ANNUAL REPORT 2016

Solving public health problems through innovative scientific research

icddr,b

Chief Editor
Professor John D Clemens

Editor
Catherine Spencer

Writer
Ian Jones

Managing Editor
Radef Anwar

Creative Editor
Aysha Wisam Rashid

Design and Illustration
Mohammad Inamul Shahriar

Photo credits

All photographs by GMB Akash, except
Md. Rabiul Hasan (page 2, 7, 8, 9, 32, 33, 36, 37, 38, 47, 48, 49)
icddr,b is committed to ethical development photography and, whenever reasonable and practical, obtains permission from photo subjects

icddr,b is an international health research institute based in Bangladesh. Policymakers and practitioners utilise our evidence and expertise to improve health outcomes and prevent premature death and disability worldwide. Established more than 50 years ago, we continue to provide life-saving services to the people of Bangladesh, and to nurture the next generation of global health leaders.

VISION

A world in which more people can survive and enjoy healthy lives

MISSION

To solve public health problems through innovative scientific research

VALUES

Excellence

We are single-minded in our pursuit of scientific rigour and operational efficiency.

Integrity

We are a responsible and accountable organisation, committed to the highest standards of behaviour.

Inclusivity

We work collaboratively throughout the organisation and with our partners.

WE ARE GRATEFUL TO OUR CORE DONORS FOR THEIR LONG-TERM COMMITMENT TO OUR WORK:

Government of the People's Republic of Bangladesh

Canada

SWEDEN

UKaid from the British people

CONTENTS

PREPARING FOR THE FUTURE

LETTER FROM THE EXECUTIVE DIRECTOR

Centres such as icddr,b can play a pivotal role in enabling countries in the global South to solve their own problems.

In September 2016, Secretary-General of the United Nations, Ban Ki-moon, released a video extolling the achievements of icddr,b, particularly its commitment to women and children. Bangladesh has indeed made great strides in reducing maternal mortality and in improving child health, and icddr,b has made important contributions to providing solid scientific evidence to help guide effective government programmes to reach these goals.

It was also gratifying to see icddr,b the focus of an extensive feature in the *New York Times* in February 2017. This drew attention to our pioneering development of oral rehydration solution (ORS), the outstanding clinical care provided at Dhaka Hospital, and our role in the development of the world's first affordable oral cholera vaccine (OCV), Shanchol.

These highlights carry important messages. ORS was developed in the South to address a problem having a catastrophic local impact. Similarly, Shanchol, manufactured in India, in part resulted from work carried out in Vietnam. In both cases, innovation in the South, driven by the health needs of the South, has delivered life-saving products suitable for the South.

Other more recent examples illustrate a similar principle. Supply of Shanchol cannot meet global needs and alternatives are urgently needed – ideally at even lower prices, given the huge number of doses a country such as Bangladesh might need. We are testing the safety and immunogenicity of two possible solutions – Cholvax, a vaccine that will be identical to Shanchol, and Hillchol, developed by Hilleman Labs in India, in collaboration with University of Gothenburg, Sweden. Importantly, in both cases, vaccine production technology has been licensed to a Bangladeshi company, Incepta Vaccine Ltd.

Furthermore, Incepta is also receiving technology from Innovax in China for manufacture of an effective hepatitis E virus vaccine, Hecolin. We are carrying out a trial of Hecolin in women of childbearing age to assess the impact of vaccination in preventing hepatitis E infection, an illness that is a major cause of maternal and perinatal mortality in South Asia.

Ban Ki-moon
UN Secretary-General (2007-2016)

I commend [icddr,b] for its work over five decades to solve public health challenges and save lives. The centre has helped to significantly reduce infant, child and maternal mortality in Bangladesh and beyond. By focusing on interventions designed for the world's poorest people, you are directly contributing to sustainable development and the promise to leave no one behind.

September 2016

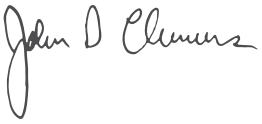
Executive Director Prof. John Clemens shows US Ambassador to Bangladesh H.E. Ms Marcia Bernicat (left) and Korean Ambassador to Bangladesh H.E. Mr Ahn Seong-doo (right) around Dhaka Hospital, icddr,b

Such developments will greatly increase the capacity of Bangladesh to address its own health challenges. Furthermore, the country stands to gain economically from the development of expertise in pharmaceutical production. We are also collaborating with local companies to develop other innovative products meeting local needs, such as a diagnostic test for enteric fever.

