



The State of the National Health Research System in South Africa

Authors:

Flavia Senkubugeⁱ

Bongani M Mayosiⁱⁱ

Knowledge produced by health research contributes to the improvement of the health of individuals and populations. This knowledge also contributes to the development of evidence-informed policies and the enhancement of performance of health systems. Using existing and new knowledge adapted to local conditions is particularly crucial in achieving the Millennium Development Goals. To achieve these and other health-related goals, a well-functioning health system must be able to produce, access and utilise research-based knowledge and the products of research.

A well-functioning health system must be able to produce, access and utilise research-based knowledge and the products of research.

The purpose of this chapter is to assess the performance of the national health research system that was envisaged by the Health Research Policy of 2001, and to highlight the recommendations of the National Health Research Summit of 2011 on the strengthening of research and development in South Africa (SA). The health research enterprise in SA is dominated by a small core of productive researchers, who are largely externally funded and focus on HIV, AIDS and tuberculosis. The representation of black research leaders is low.

The key priorities for strengthening the health research system are related to increasing funding from local governmental and non-governmental sources, developing human resources for health research, building the infrastructure for clinical research in academic health complexes, providing dedicated funding for priority health conditions, and improving the national regulatory framework for clinical trials.

Furthermore, there is a need for the development of a national system for the planning of research and its translation into policy, programmes, and practice. Finally, the health research system requires a mechanism for monitoring and evaluation to serve as a 'feedback loop' for the development of a robust health research system that is geared to addressing the priority health needs of South Africans.

ⁱ School of Health Systems and Public Health, University of Pretoria

ⁱⁱ Department of Medicine, Groote Schuur Hospital and University of Cape Town

Introduction

Knowledge produced by health research is a global public good.^{1,2} Knowledge contributes to the improvement of the health of individuals and populations, to the development of evidence-informed policies and the enhancement of performance of health systems.^{1,3} Using existing and new knowledge adapted to local conditions is particularly crucial in achieving the Millennium Development Goals.⁴ To achieve these and other health-related goals, a well-functioning health system must be able to produce, access and utilise research-based knowledge.² The Commission on Macroeconomics and Health and the Consultative Expert Working Group on Research and Development Financing and Coordination have recommended a substantial increase in health research investments globally.^{5,6} It is universally accepted that health research and scientific knowledge play a central role in addressing the prevention and control of diseases and conditions that afflict populations.

Expenditure on medical research provides a huge economic return on investment – whether measured in terms of dollar value of lives saved, health costs saved, or jobs created.⁷ Three global commissions have repeatedly demonstrated that health research is not given its proper role in improving health, equity and development in lower- and middle-income countries.^{5,8,9} The Commission on Health Research for Development was among the first to recommend that lower- and middle-income countries should spend at least 2% of their health programme budgets on health research and that donors should match this with an allocation of 5% of their (externally provided) health programme funding. These percentages have been endorsed in subsequent ministerial declarations^{10,11} but allocation of these funds has been difficult to measure and has rarely been achieved.¹

The historic strengths and weaknesses of South Africa's participation in the global enterprise of medical research were reviewed recently in a report on the revitalisation of clinical research undertaken by the Academy of Science for South Africa (ASSAf).¹² The report examines the legacy of colonialism, racism and inequality in medical research, and demonstrates how this history has shaped relationships between researchers, government, industry and the South African public. After 1994, significant strides were made in

re-orienting health care and medical research towards the needs of the majority at a policy level. The philosophy of essential national health research was embraced, which culminated in the publication of the Health Research Policy of 2001, which sought “to develop a national health research system that contributes to equitable health development.”¹³

The purpose of this chapter is to assess the performance of the national health research system as envisaged in the Health Research Policy of 2001. Another purpose is to highlight the recommendations of the National Health Research Summit of 2011 on the strengthening of research and development in South Africa (SA). This assessment is conducted within the framework presented by Pang et al. for national health research systems.¹

A framework for national health research systems

A health research system is located at the intersection between the health system and the research system of a country.¹ In SA, the health system is the responsibility of the Department of Health whereas the research system is under the purview of the Departments of Science and Technology, and Higher Education and Training. The National Health Research Committee, which is a statutory body established in terms of the National Health Act (Act 61 of 2003),¹⁴ is located in the Department of Health and is mandated to ensure that there is coordination between the activities of the public institutions (such as the Departments of Health, Science and Technology, and Higher Education and Training) in the development and management of the national health research system.

