

Bioengineering for global health

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Bioengineering has the power to improve health globally by engineering diagnostic, treatment and disease monitoring platforms that function in diverse settings, including resource-constrained contexts. In this Viewpoint, the authors highlight the pressing challenges that need to be addressed to make the field more equitable and to enable bioengineered solutions that can be implemented anywhere, anytime and by anyone.

Bioengineering research has the means to address key global health challenges. What are the areas in which bioengineering solutions could have the biggest impact? What is the most significant barrier to implementing bioengineering solutions in the real world to address global health challenges?

Audrey K Bowden: The first key to addressing any health challenge is figuring out what disease we are fighting. We cannot effectively manage what we cannot detect. Hence, two areas where bioengineering solutions can have the biggest impact are in aiding the detection and diagnosis of known and unknown disease, and in preserving our ability to manage what we can already detect. A major challenge underlying this process on a global scale, however, is to develop solutions that can be deployed in diverse, resource-constrained contexts: that is, anywhere, anytime, by anyone. A culture of scientific pride, wherein we tend to devalue unsophisticated solutions or those from unknown persons as being unintellectual, can be a significant barrier to developing such solutions, making them difficult to get published, funded or widely adopted. The story of [Onesimus](#) and the smallpox vaccine provides a sobering example. New incentive structures are needed to better align scientific values with societal needs.

The COVID-19 pandemic has been a remarkable case study. Major breakthroughs in addressing the pandemic occurred for two reasons: first, there was critical alignment of

incentives to address a pressing problem that activated the brain power of everyone and, second, we could leverage investments in yesterday's research technologies to solve today's problem. That said, the response to COVID-19 did not play out equally everywhere. First, resources to invent solutions were not equally distributed. For example, the US government's 'rich-get-richer' funding distribution scheme inherently defunded many potentially great ideas. Second, implementing solutions was stymied by cultural barriers that limited trust in the scientific method, the scientific ethic and scientific intent. Third, distribution of solutions was affected by government politics and lockdown policies, preventing equitable access for some and causing new problems (such as starvation and mental health issues) for others. Taken together, this example suggests that solving global health challenges in the real world requires more than an investment in 'good science', but also an investment in helping scientists and decision-makers learn to value all ideas and all people as inherently 'good'.

Noah Fongwen: The world is facing a myriad of health-related challenges. Whereas non-communicable chronic diseases may have a slow course with long-lasting and devastating consequences on population health, communicable diseases with outbreak or pandemic potential can rapidly result in high mortality rates, weaken economies and reverse the public health gains made over decades in many low- and middle-income regions. Bioengineering research and development can have the biggest impact in providing diagnostic and therapeutic solutions to combat the rising burden of noncommunicable diseases (such as cancers), antimicrobial resistance and infectious disease epidemics and pandemics.

In high-income settings, rapid advances have been made in improving early detection of cancers through better screening and diagnostic technologies. Research into and development of monoclonal antibodies have transformed the management of many cancers and improved survival. However, in low- and middle-income regions, the burden of cancers is unknown and screening is limited owing to the lack of access to simple

state-of-the-art diagnostics¹. Monoclonal antibodies and other life-saving anticancer drugs are not readily available in low- and middle-income regions. To bridge this gap, bioengineering research providing affordable and effective lifesaving diagnostics and drugs to low- and middle-income regions is an urgent global health priority.

Antimicrobial resistance is a silent pandemic². Predictive models have estimated that 4.95 million deaths were associated with bacterial antimicrobial resistance in 2019, suggesting that the O'Neill review's global mortality estimates of 10 million people by 2050 will be exceeded³. Bioengineering research could play a pivotal part in preventing a future global catastrophe caused by antimicrobial resistance through developing a simple point-of-care test that can reduce unnecessary antibiotic prescription by distinguishing between bacterial and viral infection. In addition, new and effective antibiotics need to be developed that can effectively target multidrug-resistant bacteria. The clustered regularly interspaced short palindromic repeats (CRISPR) technology can be used to monitor the spread of antimicrobial resistance and develop better diagnostics tools. In the future, this technology could be adapted for the treatment of resistant infections by targeting and killing drug-resistant bacteria.

