

# WITH MEDICAL DEVICES, CONTEXT IS KEY

BY BRUCE COMPTON

**W**hen faced with reports of widespread hunger, death from curable diseases and lack of access to even the most commonly available services, we in Catholic health care, thankfully, are a ministry ready to serve and ripe with resources. Oftentimes those resources include supplies and equipment that are donated to assist hospitals and clinics in developing countries. Over the past two years, CHA has done research and developed resources to assist Catholic health care in ensuring donations are made to organizations that will provide a positive impact. I was fortunate to be able to share this work at a recent conference in London.

The September 2012 Appropriate Healthcare Technologies for Developing Countries conference — AHT2012 — brought together health care technologists, clinicians, researchers and representatives of public bodies from around the world to explore effective engineering solutions to meet the health care problems of developing countries.

For me, it brought to mind the start of my career in international mission, a time when misperceptions made it common for groups to undertake overseas outreach with the best of intentions, only to end up with a mismatch of goods and services that resulted in little to no improvements in public health. Here is an example:

In 1997, a group from my diocese traveled to Haiti to learn what we could do as a community to help our brothers and sisters there. I recall a conversation the group had with the administrator of the clinic we visited. It went something like this:

Our group: “What can we do to be of assistance?”

Clinic administrator: “We need almost everything for our clinic.”

What we heard: Anything we could get and send, they could use.

Our interpretation was very misguided. In hindsight, and after continued work in the ministry, I now understand that the administrator actually was saying, “We need everything we *need*,” not “We need everything you *have*.”

## KNOWING WHAT WORKS WHERE

Because Catholic health care’s international

ministry must be conducted in collaboration, it is critical to participate in gatherings such as the appropriate technologies conference to network and learn about current partnerships that could be models for our own work. While I was attending various presentations, I thought back on the misperceptions that accompanied that trip to Haiti. We have come a long way.

It was inspiring to hear about the latest efforts to develop usable, appropriate devices for developing countries. Too, I learned about evaluating the practicality and usefulness of different technologies — a reminder that in other parts of the world, conditions can be nearly incomprehensible for Americans. Such challenges were highlighted in presentations about a broad range of devices, such as:

- A cost-effectiveness model for comparing appropriate medical oxygen supply systems, for use in low-resource health facilities with poor and intermittent power.

- A serial alarm clock for midwives and nurses in rural medical practice. In some countries, postpartum hemorrhage is a significant threat to the survival of newly delivered mothers. A programmable alarm clock run on rechargeable batteries helps midwives, nurses and patients’ family members maintain a schedule of regular checks and medications during the night shift in poorly staffed, rural institutions.

- An ingenious group of computer-assisted physical therapy stations set up in a circuit-training sequence. This served as a low-cost gymnasium for recovering stroke patients in areas with

## GIVING THE GIFT OF BREATH

By MARIE ROHDE

Lars Olson, Ph.D., is not out to save the world. He just wants to save the millions of people who die needlessly from chronic obstructive pulmonary disease (COPD), asthma, tuberculosis and other lung infections because they live in areas where there is no reliable source of electricity.

Olson, an associate professor of biomedical engineering at Marquette University in Milwaukee, has developed what he calls a human-powered nebulizer that can be carried in a backpack to the world's most remote corners and used by community health workers where there are no doctors or reliable sources of electricity.

Nebulizers are electric appliances that use compressed air to change liquid medication into a mist to be inhaled, through a face mask or mouthpiece, deeply into the air passages. The devices are commonly used to treat COPD, asthma and other lung ailments.

In the United States, nebulizers generally are a backup to metered-dose, pocket-sized inhalers that are the norm for treating pulmonary disease. But the inhalers — hand-held, pressurized canisters that spray a dose of medicated mist into a mouthpiece — can be difficult to use. The patient must insert the mouthpiece, then press the inhaler and take a deep breath at the same time, an act requiring timing and coordination.

"There was a study done in South Korea using medical students," Olson said. "Only 25 percent were able to use metered-dose inhalers correctly the first time they tried. After training, 75 percent used [them] correctly."