In terms of the framework of Pang et al., a health research system has two intrinsic goals: the advancement of scientific knowledge and the utilisation of knowledge to improve health and equity.¹ The fundamental functions of a health research system include stewardship, financing, creating and maintaining resources, and producing and using research. The state of national health research is examined in the following sections, according to the fundamental functions of a national health research system. (See Table 1.)

Table 1: Summary of the functions and operational components of health research systems

Function	Operational component
Stewardship	<ul style="list-style-type: none"> • Define and articulate vision for a national health research system • Identify appropriate health research priorities and coordinate adherence to them • Set and monitor ethical standards for health research and research partnerships • Monitor and evaluate the health research system
Financing	Secure research funds and allocate them in an accountable way
Creating and sustaining resources	Build, strengthen, and sustain the human and physical capacity to conduct, absorb, and utilise health research
Producing and using research	<ul style="list-style-type: none"> • Produce scientifically valid research outputs • Translate and communicate research to inform health policy, strategies, practices, and public opinion • Promote the use of research to develop new tools (drugs, vaccines, devices, and other applications) to improve health

Source: Pang et al., 2003.¹

The state of the South African national health research system

Stewardship

Stewardship is concerned with oversight of the entire health research system and is intended to cover both the public and private sectors.¹⁵ Two statutory bodies are entrusted with the stewardship of the national health research system in SA: the National Health Research Committee and the National Health Research Ethics Council, both of which are located in the Department of Health. The National Health Research Committee has a legislative mandate to advise the Minister of Health on health research priorities. In identifying health research priorities, the National Health Research Committee takes into account the following:

- the burden of disease;
- the cost-effectiveness of interventions to reduce the burden of disease;
- the availability of human and institutional resources for the implementation of interventions closest to affected communities;
- the health needs of vulnerable groups such as women, older persons, children and people with disabilities; and
- the health needs of communities.

Furthermore, the National Health Research Committee is required to:

- determine the health research to be carried out by public health authorities;
- ensure that health research agendas and research resources focus on health priorities;
- develop and advise the Minister on the application and implementation of an integrated national strategy for health research; and
- coordinate the research activities of public health authorities.

The new National Health Research Committee for the 2011-2013 term convened a National Health Research Summit of health research stakeholders in July 2011.¹⁶ The National Health Research Committee is carrying out the task of defining and articulating the vision for a national health research system and identifying health research priorities through a consultative process that involves the key actors in health research from academia, industry, and government.¹⁶ Through this work, the National Health Research Committee has highlighted the essential role for investment in health research to achieve a long and healthy life for South Africans,¹⁷ and has identified seven priorities for the strengthening of the national system for health research.¹⁶

In terms of its key functions the National Health Research Ethics Council, which sets and monitors ethical standards for health research and research partnerships, is required to:

- determine guidelines for the functioning of health research ethics committees;
- register and audit health research ethics committees;
- set norms and standards for conducting research on humans and animals, including norms and standards for conducting clinical trials;

- adjudicate complaints about the functioning of health research ethics committees and hear any complaint by a researcher who believes that he or she has been discriminated against by a health research ethics committee;
- refer to the relevant statutory health professional council matters involving the violation or potential violation of an ethical or professional rule by a healthcare provider;
- institute such disciplinary action as may be prescribed against any person found to be in violation of any norms and standards, or guidelines, set for the conducting of research in terms of the National Health Act; and
- advise the national department and provincial departments on any ethical issues concerning research.