During the COVID-19 pandemic, the need for better diagnostics, drugs and vaccines to stem the spread of infection and save lives was dire. Through multisectoral and international collaboration, new vaccines using mRNA technology were developed and used. Antigen and molecular tests were also developed in record time. In the post-COVID era, it is anticipated that outbreaks will occur in increasing frequency and intensity. Consequently, bioengineering research must step up to provide much needed therapeutics, vaccines and diagnostics in time to prevent the collapse of economies and avoidable loss of lives.

Bioengineering solutions intended to address global health challenges require international and interdisciplinary collaborations. However, the practice of helicopter research remains common in your field. What would need to happen

to make bioengineering research more equitable?

Noah Fongwen: Many low- and middle-income regions tend to allocate very limited resources for research and development in bioengineering. Scientists in low- and middle-income regions work extremely hard to secure grant funding, which mainly comes from organizations in the ‘global North’ (high-income regions). Most of these grants are awarded based on the interests of the funders and, therefore, the projects implemented under such schemes often become obsolete once the grant funding runs out. Strategies to prevent this practice of helicopter research need to be considered.

Recently, momentum has been building towards decolonizing the global health architecture. Even though this initiative will be challenging to comprehensively implement because colonial legacies are deeply ingrained in the way funding and health systems function, it can still be considered a step in the right direction. Any fruitful North–South collaboration needs to be on the basis of fairness, equality and mutual respect. Instead of focusing solely on providing grants, the funders and partners that intend to engage with organizations in the global South need to sustainably support programmes and initiatives that can strengthen local health systems and institutions. Building strong and self-sustaining global health institutions in the global South will play a key part in reducing research and development inequities. For example, in Senegal, the Institute Pasteur Dakar (IPD) is collaborating with institutions in the global North to develop and manufacture vaccines and diagnostics⁴. Institutions such as the IPD provide an enabling environment for research and capacity-building in bioengineering. In addition, the Africa Centres for Disease Control and Prevention (CDC) are calling for a ‘new public health order’, and strengthening health institutions is a cornerstone of such an order⁵.

Akinlabi K Jimoh: “When your neighbour’s house is on fire, there is a moral obligation for you to help quench the fire, for if you do not it would consume your own tent”, says a popular Yoruba adage. Recent events in medical science and public health have shown the veracity of the fact that the world has truly become a global village. Events in an isolated part of the world can have a global impact on locations far apart from each other. The ongoing monkeypox outbreak and the COVID-19 pandemic are perhaps the most recent examples illustrating that no matter

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how far we live from each other in the world, we are all neighbours in every sense of the word.

This has implications for having a global orientation in research findings documentation, publication and dissemination in scientific journals. Thus, the knowledge economy in science needs to take cognizance of a global approach with [strong interlinkages between countries of the global North and South in scientific publishing](#).

There should be a common purpose in research and scientific communication across regions, as innovations and breakthroughs can emanate from any laboratory and from unexpected parts of the world. It is essential to have a level playing ground to address our common problems and, importantly, to establish intentional and proactive protection and support for diversity, equity and inclusion in scientific research and publishing.

There have been many contributions to global scientific knowledge from middle- and low-income regions that have boosted global advances in scientific knowledge. For example, African scientists have made a number of ground-breaking findings in genomic research. The B.1.1.529 (Omicron) variant of SARS-CoV-2 was first reported to the World Health Organization (WHO) by researchers from South Africa and Botswana. Long-standing issues in science, technology, engineering and mathematics (STEM) are also being addressed worldwide, with great dividends in many low- and middle-income regions.

What is the role and impact of publishers and journals in addressing global health challenges? Do you feel that the way we publish bioengineering research would need to change to promote equity?

Audrey K Bowden: Dissemination is key to enable scientific impact. I have a saying in my

laboratory: “Data that aren’t published are a waste of time and resources”. This is not to say that every experiment necessarily leads to a publishable outcome, but every experiment we initiate is done with the expectation that it will contribute knowledge that we ultimately hope to disseminate in some way. Scientific journals are a major clearinghouse for disseminating scientific research, and they are a trusted source of scientific information because of their dependence on peer review. To the extent that publishers structure, manage and oversee the peer-review process, they influence the quality of the science that is published. In many cases, the standards for peer-review established by the journal affect the reputation and reach of the journal as well. In this way, the choice of which journal to submit one’s work to can affect the visibility of the work and, potentially, its impact.

