



Appendix - Project Descriptions

BRITISH COLUMBIA

Provision of Orthotic Care for Children using 3D Printed Devices

University of Victoria (Victoria, British Columbia) | Implementation Country: Nepal

If left untreated in young children, skeletal deformities like clubfoot and early-onset scoliosis can grow to become major life handicaps, preventing full participation in society due to stigma and a lack of employment opportunities.

This project will address this challenge by 3D printing high-quality, lightweight, low-cost orthotic devices. These will include corrective braces for treatment of clubfoot and torso braces for treatment of scoliosis. The goal is to create orthotics which are comparable in comfort, fit, and compliance to standard braces. The project will train local skilled clinical partners to produce the orthotics, allowing for local production of the advanced devices directly in-country.

Embracing a non-profit, sustainable business model, the project will sell the 3D printed orthotic devices to clients in high-income countries and use the net revenue to fund its activities in low- and middle-income countries. The project will start in Nepal and aims to expand to other countries.

Improving the early diagnosis of neonatal sepsis in Malawi

The University of British Columbia (Vancouver, British Columbia) | Implementation Country: Malawi

Early diagnosis of a severe infection in a baby can be difficult as it mimics many other health conditions. Some of these infections can be due to bacteria and failing to treat these infections with antibiotics early can lead to death or major disability. As a result, many infants, even those with non-bacterial infections, are treated unnecessarily with antibiotics, thus wasting scarce resources and potentially creating resistant superbugs.

To address this problem, innovators with the University of British Columbia will build a diagnostic algorithm, incorporated into a mobile phone app, to help doctors identify babies most in need of rapid treatment for a potential bacterial infection by using clinical signs, and risk factors, and subtle variations in infants' vital signs. The project will use advanced molecular blood tests to accurately detect bacterial infections, in order to improve the diagnostic precision of the algorithm and mobile phone app.

The project will obtain clinical data, including vital sign data captured using a low-cost hand/foot probe connected to a mobile phone, and a small blood sample from 500 newborns at the Kamuzu Central Hospital in Malawi over an eighteen-month period.

The predictor model will be incorporated into a low-cost mobile app and sensor device in partnership with LGT Medical (a Vancouver-based medical technology company, also supported by Grand Challenges Canada) to guide critical life-saving interventions for babies with severe infections around the world.

Uberlance: Private-public emergency ridesharing for maternal child health

WelTel Incorporated (Vancouver, British Columbia) | Implementation Country: Kenya

Transportation to health facilities can be a major challenge for pregnant mothers in rural or remote areas, where ambulances are scarce and existing ride sharing methods are informal and inefficient.

Uberlance is a private-public, app-based ride share program to facilitate lifesaving transportation for expectant pregnant women in remote, resource-limited settings. Private vehicle owners will be linked to expectant mothers in need of transportation to hospitals for delivery or for complications before or after pregnancy.

Uberlance borrows from the successful business models of other ride share programs globally, where vehicle owners are required to meet certain standards to be eligible to participate. In this case, vehicle owners will be able to charge a premium if they meet the program's standards, which include modifying their vehicles for improved patient transport and obtaining first aid training and accreditation.

The project builds on the success of WelTel's first mobile health application, also supported by Grand Challenges Canada, which provides an effective communication link between outpatients and maternal health clinics to improve engagement in antenatal care.

ALBERTA

A bedside DNA-based test for malaria in pregnant mothers

The University of Calgary (Calgary, Alberta) | Implementation Country: Ethiopia

Current tests to diagnose malaria in pregnant mothers, such as microscopy and rapid diagnostic tests (RDTs), lack the required sensitivity to detect low level infections. In order to eliminate malaria in Ethiopia in the next 10 years, per the *National Malaria Elimination Roadmap*, highly-sensitive diagnostic tests will be required.