Finally, 2016 offered another cause for celebration – the 50th anniversary of our health and demographic surveillance site at Matlab. From testing of ORS to the latest studies on hepatitis E virus vaccination, Matlab has made innumerable contributions to the health of people in Bangladesh, regionally and globally. It remains the jewel in the crown of our research infrastructure and a much-copied model for health and demographic surveillance sites worldwide.

Complementing Matlab and our other field sites are our impressive laboratory facilities, including a new genomics laboratory, which has been constructed and staffed with generous funding from the Swedish international development agency, Sida. icddr,b is thus home to an astonishing diversity of researchers, spanning molecular laboratory scientists, public health and health systems specialists, social scientists and even anthropologists, helping us to understand how best to direct our research towards the most pressing public health challenges facing the global South.

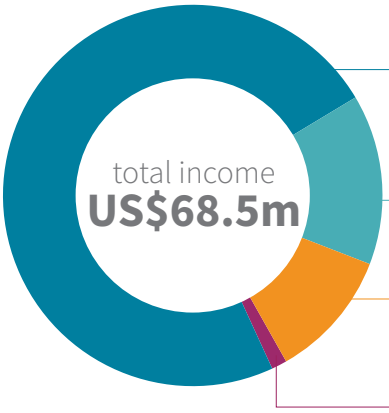
I am confident that we can harness this tremendous breadth of expertise to meet the long-standing and emerging health challenges facing the global South. And I give my special thanks to our core donor countries – Bangladesh, Canada, Sweden and the UK – for having the vision and commitment to provide us with predictable, unrestricted funding that has been key to our ability to innovate, to follow our key strategic priorities, and to invest in our wonderful staff and research infrastructure.



PROFESSOR JOHN D CLEMENS
Executive Director
May 2017

2016 IN NUMBERS

A snapshot of icddr,b funding, research, training and clinical services



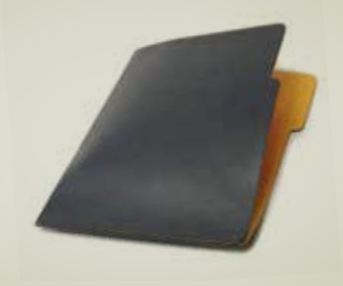
$50.2m funding from competitive sources

$9.9m other income

$7.5m funding from core donors

$0.9m other restricted income

222 scientific staff



120
new grants

415
ongoing projects

85
national collaborations

154
international collaborations

317
original papers published*

11,994
citations

* with icddr,b scientists as authors

200,209
patients treated in 2 hospitals and 1 treatment centre

54% male

46% female

729
participants enrolled in clinical research at icddr,b's Dhaka Hospital

86
national policy review committees with icddr,b representation

64
international policy review committees with icddr,b representation

2,193
attendees of icddr,b training courses

1,004
students hosted by icddr,b's orientation programme for medical students

15
faculty positions held by icddr,b staff at the James P Grant School of Public Health
(a joint venture with BRAC and BRAC university)

27
icddr,b staff contributing to teaching at the James P Grant School of Public Health

RESEARCH HIGHLIGHTS

In 2016, we published findings of national, regional and international significance.

Last year, icddr,b researchers and their national and international collaborators made important contributions to the knowledge base across our focus areas, with the potential to influence both national and international policy and practice.

Our studies cover the full spectrum of research, spanning fundamental studies on microbial communities in the gut and the impact of phage on cholera bacteria, major vaccine trials, and public health studies on key non-communicable diseases.

Importantly, our research addresses many of the key health concerns affecting Bangladesh and other countries of the global South.

GUT HEALTH

Bacterial communities in the gut could play a critical role in childhood nutrition and development – and could also be the targets of innovative new therapies.

Although nutritional interventions can save the lives of severely malnourished infants, they are typically less effective at preventing longer-term harms such as stunting, poor immune system function, and delayed cognitive development.

