Clearly, this example shows that there is a cost to migration for exporting countries, which can be detrimental both economically and in terms of the capacity of that country’s health system to function.

Remittances, the portion of international migrant workers’ earnings sent back from the country of employment to the country of origin, play a central role in the economies of many labour-sending countries and have become a focal point in the ongoing debate concerning the costs and benefits of international migration for employment.

The main sources of official data on migrants’ remittances are the annual balance of payments records of countries, which are compiled in the Balance of Payments Yearbook published by the International Monetary Fund (IMF). Global estimates of official remittance flows based on these balance of payments statistics suggest that remittances increased from US$ 43.3 billion in 1980 to US$ 70 billion in 1995 (35). Although the data based on migrants’ remittances have several deficiencies (for a review see, (3), (5), (38)), they suggest that, for a number of countries, the level of remittances is very significant in proportion to the country’s merchandise exports. As Table 2 shows, in Bangladesh, remittances were equivalent to about 44 per cent of total merchandise exports in 1993; in India, about 13 per cent in 1990; in the Philippines, about 22 per cent in 1993; and in Pakistan, about 24 per cent in 1993.

Table 2. Flow of workers’ remittances and its share in imports and exports of goods in selected labour-exporting countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>1980</th>
<th>1985</th>
<th>1990</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remittances</td>
<td>As a % of</td>
<td>Remittances</td>
<td>As a % of</td>
</tr>
<tr>
<td></td>
<td>Export</td>
<td>Import</td>
<td>Export</td>
<td>Import</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>286</td>
<td>36.1</td>
<td>12.2</td>
<td>502</td>
</tr>
<tr>
<td>India</td>
<td>2715</td>
<td>32.7</td>
<td>19.5</td>
<td>2427</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>61</td>
</tr>
<tr>
<td>Korea Rep.</td>
<td>100</td>
<td>0.6</td>
<td>0.5</td>
<td>265</td>
</tr>
<tr>
<td>Pakistan</td>
<td>2108</td>
<td>82.1</td>
<td>38.7</td>
<td>2573</td>
</tr>
<tr>
<td>Philippines</td>
<td>613</td>
<td>10.6</td>
<td>7.9</td>
<td>805</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>139</td>
<td>13.1</td>
<td>7.5</td>
<td>233</td>
</tr>
<tr>
<td>Thailand</td>
<td>348</td>
<td>5.4</td>
<td>4.2</td>
<td>809</td>
</tr>
</tbody>
</table>

Source (32)
Despite the fact that emigration of health care personnel is quite high from certain countries, there is hardly any data available on the contribution of immigrant health workers in the flow of remittance into the exporting countries.

Without more accurate information about the costs and benefits of migration, its full impact remains unclear.

Evidence from the UK suggests that the number of nurses entering the country and being registered for work is increasing. Table 3 shows admissions of non-UK qualified nurses to the nursing register from 1990-1998 (16)

**Table 3. Admissions of non-UK qualified nurses to the nursing register (1990-98)**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EEC arrangements</td>
<td>813 (24.4%)</td>
<td>456 (20.2%)</td>
<td>1,439 (33.2%)</td>
</tr>
<tr>
<td>Other</td>
<td>2,518 (75.6%)</td>
<td>1,802 (79.8%)</td>
<td>2,894 (66.8%)</td>
</tr>
</tbody>
</table>

For the planning and management of human resources policy makers need to have answers to at least the following questions: what is the stock of current human resources, what is the total costs of annual investments, what is the ratio of productive resources over the total stock of human resources.

The following indicators can be proposed for the assessment and monitoring the production of human resources:

- **Total annual investments in human resources as a per cent of total health expenditure**
  
The total annual investment ideally should include not only the expenditures on health education, but also the costs of the continuing education and other forms of professional training, which can be considered as maintenance of the quality and productivity of human resources. It should cover both public and private sectors. The feasibility of obtaining such detailed expenditure categories from the national health accounts should be explored.

- **The ratio of the number of new graduates from the health educational institutions over the total stock of health care personnel by different professions.**
  
This indicator will measure the replacement rate of human resources, and can help in the projection analysis. The data can be obtained from the academic institutions and Ministries of Health and Education.

- **The total stock, composition, and distribution of human resources**
  
The measurement of total stock of human resources should focus on the total number and the number of different categories of health care personnel per population units. Information should also be collected on the geographic distribution of human resources (inequality of human resource distribution) within the country, gender and age balance in the health workforce, distribution of human resources between public and private sectors, level and type of education, and degree of engagement in health labour force (full and half-time equivalent).
Geographic distribution of human resources has lots of implications in terms of the access to health care. Many countries experience shortage of health care personnel in rural and remote areas.