Innovators with the University of Calgary have validated a DNA-based test for malaria, called "LAMP", which is 100 to 1,000 times more analytically sensitive than current tests. In a pilot

study, LAMP detected all cases while microscopy and RDTs missed between 10 and 30 percent of cases in pregnant mothers. Traditional microscopy requires electricity, training, and quality assurance which are often lacking in low middle income countries, while RDTs cannot detect low level infections.

This project will compare LAMP against traditional testing methods and measure the outcomes in terms of lives saved at birth and reduction in illnesses in preparation for commercialization. The project will specifically target the rural poor and pregnant mothers in rural health centers across Ethiopia.

The project will work with several stakeholders and partners to plan testing and production of LAMP diagnostic kits, including Ethiopia's Ministry of Science and Technology, the Ethiopian Biotechnology Institute, and the Ethiopian Public Health Institute.

Multimometer: A vital signs device for the diagnosis of childhood pneumonia

The University of Alberta (Edmonton, Alberta) | Implementation Country: Democratic Republic of the Congo

This project will optimize and test the "Multimometer," a new tool in the fight against childhood pneumonia, an illness that killed 900,000 children under the age of 5 in 2015. This optimization will include improving the device ergonomics to enable ease-of-use in the field.

Building on the success of a forerunner, the Respimometer — a thermometer-shaped device that can measure both respiratory rate and temperature — the Multimometer will also measure oxygen saturation and heart rate. Measuring these four parameters in a single, simple-to-use device will greatly enhance diagnostic accuracy and clinical decisions in regard to treatment with antibiotics and/or oxygen.

Acute respiratory infections are a leading cause of child mortality in low-resource countries. Early diagnosis and treatment of infections by community health workers could significantly reduce this toll but, without equipment and knowhow to conduct radiology and blood tests, counting breaths is the only available way to measure the respiratory rate and diagnose pneumonia.

By creating a tool to measure not just respiratory rate but heart rate, oxygen saturation, and temperature, the project could enhance the ability of community health workers to accurately recognize and treat severe respiratory diseases and reduce mortality.

SASKATCHEWAN

Using eggshell calcium to mitigate fluorosis in Ethiopia

University of Saskatchewan (Saskatoon, Saskatchewan) | Implementation Country: Ethiopia

Worldwide, 50 million people suffer from fluorosis, a debilitating condition caused by the ingestion of excessive fluoride. Some 14 million Ethiopians alone have fluorosis, partially due to high levels of naturally-occurring fluoride in the groundwater through the East African Rift.

Severe fluorosis can cause painful and crippling damage to teeth, bones, and joints, reducing mobility and affecting livelihoods, but removing excessive fluoride from water is difficult and expensive. Diets rich in calcium may reduce the severity of symptoms by binding fluoride, but no attempt has been made to confirm this effect at the community level.

This project will expand the use of an age-old source of calcium: eggshells. Each eggshell contains 2,000 mg of calcium and, finely ground and mixed into meals, it binds to fluoride from food and beverages, preventing its absorption. The impact will be measured in fluorosis-affected areas by decreased body fluoride load, reflected in less urine fluoride excretion, and in mitigation of fluorosis symptoms.

In Ethiopia, eggs are a culturally acceptable food, eggshells are readily available, and mothers taught to mix ground eggshell with food have been accepting. The project aims to become sustainable by introducing chickens into communities, which has accompanying financial and nutritional benefits.

MANITOBA

Integrated innovation to improve maternal, newborn and child health: the graphless partograph

The University of Manitoba | Implementation Country: Kenya

Globally, about 289,000 maternal deaths occur each year, 9 percent of them due to obstructed labour. Obstructed labour also contributes to 2.6 million stillbirths and 2.7 million newborn deaths annually.

Using a partograph, a graph-based paper tool that records key maternal and fetal data during labour, could help avert these outcomes, yet globally, partographs remain underutilized due to limited graphing skills and a lack of an organizational culture that supports their use.

To address this gap, innovators with the University of Manitoba will develop and implement a novel graphless partograph, with on-site mentoring delivered in partnership with local government at facilities in the county of Taita–Taveta in Kenya.