In collaboration with Professor Jeffrey Gordon at Washington University School of Medicine, St Louis, USA, icddr,b's Dr Tahmeed Ahmed has discovered that undernutrition does not simply reflect insufficient calorie intake, but is also related to the composition of microbial communities in the gut. As infants grow, these communities undergo a series of distinctive shifts before reaching a state of maturity, and delays in this developmental programme may adversely affect infant growth and development.

In recent work, Professor Gordon and Dr Ahmed have provided new insight into the interplay between different gut microbes and healthy development. When mice raised without gut bacteria were inoculated with strains from an undernourished child from Bangladesh, a toxin-producing strain of *Bacteroides fragilis* altered mouse metabolism and triggered weight loss (1). However, a related but non-toxin-producing strain of *B. fragilis* from a healthy Bangladeshi child partially mitigated the effects of the toxin-producing bacteria. Hence the impact of a growth-retarding microbe in the gut is in part influenced by the nature of other bacteria present in the gut.

More generally, Professor Gordon, Dr Ahmed and their colleagues have written in *Science* of the potential to manipulate microbial populations in the gut in order to promote child health and nutrition (2). Although many biological and social challenges remain, this innovative approach could provide new options for the 50 million children affected by acute undernutrition and the 150 million experiencing chronic undernutrition.

1. Wagner VE *et al*. Effects of a gut pathobiont in a gnotobiotic mouse model of childhood undernutrition. *Sci Transl Med.* 2016;8(366):366ra164.

2. Blanton LV *et al*. Childhood undernutrition, the gut microbiota, and microbiota-directed therapeutics. *Science*. 2016;352(6293):1533.

DETECTING DEHYDRATION

Research at icddr,b's Dhaka Hospital has provided the first validation of a simple method for assessing infant dehydration in a low-income country.

Diarrhoeal diseases kill half a million children a year. Detecting and reversing dehydration is a critical aspect of treatment: infants with mild dehydration can be given oral rehydration therapy while those severely dehydrated require intravenous fluids.

The WHO recommends classifying patients as not dehydrated, mildly dehydrated or severely dehydrated on the basis of a range of clinical signs. However, no method for assessing dehydration has been validated against an accepted standard in a low-income setting. Hence, there is a risk that resources may not be used efficiently if infants are given intravenous fluids they do not need, and more intensive treatment may in some cases be harmful.

To develop a tool suitable for a low-income country, in 2014 researchers from Brown University, USA, and their icddr,b colleagues followed some 770 patients at icddr,b's Dhaka Hospital to identify clinical features associated with dehydration. From this work, they drew up the 'DHAKA' (Dehydration: Assessing Kids Accurately) scale, based on four easily identifiable signs: general appearance (restlessness or lethargy), breathing, skin pinch and tear production.

In a follow-up study, the team compared use of DHAKA scores and the WHO method by nurses with minimal training, in the largest ever study of child dehydration. DHAKA was both more reliable and more accurate than the WHO approach (1).

DHAKA could therefore enable healthcare workers with minimal training to rapidly and reliably detect dehydration in infants. The team is planning a similar study in rural clinics to assess whether the method can also be used in such centres.

[This study was funded by the National Institutes of Health Fogarty International Center.]

1. Levine AC *et al*. External validation of the DHAKA score and comparison with the current IMCI algorithm for the assessment of dehydration in children with diarrhoea: a prospective cohort study. *Lancet Glob Health*. 2016;4(10):e744–51.

UNDERSTANDING OUTBREAKS

Highly detailed outbreak analysis combined with innovative modelling has revealed new insights into the spread of chikungunya virus.

icddr,b researchers and colleagues from the Institute of Epidemiology Disease Control and Research (IEDCR) regularly investigate disease outbreaks in Bangladesh. With researchers from Johns Hopkins University, USA, and the Pasteur Institute, France, they have also used detailed outbreak data and advanced statistical and modelling techniques to explore the social, behavioural and environmental factors influencing the spread of mosquito-borne chikungunya virus (1).

The outbreak investigation team visited every household in Palpara, a village 60 miles from Dhaka, interviewing nearly 2,000 people in 460 households. Some 364 people (18%) reported symptoms of chikungunya infection (fever with severe joint pain or rash).

Combining this information with geographic data on the location of households and data on people's daily movements, and applying statistical methods to manage uncertainty in data, the team was able to gain important insight into how the outbreak had unfolded.