While the National Health Research Committee and the National Health Research Ethics Council may be considered to be effective in the majority of areas of their functions, there are areas of research stewardship that are neglected, such as planning, coordination, and monitoring and evaluation of the health research system.¹⁶

Financing

The 2008/09 National Survey of Research and Experimental Development (R&D) recorded gross domestic expenditure on R&D (GERD) of R21.0 billion for all research in SA, which was a nominal increase of R2.4 billion from the R18.6 billion recorded for 2007/08.¹⁸ The 2008/09 expenditure represents a 13.0% nominal increase over that of the previous year, but was insufficient to keep up with the increase in the nominal Gross Domestic Product (GDP) of 14.2% over the corresponding period. As a consequence, R&D expenditure, expressed as a percentage of GDP, dropped slightly from 0.93% in 2007/08 to 0.92% in 2008/09. The largest proportion of research and development expenditure is on engineering and natural sciences (45% of total research and development expenditure), while expenditure on the health sciences is 14.8% of the total (about 0.14% of GDP). SA is aiming to spend R45 billion on research and development and reach its target for gross expenditure on research and development of 1.5% of GDP by 2014.¹⁹

The procurement and allocation of funds for research is the second central function of a health research system.¹ There is consensus, however, that the health research system of SA is severely underfunded from local public and private sources.^{12,16} For example, the National Health Research Committee has estimated that the National Department of Health (NDoH) spent 0.37% (R416.5 million) of its health budget (R112.6 billion) in health research in the 2010/2011 financial year, which falls far short of the recommendation of the health research policy in SA of 2001 and subsequent undertakings by the Ministry of Health in Mexico¹⁰ and Bamako¹¹ to invest 2% of the health budget in health research.

According to the ASSAf report:

[t]he key narrative of clinical research in SA over the last two decades has been that of a largely unplanned, but cumulative, disinvestment in publicly funded programmes, resulting from the withdrawal of the health departments of provincial governments from this sector (academic hospitals are now funded for service functions only), the absence of discounts for research tests from the business model of the National Health Laboratory Service,

chronic underfunding of the Medical Research Council despite its obviously important mandate for maintaining and developing medical/clinical research capacity in the country, and the lack of funding streams to universities that might in principle have been applied to meet the overall shortfall in support.¹²

This policy trajectory has had a chilling effect on indigenous clinical science in the country over the past 10-20 years.²⁰

Creating and sustaining resources

Creating and sustaining human and physical resources for health research is the third central function of a health research system.¹ The key strengths of the South African health research system with respect to human and physical resources include having a small but productive core group of highly skilled researchers that comprise experts in laboratory, clinical and epidemiological aspects of HIV and AIDS and tuberculosis (TB), non-communicable diseases, maternal and child health, and violence and injury.¹⁶ There are also several large AIDS and TB clinical research units (in KwaZulu-Natal, Gauteng and Western Cape)²¹⁻²⁵ and demographic surveillance systems that are part of the international INDEPTH network (in KwaZulu-Natal and Mpumalanga).²⁶

The main weaknesses include the low level of funding for health research from the South African government in human and infrastructural resources for health research (e.g. less than 30% of total funding for HIV and AIDS and TB research comes from local sources), which is partly a manifestation of the relatively low level of government investment in research and development in general (0.92% of GDP in 2009). As a result, SA has a small number of researchers relative to other countries in the Brazil, Russia, India, China and SA (BRICS) grouping. For example, there are 1.4 full-time equivalent (FTE) researchers per 1 000 employed people in SA compared with 8.2 per 1 000 in Russia.¹⁸

This under-resourcing of the health research system in SA is associated with a dearth of training programmes and career paths for health researchers, and a virtual absence of clinical research centres that are funded by the state in the academic health complexes that have the statutory mandate to produce new knowledge.¹²

