

Research and clinical aspects of immunology in Africa

Elopy Nimele Sibanda

There are few immunologists in Africa. Researchers predominantly study the immunology of infectious diseases (HIV, malaria and tuberculosis), HLA genotypes and cytokine secretion patterns. Lack of research funding is the problem; continued, equitable international collaboration is a short-term answer. Sustainable development will come when African countries find ways of training and retaining scientists who will produce research and diagnostic tests. The Internet should be utilized to improve communication and as a conduit for online, virtual immunology courses.

Addresses

Department of Immunology, University of Zimbabwe Medical School,
PO Box A178, Avondale, Harare, Zimbabwe;
e-mail: esibanda@africaonline.co.zw

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Introduction

The development of immunology in Africa is closely associated with the study of the many endemic tropical infectious diseases. Advances in immunology are increasingly applied to aid the understanding of host–microbe interactions and as tools used in the prevention (by vaccination) or diagnosis of disease. The current HIV/AIDS epidemic has resulted in an unprecedented explosion of immunology research around the world. According to the UNAIDS report of the year 1999, two-thirds of people living with HIV in the world are in Africa. This has created the greatest challenge for immunology in Africa to date. It is the remit of immunologists (and others) to make serological diagnosis of HIV, to monitor CD4⁺ T lymphocyte attrition, to monitor indices of immune restitution and to manage patients with this multi-system immunodeficiency disease. The preparedness of Africans to face these challenges hinges on the availability of appropriately trained personnel working in adequately equipped laboratories based in institutions that promote research and clinical aspects of immunology.

To obtain background information, an English- and French-language questionnaire was sent to at least one center in every country in Africa. The questionnaire sought to establish the presence of immunologists, their participation in teaching, research or clinical service, the research infrastructure, the availability of training opportunities for fundamental and clinical immunologists and the career paths available to graduate immunologists. Respondents were requested to highlight perceived impediments to the development of immunology. This article summarizes the findings of the questionnaire as well as assessing current research activity, as established using a country-by-country PubMed query Medline search using the country name and immunology as the search words.

The respondents

Scientists and clinicians who responded were based in universities, hospitals and research institutions. The majority of them (31/40) were in English-speaking countries. Responses from all three Portuguese-speaking countries and six of the French-language countries (Algeria, Burkina Faso, Cameroon, Ivory Coast, Senegal and Tunisia) were incorporated. These results may therefore inadequately reflect the true status of immunology in Francophone African countries. The respondents, who were university professors (31%), other holders of doctorate degrees (57%) and other University graduates (12%) included 39 immunologists, 22 microbiologists, 11 clinicians, 6 parasitologists and 11 laboratory technologists. Their often-overlapping duties included teaching at universities (31%), research (34%) and the laboratory diagnosis of immunological diseases (30%). The 7 clinical immunologists (5%) were also involved in bedside clinical care of patients. The respondents were considered qualified to reliably comment on the status of immunology in their respective countries and their comments form a basis for the rest of this article, which covers various categories: training in immunology; research facilities and research topics; clinical immunology/allergy and veterinary immunology; research funding; and immunological societies.

Training in immunology

The teaching of immunology varied from country to country. Undergraduate courses are offered in increasing numbers of universities. In countries with no dedicated faculty, immunology is taught in the context of microbiology, parasitology or biochemistry. The content of the courses may be influenced by the biases of the teaching staff. Some countries (Botswana, Guinea, Lesotho and Swaziland) do not offer immunology courses at all. Increasingly, graduate students carry out part or the whole of their PhD research projects in African institutions. Notwithstanding, sizeable numbers still receive their training outside the continent, commonly in Europe, North America or Japan. Training programs in these countries are long, costly and only accessible to small numbers of students. The Kenyatta University in Kenya is one of a few African universities to offer a Masters degree in Immunology. The introduction of a Postgraduate Diploma in Allergology in Cape Town, South Africa, and a Masters of Medicine in Clinical Immunology degree at Khartoum University in Sudan is imminent.

Three established short courses with a significant immunology content are offered in Africa. The most successful is the English- and French-language Louisiane course on Immunology and Vaccinology as Applied to Infectious Diseases that has been run for twenty years alternately in English- or French-speaking African countries. Refresher

courses with the participation of international facilitators are conducted alternatively in English- or French-language venues in Africa. The other two short courses are the African International Course on Serological Diagnostic Techniques and the Ismalia Course on the Immunology of Infectious Diseases, which are conducted by Peter Mason in Zimbabwe and Ahmed el-Gohary in Egypt, respectively. Participation is limited by funding.

Research facilities and research topics

The major immunology research areas were infectious diseases (HIV, malaria, tuberculosis and leishmaniasis), the development or standardization of diagnostic tests and the diagnosis of diseases of the immune system including allergy (Table 1). Published articles covered immunogenetics and cytokine studies as well as cellular and humoral immunity. These topics are discussed region-by-region below.