Although the virus is not transmitted from person to person, the spread of infection typically centred on individual homes – more than a quarter of infections spread within the same household. Women were more likely to be affected, because they spent more time at home. Although more than half of households used coils to repel mosquitoes, they had no impact on infection rates.

The work provides important new insight into the spread of chikungunya, of potential relevance to other mosquito-borne infections such as Zika virus and dengue. More generally, the results illustrate how data collected during outbreaks, allied to new computational approaches, can reveal more about the spread of pathogens, and suggest strategies for controlling future outbreaks.

1. Salje H *et al*. How social structures, space, and behaviors shape the spread of infectious diseases using chikungunya as a case study. *Proc Natl Acad Sci USA*. 2016;113(47):13420–5.

FLU VACCINE

A phase III trial has shown that an intranasal flu vaccine is safe and provides young children with significant levels of protection.

Young children are particularly vulnerable to influenza infection, which can lead to potentially life-threatening pneumonia. To protect young children, there is growing interest in so-called live attenuated influenza vaccines (LAIVs) which are relatively easy to manufacture and, importantly, can be delivered intranasally rather than by injection.

Through an innovative technology transfer agreement organised by the WHO, an LAIV developed in Russia is now being manufactured in India. However, it has never been formally evaluated in a resource-poor setting.

With US colleagues, an icddr,b team recently completed the first large-scale randomised controlled trial of the Russian LAIV, in urban Kamalapur and rural Matlab. The vaccine was both safe and efficacious in infants aged 2–4 years, showing a vaccine efficacy against vaccine-matched strains of 57.5% (1).

The results suggest that a single dose of the Russian backbone LAIV could have a significant impact on the influenza disease burden in Bangladesh and other Asian countries.

[The LAIV trial was funded by the Bill & Melinda Gates Foundation.]

1. Brooks WA *et al*. Efficacy of a Russian-backbone live attenuated influenza vaccine among young children in Bangladesh: a randomised, double-blind, placebo-controlled trial. *Lancet Glob Health*. 2016;4(12):e946–54.

CONTROLLING CHOLERA

icddr,b is making vital contributions to national and international cholera vaccine strategies.

Cholera is endemic in Bangladesh, affecting some 300,000 people and claiming 4,500 lives every year. As icddr,b research has shown, there is growing evidence that affordable oral cholera vaccines (OCVs) could significantly reduce these numbers.

A large phase III trial in Dhaka showed that even a single dose of the OCV Shanchol was highly protective, particularly against the most dangerous dehydrating form of cholera, in adults and children over the age of 5 (1). Although a two-dose regimen is likely to remain the standard course, to ensure that young children are protected, the results argue that Shanchol would still have beneficial effects even in situations where it is difficult to ensure that people receive two doses.

Importantly, an icddr,b-led study has also shown that Shanchol is safe and stimulates strong immune responses even when stored at elevated temperatures (2). This suggests that the vaccine retains its potency even when not refrigerated, making it much easier to distribute to populations in need without the requirement of a cold chain.

Although the WHO has established a global stockpile of OCV, demand vastly exceeds supply. Furthermore, despite its low cost, there is some doubt whether large-scale use of Shanchol would be cost-effective in Bangladesh. To address these issues, icddr,b is involved in trials of two OCVs that are being locally manufactured following the transfer of technology to Bangladesh.

One trial, supported by a US$1.3m grant from the Bill & Melinda Gates Foundation to the International Vaccine Institute (IVI) in South Korea, is comparing the safety and immunogenicity of the locally produced 'Cholvax' vaccine with that of Shanchol. Cholvax has been developed by the IVI, which has transferred its vaccine manufacturing technology to a local Bangladesh company, Incepta Vaccine Ltd. The second study will assess the safety and immunogenicity of two formulations of a second vaccine being manufactured by Incepta – Hillchol, which has been developed by MSD Wellcome Trust Hilleman Laboratories Pvt Ltd in collaboration with Gothenburg University, Sweden.

icddr,b has also received major funding from the Gates Foundation to develop a strategy to pave the way for control of endemic cholera, by providing evidence for the rollout of locally produced OCV in Bangladesh. The work will map the current nationwide disease burden associated with cholera, and develop a range of possible costed immunisation strategies targeting those most in need.

