Generating Appropriate Technologies for Health Equity:

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By Gail Reed, MS

Immunologist by training, Dr Fernández Yero began his career in medical technology at the National Center for Scientific Research in Havana, working at the behest of several hospitals to develop the first Cuban alpha-fetoprotein test. It was the 1970s, a time when a single public health system was taking shape in Cuba and many of the main poverty-related social determinants of health had been tackled. "We were looking for technologies of the future," he says, "to see what we could do that could be applied throughout a national public health system." Sixteen generations of equipment later, Dr Fernández Yero heads the 21-year-old Immunoassay Center, a leader in the field of medical technology for population health. The road traveled has not been an easy one, lack of resources threatening delays and detours along the way. He shares his thoughts with *MEDICC Review* on his work, the meaning of appropriate technology and the challenges he foresees ahead.


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***MEDICC Review*: What makes a particular technology 'appropriate'?**

José Luis Fernández Yero: Broadly speaking, I would say technology is appropriate when it is accessible to the people who need it in any particular country or region; when it increases health care coverage as efficiently as possible within the resources at hand. I say 'as efficiently as possible' since appropriate technology—at least in our own case—has a greater dose of justice than of economics. That's the bottom line. Because if you are only guided by economics, then the cheapest will always be the 'best', and less economical but more effective technologies and drugs will never have a chance.

At the same time, it's a tough balance to achieve, since efficiency also makes ethical sense: health planners have to use resources in the most rational, optimal way in order to preserve the right to health for the greatest number of people. In the context of social justice, poor resource management implies wasteful spending on some to the detriment of others.

Assessments of the social determinants of health reveal that poor people, uneducated people and people living in marginalized neighborhoods are more likely to get sick and to die than those who are better off. This tells us that everywhere efforts should prioritize these people's health through prevention strategies, supported by appropriate technologies.

In our experience, sustainable health depends more on health promotion and disease prevention—including application of technologies for broad health coverage that are appropriate for the socioeconomic environment—than on application of complex technologies or the latest models advertised by market-driven transnational manufacturers.

***MEDICC Review*: Where are most innovations in appropriate technology developed?**

José Luis Fernández Yero: For the most part, 'appropriate technology' comes from industrialized countries and is intended for us, in developing countries. Unfortunately, the solutions proposed are not usually what we need. It's difficult for someone in Boston to imagine what's needed in Maisí [the eastern tip of Cuba—eds.].

These researchers tend to imagine that we have limited education or limited intellectual capabilities for assimilating new technologies when the real problem is often limited infrastructure. For example, they see centralization of technology as the answer to many problems. But let's say laboratory blood testing were to be centralized. That presupposes an efficient postal system to get samples to the lab, which you won't find in Cuba, Latin America or Africa. So, in this case, such a centralized laboratory model is bound to fail. And there are countless other well-intentioned examples.

We have to devise our own technologies, by developing countries for developing countries, to be applied appropriately. That is the other key: solving health problems is as much about how you apply the technology as it is about the technology itself. Take infant mortality in Cuba as a health outcome: in 2008, it dropped to below 5 deaths per 1,000 live births. We don't have the same high-tech capabilities as the United States or Canada, but we have lower infant mortality—in part because we have been able to bring the necessary technology closer to all pregnant women and newborns.

***MEDICC Review:* What has the Immunoassay Center's R&D contributed to better health outcomes in Cuba over the years?**

José Luis Fernández Yero: We began, as you know, as a team working to develop an economical alpha-fetoprotein screening

test to detect fetal malformations, allowing women and couples to make an informed decision about continuing pregnancy, contributing both to a reduction in infant mortality and better medical attention for children born with problems.

Since then, we have developed 28 diagnostic tests and 16 generations of equipment to screen for conditions ranging from congenital hypothyroidism and phenylketonuria (PKU) in newborns, to HIV, hepatitis and dengue. Our leading products are the ultra-microanalytic system (SUMA) and reagent kits (UMELISA and UMTEST). These diagnostic tools are closely linked to public health programs, such as maternal-child health, and to epidemiological surveillance for infectious diseases. For example, in 1986, Cuba became the second country in the Americas (after Canada) to provide full newborn screening coverage for congenital hypothyroidism. Today, all Cuban infants are tested at birth for hypothyroidism, PKU, congenital adrenal hyperplasia, biotinidase deficiency and galactosemia. These tests alone have been decisive in guaranteeing a better quality of life for hundreds of Cuban children and their families.