The project embraces an Integrated Innovation[®] approach by combining science (the evidence-based, low-cost, simple tool will promote the uptake of knowledge and skills), social (mentoring by local quality improvement teams will identify and address cultural and organizational factors that impede implementation and uptake) and business innovation (insertion within local health systems and alignment with county and country priorities will promote sustainability and scaling).

If successful, the initiative could be scaled up across county and national platforms, helping to address inequity and transform the lives of women and newborns by improving the quality of essential maternal and newborn health services in Kenya.

ONTARIO

Field study of malaria laboratory testing using mobile telephones

Amref Health Africa in Canada (Toronto, Ontario) | Implementation Country: Kenya

There is a large need for high-quality malaria diagnostics in Africa, where an estimated 90 percent of the world's malaria deaths occur, including the loss of a child every minute.

In partnership with Mobile Malaria Labs (MOMALA), Amref Health Africa will work to address this challenge by increasing the capacity of laboratories and improving the accuracy of malaria diagnosis. The project will subsequently improve appropriate treatment and reduce over-consumption of anti-malarial medicines.

The project will introduce a novel, affordable, easy-to-use and reliable method of diagnosing malaria based on microscopy – which remains the accepted standard – through a specially designed mobile app to diagnose malaria. The app makes use of a proprietary algorithm which is able to diagnose malaria from a microscopic image of a blood film with accuracy, comparable to expert microscopy. By applying this algorithm, the process of microscopy will be performed more rapidly and more reliably.

Amref Health Africa will field test the app in the counties of Homa Bay and Kwale in Kenya. The local Ministries of Health and other stakeholders in these areas are already involved and ready to scale-up after the field test.

ParentUp - SMS-based maternal support and postpartum depression in urban locales in the Philippines

RQDN Labs (Toronto, Ontario) | Implementation Country: Philippines

Postpartum depression occurs in approximately 10 to 18 percent of women following birth, and is a critical risk to new mothers and their babies. Research has shown that support programs are effective in assisting women to manage and overcome their postpartum depression.

ParentUp is a mobile phone service which aims to provide informational and emotional support from pregnancy until a child's early years, and can also be used by new dads. Via text messages, new parents who opt in will receive information and mothers will answer screening questions to identify those at risk for postpartum depression. The service will also connect the mothers to appropriate caregivers via community health centers. Parents can also talk one-on-

one with nurses, other health professionals, and volunteer parents, using a support phone hotline.

The proof-of-concept project will recruit pregnant women and/or new parents from 3 low-income communities in Caloocan City in the Philippines.

The project aims to generate data on postpartum depression in the Philippines, help underscore the importance of support to address the problem in a disadvantaged, high-risk population, and examine the impact of support mechanisms on the mental health of these women and their children.

Instant ramen supplemented with locally-produced Spirulina alga to improve child nutrition

The University of Toronto (Toronto, Ontario) | Implementation Country: Philippines

Nearly half of Filipino households fail to reach desired daily protein consumption levels, and 35 percent of children under 5 in the Philippines suffer from anemia.

Innovators with the University of Toronto will address this challenge by producing instant ramen supplemented with Spirulina, a nutrient-rich alga providing far more protein per gram than meats or plant sources, all essential amino acids, high iron, and vitamins A, B12, and K. The alga will be added to the flavour packets of the dried instant noodles, which are commonly eaten by local children but lacking in nutrition.

Spirulina thrives in warm water and the project will produce the alga locally by developing production methods based on simple, locally-available resources, such as cement ponds and plastic tubs. The process will be designed to integrate into the local lifestyle, emphasizing methods implementable by mothers while caring for young children and allowing a group of women to run a pilot cooperative-style business at the initial test site, Napsan, a village in Palawan.

Once sustainable local production is established in Napsan, the model will be exported to other villages. If production exceeds what is required locally, the product will be exported to high-end markets in Manila or Canada, creating economic opportunities for local mothers.