The deficit of human resources for health research is being addressed at a policy level through the new Human Resources for Health Plan.²⁷ This plan has made the revitalisation of education,

training and research one of its strategic priorities. The interventions and actions that have been identified are the growth of academic health practitioners through a doctorate driven National Health Scholars Programme²⁸ and the establishment of Research Chairs in Health Sciences in the future. This plan endorses the major recommendations of the report on clinical research of the ASSAf.¹²

Producing, synthesising and utilising research

The production of valid research disseminated in scientific publications in peer-reviewed and grey (non-peer-reviewed) literature, policy publications, reports, books or discussion papers, patents and new processes is the fourth function of the health research system.¹ Pouris reported the findings of a recent scientometric analysis of SA's research outputs during the period 2000-2010, which evaluated the effects of policy interventions on research publications.²⁹ A number of public policy interventions were introduced during the period under review, including the introduction in 2003 of a new funding formula that financially supports the higher education institutions according to their research outputs (number of publications and number of postgraduate students produced).³⁰ In contrast to earlier investigations by Pouris, it was found that SA's world share of publications had increased over the past decade.^{31,32} SA improved its overall international ranking by two positions during 2000-2010 and was ranked 33rd in the world during 2010 in terms of the absolute number of scientific publications in all fields of research.

The country's share in world literature has increased in all disciplines of health sciences from an average of 0.40 (2000-2004) to 0.60 (2006-2010) (Table 2).²⁹ The activity index, which is the ratio of the country's share of the world publication output in a given field to the country's share of the world publication output in all science fields, also increased in all fields of health sciences except for Clinical Medicine and Pharmacology and Toxicology (Table 2). An activity index of one indicates that the country's research output in the given field corresponds to the world average; an indicator larger than one reflects a higher-than-average emphasis in the field. The falling activity index in Clinical Medicine and Pharmacology may be regarded as a manifestation of the disinvestment in clinical science over the past 20 years that was identified in the ASSAf report.^{12,20}

Table 2: SA's world share and activity indices in health sciences and related disciplines

Discipline	2000-2004		2006-2010	
	World share	Activity index	World share	Activity index
Biology and Biochemistry	0.35	0.71	0.54	0.92
Clinical Medicine	0.40	0.82	0.45	0.76
Immunology	0.49	1.00	1.09	1.85
Microbiology	0.57	1.16	0.78	1.32
Neuroscience and Behaviour	0.17	0.35	0.22	0.37
Pharmacology and Toxicology	0.39	0.80	0.42	0.71
Psychiatry and Psychology	0.45	0.92	0.69	1.17
Overall	0.40		0.60	

Source: Pouris, 2012.²⁹

As presented in Table 3, a relative citation index above one indicates that the country's publications in the particular field attract more than the average citations in the world and an index of less than one indicates that the field attracts fewer citations.²⁹ Table 3 shows that all disciplines in health sciences are improving their impact except Psychiatry and Psychology. South African publications in Microbiology, Clinical Medicine, and Immunology attract more citations than the average citations in their fields. This shows that in Clinical Medicine, although the level of activity was declining in the period under review, the quality and impact of South African work in this field continue to improve. South African health researchers are publishing an increasing number of high-quality publications on priority conditions such as HIV and AIDS and TB in high-impact journals such as the *New England Journal of Medicine*, *Science*, *Nature Medicine*, and *The Lancet*.³³⁻³⁸

Table 3: Relative impact of South African publications during 2000-2004 and 2006-2010 in health sciences and related disciplines

Discipline	Relative impact	
	2000-2004	2006-2010
Biology and Biochemistry	0.56	0.81
Clinical Medicine	0.86	1.15
Immunology	0.71	1.09
Microbiology	1.00	1.27
Neuroscience and Behaviour	0.63	0.71
Pharmacology and Toxicology	0.58	0.70
Psychiatry and Psychology	0.67	0.61
Overall	0.72	0.91