1. Qadri F *et al*. Efficacy of a single-dose, inactivated oral cholera vaccine in Bangladesh. *N Engl J Med*. 2016;374(18):1723–32.

2. Saha A *et al.* The oral cholera vaccine Shanchol™ when stored at elevated temperatures maintains the safety and immunogenicity profile in Bangladeshi participants. *Vaccine*. 2016;34(13):1551–8.

CHOLERA INSIGHTS

Cholera bacteria may have evolved mechanisms to collectively resist predation by phages after an epidemic, ensuring some cells survive to seed future cholera outbreaks.

Bacteriophages (bacterial viruses) are thought to play a key role in controlling proliferation of *Vibrio cholerae*, the bacterium that causes epidemics of cholera. Seasonal cholera epidemics are reportedly modulated by phages, which naturally cause epidemics to collapse after reaching a peak. However, *V. cholerae* has evolved mechanisms to combat phages, and recent work led by icddrb's Dr Shah Faruque has revealed a new mechanism involved in the anti-phage defences of *V. cholerae* (1).

In the environment (and after colonisation of the gut), *V. cholerae* is often found in biofilms or clumps of cells, which represent a 'high cell density' state of the bacteria. In this state, the bacteria can communicate with each other through chemical signals using a mechanism known as 'quorum sensing'.

In *V. cholerae*, quorum sensing activates certain regulatory mechanisms that alter physiological processes, including enhancement of phage resistance. Potentially, these induced defences enable some cholera bacteria to survive the phage onslaught and seed the next seasonal epidemic.

The results also have possible implications for 'phage therapy' – use of phages to treat *V. cholerae* or other bacterial infections. As quorum sensing by bacteria growing in the host during infection may render *V. cholerae* resistant to phages, it may be possible to enhance the efficacy of phage therapy by adding agents that inhibit quorum sensing.

1. Hoque MM *et al.* Quorum regulated resistance of *Vibrio cholerae* against environmental bacteriophages. *Sci Rep.* 2016;6:37956.

COMBATING HYPERTENSION

A feasibility study suggests that an easily implementable multicomponent intervention can significantly reduce blood pressure in at-risk rural populations.

High blood pressure is a major risk factor for cardiovascular disease, the leading cause of mortality worldwide. The COBRA-BPS trial is assessing whether a public health intervention based on five relatively simple components, using community health workers and existing public health infrastructures, can reduce high blood pressure levels in rural Bangladesh, Pakistan and Sri Lanka. COBRA-BPS is being led by Professor Tazeen Jafar from Duke University, USA; work in Bangladesh is being led by icddr,b's Dr Aliya Naheed.

A feasibility study conducted in the three countries found that the multicomponent intervention could be delivered effectively, and had a significant impact on blood pressure levels, particularly in those with uncontrolled hypertension (1). Stakeholder interviews revealed widespread support for the programme.

Encouraging results from another icddr,b trial suggest that sustained falls in blood pressure may be achievable. A two-year follow up of an intervention based on targeted education and ongoing contact with community health workers found continuing evidence of reductions in blood pressure and enhanced blood pressure control compared with control groups (2).

1. Jafar TH *et al.* Control of blood pressure and risk attenuation: a public health intervention in rural Bangladesh, Pakistan, and Sri Lanka: feasibility trial results. *J Hypertens.* 2016;34(9):1872–81.

2. Chowdhury MA *et al.* Effect of community health worker-provided targeted education with regular follow-up of hypertensive patients on blood pressure control: 24-month results of a longitudinal study in Bangladesh. *Int J Non-Commun Dis* 2016;1:105–15.

THE IMPACT OF DIABETES

Diabetes is a growing problem in Bangladesh, and one that seems to affect Bangladeshi people particularly badly.

Like many low- and middle-income countries, Bangladesh faces a rising tide of non-communicable disease, particularly cardiovascular disease and type 2 diabetes. Although the exact prevalence of diabetes is unclear, a recent scoping review of published studies suggested it affects some 7.4% of the population (nearly 12 million people) and numbers are steadily rising (1).

Furthermore, an exploratory study in urban Dhaka and rural Matlab revealed that the true picture of diabetes may be even worse than these figures suggest, because of the growing impact of obesity. Of 1,200 adults with no diagnosis of diabetes, 6.6% showed evidence of diabetes and 16.6% of pre-diabetes, with the urban population being particularly at risk (2).