Western and Northern Africa

Research in most French-speaking African countries is conducted in a network of Pasteur Research Institutes, university departments and teaching hospitals. Dakar in Senegal is a center of intense immunology research into the virology and immunology of HIV-1 and HIV-2 [1]. In the neighboring country, Gambia, immunologists at the Medical Research Council (MRC) research station investigate malaria, tuberculosis and vaccine-preventable meningococcal diseases [2]. Little is known about immunology research in Mauritania. Basic and clinical immunology research in countries of the Western Mediterranean belt (Algeria, Morocco, Libya and Tunisia) is relatively well developed and the research centers collaborate with French institutions. The immunology of schistosomiasis and hepatitis is one of many areas of investigation in Egypt.

The Horn of Africa

Ethiopia and Sudan host the main immunology research facilities in the Horn of Africa. Addis Ababa in Ethiopia is home to the Armauer Hansen Research Institute (AHRI) and the Ethiopian Health Research Institutes. Immunology topics that are studied include leprosy [3] leishmaniasis [4], tuberculosis [5] and HIV [6]. The AHRI boasts some of the best tissue culture facilities and expertise in the region. Research in Sudan is concentrated in the northern half of the country where the Khartoum University, the Institute of Endemic Diseases and the Tropical Medicine Research Institute are located. Some effort is expended on developing immunology diagnostic tests to aid research in leishmaniasis [7]. Other topics of study are malaria, schistosomiasis and, more recently, HIV/AIDS and allergy. Research institutions in both Ethiopia and Sudan have had collaboration with universities in Nordic countries. This has availed training opportunities to a number of young immunologists. There is little information on immunology activities in Djibouti, Eritrea and Somalia. These countries have experienced political instability in the past decade.

Table 1

Clinical and research activities of respondents to the questionnaire.

Proportions of laboratories that perform various diagnostic tests	
Serological tests	23%
Immunoglobulin quantitation	19%
T cell subset quantitation	16%
Complement determination	8%
HLA typing	8%
Allergy diagnosis	8%
Research and teaching interests of respondents	
Parasites and infectious diseases	36%
Immunodeficiency and HIV/AIDS	30%
Allergy diagnosis and treatment	15%
Autoimmune diseases	14%
Immunotherapy/transplantation	12%
Clinical immunology	1%

East Africa and the African Great Lakes region

Kenya's research institutions include the Kenya Medical Research Institute (KEMRI), the Institute for Primate Research, the Kenya Trypanosomiasis Research Institute, ILRAD (International Laboratory for Research on Animal Diseases) and four national universities. In the review period, HIV, cytokines in malaria [8] and MHC [9] studies were undertaken. Tanzania's National Medical Research Institute and Muhimbili College of Health Sciences in Dar-es-salaam are the centers of tuberculosis, malaria and HIV/AIDS research. This emphasizes the development of cost-effective and sustainable diagnostic tools. Ugandan immunologists work at the Uganda Viral Research Institute and the Makerere University; they study HIV/AIDS and other tropical infectious diseases. The civil conflict in Burundi and Rwanda disrupted collaborative research projects. Research has resumed with immunologists in both countries. Current studies include HLA polymorphisms [10] as well as malaria and HIV.

Central Western Africa

Ivory Coast, Ghana and Cameroon have active immunology research programs. In the Ivory Coast, the major research emphasis is on HIV. Specific studies include those examining the natural history and subtypes of HIV. Ghana's Noguchi Memorial Research Institute for Medical Research remains one of the leading research institutes in Africa. Immunologists extended their study of malaria by investigating the cytokine balance [11] and $\gamma\delta$ T cells [12]. Cameroonian immunologists predominantly study the immunology of malaria [13] and onchocercosis [14]. Data on class I HLA genotypes [15] and the interaction of these with *Plasmodium falciparum* malaria [13] were independently reported in the review period. Information on immunology activities in Nigeria is scant. Prevalence data on HIV and filariasis were reported by investigators from Sierra Leone [16,17].

Central and Southern Africa

Immunology research in Zambia takes place at the University of Zambia and the Tropical Diseases Research

Institute. In Lusaka, Francis Kasolo and colleagues have built an unrivalled research capacity with scarce but well-managed resources. Zimbabwe has one of the few dedicated University Departments of Immunology on the continent. The other research facilities involved in immunology research are the Blair Research Institute, The Biomedical Research and Training Institute, The Veterinary Research Laboratory and various other university departments. The focus of immunology research is HIV/AIDS; specific areas are pediatric infections, mother-to-child transmission, neurological co-infections and cytokine gene polymorphisms in HIV-related malignancy [18].

In Mozambique, immunologists contribute to teaching and conduct research in HIV/AIDS and malaria [19,20]. The development of immunology in Botswana, Malawi and Namibia has been delayed by the erstwhile absence of Medical Schools. South Africa has the highest concentration of immunologists in Africa. Major universities and the South African Medical Research Council have immunology research and training programs. The investigation of HIV-related cervical cancer has been a topic shared by immunologists and virologists in Cape Town [21].