Source: Pouris, 2012.²⁹

SA is emerging as a leader in Africa in the fields of the synthesis and utilisation of research findings. The South African Cochrane Centre at the Medical Research Council is part of the international Cochrane Collaboration, which is a non-profit organisation operating worldwide that disseminates up-to-date systematic reviews on the effects of healthcare interventions carried out in order to help people make well-informed decisions.³⁹ There are also several academic groups that are involved in translation and implementation science, such as the Knowledge Translation Unit at the University of Cape Town and the Priority Cost Effective Lessons for Systems Strengthening – SA (PRICELESS SA) at the University of the Witwatersrand.^{40,41} There is, however, no nationally agreed upon framework for the translation of research evidence into policy, programme and practice – such as the National Institute for Health and Clinical Excellence (NICE) in the United Kingdom (UK).⁴²

Key findings and recommendations

There is an increasing realisation of the need to promote indigenous health research in SA. The decline in investigator-initiated original clinical research activity in the mid-2000s prompted the ASSAf to produce recommendations for the revitalisation of clinical research, including increased funding, the training of a new cadre of health researchers, the establishment of clinical research centres, and improved regulation and planning of the health research enterprise.¹² The NDoH also recognised the essential role of health research in achieving a long and healthy life for all South Africans through its 10 Point Plan of 2009 to 2014, which includes “strengthening of research and development” as its 10th priority.⁴³

The National Health Research Committee acted upon policy directives of the NDoH by convening a National Health Research Summit in July 2011, which identified seven challenges and produced recommendations for the revitalisation of the health research system in SA. These are presented in Table 4.¹⁶

Table 4: Key findings and recommendations for the strengthening of the health research system in SA

Key finding	Recommendation
Financing: There is inadequate funding of health research by the Government of SA.	The NDoH should consider the progressive implementation of its commitment to the proportion of the national health budget allocated to research and development from 0.37% to 2.0% over the 2012-2014 period, as required by the National Health Research Policy of 2001 and commitments made in Mexico (2004) and Bamako (2008). This measure has the potential to lift the investment in health research from <R500 million at present to >R2 billion (fourfold increase).
Human Resources: There is a shortage of human resources for health research in SA, especially black South Africans and women.	The increased funding should be used to at least double the number of health researchers and academic clinicians over the next 10 years, in line with the Human Resources for Health Strategy of SA (2012/13-2016/17). The increased production of health researchers may be achieved by the creation of a 'National Health Scholars Programme' to fund doctoral studentships, post-doctoral fellowships, mid-career research posts, and research chairs in all healthcare fields, including medicine, dentistry and nursing.
Health Research Infrastructure: There is a lack of health research facilities and infrastructure in academic health complexes that are required by the National Health Act of 2003 to conduct research into priority health problems of South Africans.	The new funding should also be directed at developing the health research infrastructure of the academic health complexes. The ASSAf report on the revitalisation of clinical research identified the priority of creating clinical research centres in the academic health complexes to facilitate research occurring alongside service and teaching. Creating clinical research centres should form part of the hospital revitalisation programme in preparation for the introduction of the National Health Insurance scheme.
Priority Research Fields: The priority research areas are surveillance, knowledge translation, integration of care, health economic evaluation, diagnostics, therapeutics and vaccine development to address the quadruple burden of disease, social determinants of health, and strengthening the health system.	The new funding should also be used to create a National Priority Health Research Fund to stimulate and support new and innovative research programmes that address the research priorities related to the quadruple burden of disease, health systems strengthening, and combating the social determinants of health (that seek to achieve the outcomes of the Negotiated Service Delivery Agreement (NSDA) of the NDoH). These funds should be tied to measurable achievement of the objectives of the NSDA.
National Regulatory Framework: There is a cumbersome regulatory system for registration of new medicines and conducting of clinical trials under the Medicines Control Council (MCC).	The proposed South African Health Products Regulatory Authority should heed the recommendations of the ASSAf report on a progressive and efficient regulatory regime for health research in SA. ¹²
Planning and Translation: There is a virtual absence of national planning, coordination and translation of research into health innovations, policy, programmes and practice.	A process should be commenced to establish a body that is similar to the NICE in the UK in order to ensure the orderly translation of research.
Monitoring and Evaluation: There is a lack of national mechanisms for monitoring and evaluation of the performance of the health research system of SA.	Consideration should be given to the development of a monitoring and evaluation tool as a module of the National Survey of R&D of the Department of Science and Technology.