Citation-based metrics are routinely used, but potentially flawed, measures of scientific impact. Such metrics, which stem from the visibility of a study as well as others’ willingness to give credit to it, are well known to pose challenges with promoting equity. First, the act of publication itself does not guarantee visibility of one’s work. Work is only visible to the extent that others choose to read it. This choice implies that they are interested enough to seek out work done by others in either related or distant fields. Unfortunately, the sheer volume of science being published precludes researchers from staying fully abreast of all the relevant scientific work that is published. Search engines and targeted news feeds can help, but these tools are largely populated with keywords chosen by the interested researchers and do not always capture new, diverging and emerging ideas, such as may be contributed by researchers from historically excluded groups in science. Second, the decision to cite

another's work is a complex decision that may be influenced by a number of factors, including the number of allowable citations, the politics of scientific relationships, one's own scientific lineage, confirmation bias and the deemed importance of the contribution to one's own work. Importantly, scientific networks are rarely diverse and, thus, each of these factors can limit the likelihood that citations are equitably distributed. In short, people tend to cite not just the work they know but also the work of those they know.

To the extent that publishers and journals publish research that can help to address global health challenges, they have a key role in advancing this research. That said, incorporating strategies to promote equity can improve the part that they play in addressing global health challenges. For example, by highlighting global health challenges in feature issues or in calls for contributions on related topics, journals can both provide the incentive needed to call attention to the importance of global health challenges and encourage participation from a broad range of researchers who are interested in a given topic. In this way, published research is not limited to topics that are 'popular' among the reviewer pools, which themselves may lack a diversity of researchers and perspectives, as they are often populated with researchers who have published in similarly tiered journals. Additionally, journals may consider new ideas to help curate and expand the citation lists of the papers they publish to ensure a more comprehensive representation of research, whose visibility is limited by authors' search efforts and research networks. Given advances in search engines and machine-learning-based natural language processing networks, one could imagine a new tool that reads manuscript submissions and outputs a list of suggested citations that can then be added as a supplemental citation list or incorporated into the main citation list upon approval from the editor and author. This strategy may make it possible to improve the visibility of lesser known research and researchers, and allow for greater partnership between authors and editors in ensuring the completeness and accuracy of published scientific research.

Akinlabi K Jimoh: There are a lot of similarities between researchers, editors and publishers.

They all seek knowledge. Publishers and journals (including editors) contribute to efforts in addressing global health challenges. They are key to ensuring the continuity and sustainability of research relevant to human lives. Also, collaboration, resource sharing and cooperation among publishers, editors and researchers could further improve global health research. This may, in turn, lead to the development of long-lasting health solutions, a major forte for bioengineering research. Innovative health solutions are at the core of improving global health⁶.

In a statement on promoting global health, the **World Association of Medical Editors (WAME)** urged both editors and publishers, stating that they have a social responsibility to promote and foster global health by constantly publishing quality research that helps to improve health worldwide. While published biomedical research aids in keeping the public aware of global health-related issues, editors and editorial boards are also socially bound to the task of critically analysing research meant for publications. The analyses should be carried out with the aim of harmonizing research to effectively meet the demands of global health challenges, in that they are actually contributing to solving problems of global health.

These publications should also seek to address other issues related to global health; that is, political, economic, religious and environmental factors, which may compromise the sustainability of global health. These should be carefully analysed and incorporated into editorial perspectives, where necessary. Biomedical papers need to be steered towards solution-based, innovative narratives, more focused on the needs and demands of global health and related concerns. Publications also need to be objective and promote equity in research and innovations devoid of discrimination along racial, gender and ethnic dimensions.

Considerations should be made regarding low- and middle-income regions, where the majority of the burdens of global health falls. Publications should aim at affecting health-related policy changes in low- and middle-income regions, and publishers should ensure equitable access to their journals⁷.


Researchers, editors and publishers can contribute to improving global health, offering their expertise to young editors and

researchers starting out, enabling research access to low- and middle-income regions, and using their powerful voices to effect policy changes in global health-related issues. **This would eventually ensure the development of key capacity in the global South and a win for all, including the field of bioengineering.**

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Competing interests

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This would eventually ensure the development of key capacity in the global South and a win for all, including the field of bioengineering: <https://www.weforum.org/agenda/2020/12/3-scenarios-for-how-bioengineering-could-change-our-world-in-10-years/>

World Association of Medical Editors (WAME): <https://wame.org/page3.php?id=81>

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