Foodborne bacterial testing and disinfection education for women in Egyptian communities

The University of Toronto (Toronto, Canada) | Implementation Country: Egypt

There is an urgent need to enable and educate mothers and caregivers in poor communities with low-cost, easy home tests for bacteria in food, and for better education about food sanitation methods. In developing countries, foodborne bacteria are a significant cause of illness and death, especially for those with compromised or undeveloped immune systems, such as pregnant women and infants. Foodborne pathogenic bacteria such as *Listeria*, *Campylobacter* and *Salmonella* often cause birth defects, miscarriage and diarrhea, but do not have simple identification tests.

Diarrhea is a common illness associated with contaminated food, unsafe water, and bad sanitation, causing 1 in 9 child deaths worldwide. Treatments of oral rehydration therapy and antibiotics are in short supply, and the overuse of antibiotics is causing an emergence of resistant bacteria.

Starting with communities in squatter settlements around Alexandria, Egypt, innovators with the University of Toronto will:

- 1) Develop a low-cost, fast, easy home test for bacteria detection in food/water,
- 2) Test local and commonly available disinfectant products and methods for cleaning food preparation surfaces in very poor Egyptian communities,
- 3) Conduct community outreach to teach food testing and surface cleaning awareness, and
- 4) Establish an online tracking/surveillance database system for reporting diarrhea cases.

Electricity-free cold chain for vaccine delivery

NuPhysics Consulting Ltd. (Toronto, Canada) | Implementation Country: India

Around 9 million children fail to get vaccinated in India each year, and are therefore vulnerable to diseases like tuberculosis, measles, and diphtheria. Not being vaccinated is more common in the rural areas of India, where 70 percent of the population resides. This is due in part to scarce or complete lack of electricity to power refrigerators, which are required to keep vaccines cool.

Vaccines are required to always be stored in low temperatures between 2 and 8 degrees Celsius. Currently, ice lined refrigerators are used to maintain the low temperatures for the entire day, requiring 8 hours of electricity. Vaccines often have to be consumed on-delivery and cannot reach or be stored in rural areas which experience voltage fluctuations, denying vaccination to many.

This project has developed an inexpensive technology that can be added to current ice lined refrigerators and vaccine carriers to increase the time of cooling without electricity. The holdover time for the new vaccine carriers would be extended by a minimum of 10 hours. The project aims to significantly increase the reach and distribution of vaccines to areas with no or fluctuating electricity supply.

Children's Automated Respiration Monitor (ChARM) for child pneumonia diagnosis by community health workers in Mali

The Canadian Red Cross Society (Ottawa, Ontario) | Implementation Country: Mali

In Mali, a country with remote populations and threats to stability, access to accurate diagnosis, treatment and appropriate referral determines a child's survival. In 2007, the Mali Ministry of Health introduced Integrated Community Case Management, authorizing community health workers to diagnose and treat pneumonia, malaria, diarrhea and malnutrition in children under five. However, in 2013, Mali reported 231,500 cases of pneumonia, and only 20 percent were treated by community health workers. In the project target area, 2016 baseline findings showed

an even lower rate of treatment with only 13 percent (6-23 CI) in Koulikoro and 1 percent (0.1-6 CI) in Sikasso of pneumonia cases being treated by community health workers.

Increasing the quality of community health workers' diagnostic skills is challenged by inadequate funding. Poor competency to correctly count respiratory breaths, a key indicator for pneumonia detection, puts community health workers at risk to frequently misdiagnose pneumonia and overprescribe antibiotics.

This project will use Philips' Children's Automated Respiratory Monitor (ChARM) to minimize the risk of pneumonia misdiagnosis and as a teaching tool so community health workers can evaluate their breath counting skills against ChARM's automated readings. A randomized cluster trial to evaluate ChARM's potential to improve the quality of diagnosis and use as a teaching tool, will be particularly valuable in fragile settings.

