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REVIEW

Paediatric radiology seen from Africa. Part II: recognising research advantages in a developing country

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Abstract Radiologists in developing countries cite numerous reasons for poor research output including heavier workloads, poor remuneration (resulting in "brain drain"), poor infrastructure, language barriers, lack of modern imaging equipment, and a disease spectrum that may be of little interest to journals and readers in the developed world. On the other hand, large populations of patients suffering from distinctive diseases, cost-effective healthcare systems, and a set-up with highly centralised tertiary referral hospitals, may be seen as advantages to those willing to tap into this as a data source for research. The lack of resources may even stimulate cost-effective innovations relevant to the needs of poor communities. This paper challenges preconceived ideas and identifies advantages for radiologists in developing countries to producing good research and publications. It also cautions against "annexation of sites" by stakeholders from developed countries, and suggests simple solutions to maximise research output without a significant financial cost.

Keywords Developing countries · Research · Publishing

Introduction—obstacles to research

The most commonly cited barriers to performing research include lack of institutional and healthcare provider support (due to perception of the role of radiology in the institution as a service provider only), time spent providing a clinical service, diminished income associated with doing research (rather than clinical work), lack of protected time for conducting research, lack of appropriate space to support competitive research, poor communication within radiology causing lack of co-operation between clinical radiologists and researchers, and cultural conflicts between departments and trainees who have little or no interest in research (Table 1) [1–3]. More specific to radiologists, obstacles for performing research also include inexperience, lack of a culture for and official training in research, and lack of mentors, as well as universities and funding-bodies not valuing clinical research [2–4]. In developing countries, there are additional reasons for poor research output, including heavier workloads, poor remuneration (resulting in a "brain drain") [5], poor infrastructure, language barriers, low-technology equipment, and a disease spectrum that may be of little interest to journals and readership in the developed world. The journal *Paediatric Radiology*, which represents the paediatric radiology societies of North America, Europe, South America and Asia-Oceania, recorded that only 2% of all articles published 2006-2007 originated from Africa (all from South Africa; personal communication, Springer-Verlag).

This article challenges these preconceived ideas and identifies several advantages for radiologists in developing countries for producing research and publications (Table 2). It is based predominantly on our personal experience as South African, research-interested, paediatric radiologists.

Research advantages in developing countries, and collaborative models

Developing countries have large populations suffering from a range of diseases related to poverty. Not only does this present

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Table 1 The most commonly cited obstacles to research in medicine

Global	Specific to developing countries
Lack of institutional support, and no "culture" for research	Heavy workload: more patients with serious disease and fewer trained staff due to "brain drain"
Lack of formal research training	Poor infrastructure and lack of modern equipment
No protected time—staff busy providing clinical service	Poor remuneration
Less income than clinical work	Language barriers vis-à-vis indigenous population (e.g. getting consent, explaining research, collecting data)
Lack of dedicated space	Disease spectrum perceived not to be of interest to journals and readers in developed countries
Poor collaboration between clinicians and researchers	
Lack of interest	
Lack of mentors	
Inexperience	

large numbers of research subjects but also unique disease profiles that cannot be studied in developed countries. Developing countries are also attractive as cost-effective research settings for multi-centre trials because of favourable exchange rates and more affordable imaging related to lower personnel costs and the fixed prices of national health systems. Research funding can help state-run institutions to boost their earning capacity and often results in equipment remaining available for clinical use after completion of a trial. The predominant model of investment by developed countries in research and research training in undeveloped countries is through "annexed sites", led and managed by expatriate staff. Advantages of such a model include tight expatriate control with an increased likelihood of good-quality research, especially when the work is carried out in a challenging environment [6]. This in turn secures further investment. Humanitarian aid organisations use this model to combine research institutions like Epicentre (a branch of Médecins sans Frontières) with clinical collaborators in Africa and elsewhere in their search for relevant diagnostic techniques as cost-effective solutions ("parachute research"). This practice may, however, over-emphasise the results of research and ignore issues like ownership, sustainability, and development of a national research capacity. Costello and Zumla [6] believe that the research model supported by many funding agencies remains semi-colonial in nature and that foreign control in dictating research priorities and project management may also have negative consequences that may outweigh the benefits. National academic leaders and institutions therefore need to be involved if research is to be translated into clinical practice. Academic infrastructure in many developing countries needs to be maintained, and a cooperative research partnership monitored by funding agencies should rest on four broad principles: mutual trust and shared decision-making, national ownership, emphasis on getting research findings into policy and practice, and development of a national research capacity [6].

