ANALYSIS

Delivering cost effective healthcare through reverse innovation

High income countries have much to learn from lower resource settings about cost effective healthcare innovations, argue **Mark Skopec and colleagues**

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The process of reverse innovation, where ideas originating in low resource settings are adopted by higher income countries, challenges the notion of developed countries as the instigators of healthcare transformation.¹ Between 1985 and 2009, the annual growth rate of patent applications in low and middle income countries was 19%, leading them to double their share of global patent applications (from roughly 4% to 8%).² As healthcare services increasingly seek to optimise their cost effectiveness, the efficient and scalable solutions used in lower resource environments provide an opportunity for wider learning.

Reverse innovation is a broad term, encompassing innovations that have been ideated, trialled, tested, and adopted in low and middle income countries, before being used by healthcare providers in high income countries.²⁻⁴ The term itself has problems, arguably perpetuating the view that innovation normally flows from high to low income settings, thereby undermining the shift in knowledge translation that it seeks to promote.⁵ Nevertheless, reverse innovation presents a broad range of opportunities and challenges in healthcare. Several reverse innovations have the potential to provide considerable efficiency benefits and cost savings to the NHS.

Examples and opportunities

In 2009, General Electric developed the GE Mac 400, a handheld portable electrocardiogram (ECG) device, originally designed for use in rural India.³ It costs \$1000 (£775; €900), a fraction of the cost of similar devices sold in high income countries (GE Healthcare lists the price of hospital class units as between \$2000 and \$10 000). The engineers who developed the Mac 400 recognised which features of the hospital class units were most essential and which could be sacrificed to decrease costs. The Mac 400 is battery powered, has a simplified operating system using only two buttons, and is equipped with a printer to print examination results. The Mac 400 might not offer the same detail or variety of functions available to in-hospital users, but its portability has made ECG examinations more widely available.⁶ The device proved highly successful, so General Electric began to market the device in the US as well, where doctors in isolated rural communities face the same challenges

as those in low and middle income countries. The low price of the handheld device, coupled with its clinical efficacy in the field, has made many doctors in the US wonder why they should pay the premium price for traditional ECG machines when they can get one that is just as effective for a fraction of the cost.³ Thus, innovations initially developed for low resource settings have the potential to provide savings in high income settings.

Reverse innovation is not limited to technologies or products. Kangaroo care is a practice that involves skin-to-skin contact between a preterm infant and their parent for as much time as possible every day. This method was first introduced in Colombia nearly 25 years ago, when access to expensive neonatal intensive care units was limited.⁷ Its positive impact (reducing infant mortality, infection, and length of hospital stay and improving mother-infant bonding, breastfeeding, and maternal satisfaction) is well documented and has led to its routine use in maternity units throughout the world.⁷

The Ponseti technique for treating congenital talipes equinovarus, commonly known as clubfoot, was expanded and used at scale in low and middle income countries such as Malawi⁸ and Uganda,⁹ which are home to 91% of the 174 000 children born with clubfoot each year,^{10 11} as an alternative to expensive surgical correction. Since then, multiple studies have been published on the efficacy of the treatment,^{8 12} and it is now the gold standard treatment for clubfoot in the UK.¹³

Development agencies in high income settings are increasingly recognising the opportunities of reverse innovation. The Norwegian government's international development department, Norec, mandates that all international partnerships it funds must be mutually beneficial, through exchange of personnel and expertise with low and middle income partners. In the UK, institutions such as the Tropical Health Education Trust, through its health partnership schemes, and Health Education England, through its earn, learn, and return schemes and the Global Health Exchange, are looking to identify innovations from low and middle income countries that might benefit the NHS. Efforts include facilitating employment of overseas professionals in the NHS or identifying innovations overseas and then promoting them in the UK. Tropical Health Education Trust's *In Our Mutual Interest* report and the chief medical officer's annual

report in 2019 both call for NHS organisations to actively engage in mutual two way learning with low and middle income countries.^{14 15}

Table 1 shows innovations that have been conceived, developed, trialled, or scaled in low income settings that warrant further consideration for piloting in the NHS. More details and additional examples can be found in supplementary table 1. The scope of reverse innovations is broad and the innovations considered here have a range of different advantages, evidence bases, and potential efficiency savings underpinning the rationale for their adoption in the UK.