Moreover, while diabetes is often portrayed as a disease of the affluent, the picture in Bangladesh is more complicated. An analysis of data from Bangladesh's Health and Demographic Surveys suggests that diabetes disproportionately affects wealthy urban populations but also people in poor rural areas (3).

Strikingly, diabetes seems to have a particularly big impact on quality of life in Bangladesh. In a case control study, having diabetes was associated with a much steeper drop in quality of life scores than in other countries (4). Curiously, this was not linked to diabetic complications, which usually have the strongest influence on quality of life. Instead, it may reflect the financial impact of diabetes – people with diabetes spend six times as much on healthcare as those without (5).

Recently completed research has revealed that diabetic retinopathy, an irreversible eye condition leading to blindness, is as prevalent as cardiovascular disease, affecting nearly one in four patients attending tertiary care hospitals in Bangladesh. A range of factors were associated with development of retinopathy, including uncontrolled diabetes, raised blood pressure and high levels of 'bad' cholesterol, suggesting possible prevention strategies.

In ongoing diabetes-related research, interviews with pregnant mothers with gestational diabetes and healthcare staff at maternity clinics are being used to shape a culturally-context sensitive intervention to prevent the development of type 2 diabetes in this group of women.

1. Biswas T *et al.* Increasing prevalence of diabetes in Bangladesh: a scoping review. *Public Health*. 2016;138:4–11.

2. Alam DS *et al*. Overweight and abdominal obesity as determinants of undiagnosed diabetes and pre-diabetes in Bangladesh. *BMC Obes*. 2016;3:19.

3. Biswas T *et al.* Socio-economic inequality of chronic non-communicable diseases in Bangladesh. *PLoS One.* 2016;11(11):e0167140.

4. Safita N *et al*. The impact of type 2 diabetes on health related quality of life in Bangladesh: results from a matched study comparing treated cases with non-diabetic controls. *Health Qual Life Outcomes.* 2016;14(1):129.

5. Shariful Islam SM *et al*. Healthcare use and expenditure for diabetes in Bangladesh. *BMJ Global Health* DOI: 10.1136/bmjgh-2016-000033

TRAVEL TIME

In a poor urban area, travel time has a major influence on women's use of emergency obstetric services.

There is considerable scope to save mothers' lives by increasing women's use of health facilities during childbirth. Numerous initiatives have aimed to increase use of emergency obstetric care (EmOC), but take up remains low.

Travel time to health facilities is well known to affect take up of EmOC services, but has mostly been studied in rural settings where women may live considerable distances from specialist services.

However, in urban areas, women in deprived areas with poor road infrastructure may find it difficult to travel even short distances to facilities. To investigate this question, icddr,b researchers combined data from a survey of healthcare-seeking behaviour in Sylhet City – a poor urban area with low take up of EmOC services – with a comprehensive geo-referenced census of health facilities.

Remarkably, the study revealed that a five-minute increase in travel time to the nearest EmOC facility was associated with a 30% drop in the likelihood of using a facility (1). This disincentive probably reflects the area's poor road infrastructure and women's lack of access to suitable transportation.

The surprisingly large impact of travel time on EmOC use suggests that more emphasis needs to be given to the location of facilities with respect to population centres and to the provision of emergency transportation. Nevertheless, the greatest influences on EmOC use were mothers' education and enrolment in antenatal classes – promotion of which could also enhance use of EmOC services.

1. Panciera R *et al.* The influence of travel time on emergency obstetric care seeking behavior in the urban poor of Bangladesh: a GIS study. *BMC Pregnancy Childbirth*. 2016;16:240.

DIAGNOSTIC DEVELOPMENTS

Clinicians may soon have access to a simple 'dipstick' tool for diagnosing enteric fever.

Enteric fever, caused by infection with *Salmonella* Typhi and Paratyphi, is difficult to diagnose on the basis of clinical signs alone. icddr,b researchers have developed a new diagnostic method, based on detection of anti-*Salmonella* antibodies in acutely infected patients. This 'TPTest' was recently shown to be highly specific and sensitive, outperforming two commercially available tests (1).