Heavy workload, or large database for research?

According to Taylor [7], hospitals in the United States that serve large indigent populations covered by government-sponsored insurance programs have little surplus money to

Table 2 Advantages of developing countries as settings for radiological research

Large workloads provide large populations for inclusion in research
Cost-effectiveness due to favourable exchange rates, lower labour costs, and affordable imaging prices at state-run facilities
Unique disease profiles such as HIV, tuberculosis and trauma
Highly centralised referral of significant disease because of limited tertiary services
Primary healthcare centres servicing local communities allow for long-term longitudinal follow-up research
Spontaneously conceived low-cost innovative solutions derived from needs stimulate research into maximising low-end imaging technology
"Bench to bedside" translational research directly benefits patients
Research relating to role extension driven by shortages of trained staff
Research into computer aided diagnosis driven by need from rural environments lacking staff
Researchers are few and easily identified for funding—career building and recognition for funding is less competitive
Radiology research to decrease imaging examinations has no conflict with the pay-for-service systems, which is therefore not an ethical dilemma

invest in research. However, from another perspective, a perceived heavy workload could be seen as a precious source of large amounts of data on unusual endemic diseases. Performing research to match the institutional environment with the disease profile is recommended [7]. South Africa, for example, is one of the countries most severely affected by the acquired immune deficiency syndrome (AIDS) epidemic, with the largest number of human immunodeficiency virus (HIV) patients in the world. UNAIDS estimated that in 2009, the total number of people living with HIV in South Africa was 5.7 million [8]. In South Africa, the HIV epidemic has increased exponentially during the last 6 years [9]. This is in addition to the Western Cape region having the highest prevalence of tuberculosis in the world, with disease rates more than double those observed in other developing countries and up to 60-times those currently seen in the United States and Western Europe. The incidence calculated from the Tuberculosis Treatment Register was 441/100,000/year among children and 845/100,000/year among adults [10]. It is encouraging for researchers in developing countries seeking funding when Dixon [2] notes in an editorial commentary that there is currently far more funding available for HIV-related disease than for osteoarthritis. Violence and trauma are also common in the developing world, and can be a source of valuable research data [11, 12].

Fragmented health system, or source for comparative investigations?

A shortage of tertiary referral centres is a public health issue and a problem for patients who require more advanced healthcare and often high-technology imaging. This is even more relevant to paediatric radiology, where, for example in South Africa, there is only one dedicated paediatric hospital offering oncology, transplant and surgical expertise. For paediatric radiology, this may be seen as advantageous. Children first present to primary healthcare centres and are then sometimes referred to this tertiary care facility for advanced imaging procedures [13]. This provides a confined database for research within the academic referral centre. With this referral system, the regional services are equipped with lower-order imaging equipment (plain radiography), and academic referral centres with high-end modalities (CT and MRI), allowing for comparison of the efficacy of different modalities. This type of research should attract funders interested in more cost-effective care [3]. In paediatric radiology, for example, this resulted in research examining the usefulness of skull radiographs as a triage tool for referral of children with head injuries [12].

Strife and Ball [3] commented that paediatric radiology must perform research that links technological advancement with direct patient benefit. In developing countries, this may involve imaging children with tuberculosis and HIV. HIV and tuberculosis clinics at regional centres have large outpatient populations that provide data on long-term vertical follow-up (such as mother-to-child transmission of HIV). Use of basic imaging equipment, such as plain radiographs and US, often results in cheap and feasible innovations, e.g., US (mobile; non-ionising radiation) instead of radiography for detection of mediastinal lymphadenopathy [14, 15]. Innovations in cost-effective imaging also come about when "emerging entities" (such as HIV infection and related complications) are imaged with conventional technology, and such activity often results in imaging protocols more suitable for resource-restricted countries. Cost-effective alternatives to CT, such as high-kilovoltage radiographs for visualisation of the airways, are worth investigating for making the diagnosis of tuberculous lymphadenopathy, which characteristically compresses the airway [16].

Understaffing, or fertile ground for investigating role extension?

Funders looking for research that reduces the cost of care should look to developing countries where this type of research is already driven by necessity [3]. Lack of qualified personnel stimulates exploration of role extension, such as radiographer reporting imaging studies, and the use of pro-forma reporting tick-sheets [17, 18] which can be evaluated both retrospectively and prospectively. Computer-aided diagnosis for primary pulmonary tuberculosis and tuberculous meningitis (both in progress in South Africa) is being developed in a research effort driven by a clinical need due to lack of radiologists in rural hospitals (personal communication, Ben Irving, University College London). Lack of expensive proprietary digital imaging solutions has stimulated do-it-yourself teleradiology [19, 20] and digital image viewing solutions [21].

