Seventy per cent of medical equipment sent to sub-Saharan Africa sits in store rooms gathering dust. Sent with good intentions, there simply isn’t the infrastructure in place to use it.

Speaking at the Appropriate Healthcare Technologies conference in London, Dr Oluwole Awojobi Srr, a consultant surgeon who runs a clinic in Oyo State in rural Nigeria, explained that with an erratic electricity supply, medical equipment that needs power can quickly become problematic to use and maintain.

Awojobi explains that a shortage of equipment has prompted a technological devolution of sorts. 'We fabricate equipment that is cheap to make and easy to use,' he says. One of his most effective designs is the bicycle centrifuge, which uses centrifugal acceleration to separate samples for medical analysis. Made by local people from local materials, the centrifuge is a crucial piece of kit for Awojobi, given the high incidence of anaemia among his patients, in particular children and pregnant women.

'With the pedal going 60 times per minute we can get 5,400rpm,' says Awojobi, which he claims is more than enough for an effective capillary tube holder. For half the price and half the size, he also designed a hand drill-operated centrifuge that can generate up to 4,400rpm. Awojobi cites the World Health Organisation Declaration of Alma Ata made in 1978, which states that ‘primary healthcare is essential healthcare based on practical, scientifically sound and socially acceptable methods and technology’.

Homegrown technology suits and supports the local environment, he says, because it provides jobs and can be quickly repaired by skilled villagers even if it becomes faulty, and fosters the sort of ‘spirit of self-reliance’ mentioned in the Declaration.

Low-tech solutions also strike a blow against crooked dealing, says Awojobi. ‘Everybody knows the corruption that goes on in African countries – the kickbacks from this technology would be minimal because it is low-cost,’ whereas as many high-tech,
thinking, Dr K Siddique-e Rabbani, from the University of Dhaka in Bangladesh, explored low-cost ways of obtaining safe drinking water. Over the last 30 years there has been an ongoing project to switch the rural Bangladeshi population from surface water to tube wells. Unfortunately, due to arsenic seepage, the wells constitute a severe public health problem, with 18 million people drinking poisoned water each day.

Rabbani explained the two possible engineering approaches to the problem – remove arsenic from groundwater or the diarrhoea germs from surface water. Occurring at depths from 20–100m, arsenic is more difficult and expensive to remove than the diarrhoea-causing germs, which can be neutralised by applying 60°C heat for half an hour. Rabbani claimed that given US$40million of international aid has failed to mitigate the arsenic seepage, efforts should be focused on increasing awareness of simple ways to clean surface water. "We already have the technology to do this, but nobody tells the people because there is no money in doing so."

Effective solar water pasteurisation technology is easily available, says Rabbani, with just a piece of cloth and boiling water. If boiling is not possible, alternatives can include rainwater collection (using a wooden frame and sheet of polyethylene with a hole in it) or an easy-to-assemble solar radiation boiling device. Made from hay, a bamboo tray, four transparent polyethylene sheets larger than the tray and weights to keep them down, the device uses the greenhouse effect to reach temperatures of up to 80°C. After two hours, the water is safe to drink. Rabbani went on to explain that using a similar technique, even water left in a plastic bag can be effectively pasteurised. "At just 45°C, the E. coli is dead."

Keep it simple

"We need simple equipment," said Rabbani. "We don't need gimmicks, we don't need automated analysis all the time. That's not to say we don't want modern technology, it just needs to be appropriate."

Awojobi agreed that despite seeming like a technological step backwards, simpler iterations of medical devices can be more effective given the circumstances. "Automation is not the key to the developing world. We have a lot of manpower and we should use it to solve our problems," Robert Neighbour, a designer of medical technology and Director of Diamedica, based in Devon, UK, echoed the sentiment, saying, "People are expensive here and equipment is cheap. In the developing world, the reverse is true. They need the same equipment, but only when they have the same infrastructure. That won't happen for a long time. We need to cut our cloth to meet the circumstances."

Another problem is that international community gets bogged down in rules, regulations and technical specifications, says Neighbour. "International standards are generally written by six or seven people from developed countries. Unsurprisingly, they are aimed at the developed world. Inappropriate equipment then turns up all over the place, all of it usually meets regulatory standards. Unfortunately it sits in the room and never gets used." Likewise, Rabbani claimed that going through official channels was unlikely to produce results. "In the third world, regulation is a big problem. Bribes get given and things that don't work get put in place. If we give more power to Government, we'll have poorer service."