The TPTest requires laboratory facilities, so the icddr,b team is also working with a local company to develop a more simple rapid diagnostic test based on a dipstick method; this dipstick was recently shown to have very high sensitivity and specificity when tested under laboratory conditions (2). Potentially, the dipstick could be used in clinical management, surveillance and in assessing control programmes in low-income settings.

In the long term, there is a need for a rapid point-of-care diagnostic – a challenge for enteric fever as bacteria are present at very low levels in the bloodstream. Researchers at Harvard Medical School and icddr,b are adapting a magneto-DNA nanoparticle assay platform to detect *Salmonella* directly from blood samples. In proof-of-principle studies, the method detected *Salmonella* in blood samples from five patients with confirmed enteric fever within 3.5 hours (3).

1. Islam K *et al*. Comparison of the performance of the TPTest, Tubex, Typhidot and Widal immunodiagnostic assays and blood cultures in detecting patients with typhoid fever in Bangladesh, including using a Bayesian latent class modeling approach. *PLoS Negl Trop Dis*. 2016;10(4):e0004558.

2. Khan IH *et al.* Development of a simple, peripheral-blood-based lateral-flow dipstick assay for accurate detection of patients with enteric fever. *Clin Vaccine Immunol.* 2016;23(5):403–9.

3. Park KS *et al.* A magneto-DNA nanoparticle system for the rapid and sensitive diagnosis of enteric fever. *Sci Rep*. 2016;6:32878.

Programme lead
DR SHAMS EL ARIFEEN
Senior Director
Maternal and Child Health

Reducing maternal and neonatal mortality

We discover, develop and evaluate new interventions, and help improve the delivery and scale-up of existing interventions, to prevent and treat maternal complications, adverse birth outcomes and life-threatening neonatal conditions.

Our work spans the full spectrum of research, including epidemiological studies, operations and implementation research, clinical trials, evaluation of healthcare delivery systems, and health systems research.

We are studying key aspects of maternal and newborn health, including biological and social factors associated with increased risk of preterm birth and low birth weight, newborn infections, and other major maternal and newborn complications. We use this new understanding to develop and test possible solutions for use in resource-poor settings.

We also advise on the design of appropriate delivery strategies and evaluate existing programmes at scale. Our focus is on generating evidence to support scale-up of cost-effective interventions globally. We also work closely with the Government of Bangladesh in formulating policies and programmes.

PRE-TERM BIRTH

More than 3,400 women have been enrolled into a new population-based prospective cohort, the Preterm and Stillbirth Study Matlab (PreSSMat), funded by the Bill & Melinda Gates Foundation. The cohort has been established to gather information on factors potentially contributing to pre-term birth – which accounts for around a third of the estimated 2.7 million neonatal deaths occurring globally each year – and other pregnancy-related health issues. Social and demographic information is being collected at household visits and a variety of biological samples are collected and stored during clinic visits and at delivery to support a multitude of studies on pre-term birth and other adverse pregnancy outcomes.

SEPSIS MANAGEMENT

icddr,b researchers have begun an evaluation of the implementation of the Government of Bangladesh's new National Sepsis Management Guidelines at selected facilities within Kushtia district. The study will provide detailed information on the quality of care delivered and challenges experienced during implementation, to guide future national scale-up activities.

NETWORKING FOR CHILD HEALTH

icddr,b has joined the Child Health and Mortality Prevention Surveillance (CHAMPS) network. Run by the Emory Global Health Institute and funded by the Bill & Melinda Gates Foundation, CHAMPS is a 20-year initiative to establish the infrastructure to obtain data on causes of death of children under five years of age in South Asia and sub-Saharan Africa. In partnership with the Institute of Epidemiology, Disease Control and Research, Ministry of Health and Family Welfare (GoB), a surveillance site at Baliakanda and public hospitals in Faridpur and Rajbari will use techniques such as minimally invasive tissue sampling to investigate causes of death, information that will enable policymakers to plan and prioritise interventions.

http://champshealth.org

BIRTH AND DEATH NOTIFICATION

A pilot study has evaluated different mechanisms for comprehensively capturing timely information on births and deaths. Current data collection is incomplete, leading to a reliance on costly and time-consuming data collection through surveys. The pilot, run at two sites in Bangladesh, gathered a substantial proportion of births and deaths within a short time span. Findings were communicated to policymakers, development partners and researchers at a dissemination workshop.