Lone academic, or research leader?

Whereas in the developed world it is beneficial to be part of the large research fraternity that provides the costly infrastructural support and distribution of research funding [3], the researcher in the developing world may find himself or herself poorly supported, and isolated from clinical colleagues. This can, however, result in the researcher becoming a "big fish in a small pond" with an unchallenged shot at an academic career, the possibility of attracting a large amount of funding, staff and research students.

Research ethics—obstacle or driving force?

For researchers in paediatric radiology in developing countries, ethics are important in different ways. First, when working alone in environments that are poorly monitored, and where the population is uneducated and often vulnerable through political turmoil, research ethics principles must be adhered to. It is, therefore, important that research be performed through universities and institutions that have research ethics boards. This is especially true when children are exposed to ionising radiation [22]. Furthermore, the ethical awareness of a paediatric radiologist should be a driving force, for example to reduce radiation exposure, and eliminate or reduce unnecessary or inappropriate investigations [23]. Well-known factors that lead to an increased number of imaging investigations include financial benefit, especially in a fee-for-service model [23]. Research that leads to a decrease in unnecessary procedures may be carried out more successfully when there is no financial incentive for performing an examination, and where public coffers are extremely limited.

Practical strategies that work

Below are listed some key concepts that we have used for promoting diagnostic imaging research in a developing country that historically had a poor research output (Table 3).

Mentorship/apprenticeship Coaching individual trainees in the most basic tasks—such as literature searches, scientific writing, image processing, formatting and legend creation, referencing, submission and, most of all, formulating ideas for research—is recommended to break the fear barrier and create independent researchers [7]. Waiting for young doctors to perform research on their own the "hard way" has been an obstacle to research in clinical disciplines due to lack of research training [3].

Table 3 Practical strategies that promote research

Mentoring trainees
Streamlining processes
Simultaneously collecting data for several research questions
Re-investment of outcomes (skills, funds, technology)
Collaboration with clinicians
Creating simple, step-by-step practical guides
Encouraging output on all levels, from case reports to original research
Allocating and protecting time for research
Commitment to initiated projects
Leadership commitment

Streamlining the research environment Enabling ethics and protocol applications; providing simplified guidelines within the department; providing both hard- and soft-copy forms in the research room; supplying relevant names, contact numbers, email addresses and simple maps to drop-off areas; summarising university rules into a simple checklist; and providing a document pack for each student (both in hard and soft copy) paves the fast-lane, allowing more time for actually collecting and analysing data, and writing papers.

Utilising the data Making full use of the data for publication, congress presentation, extracting case reports, writing review articles and lecturing students ensures that the effort is worth it. This maximises output; of course, care must be taken not to duplicate publications.

Re-investment Subsidies and financial rewards from successful publications, society support and sponsors should be pumped back into infrastructure and incentives [3]. The research lab can be developed into a state-of-the-art training area, where new trainees can undergo research tuition modules as part of their radiology training.

Collaboration with clinicians Paediatric radiologists who interact with other specialities through their area of interest can create long-term interdisciplinary collaborations and gain access to relevant clinical data [3]. Radiology, serving almost all disciplines, has ties with numerous clinical departments, specialised clinics and treatment centres. This offers a source of referral, clinical data, and other contributions to radiological publications. Examples include HIV clinics, oncology centres, paediatric pulmonology, paediatric surgery, and more narrow clinical spheres, such as a neurofibromatosis clinic. Paediatric radiologists must avoid being only "tagged on" as someone preparing images for publication, describing imaging findings, and writing captions; they should indeed rather engage as equal partners.

Simple guides Publication of research findings involves systematic presentation of logical observations in a format that is acceptable to scientific journals. Strict adherence to a journal's specific format and requirements is the (time-consuming) gateway to publication. Guides can be designed to provide step-by-step problem-solving assistance from conception to publication of research, thereby helping inexperienced researchers avoid common errors.

From case reports to original research Clinical journals enjoy publishing images as part of short reports to diversify their content, and these rubrics often have simple submission templates. Although such publications do not attract funding, they do have a place in the output from a radiology department [3]: they offer inexperienced researchers a starting point and

a relatively painless entry into publishing. Case reports are, however, ever less attractive to journals as they negatively affect the impact factor by counting as a publication that is rarely cited in other papers. Original hypothesis-driven research should be the ultimate goal for radiology researchers to enhance their chances of publication, and to attract funding.