Olson said that because nebulizers require almost no training of the patient, they are a better choice for the developing world — as long as the devices don't require electricity. In communities where power is erratic or nonexistent, even battery-operated nebulizers are not a reliable solution because the batteries will have to be replaced or recharged.



Lars Olson

Karen Kenyon

To solve the power problem, he and his team have created prototypes, run trials and are now attempting to raise money to begin manufacturing nebulizers that operate by foot pedal or hand crank. "It's not high-tech. It's not sexy," said Olson. "We are meeting some resistance from investors."

Yet the need is great. According to the World Health Organization (WHO), lower respiratory infections are the top cause of death in low-income countries. Olson's goal is to manufacture enough of the

**"But walking with the poor in Guatemala transformed me. It's a different kind of challenge to build an inexpensive device that can save lives."**

human-powered nebulizer machines to provide one for every community health worker serving a community without a stable power supply — an estimated 1.6 million. The low-tech devices should cost between \$50 and \$100 to produce, and they have multiple applications for treating lung conditions, Olson said. "COPD kills more people than AIDS," he said. "It's a neglected, non-communicable disease that's growing, in part, because of global

warming."

Nebulizer use can help diagnose tuberculosis at an early stage, and, Olson said, because the mouthpiece can be easily sterilized, nebulizers can deliver vaccines effectively without the contamination risk of needles.

"One study showed that it took only a fifth of the amount of vaccine if delivered by nebulizer," Olson said. "The idea is that we could develop a vaccine that would be more effective and not have the same risk as needles."

There are currently two prototypes of the human-powered nebulizer: one that operates by pedaling a modified stationary bicycle and the other by turning a hand crank. A pneumatic pump piston system produces the air that travels through a one-way valve and a flow regulator. Olson said a study that is soon to be published found that the quality of the resulting mist is the same as that created by a traditional electric nebulizer.

A family member or health care worker is expected to provide the power by pedaling or cranking. "That sends another message: One person's work is directly providing for a brother's or sister's health care needs," Olson said.

"We learned that we had to use two people in the pictures of the bicycle version," he said. "When we first introduced

it, people said, 'You expect someone with asthma to pedal?'"

The seed for the nebulizer project was planted

in 2004 when Olson accompanied a Marquette student group led by Sr. Jan Gregorcich, SSND, to Guatemala. Sr. Gregorcich makes frequent trips to the country that is still recovering from 36 years of bloody civil war. Although the war ended in 1996, Guatemala remains entrenched in poverty, particularly in the rural areas where more than half the population lives.

"We could see the results of the war,"

Olson said. “She had us walk with the poor.”

Others in Olson’s department initiated civil engineering projects such as building bridges and a sewer system. The lack of reliable power was a special challenge to Olson, whose specialty is in biomedical devices. The wealthy Guatemalans in cities have nebulizers in their homes, while the poor, particularly those in rural areas, have nothing.

“I train people to build million-dollar devices that save people’s lives,” Olson said. “But walking with the poor in Guatemala transformed me. It’s a different kind of challenge to build an inexpensive device that can save lives.”

The first human-powered nebulizer was developed by a group of undergraduates for a senior design project. They used a chopped-off chassis from an ordinary bicycle to fire the pistons.

Used in parts of South Africa, the human-powered nebulizer was recognized by *Popular Science* as one of the seven ways that pedal power will change the world. While the device worked well, Olson and his team learned that it was not culturally compatible everywhere. When they took a pedal-powered nebulizer to the outback of Guatemala, the women there immediately tried to turn the pedals with their hands.

Dismayed, Olson thought: “This is never going to work. You can’t generate enough power by hand to make it work.”

But the women kept saying *molina*, referring to the everyday device they crank to grind maize, a staple of their diets. They expected the nebulizer to work the same way, and that expectation gave birth to a new version of the machine — one that uses a crank. The hand-powered nebulizer weighs about 11 pounds and measures slightly less than 20 x 22 x 15 inches.

“We listened and we learned from them,” Olson said. “In South Africa, where women ride bicycles all the time, the pedal-operated device was perfect.”