One of the key determinants of labour market behaviour is age. In the US and the UK, for example, nursing and midwifery workforce experience noticeable “ageing”. In the US, the average age of registered nurses increased by more than 4 years between 1983 and 1998 (6,7). An “ageing” workforce has a number of significant employment policy implications, chief of which is deciding how to replace the loss in labour force as many nurses will retire around the same time. Buerhaus et al (2000) predict that in the United States the RN workforce will be 20% below projected requirements by 2020 (7).

Assessing gender balance in the health workforce is also interesting, as it may reveal the extent to which women and men have equal opportunities in education and career choice. However, in health care, gender can be important for other reasons too. For example, communication patterns between physicians and patients during the medical visit reveal behavioural gender differences and varying satisfaction levels depending on physician gender. The communication style of female physicians often includes slightly more focus on the patient's emotional and psychosocial concerns, more positively toned communications, and a more egalitarian style reflected in increased levels of patient participation (15,34). Nurses have often attributed their poor pay and conditions to the fact that nursing is a female dominated profession, in which the work which nurses do is seen simply as women’s work, and not given a high market value (36).

The distribution of providers between the public and private sectors is important for estimating the relative size of each sector. Also, it might be a useful variable for explaining some of the outcomes of health service provision function, such as coverage, provider performance, etc. In some countries, the estimation of the size of the private provider sector by the amount of private expenditure on health might lead to overestimation, because a large proportion of health care personnel employed in public sector see the patients on the terms of the private practice, and therefore a significant share of private payments goes to public providers. For this reason, the direct measurement of the size of the private/public provider sectors might be more useful than its estimation by the amount of private spending.

The data on the total stock, composition and distribution of human resources can be obtained from labour force surveys, census, provider surveys, national Ministries of Health or Labour, professional associations, etc. There are several examples of relevant provider surveys, such as the National Sample Survey of Registered Nurses in the U.S.A. The history of labour force surveys starts in 1940 in the U.S.A. In Europe, the first labour force survey was conducted in France in 1950.

The census is currently widely used by many countries and international agencies (UN, ILO, OECD, European Union and others). Besides the characteristics of household, families, and so on, the census present some variables concerning the workforce analysis, such as: workforce characteristics: employment in health care, hours of work, remuneration, social security, etc.

Some of the examples of the usage of the census data include the following:

In 1997, US Bureau of the Census provided detailed data on employment in health care and social assistance settings at the state and sub-state levels (40). In 1998, US Bureau of the Census, which covers a nationally representative sample of more than 100 000 individuals collected data on employment of registered nurses (8). The European Community Household Panel study (ECHP) profiles labour market experiences in the European Union (13).

Once every 10 years the US Bureau of Census undertakes the constitutionally mandated Census of Population and Housing for apportioning of the House of Representatives (18). The 1990 and 2000 World Population and Housing Census Rounds held by United Nations Statistics Division

There is no a standard global classification of occupations so far that could be used across countries with census. However, most of the countries use national standard occupational classifications developed in response to a growing need for a universal occupational classification system. Such a classification system would allow government agencies and private industry to produce comparable data.

More discussion about the use of labour force and provider surveys, as methods for assessing and monitoring human resource generation in health systems, will be provided in the another document on data collection methods (see "Data Collection Strategies for Service Provision, Resource Generation, and Health Care Finance Functions", O. Adams, B. Shengelia, W. Savedoff, A. Goubarev).

- **Migration of human resources**

Indicators to capture migratory flows could include numbers of foreign health workers entering a country or seeking admission to a professional register, numbers of health workers leaving a country, or migrating from rural to urban areas.

The data on migration of health workforces could be obtained from professional registries, labour force surveys, providers surveys, special bodies of government dealing with immigration issues.

### 3. **Physical Capital**

Physical resources together with human resources are an important part of health system's capital, which has been defined in the World Health Report 2000 as existing stock of productive assets. In the literature, physical resources normally encompass three broad categories: buildings/structures with auxiliary facilities (power generators, water pumps etc. depending on local conditions); medical equipment; and logistics including supply systems, transport, warehouses, and their logistic facilities (43). Physical resources are often referred to as health system infrastructure and technology/equipment. Physical resources provide the material platform on which the delivery of care rests. Quality and numbers of staff as well as availability of drugs and consumables are of little value without adequately built and equipped facilities, just as the latter by themselves are of little utility without the former.

Physical resources represent a significant investment for the health sector. This investment is constantly increasing, reflecting technological progress. The graph below (Fig. 10) represents the trend in total per capita investment in medical facilities (in PPP terms) in OECD countries from 1980 to 1999:
This graph demonstrates that there is a considerable variation between different OECD countries in terms of their per capita total investments in medical facilities. As the investment increases over time the variation between the countries also increases. The country that is experienced the highest increase in per capita investment is Norway. As we demonstrated earlier, in the introductory section, the OECD countries with lower total health expenditure as a % of GDP tend to invest more in medical facilities as a % of total health expenditure (see table #).