The project is embedded in a 2016-2020 health program with the Mali Ministry of Health, the Malian and Canadian Red Cross Societies, and the Hospital for Sick Children. The embedded nature reduces project costs.

QUEBEC

Improving the diagnosis of childhood tuberculosis in high burden settings

*The Research Institute of the McGill University Health Centre (Montreal, Quebec) |
Implementation Countries: Malawi, The Gambia*

In 2015, there were an estimated 1 million incident cases of tuberculosis in children younger than 15 years of age, and as many as 210,000 children died of tuberculosis. About 75 percent of all childhood tuberculosis cases occur in the 30 high burden countries, the majority of which are in sub-Saharan Africa. Differentiating tuberculosis from other respiratory diseases in children is difficult, especially if diagnosis relies on clinical and X-ray features or microbiological tests, since children often cannot produce sputum from deep in the throat.

This project will validate a novel diagnostic biosignature to distinguish tuberculosis disease from other respiratory diseases among children in Malawi and The Gambia. This biosignature has the potential to be developed into a non-sputum-based point-of-care test.

The biosignature was previously identified in HIV-negative children. The project will use archived and new samples obtained from children with suspected tuberculosis. Analysis of the samples will be carried out at the Medical Research Council Unit The Gambia (MRCG).

Improving clinical care and survival of newborns in Cambodia using tablet applications and pay-for-performance

*Department of Family Medicine, McGill University (Montreal, Quebec) | Implementation Country:
Cambodia*

Cambodia has a high neonatal mortality rate, mostly among the poor and rural population. A recent study in Cambodia indicates that health workers have low retention of clinical knowledge in newborn care eight months after training.

This project will address deficiencies in the knowledge and skills of health workers and improve their clinical performance in newborn care to help save lives and improve health. The project will develop simple, user-friendly tools including video clips on newborn resuscitation, immediate newborn care, and referral for appropriate care, complemented by quizzes and checklists.

Health workers will be provided with a monthly incentive if they meet the required frequency in using the applications. They will also be supported with routine supervisions and coaching.

The project will be piloted in 8 primary health facilities in Cambodia in partnership between McGill University, University of Health Sciences–Cambodia, and Cambodia’s Ministry of Health.

STREAMS: Strengthening the relationship between primary care nurses and community health workers using technology-enabled home visits for pregnant women

The Royal Institution for the Advancement of Learning/McGill University (Montreal, Quebec) | Implementation Country: Burkina Faso

Burkina Faso is one of the world’s poorest countries. Despite free prenatal care, access to care remains an issue for rural women, as this often means walking for an entire day through harsh conditions. As a consequence, nearly 70 percent of expectant mothers receive only 1 of the 4 recommended visits, putting themselves and their babies at risk.

This project aims to provide rural expectant mothers with convenient access to a nurse without the need for travel by using technology to improve communication between rural community health workers and nurses. Community health workers often work in isolation and without ready access to nurses’ expertise. The project will use an mHealth application accessible on an iPad to facilitate this communication and make interactions faster and easier. This technology gives nurses access to health information entered by the community health workers in real-time, facilitating timely intervention and mentorship when required. It also enables video conferencing between nurses in the clinic with community health workers and pregnant mothers in the villages.

The juxtaposition of telecommunications technology, public-private partnership and process innovation will create an empowering environment for rural women and serve as a model that can be expanded beyond pregnancy and to isolated communities globally. The initiative has the confirmed backing and political support from local, regional and ministerial health authorities, buy-in from industry, and access to data management software, which are essential for future scaling-up.

Low-cost microchips to diagnose the cause of persistent diarrhoeal diseases in children

Sensoreal Inc. (Montreal, Quebec) | Implementation Country: Bangladesh

Diarrhoea is the second leading cause of death in children under five years old. Globally, there are nearly 1.7 billion cases of childhood diarrhoeal disease every year, killing around 525,000 children under five.