With the engineering part of the project running smoothly, it then took some time to figure out how to bring the devices into proper use. Eventually a solu-

### **Used in parts of South Africa, the human-powered nebulizer was recognized by *Popular Science* as one of the seven ways that pedal power will change the world.**

tion came into focus: training community health workers how to use and clean them.

“It was the missing link,” said Olson. “It was how to get it into the real world.”

Olson credits two others with helping him develop a simple, yet lifesaving, health technology for a developing country’s poor — M. Therese Lysaught, an associate professor of theology at Marquette who specializes in bioethics, and Chris Hallberg, who worked on the first hand-cranked nebulizer while he was a Marquette undergraduate.

“Women in the rural areas of Guatemala use wood-burning stoves that are unventilated,” Lysaught said. “That results in a high incidence of COPD, particularly among women who cook over these stoves all of their lives. Typically, a 35-year-old woman’s lungs are completely filled with soot.”

While some might argue that outreach efforts should be directed at getting to the root cause of the women’s health problems, whether it is poorly ventilated

cooking stoves or the high percentage of tobacco smokers, Olson is realistic.

“We have to treat people who are sick today,” he said. “Until Godot comes, we want to do what we can to give life and breath to the poor.”

Students like Hallberg have helped Olson create both prototypes, and they continue to experiment with others. Much of the equipment in Olson’s lab looks like the results of a trip to a flea market. The metal and wooden frame of a treadle sewing machine rests near the chopped-off chassis of an ordinary bicycle. A metal device that looks like a stair stepper, an exercise device sold on infomercials, sits on a shelf.

Hallberg, who is now in medical school at the University of Washington in Seattle, also ran a clinical trial of the device in El Salvador.

“The reality of health care in these developing countries is that we need to empower people who have little formal education,” said Hallberg, who is fluent in Spanish and worked in El Salvador as a Fulbright scholar. “This is a lifesaving device that is easy to use anywhere in the world.”

With that in mind, Lars Olson dreams of other applications for the human-powered nebulizer, once it is mass produced.

“Maybe we could develop nebulized antibiotics,” he said. “Yes, that could be a long way down the road, but it could become a single platform for treating many diseases.”

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scarce or no rehab facilities.

■ Tactile sensing fabrics for detecting impairments in leprosy patients. This system of sensors in fabric and gloves gathers information about the condition of the patient's skin and limbs.

Juggling oxygen supply and power shortages; keeping newly delivered mothers under a regular schedule of observation during the night shift; making rehab possible for recovering stroke patients; monitoring the progressive effects of leprosy — these are not issues we typically worry about in the States. We therefore have to educate ourselves about the developing world's needs in order to best fulfill them.

One thing is clear: international mission work is not about us — not our solutions, not our way of thinking, not our time lines. Two women I met at the conference underscored the importance of looking at the community's needs in the developing world as the needs are understood and agreed upon by the people living there.

Shauna Mullaly has worked with the London-based Tropical Health Education Trust to create and launch a program to improve maintenance and management of medical equipment across five countries in sub-Saharan Africa. According to Mullaly, hospitals in low- and middle-income countries frequently report that the poor state of medical equipment is a key challenge they face in delivering essential services. An estimated 50 percent to 80 percent of medical equipment is out of service in these regions.

Mullaly said the trust is launching a program that will allow U.K. volunteer health workers and

biomedical engineers to implement training projects in South Sudan, Zambia, Ghana, Uganda and Ethiopia. The projects will focus on working in collaboration with partners in those countries to ensure that equipment maintenance staff receive the necessary training, have the necessary tools, equipment and reference materials in their work-

**“The Church understands poverty in light of the vision of *integral human development*. Integral human development encompasses all that is needed for a truly dignified human life, including material, social, and spiritual resources.”**

— From “The Faces of Global Poverty,” a report from the United States Conference of Catholic Bishops and Catholic Relief Services initiative, *Catholics Confront Global Poverty*.

shops and are more effectively engaged in equipment decision-making in their hospitals. The trust also aims for greater awareness of good practice for medical equipment donation, the resources available for those donating equipment and an understanding of the role of medical equipment personnel. CHA's research on medical surplus donation underscores some of the issues the trust's program will address, she said.