Health authorities are confronted with a bewildering array of choices when making difficult decisions on investment in medical equipment. The number of different types, brands and models of medical devices offered on the world market in 1994, was estimated at 750,000 produced by some 10,000 manufacturers (27). The same source estimates that the number of makes and models had almost doubled by the year 2000. This unprecedented pace of technology development and transfer has, in many instances, far exceed the capacity of health systems to track the innovations and to put in place adequate support systems for use of new technology. Monitoring innovations is important, as technological progress strongly influences the economic and clinical lifetime of physical capital: old investments quickly become outdated as new and improved technologies emerge.

New investment is a critical activity for adjusting capital stock and creating new productive assets. Information on such investment is essential for policy makers as they make decisions about the allocation of resources now, as opposed to investments that will support the provision of health services in the future. Past sustained investment has resulted in adequate stock in most industrialized nations permitting, in some cases, lower capital investment now than some 15 or 20 years ago (44).

Acquiring physical resources is only one step in the many that make up the capital assets management function and requires that attention be given to the overall technology life cycle. The expenditure plan should therefore be based on life-cycle costing, which takes into account factors such as maintenance, repair, operation and depreciation. Experts suggest, based on service records at facility level, that the annual allocation for maintenance in relation to replacement cost, should be about 5-15 per cent for medical equipment, 2-3 per cent for buildings and plant, and 5 per cent for vehicles (42;45). Most medical equipment needs to be replaced within 5-20 years depending on the type and the way it is handled. Reasonable estimates of the combined annual costs for equipment maintenance and replacement, based on documented experience from development
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agencies, is 20-25 per cent of the current purchase (4). As an illustration, the replacement value of medical equipment in the NHS acute trusts in England is around GB£3 billion, with some GB£220 million spent annually on acquiring new equipment and replacing old ones, and a further GB£120 million spent on maintenance (23).

The situation in developing countries, where information systems are weak and data not readily available, merits special attention. These countries account for only an estimated 10 per cent of the world medical equipment market (17). But the small share of expenditure on infrastructure and equipment is estimated, from formal and informal reports, to be as high as 40 to 50 per cent of the total public health budget in some developing countries. Equivalent figures are typically not more than 5 per cent among OECD countries (44).

The acquisition of physical resources should be driven by health/clinical necessity. To maximize the utility of these resources, countries need to monitor factors which influence their use within the context of their specific delivery systems or services. While it may be interesting to have a large number of indicators, given the complex issues involved in planning and managing physical resources, a parsimonious set that provides insights into the operation of the health system may be more feasible for health systems performance. The following measures are proposed:

- **Annual new investment in health facilities as a % of the total health expenditure**
  
  This measure would be designed to capture the decisions that are made each year to invest in new capital. These decisions are not made in isolation from other investments (expenditures) in the same year. The ratio of annual investments in health facilities as a proportion of total health expenditures will provide the policy maker with information on the allocation of resources.

- **The annual expenditure on maintenance as a percentage of annual investment in health facilities**
  
  This measure will provide information on the state of productivity of the asset. The ratio of annual investment in maintenance as a proportion of total investment in health facilities will give information on the balance between investment and maintenance. Annual investment in maintenance can also be expressed as a proportion of total stock of equipment and physical plants (replacement costs) in the system. This will provide information that can be used in the estimating the productive life of the capital stock. The hypothesis is that a country with a lower ratio of investment in maintenance to capital stock will have a higher degree of inefficient use of the capital stock.

- **Total stock of health facilities (current value) in the system as a proportion of GDP.**
  
  This measure aims at collecting information on the value of existing facilities in the system, and can be used as a proxy for the total investment the country has made. Over time, it can show the changing worth of physical investments in the country.

4. **Knowledge**

Growth in the available knowledge or advances in technology -such as new drugs- can substantially increase the capacity of human resources to solve health problems, and thereby improve the performance of health systems (44).

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3 The anecdotal nature of some of the references in this section stems from the dearth of statistics regarding expenditure on, and quality and state of physical resources in developing countries. We are left with formal and informal reports as the primary source of data, in trying to draw attention to the problems of physical resources in these countries.
New knowledge is created from investments in research and development. There is a need for building alliances between researchers, decision-makers, users and funders in the identification and formulation of problems for research, believing that early collaboration will result in a better utilization of the results. Recent studies which have focused on the use of new knowledge in clinical practice have also concluded that perceived relevance of the knowledge to the user is vital in changing behaviour (26). Involving stakeholders in the process of production of knowledge appears to be a method of improving its application, and therefore ultimately, the quality of health care (30). Investing in the generation of knowledge has, therefore, two major components: investment in research and development and investment in use of the findings (19).