Commitment A large amount of research monies is wasted on projects that are never completed, never published, or fail to have a clinical impact [3]. Leaders of research programs must commit to complete and submit projects that have been left unfinished by exiting or incapable trainees. Although time-consuming, started projects should be published, and supervisors should take responsibility for actively reformatting and submitting all unpublished work that they have initiated. Supervisors should also protect their students' position as first authors; ghost writing is an undesirable practice that must be avoided and discouraged.

Rewards and incentives These can take many forms. In contrast to countries with adequate funding and "pay-for-papers programs" [24], departments in developing countries often have no research budget to create financial incentive or offer full-time research positions. Creating a competitive atmosphere, offering a relatively cheap annual award (such as a small trophy or book prize for "Best new researcher", "Best original paper", etc.) can stimulate competitive young doctors. When there is a budget, rewards such as reimbursement of travel and registration expenses for congresses are productive. When there are no funds, providing research afternoons, additional academic leave and protected periods during the workday for research are often considered rewards, while actually enhancing the research effort (Fig. 1). Professional societies have awards geared towards international applicants (such as the Derek Harwood Nash scholarship) and outreach programs that support developing countries (such as the CIRE VIP international lecture program). Simply announcing successful publications and congratulating the authors publicly at a departmental meeting in front of their peers or producing an internal certificate from the home university may have a similar effect to an award. Displaying copies of published papers on the department notice board by the mentor acknowledges the effort, creates a sense of pride and exposes the research success to other departments that may be stimulated to collaborate (Fig. 2) [7].

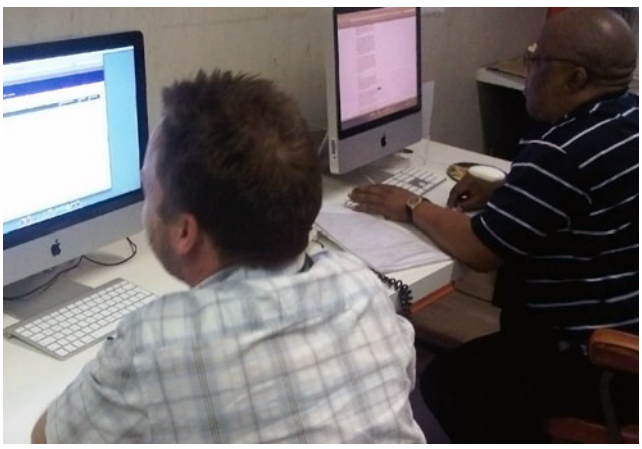

Fig. 1 Two trainees at the University of Witwatersrand in Johannesburg, South Africa, take advantage of protected research-time during normal working hours. Computers, Internet and library access make this lab a sanctuary for advancing their work, while journal instructions, university rules and ethics application forms are available in both hard and soft copy to streamline the process

Fig. 2 The senior academic, who guides students through literature searches and manuscript corrections, spearheads a university research group mentoring session in South Africa. Successful publications are pinned onto the notice board to acknowledge the trainees' efforts, create a sense of pride, and attract interest and collaboration from other departments

Leadership commitment This has been identified as the most critical component of a research effort, and the most important factors for success are those put in place to make research easier and less time-consuming [1, 24]. The leadership of a paediatric radiology department must place value not only in those who do clinical work but also in those who research [3]. Research must be considered of equal importance to service provision and training, and

Table 4 Benefits and synergies of research in developing countries

Improved recruitment of skilled and motivated staff
Improved clinical care
Improved cost-benefit of clinical care
Equipment provided for research may be used clinically
Increased institutional revenue via research funding stream
More useful results that are applicable to the local/regional populations

must be allocated protected time and attention, particularly in busy departments. Taking the fear out of research, removing painful administrative tasks, and providing a motivating forum and a dedicated workplace, are keys to success.

Benefits

A great academic department is characterised by a high research output, and several positive secondary effects are likely (Table 4). It attracts the best staff and students, who in turn make it stronger. Paediatric radiology research requires innovative approaches based on existing healthcare systems [3]. Recognising the advantages of existing systems, and patients, in developing countries can transform overworked "underdog" radiology departments into research hubs and academic centres of excellence. Developing countries, with conditions that may seem obstacles at first, can offer excellent opportunities for research. Paediatric radiologists have many avenues for taking advantage of these, while benefiting children and communities in the process.

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