In some cases, modelling studies have sought to quantify potential benefits. A study examining the potential effects of adopting the Brazilian family health strategy, wherein community health workers would provide household health promotion throughout the UK, showed that it could facilitate 753 592 additional screenings for cervical cancer, 365 166 for breast cancer, and 482 924 for bowel cancer, as well as provide measles, mumps, and rubella (MMR) vaccinations for an extra 16 398 children at 12 months and 24 716 MMR2 vaccinations at 5 years, all by identifying people eligible for these services who had not yet been reached.¹⁷ The Arbutus medical drill cover, a sterilisable pouch that converts a regular hardware drill into a surgical grade drill, would offer cost savings between 85% and 94% compared with the existing technology used in the NHS and could save individual trusts up to £250 000 a year.¹⁹ Mosquito net mesh is made of the same material as commercial mesh, but is considerably cheaper (\$0.0043 compared with \$108) and has been used successfully for hernia repair in India and several sub-Saharan countries.^{29 30} With 70 000 surgical hernia repairs undertaken in the UK in 2001-02, the use of the mosquito net mesh would present a major cost saving.

Challenges

Innovations from low and middle income countries are not inherently beneficial to high income health systems. Each one should be assessed on its merits and with consideration of the adoptive environment. The potential market for Prepex, for example, a non-surgical circumcision device used throughout sub-Saharan Africa to prevent HIV transmission in adults, is likely to be quite small in the UK, where circumcision is mostly for religious reasons and conducted shortly after birth.

The innovations are often neither patented nor owned by anyone, presenting challenges in terms of obtaining regulatory approval and promoting entry to new markets. This is the case for using mosquito net mesh for hernia repair. Frugal innovations are also often repurposed technologies, and this is a challenge when it comes to obtaining CE marking, which is for a specified purpose and can require premarket studies approved by the Medicines and Healthcare Products Regulatory Agency, as is the case for the Arbutus medical drill cover system.

Reverse innovation does not always provide the intended benefits. Conditional cash transfer (CCT) programmes in Mexico and Brazil have been used to provide incentives for students to attend school and perform well in exams,^{31 32} as well as to encourage patients to adhere to drug regimens or weight loss programmes.^{33 34} Oportunidades in Mexico has been among the most successful CCT programmes³⁵ and led the New York City mayor's office to implement a similar programme for low income families living in the city.³⁶ The overall effects were mixed; although poverty and material hardship decreased over the course of the pilot, educational effects were most pronounced among academically prepared ninth graders (14-15 year olds) but not their less proficient peers.³⁶ The programme resulted in

a small rise in the rates of health coverage, but no increase was observed in preventive visits to the doctor. The failure to show benefit in one setting does not undermine the potential or rationale for reverse innovation, but it does indicate that tailoring to contexts, careful evaluation, and a preparedness to adapt the intervention will be important. Implementation of any new innovation in a complex system requires resources, time, and engagement, so pilot projects, starting with feasibility and acceptability studies, adapting the innovation where necessary, and building the evidence base for adoption, are essential.

Reverse innovations, by virtue of their origin, tend to be frugal—doing more, with less, for more people, driven by the necessity to use resources more efficiently.^{37 38} The resulting technologies, techniques, or models strive to deliver care at a comparable level to best practice in high income settings but at a fraction of the cost. Some reverse innovations might be slightly less effective, but because of their extremely reduced cost can reach a far broader proportion of the population, resulting in a greater overall impact. Thus, future discussion of reverse innovation must consider possible trade-offs in terms of cost and standards in the quality of care that we are willing to accept. Anticipated cost savings might not be realised in high income settings owing to, for example, different cost structures and salary scales.

Every innovation will present specific challenges related to its nature, its features, and the context in which it is applied. But general challenges are also worth considering, such as how to define what is and what is not a reverse innovation. Von Zedtwitz and colleagues defined several types of reverse innovation based on the location of the original idea, its development, and scaling up.² So reverse innovation can include innovations that actually originate in high income countries before being tested and scaled up in low and middle income countries and then re-entering high income markets after proof-of-concept has been established. The Ponseti technique is a good example of this. Although it was widely adopted in low and middle income countries, it was developed by Ignacio Ponseti Vives, an orthopaedic surgeon at the University of Iowa in the 1950s.¹¹

Following the trajectory and spread of reverse innovations is challenging. Attempts to adopt innovations from low and middle income countries, whether successful or failed, are rarely published or even documented.¹¹ Identifying high value, low cost innovations from low and middle income countries in the first place can be challenging. These innovations are often quick fixes to intractable local health service delivery problems and are not patented, evaluated, or documented. Some notable databases are available—such as the Centre for Health Market Innovations and the World Health Organization Compendium for Technologies for Global Health—but many remain under the radar. In the UK, the NHS's extensive commitment to overseas volunteering and partnership is an opportunity to identify innovative practice and, if well documented, could become a repository for innovative solutions discovered in these settings.