Health research takes place in a number of settings, universities, hospitals, research institutes and centres, industrial laboratories and government facilities, Funding for research can come from the private sector, from the public sector or through joint ventures. With respect to developing countries, funding for research may also come from donor countries.

Concern over the level, balance and return on research investment has become high on the policy agenda of many countries. Buxton et al. (9) in discussing research in the United Kingdom suggest that the direct opportunity cost of substantial investment of NHS funding is spending on patient care. NHS research is expected to generate returns, through improvements in health and welfare, and thus there is pressure to justify the total allocation of resources to research, as opposed to health services.

Without investments in knowledge health, systems will lag behind in the application of new and appropriate technology in the provision of health services. The World Health Report, 2000 argues that new knowledge has contributed to shifting the boundaries between hospitals, primary health care and community care. Further vaccines have altered the strategy and costs of tackling epidemic diseases such as measles and poliomyelitis and new vaccines will continue to necessitate re-thinking to ensure an efficient mix of inputs in national health strategy.

For the assessment and monitoring of the generation of knowledge the following measures can be proposed:

- The total annual investment in research and development.

Linking annual investment to total health expenditures will give an indication of the allocation decisions being made by countries. Given the nature of investments in Research and development it will important to separate out investments by the public sector and the private sector. In the future, it will also be useful for policy makers to have comparable information on the distribution of investments in knowledge.

There are currently a number of countries and research consortia (e.g. Global Forum on Health Research) that are engaged in trying to define and get good measures of health research. The data on investments in research and development could be obtained from national health accounts, from various government sources, and donor agencies.

There is a growing body of evidence that certain mechanisms are more likely than others to bring about individual and organizational change in the way that new knowledge is used in policy development and in practice (21;26). Investment in knowledge generation must be accompanied by changing methods of knowledge dissemination, application and use, so that assessing the investment in knowledge must also include an assessment of what measures are taken to ensure knowledge is relevant. The two suggested here are a review of professional development and continuing education methods, and the process of involving stakeholders in the generation of the research agenda.
5. **Conclusions**

In the current paper we argued resources are crucial components of health system. However, there is little systematic evidence on the impact of investments decisions on the performance of health. The data for many countries on various aspects of resource generation function are scarce, making it difficult to perform cross-country comparisons. The link between health care resources and population health is not well understood. This paper suggests that: 1) investment decisions have long-term implications for health systems; 2) investment decisions in health systems are subject to the political influence of different stakeholders; 3) there is a significant variation among countries in terms of their investment patters and resource profiles; 4) investment decisions affect the geographic distribution of health care resources and services; and 5) investment decisions in health systems affect other systems as well.

We discussed two categories of resources for health systems: human resources and physical capital.

We defined human resources as the stock of all individuals engaged in the promotion, protection, or improvement of health of population. For the assessment and monitoring of human resource generation we proposed following measures:

- Total annual investments in human resources as a per cent of total health expenditure
- The ratio of the number of new graduates from the health educational institutions over the total stock of health care personnel by different professions.
- The total stock, composition, and distribution of human resources

We defined physical capital as a combination of three broad categories: buildings/structures with auxiliary facilities (power generators, water pumps etc. depending on local conditions); medical equipment; and logistics including supply systems, transport, warehouses, and their logistic facilities. For the assessment and monitoring of the generation of physical capital we proposed the following measures:

- Annual new investment in health facilities as a % of the total health expenditure
- The annual expenditure on maintenance as a percentage of annual investment in health facilities
- Total stock of health facilities (current value) in the system as a proportion of GDP.

For the assessment and monitoring of the investments in knowledge generation we propose to measure total annual investment in research and development.
Reference List

(1) Abt Associates. Hospital Financing Study for Georgia. 1999, Bethesda, MD


(9) Buxton M, Croxson B, and Hanney S. Assessing the Payback for Health R&D: From ad hoc Studies to Regular Monitoring. 1999,


(18) Kelter LA. Counting the countries: effects of Census 2000 on employment. MONTHLY LABOUR REVIEW, 2000; February:24-29.


(26) NHS. National Health Service Centre for Reviews and Dissemination. EFFECTIVE HEALTH CARE BULLETIN, 1999; 5(1).


(30) PAHO. Strategies for utilization of scientific information in decision-making for health equity. 2001.


(34) Roter DL, Hall JA. How physician gender shapes the communication and evaluation of medical care. MAYO CLINIC PROCEEDINGS, 2001; 76(7):673-676.


(40) U.S. Census Bureau. U.S. Census Bureau. *U.S. Census Bureau*, 2001,

(41) *Health Personnel Development in Sub-Saharan Africa*. The World Bank, Population and Human Resources Department, 1992