Clinical immunology/allergy and veterinary immunology

The two components of clinical immunology — patient care and the laboratory diagnosis of health or disease using immunological techniques — are inadequately developed in Africa. The numbers of clinical immunologists are low and physicians, pediatricians, dermatologists, otorhinolaryngologists and pathologists perform some of their duties. Until the promulgation of the IUIS/WHO/IAACI (International Union of Immunological Societies/World Health Organization/International Association of Allergology and Clinical Immunology) report [22] there were no international guidelines for training and certification in clinical immunology. The adoption and implementation of these guidelines has been slow, with only one country (Zimbabwe) keeping a separate register of clinical immunologists in Sub-Saharan Africa. This has created a framework for the training of clinical immunologists and crystallized career paths for graduates.

The practice of clinical immunology is only effective if supported by functional, suitably staffed laboratories. The (Table 1) establishment of laboratories is hampered by the high cost of equipment and reagents. There is also reluctance by laboratory technologists to take up training in the speciality when career opportunities are doubtful.

Allergic conditions are common in Africa, but the practice of allergology is in its infancy. Societies dedicated to promoting the practice of allergy are emerging. The Allergy Society of South Africa is the largest in Africa. This society publishes the international journal *Clinical Immunology and Allergy* and is involved in the development of a Diploma Course in Allergy. There is a smaller Allergy Society in Zimbabwe and nascent allergy activities in Botswana and Sudan.

Considerable veterinary immunology work is conducted in Kenya, Zimbabwe, South Africa and Ethiopia. These countries have veterinary research units within which immunology plays an important part.

Research funding

Universities and research institutions in Africa are inadequately funded. Many bright scientists are unable to do any meaningful research without collaboration with individual researchers or institutions from outside Africa. Externally funded research projects appeal to African immunologists. Collaboration is essential: this provides funding and allows staff exchanges, both of which impact on the quality of research.

Research partnerships tend to be weighted in favor of the party with the grants; consequently projects are sometimes designed for implementation in Africa, with only token participation African scientists. Infrequently the results are published without reference to, or acknowledgement of, the efforts of the African scientists. Often, on completion of the high-tech projects (or termination of funding), local researchers find their skills inappropriate for their countries and thus emigrate, thereby depriving African institutions of premium scientific staff. This further compromises the fragile research capacity.

The need to answer pertinent and locally relevant research questions, rather than the ad hoc availability of research funding, is a better driving force behind sustainable research as this promotes continuity and sustainability. Until that can be achieved, international immunology organizations such as the IUIS or the International AIDS Society could consider adopting voluntary peer-noticed codes of research conduct for its members and seek to ensure that reports of research findings involving African material appropriately acknowledge the contributions of African counterparts. International funding-agencies involved in research within Africa could also promote the sustainable development of immunology by encouraging the projects that include items that build capacity through training as well as strengthen the capacity in collaborating research institutions.

Immunology societies

The emergence and increased activity of national societies for immunology has markedly increased awareness and interest in the speciality. With only a few exceptions, countries with national immunology societies (Algeria, Burkina Faso, Cameroon, The Democratic Republic of Congo, Egypt, Kenya, Nigeria, Senegal, South Africa, Tunisia and Zimbabwe) have successful research and teaching programs. In the West African region, immunologists prudently established the inter-country West African Society of Immunologists (WASI), whose aims include the promotion of fundamental and clinical immunology. Ethiopian and Sudanese immunologists are in the process of establishing national societies. A joint meeting of these societies (in

Cameroon in 2000) allowed African immunologists unprecedented contact with prominent immunologists from all over the world. The societies are poised to play important roles in all aspects of immunology development in Africa.

Conclusions: what can be done and what needs to be done

The challenges facing immunology in Africa are the numbers of immunologists, inadequate research, suboptimal infrastructure, blurred career paths, a lack of recognition of the speciality, poor funding and poor communication. The goal is to train and retain immunologists who will teach and do research and will provide conducive and rewarding environments. In order to attain this goal, it is desirable to expose students to the subject early in their training. An essential first step is the inclusion of immunology in student curricula. Immunology staff could be identified by including the few immunologists available in each country in faculty-neutral structures such as immunology journal clubs or societies. Once critical masses have been achieved, these could then be formed into immunology units or sections in order to offer the subject an independent identity and scope to develop. The authoritative IAACI/WHO/IUIS guidelines could then be adapted to meet local needs.

At a regional level, it would be advantageous to identify centers of excellence in four or more geographical regions within Africa. These centers could then provide specialized laboratory training. The few courses that are run within Africa could be coordinated and harmonized such that the content of each course became a component module of a multi-center course leading to a registrable qualification.

This leaves the problem of linking up immunologists within Africa. The telephone infrastructure is poor and postal communication can take months. The Internet remains the only sustainable method of efficient communication. This could enable the conduct of virtual immunology courses. The use of the Internet could enhance communication between immunology students and resource persons inside and outside Africa, and facilitate access to electronic journals and other educational resources as well as open the study of immunology to anyone who has a computer. A large number of willing teachers of international repute could contribute to these courses at minimum expense to the African scientist. The limiting factor could be the availability of on-the-bench practical training. The harmonization of attendance courses that are already taking place in African centers could provide an opportunity for immunology benchwork. Alternatively, the practical aspects of the courses could be held in well-supported resource centers within Africa.

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