Instead, he proposed getting civil society (such as teachers) more involved in spreading awareness of simple solutions. Meanwhile, health organisations should be promoting an open-source healthcare technology sector, rather than one that revolves around patents and contracts. "We want it to be open, which is why we are not patenting our products," says Rabbani. "Global economic disparity is mostly due to a technological disparity."

"Appropriate technology is the ultimate solution to the problems of the developing world," added Awojobi. "We must create our own technologies to suit our own problems."

and therefore expensive, contracts get awarded despite the equipment being totally unsuitable for the area it is destined for. Awojobi also claims the lack of kicks from his projects has precluded any financial backing from the Nigerian Government, but he is unfazed and prepared to go it alone. That is the way we have survived. I have not relied on Government for anything."

Awojobi said that he was working on a variety of similar projects, including one for a low-cost operating table, before leaving the stage to rapturous applause. 'Ingenious and straightforward and more importantly, repeatable,' said Len Cornish, from non-profit organisation Global Healthcare Projects.

Water, water, everywhere...

Following a similar 'simple but effective' line of
Materials World takes a look at some recent examples of appropriate technology designed specifically for the developing world.

Comfortably numb travel kit

Designed for doctors in the field, the DPA 01 portable anaesthesia system is a piece of hospital equipment stripped down to its bare essentials so it can fit in a shockproof and waterproof suitcase. Instead of relying only on compressed gas (problematic to find and maintain supplies of), it accepts any oxygen source available and can be ventilated using the in-line self-inflating bag. Costing £3,000, the kit is already being used by doctors on the ground in Syria and Haiti.

Ticket to sterilise

In the far-flung regions of Rajasthan in northern India, women want fewer children. With limited access to modern family planning techniques, female sterilisation is the most practical solution. Marie Stopes International (MSI) hopes to provide a hop on, hop off sterilisation bus that carries a clinical team, operate and energy equipment, medicines, and everything needed to help meet a demographic desire for smaller families. With only 569 of households in Rajasthan having electricity, the bus needs to provide its own light for surgeons to work by. As natural light, gas lamps and solar panels all have their pitfalls, the outreach vehicle is kitted out with an inverter that converts DC electricity from battery to provide AC power to the operating room. Although one delegate suggested that the use of LEDs might be more efficient, Kate Worsley from MSI pointed out that, ‘We want them to be able to buy parts anywhere, and the advantage of the inverter is that the team can charge their phones or other equipment from it.’

Can touch this

In the West we drink our tea from ceramic mugs, but in the Indian sub-continent, steel tumblers are the receptacle of choice. This can cause problems for leprosy patients, who often cannot sense if the metal has become too hot, causing burns, blisters and ulcers. A team from the Leprosy Mission in New Delhi and Vellore Institute of Technology University in India has been designing a glove with sensors that can collect the haptic information (such as roughness, temperature, stiffness, shape) that leprosy patients are not able to, creating a feedback system that can track pressure and temperature and alert the patient to imminent injuries.

Lifebox

Seemingly straightforward operations can go badly wrong if basic safety checks are not performed. Without monitoring, it can be hard to spot a patient whose oxygen levels are failing until it is too late. Although the use of a pulse oximeter is required to conduct the World Health Organisation Surgical Safety Checklist, more than 31 million operations take place each year without one. So much equipment is necessary but the supply chains just aren’t there, says Sarah Kessler from the Lifebox Foundation. The Lifebox is a stripped-down, streamlined version of the observation machine used on patients upon entry to hospital. Available for £160 (which includes cost of delivery to destination country), it features a simple design with few buttons, has a falling alarm tone to alert nurses to dangerous blood oxygen levels, can last for 12 hours off a fully charged lithium ion battery, and can run off AA batteries.

Sound the alarm

With poorly staffed health institutions in rural Nigeria, primary postpartum haemorrhage is a major cause of maternal death. The situation is made worse by unreliable electricity, which can make regular monitoring and drug administration uncertain, turning otherwise manageable conditions into fatalities. With this in mind, Oluymombo Awojobi Jrn has followed in his father’s footsteps and designed a low-cost serial alarm clock that can be made from local parts for less than £10. It contains part of an electronic watch in a 40-pin microcontroller chip and can be set to beep at regular intervals to prompt the nurses to do their rounds.