I should mention that we regularly monitor diagnostic kits and reagents for accuracy of results, and all our laboratories in Cuba and Latin America participate in international monitoring, such as the US Centers for Disease Control Newborn Screening Quality Assurance Program's proficiency testing panels.

Our Center is also responsible for protecting the country's blood supply, screening and certifying all blood donations.

In all, some 50 million tests have been carried out with the Center's technology, which is decentralized in 181 laboratories throughout the public health system, reaching every municipality in the country. Another 55 laboratories are located in research institutions and armed forces health facilities.

***MEDICC Review:* How does the Center finance its research, development and production?**

José Luis Fernández Yero: We stopped receiving a budget from the government at the beginning of the economic crisis in the early 1990s. Since then, we finance our own R&D, as well as production, through sales and exports. In 2008, we grossed US $22 million. That is being re-invested and has already made possible the addition of 42 laboratories in Cuba in 2008, and another 64 will be added in 2009. As a result, some municipalities will now have three labs. This is important, since the technology is continually moving closer to the community.

We sell our products to the Cuban health system at reduced prices in local currency and to other countries at prices well below those charged by other manufacturers. Our main contracts are with Mexico, Colombia, Venezuela, Bolivia, Brazil, Argentina and China. Now, we're extending our market into Paraguay, Peru and Ecuador.

We have also set up labs in several countries, including Argentina (43), Mexico (88) and Angola (80). This has expanded screening programs there, especially for pregnant women and newborns.

***MEDICC Review*: What is on the horizon for the Center's work?**

José Luis Fernández Yero: A few years ago, the Ministry of Public Health asked us to begin working on non-communicable chronic conditions, which are the main health problem in Cuba today. Some 49% of Cubans die from metabolic syndrome and another 38% from cancer. Progress in early detection and control of these illnesses will mean longer lives and better quality of life for millions of Cubans.

One example is prostate cancer, responsible for the death of 2,540 Cuban men in 2007. We have now developed our own prostate-specific antigen (PSA) test for early detection and are gradually extending its availability across the country for annual testing of all men aged 50 and over. In other words, we now have a tool for mass screening as opposed to limited availability of the imported test, which was costing us about US $14 apiece. In addition, since all that is required is a blood sample, rather than a rectal exam, men will be more willing to be tested. Over half of men with prostate cancer can be cured if the disease is caught early, meaning that we have the potential of saving 1,000 lives a year once this test is available nationally. What's more, about 95% of these tests will be negative, and, because the laboratories are located in each municipality, the results are known immediately, giving peace of mind to thousands.

Another example is colon cancer: we're working on a test to measure human hemoglobin in feces, which is more precise than the current test detecting any kind of blood in feces. This will allow us to make better early diagnoses of this cancer, which affects Cuban women more than men. About 1,000 women in our country die annually from colon cancer, but approximately 80% could be saved if diagnosed early enough.

In terms of other chronic conditions, we're currently registering a test for quantitative measurement of microalbuminuria, which is important for diseases associated with vascular damage, especially chronic kidney disease.

Finally, a glucometer developed by our Center (SUMAsensor) is now being introduced in Cuba and is being registered in Mexico and Argentina.

The SUMAsensor "tropical glucometer" developed by the Cuban Immunoassay Center in Havana.