Sara Kessler represented Lifebox, a major international initiative to combat the global pulse oximetry gap. Oximeters monitor the levels of oxygen in the blood — a routine surgical operation can be fatal without such monitoring. By providing low-cost, robust oximeters and education, the London-based organization is helping anesthesia providers gain the tools and training they need to make surgery safer.

Kessler said more than 77,000 operating rooms worldwide have to make do without pulse oximeters, and tens of thousands of lives are lost every year. With the World Health Organization (WHO) and the World Federation of Societies of Anesthesiologists, Lifebox designed a pulse oximeter for low-resource settings and is now making those devices available.

Another highlight of the conference was the opportunity to share CHA's research on medical surplus (and it was gratifying to hear how often it was cited by others in their presentations). The

**“Those who work for the Church's charitable organizations must be distinguished by the fact that they do not merely meet the needs of the moment, but they dedicate themselves to others with heartfelt concern, enabling them to experience the richness of their humanity.”**

— Pope Benedict XVI, *Deus Caritas Est*

CHA research indicates:

■ As few as 1 in 12, or 8 percent, of CHA member hospitals work with medical surplus recovery organizations. These groups help ensure that donations of medical surplus are both functional and appropriate.

■ Many donations fail to accomplish their life-saving objectives.

■ Medical surplus donations carry substantial environmental liabilities. Donors frequently have no assurance their contributions can be used in an environmentally sound manner, and donations often wind up in landfills. For example, a year after the 2010 Haitian earthquake, a CHA representative visited four Haitian hospitals and found completely unusable donated equipment left idle at three of them. In one instance, X-ray machines containing radioactive material were abandoned

**“The aid world is strewn with failures that were imposed from the top down. Success takes the opposite direction. It is developed on the ground in Burkina Faso or Bangladesh, in Malawi or Mindanao.”**

— Dr. Carolyn Woo, president and CEO of Catholic Relief Services. Catholic Social Ministry Gathering, Feb. 20, 2012.

in the grass near the facilities. That scenario illustrates the gravity of the environmental issues at stake.

■ Wasted efforts are too often evident. Undoubtedly, CHA members’ participation in surplus donation is motivated by the mission to deliver health care to those in need and to facilitate responsible stewardship of resources. However, in some instances, they unwittingly contribute to the problem.

A PDF of the report, along with a guide for assessing a medical surplus recovery organization and several videos to provide insight and inspiration on the topic, are posted at [www.chausa.org/medicalsurplus](http://www.chausa.org/medicalsurplus).

It is important that the data — even though it isn’t always positive — now exists as a resource so Catholic health care can make sure donations will, in future, fulfill the mission.

Another important resource is the WHO report, “Medical Devices: Managing the Mismatch,” available online at [http://whqlibdoc.who.int/publications/2010/9789241564045\\_eng.pdf](http://whqlibdoc.who.int/publications/2010/9789241564045_eng.pdf).

It reveals that almost 95 percent of medics practicing in less-developed countries rely on medical technology that has been imported. More than half of this technology, however, is not used because staff lacks the means to maintain the equipment or they don’t know how to operate it.

Other problems include unreliable power and water supplies; inappropriate donations of equipment, consumables and pharmaceuticals; unsafe disposal of medical equipment and waste; political instability and war.

The developing world needs appropriate, affordable, sustainable and quality equipment, supplies and support. The WHO report clearly makes the case that this column shares: A medical device needs to be appropriate for the context or setting in which it is intended — and the people being served are the greatest source for determining what is appropriate. Then, for maximum effectiveness, the correct medical device needs to be linked

with its corresponding health need.

When it comes to medical surplus donations, the central issue for Catholic health care is as simple as this: First, do no harm.

As we continue in our international work, we must look towards how we can best be a part of improving the health of all of our global brothers and sisters — even if it requires us to take a step back to assess the real outcomes of current activities.

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