Source: [Mayosi et al., 2012](#).¹⁶

These recommendations, which have been accepted by the Ministry of Health,¹⁶ call for:

- increased funding for health research by the Department of Health, in line with the National Policy for Health Research of 2011 and the Mexico and Bamako declarations, from 0.37% to achieve the 2.0% of the national health budget;
- the training of a new generation of health researchers, especially black people and women, (through a National Health Scholars Programme);
- the development of health research infrastructure in the academic health complexes that will facilitate research-based re-engineering of primary health care (through the funding of clinical research centres);
- the funding of priority research projects designed to increase the lifespan of South Africans (through a national priority research projects fund);
- the improvement of the national regulatory framework for health research (through the new South African Health Products Regulatory Authority);
- the creation of a national mechanism for planning and timely translation of research findings into policy, programmes and practice (through a structure similar to the NICE in the UK); and
- the development of a national system for evidence-informed monitoring and evaluation of the effectiveness and impact of the health research system on the burden of disease in SA (possibly through the National Survey of R&D of the Department of Science and Technology).

Future editions of the Review will track the progress made in implementing these recommendations.

Conclusion

A new consensus is emerging on the fundamental importance of a national health research system in achieving a long and healthy life for all South Africans.⁴⁴ The alignment between the 10 Point Plan, the scientific advice of expert committees and the health research community in general has resulted in a rapid uptake of recommendations to revitalise the health research system in SA.⁴⁵ The *South African Journal of Science* has commented that:

[t]he present case is an example of how government policymaking can be productively influenced, by an expert committee (in this case the National Health Research Committee) acting on recommendations which were made by a panel appointed and managed by an independent national science academy (ASSAf) and debated by a cross section of stakeholders in the community. This process could be widely applied to the benefit of our society.⁴⁵

If the recommendations of the National Health Research Summit of 2011 to strengthen the national health research system were implemented (Table 4), SA might be on a 'high road' to success in health research over the coming decades.