Cuban Immunoassay Technology in the National Public Health System*

TEST	Year Introduced	Number of Tests Performed and/or Universe	Cases Detected (mass screenings only)	Technology
PREGNANT WOMEN				
Congenital malformations (Alfa-fetoprotein)	1982	3,364,151	7,536	UMELISA AFP
Ectopic Pregnancy & Trophoblastic Disease (Human Chorionic Gonadotropin)	1992	Case-by-case basis (available nationwide)	n/a	UMELISA HCG
NEWBORNS				
Congenital Hypothyroidism (Thyroid Stimulating Hormone)	1986	2,917,438	754	UMELISA NEONATAL TSH
Phenylketonuria (Phe)	2000	620,235	11	UMTEST PKU
Congenital Adrenal Hyperplasia (17-OH-Progesterone)	2005	343,551	11	UMELISA 17 OH NEONATAL PROGESTERONE
Biotinidase deficiency (Biotinidase)	2005	324,735	1	UMTEST BIOTINIDASE
Galactosemia (Galactose)	2005	288,626	2	UMTEST GAL
INFECTIOUS DISEASES				
HIV-AIDS (anti-HIV1&2)	1988	24,616,148 (including blood donors, pregnant women, and for general epidemiological surveillance)	10,615 seropositive tests Of blood donors: 0.63%	UMELISA HIV 1+2 RECOMBINANT
Hepatitis B (HBsAg & other serological markers)	1986	15,770,641 (including blood donors, pregnant women, and for general epidemiological surveillance)	Non-specific reactivity among blood donors: 0.97% Confirmed cases among blood donors: 70,590 (0.74% of blood donors)	UMELISA HBsAg PLUS HBsAg CONFIRMATORY TEST UMELISA ANTI- HBsAg UMELISA ANTI-HBc UMELISA ANTI-HBc IgM
Hepatitis C (anti-HCV)	1992	8,586,826 (including blood donors and for general epidemiological surveillance)	Reactivity in blood donors: 0.85%	UMELISA HCV
Dengue (IgM antibodies)	1995	Suspected cases during outbreaks	n/a	UMELISA DENGUE IgM PLUS
Leprosy (IgM antibodies)	1993	Suspected cases	n/a	UMELISA HANSEN
Chagas (IgG antibodies)	1994	All travelers to Cuba from endemic countries or regions	n/a	UMELISA CHAGAS
Tetanus (IgG anti-toxin)	1996	Blood donors	Donations with required titers used for production of human tetanus immunoglobulin	UMELISA TETANUS
NON-COMMUNICABLE CHRONIC CONDITIONS				
Diabetes Mellitus (blood glucose)	2008	Diabetic patients	Currently being rolled out through primary care services	SUMASensor (Glucometer)
Prostate cancer (Prostate-Specific Antigen)	2003	63,606	n/a	UMELISA PSA
Atopic diseases (Total IgE)	1987	Children with suspected allergies	n/a	UMELISA IgE

*updated October 2008
Source: Immunoassay Center, Havana.

We sell it very economically to the Cuban public health system and internationally at about 60% the price of other similar equipment.

The Cuban-developed glucometer for diabetic patients is specially designed for tropical climates (each dipstick packaged separately with an enclosed dehumidifier sachet) and can be regulated for skin thickness (important for children). Test results appear in 25 seconds.

We've begun distributing it through hospitals (starting with ICUs and neonatal units) and also at the primary care level in those places where the annual family physical checkup is being piloted. This exam offers a more integrated approach to preventive care, taking into consideration genetic and environmental factors, and the gloucometer is being included in the technology for this program.

Eventually, each severe diabetic will have their own glucometer at home, and the neighborhood family doctor-and-nurse offices will have them to measure the glucose levels of other diabetics two to three times a week. This will mean a tremendous improvement in quality of life for diabetic patients, who now have to go to a polyclinic to have their blood tested.

***MEDICC Review*: What are the Center's biggest challenges now?**

José Luis Fernández Yero: Organizing and managing an efficient network of the 181 laboratories located in all the country's municipalities. People are always more difficult than molecules.

Looking further ahead, we have to think of personalizing tests for susceptibility to certain diseases and conditions—but personalizing them for 11 million people, not just a few individuals. Susceptibility can then be included in each person's clinical history, along with other risk factors. This means introducing nanotechnology at the population health level for lower-cost active screening, facilitating detection of many conditions with a single assay.

We continue to dream and to push forward, propelled by the pressing problems in Cuba and in other developing countries where we think we can make a contribution.