Much progress is being made to level the playing field in global health innovation, but extreme inequity remains in terms of the production, publication, and consumption of healthcare research and innovation, favouring the global north.³⁹⁻⁴¹ The country of origin of a product serves as a cue for quality, reliability, and safety in the marketing and consumer research literature,^{42 43} and products from low and middle income countries are discounted early on because of this extrinsic cue. Country of origin effects are therefore likely to play a vital role in the adoption and propagation of healthcare innovations that have been ideated,

developed, and primarily marketed in low and middle income countries.^{2 44 45} We need to challenge the biases that continue to favour the dominant, often North American and Eurocentric, narrative around distribution of global innovation. By considering the value of adopting innovations from low and middle income countries in high income settings, as well as recognising the scientific contributions of the countries from which they originate, we can create an innovation landscape that is more equitable. The related decolonisation movement—which encourages us to challenge entrenched power structures and promote a diversity of knowledge sources, in particular from low income countries, and is a focus in many higher education institutions in the global north—is a useful impetus to make us aware of the unconscious biases that undermine social and cognitive justice.^{46 47}

Conclusions

Despite the growing literature around reverse innovations, and the notable potential for cost and efficiency savings, only a select few have been successfully implemented in the health systems of higher income countries. Many specific and general challenges impede the adoption and diffusion of reverse innovation in the UK. But given the wide variety of low cost, high value innovations originating in low and middle income countries, we need a concerted effort to identify potential reverse innovations, stimulate the demand for them in the NHS, and fund their pilot testing in local contexts. Beyond the potential for radical cost reduction, reverse innovations are also a source of new ideas, enabling practitioners in high income countries to broaden their horizons, while levelling the playing field in global knowledge production.

Key messages

Low resource countries are increasingly recognised as sources of frugal healthcare innovations—whether technologies, process, or models—that do more, for less, for many

These innovations offer the potential for cost saving if adopted in high income settings, such as the NHS—this process is often referred to as reverse innovation

Each innovation comes with its own specific barriers to adoption, such as regulatory hurdles or community standards

General challenges include identifying the potential innovations, resourcing and managing their adoption, and the perception that innovations from low resource countries are not adequate or appropriate for high income settings

The resource constraints facing high income country health systems, such as the NHS, mean that adopting frugal innovations from low resource countries is timely and needed

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Table

Table 1 | Reverse innovations that could benefit the NHS

Innovation	Country of origin	Unique selling point	Rationale for adoption in the UK	Probable challenges
Family health strategy	Brazil	Community health workers deliver comprehensive health promotion to all households. ¹⁶	At scale, community health workers could enable additional cancer screenings and vaccinations and better management of non-communicable diseases. ¹⁷	Task shifting and patient choice. Lay workers would have to be identified and trained, and patients would likely no longer be able to choose which GP they visit, as these would be assigned based on geographic catchment areas.
Arbutus medical drill cover system	Malawi (Canadian enterprise)	A sterilisable pouch that converts a regular hardware drill into a surgical grade drill. ¹⁸	Cost savings for the NHS range from 85% to 94%. ¹⁹ Current drills in use, such as those produced by Stryker, cost roughly £23 000 because they are safe to autoclave. ¹⁹	Approved by the US Food and Drug Administration but currently lacks CE marking. ¹⁹
Mosquito net mesh for hernia repair	India	Mosquito net mesh is made of the same material as commercial mesh but 20 000 times cheaper. ²⁰	As safe and effective as commercial mesh and more cost effective than oral rehydration therapy. Most follow-up data are collected 12 months postoperatively. ²¹	Potential patient safety issues surrounding limited long term data and no CE marking. Additional investigations of patients with implanted mosquito net mesh must be carried out.
Friendship bench	Zimbabwe	Brief psychological interventions delivered by lay health workers (independent healthcare providers). ²²	Sustained effect on depression outcomes over 12 months, cost effective. ²³ Once lay health workers have been identified, the techniques necessary to deliver psychological interventions are easily transferable.	Professional regulation and training lay health workers.
Sproxil	Nigeria, Kenya, and Ghana (US enterprise)	Detecting and combating counterfeit drugs using mobile product authentication. ²⁴	Sproxil's mobile product authentication codes have been used over 8.5 million times by consumers to verify a range of different products. ²⁴ A no deal Brexit, might leave the UK susceptible to counterfeit drugs. ²⁵	Compliance, buy-in, and participation from manufacturers, pharmacists, and consumers could prove challenging because changing behaviour is difficult. ²⁶
Hemafuse	Kenya and Ghana (US enterprise)	Manually operated autotransfusion device that can be used to collect a patient's blood during an internal haemorrhage. ²⁷	Autotransfusion process is quick, device is easy to use and costs roughly \$60 per patient, compared with \$250 for a bag of donor blood. ²⁸ A viable solution to donor blood shortage and a cost effective alternative to expensive autotransfusion devices.	Regulatory approval is more challenging in the UK, requiring clinical trials and patent applications.