This project will produce a low-cost, highly-sensitive, rapid and easy-to-use diagnostic tool for simultaneous detection of the four most common gastrointestinal pathogens causing persistent diarrhoea in children: 1.) Giardia Lamblia, 2.) Cryptosporidium Parvum, 3.) Enteroaggregative Escherichia coli and 4) Rotavirus.

Sensoreal has developed prototypes of a variety of microchips capable of measuring a disease biomarker using a drop of blood. Manufacturing of the microchip costs only \$0.50, allowing for a wide range of customers.

For this project, Sensoreal will first engineer a vial containing a buffer solution and a filter, into which 50 microliters of a stool sample is placed. Proteins are dissolved in the buffer and the analyte passes through the filter. When the vial is then connected to the microchip, a colorimetric immunoassay is performed and the presence or absence of the four gastrointestinal pathogens is revealed, all in less than 25 minutes.

NOVA SCOTIA

Blue Fuel - Innovative faecal sludge treatment

Aerosan (Halifax, Nova Scotia) | Implementation Country: Nepal

There are more than 68,000 septic tanks and latrines in the Kathmandu Valley, which are regularly emptied by public and private collection/utility services. With few treatment options available, the sludge is regularly dumped untreated in surface waters. A large percentage of the faecal sludge is discharged untreated to drinking water sources like the Bagmati River, resulting in high incidence of waterborne disease.

Children under the age of five are the most affected, with an estimated 44,000 dying every year in Nepal from waterborne diseases. Pregnant mothers also experience significant health impacts, including dehydration, spontaneous abortion, and fetal death.

Aerosan views faecal sludge as a potential, high-value, energy rich resource. This 'black gold', when processed under pressure and heat, can create a fuel source as efficient, yet far more sustainable and clean burning, than charcoal. This project will leverage existing waste collection to process faecal sludge into high-value, cost effective energy resources for the Nepalese brick manufacturing sector, thus not only having a positive effect on the environment but also lessening dependency on expensive imported coal.

A sustainable business model for public toilets in Nepal

Aerosan (Halifax, Nova Scotia) | Implementation Country: Nepal

Public toilets are vital to the design of sustainable, inclusive cities. However, without proper regulation and management incentives, public toilets suffer from inadequate maintenance and unhygienic conditions.

Women and children are disproportionately affected by a lack of access to sanitary toilets, and are most likely to “hold on”, resulting in urine and pathogen retention, bladder distension, and continence problems. They are also disproportionately affected by the negative nutritional consequences: lack of proper toilet access has been shown to increase diarrhoeal disease illness while reducing macronutrient absorption, and young children are especially prone to malnutrition’s negative health impacts.

Aerosan will enable public toilet operators to increase their profitability and scale their business, acting as a bridge between private public operators, non-governmental organizations, and government. The core of the project is to create an income stream, by producing saleable biogas from an anaerobic digester attached to public toilets, which largely benefits the toilet operators. The aims include the bundling of services (like shops, restaurants, and Wi-Fi), biogas systems, sanitation training and maintenance incentive programs to increase toilet use and incentives for maintenance.

Helping Babies Survive in Jamaica: An integrated needs-based approach for human resources for health planning and training

Dalhousie University | Implementation Country: Jamaica

With neonatal deaths and stillbirths being reported in the news, maternal, newborn and child health is a priority area of Jamaica’s Ministry of Health.

Innovators at Dalhousie University aim help by working at the system level, applying a needs-based workforce planning framework, as well as at the service level, by implementing the Helping Babies Survive suite of health provider training programs. By integrating these, the project will contribute to the overall action being taken by the Ministry of Health through their Programme to Reduce Maternal and Child Mortality and build upon their already-established commitment to needs-based planning, leading to scalability and sustainability.

The project is being developed jointly in partnership between the Jamaica Ministry of Health, the Women’s Health Network Jamaica, and the Dalhousie University WHO/PAHO Collaborating Centre on Health Workforce Planning & Research.