References

- 1 Pang T, Sadana R, Hanney S, Bhutta ZA, Hyder AA, Simon J. Knowledge for better health: A conceptual framework and foundation for health research systems. *Bull World Health Organ.* 2003;81(11):815-20.
- 2 Røttingen JA, Chamas C, Goyal L, Harb H, Lagrada L, Mayosi BM. Securing the public good of health research and development for developing countries. *Bull World Health Organ.* 2012;90(5):398-400.
- 3 Pardes H, Manton KG, Lander ES, Tolley HD, Ullian AD, Palmer H. Effects of medical research on health care and the economy. *Science.* 1999;283(5398):36-7.
- 4 Chopra M, Lawn JE, Sanders D, Barron P, Abdool Karim SS, Bradshaw D, et al. Achieving the Health Millennium Development Goals for South Africa: Challenges and priorities. *The Lancet.* 2009;374(9694):1023-31.
- 5 Sachs JD. Macroeconomics and health: Investing in health for economic development. Report of the Commission on Macroeconomics and Health [Internet]. 2001. URL: <http://whqlibdoc.who.int/publications/2001/924154550x.pdf>
- 6 World Health Organization. Research and development to meet health needs in developing countries: Strengthening global financing and coordination. Report of the Consultative Expert Working Group on Research and Development: Financing and coordination. Geneva: World Health Organization; 2012.
- 7 Rosenberg LE. Exceptional economic returns on investments in medical research. *Med J Aust.* 2002;177(7):368-71.
- 8 Commission on Health Research for Development. Health Research: Essential link to equity in development. New York: Oxford University Press; 1990.
- 9 Imrie H, Freel M, Mayosi BM, Davies E, Fraser R, Ingram M, et al. Association between aldosterone production and variation in the 11beta-Hydroxylase (CYP11B1) gene 10.1210/jc.2006-1481. *J Clin Endocrinol Metab.* 2006;91(12):5051-6.
- 10 Wiysonge CS, Bradley H, Mayosi B, Maroney R, Mbewu A, Opie L, et al. Beta-blockers for hypertension. *Cochrane Database Syst Rev.* 2007; 1(1469-493X (Electronic) IP - 1 DP - 2007): CD002003.
- 11 The Bamako call to action: Research for health. *The Lancet* 2008;372(9653):1855.
- 12 Mayosi BM, Dhali A, Folb P, Gevers G, Hussey G, Kirkman M, et al. Revitalising clinical research in South Africa: A study on clinical research and related training. Pretoria: Academy for Science of South Africa; 2009.
- 13 National Department of Health. Health research policy in South Africa. Pretoria: National Department of Health; 2001.
- 14 Republic of South Africa. National Health Act (Act 61 of 2003).
- 15 World Health Organization. The World Health Report 2000. Geneva, Switzerland: World Health Organization; 2000.
- 16 Mayosi BM, Mekwa JN, Blackburn J, Coovadia H, Froedman IB, Jeena M, et al. Strengthening research for health, innovation and development in South Africa: Proceedings and recommendations of the 2011 National Health Research Summit. Pretoria: National Health Research Committee; 2012.
- 17 Buthelezi L. Health Department to spend five times more on research. *BusinessReport* [newspaper online]. 02 May 2012 [cited 24 January 2013]. URL: <http://www.iol.co.za/business/business-news/health-department-to-spend-five-times-more-on-research-1.1286794#.UQDNml5QY0s>
- 18 National Department of Science and Technology. National Survey of Research and Experimental Development (2008/09 Fiscal Year). Pretoria: National Department of Science and Technology; 2010.
- 19 National Department of Science and Technology. Strategic Plan for the Fiscal Years 2011–2016. Pretoria: National Department of Science and Technology; 2011.
- 20 Gevers W. Clinical research in South Africa: a core asset under pressure. *The Lancet.* 2009;374(9692):760-2.
- 21 Centre for the AIDS Programme of Research in South Africa [Internet]. c2009 [cited 27 November 2012]. URL: <http://www.caprisa.org/SitePages/Home.aspx>
- 22 WITS Health Consortium [Internet]. [cited 27 November 2012]. URL: <http://www.witshealth.co.za/Pages/default.aspx>
- 23 Desmond Tutu HIV Foundation [Internet]. [cited 27 November 2012]. URL: <http://www.desmondutuhivcentre.org.za/>
- 24 The AURUM Institute [Internet]. [cited 27 November 2012]. URL: <http://www.auruminstitute.org/index.html>
- 25 Desmond Tutu TB Centre [Internet]. [cited 27 November 2012]. URL: http://sun025.sun.ac.za/portal/page/portal/Health_Sciences/English/Centres/dtbc
- 26 INDEPTH Network [Internet]. [cited 27 November 2012]. URL: <http://www.indepth-network.org/>
- 27 National Department of Health. Human Resources for Health South Africa . HRH strategy for the health sector : 2012/13-2016/17. Pretoria: National Department of Health; 2011.
- 28 Nordling L. South Africa invests in health research training. *Nature News Blog* [newspaper online]. 26 April 2012 [cited 27 November 2012]. URL: <http://blogs.nature.com/news/2012/04/south-africa-invests-in-health-research-training.html>
- 29 Pouris A. Science in South Africa: The dawn of a renaissance? *S Afr J Sci.* 2012;108(7/8):1-6.
- 30 Steyn AGW, de Villiers AP. Public funding of higher education in South Africa by means of formulae [Internet]. 2004 [cited 25 November 2012]. URL: http://www.che.ac.za/documents/d000146/5-Review_HE_SA_2007.pdf
- 31 Pouris A. The writing on the wall of South African science: A scientometric assessment. *S Afr J Sci.* 1996;92:267-71.
- 32 Pouris A. South Africa's research publication record: The last ten years. *S Afr J Sci.* 2003;99:425-8.
- 33 Abdool Karim SS, Naidoo K, Grobler A, Padayatchi N, Baxter C, Gray AL, et al. Integration of antiretroviral therapy with tuberculosis treatment. *NEJM.* 2011;365(16):1492-501.
- 34 Abdool Karim Q, Abdool Karim SS, Frohlich JA, Grobler AC, Baxter C, Mansoor LE, et al. Effectiveness and safety of tenofovir gel, an antiretroviral microbicide, for the prevention of HIV infection in women. *Science.* 2010;329(5996):1168-74.
- 35 Moore PL, Gray ES, Wibmer CK, Bhiman JN, Nonyane M, Sheward DJ, et al. Evolution of an HIV glycan-dependent broadly neutralizing antibody epitope through immune escape. *Nat Med.* 2012;18(11):1688-92.
- 36 Dheda K, Shean K, Zumla A, Badri M, Streicher EM, Page-Shipp L, et al. Early treatment outcomes and HIV status of patients with extensively drug-resistant tuberculosis in South Africa: A retrospective cohort study. *The Lancet.* 2010;375(9728):1798-807.

- 37 Kerstjens HAM, Engel M, Dahl R, Paggiaro P, Beck E, Vandewalker M, et al. Tiotropium in asthma poorly controlled with standard combination therapy. *NEJM*. 2012;367(13):1198-207.
- 38 Fairall L, Bachmann MO, Lombard C, Timmerman V, Uebel K, Zwarenstein M, et al. Task shifting of antiretroviral treatment from doctors to primary-care nurses in South Africa (STRETCH): A pragmatic, parallel, cluster-randomised trial. *The Lancet*. 2012;380(9845):889-98.
- 39 The South African Cochrane Centre [Internet]. [cited 25 November 2012].
URL: <http://www.mrc.ac.za/cochrane/cochrane.htm>
- 40 Knowledge Translation Unit, University of Cape Town Lung Institute [Internet]. [cited 25 November 2012].
URL: <http://www.knowledgetranslation.co.za/>
- 41 PRICELESS SA: Priority cost effective lessons for systems strengthening - South Africa [Internet]. [cited 25 November 2012].
URL: <http://www.pricelessa.ac.za/Pages/default.aspx>
- 42 National Institute for Health and Clinical Excellence [Internet]. [cited 25 November 2012].
URL: <http://www.nice.org.uk/>
- 43 The South African health improvement plan 2009 [Internet]. [cited 25 November 2012].
URL: http://www.sarrahsouthafrica.org/LinkClick.aspx?fileticket=_cJl2FdD4-g%3D&tabid=2067
- 44 Mayosi BM, Lawn JE, van Niekerk A, Bradshaw D, Abdool Karim SS, Coovadia HM. Health in South Africa: Changes and challenges since 2009. *The Lancet*. 2012; 380(9858):2029-43.
- 45 Purposeful support for health research in South Africa. *S Afr J Sci*. 2012;108(5/6): 1. [cited 27 November 2012].
URL: <http://www.sajs.co.za/sites/default/files/publications/pdf/1268-9425-2-PB.pdf>