QUALITY OF CARE FOR SEPSIS

A package of interventions implemented at two rural subdistrict hospitals significantly improved the quality of care provided to neonates and young infants with sepsis, a major cause of death in low-income countries (1). Through the 'Interrupting Pathways to Sepsis Initiative' (IPSI), researchers from icddr,b and the University of British Columbia, Canada, worked with the Ministry of Health and Family Welfare to implement a range of organisational and care measures to enhance the speed and quality of care delivered to babies and young infants at risk of sepsis. Children with sepsis received the first dose of injectable antibiotic within a median of 30 minutes of admission. The work suggests that implementation of a package of simple interventions can have a major impact on care quality in lower-level facilities in low-income countries.

1. Rahman AE *et al.* Managing neonatal and early childhood syndromic sepsis in sub-district hospitals in resource poor settings: Improvement in quality of care through introduction of a package of interventions in rural Bangladesh. *PLoS One*. 2017;12(1):e0170267.

GESTATIONAL AGE ESTIMATION

A newly launched project is comparing the ability of three community-based interventions, including innovative electronic recording of data, to improve the recall and reporting of the date of last menstrual period in poor rural settings. Date of last menstrual period is a simple and useful way to estimate gestational age, important for detecting and managing premature births, but a significant proportion of women struggle to recall their menstrual dates.

ADOLESCENT SEXUAL HEALTH

A databank of responses to frequently asked questions, developed by icddr,b to support adolescent sexual and reproductive health promotion, has been used to create a novel mobile app. In 2012, an icddr,b study collected 5,000 questions from Bangladeshi adolescents and developed and validated socially and culturally appropriate responses. In a USAID-funded project, these responses were used to update information materials ('Nijeke Jano' or 'Know Thyself' booklets), which are available on Government websites and used by several adolescent health programmes. In 2016, Dnet, a local social enterprise, used the responses to create a mobile app in Bangla, 'Aponjon Koishor', available for free from Google Play, the Microsoft Store and iTunes. The app was launched in April 2016 by the State Minister for Information Communication Technology.

INTIMATE PARTNER VIOLENCE

A study of more than 3,000 married women across 77 villages has found that women who married after the age of 18 were at reduced risk of intimate partner violence, but those who married early – before the age of 15 – were at increased risk (1). However, in villages with a high incidence of early marriage, the protective effects of later marriage disappeared. Currently, some 65% of Bangladeshi women are married before the age of 18, and discouraging early marriage at a community level could help to reduce levels of intimate partner violence.

1. Yount KM *et al.* Child marriage and intimate partner violence in rural Bangladesh: A longitudinal multilevel analysis. *Demography*. 2016;53:1821–52.

Programme lead
DR TAHMEED AHMED
Senior Director
Nutrition and Clinical Services

Preventing and treating maternal and childhood malnutrition

We study the biological and non-biological mechanisms underpinning maternal and childhood malnutrition, develop innovative interventions to prevent and treat these conditions, and evaluate the efficacy, feasibility and scalability of new interventions.

We carry out a wide range of research, from basic laboratory studies to evaluations of implementation of preventive and treatment programmes and support for policy development.

We aim to develop a better understanding of the origins and implications of malnutrition, taking a broad perspective encompassing the many biological and social factors affecting gut health and nutrition.

We have developed ready-to-use supplementary and therapeutic foods based on locally available ingredients (such as rice, lentils and chickpeas). We have been evaluating their acceptability to children, their efficacy and their impact in field trials.

We also work closely with the Government of Bangladesh, analysing barriers to the effective implementation of maternal nutrition programmes and ensuring that national nutrition policy-making is based on high-quality evidence.

GUT HEALTH

Interactions between gut bacteria can have a significant impact on weight loss (see page 10).

NUTRITION AND AGRICULTURE STRATEGY

icddr,b researcher Dr Tahmeed Ahmed has contributed to a new Strategic Review of Food Security and Nutrition in Bangladesh. Commissioned by the World Food Programme, the review highlights major progress made since the 1970s but identifies a number of remaining challenges – including persistently high levels of childhood stunting and acute malnutrition, the widespread lack of nutritious and diverse diets, as well as future threats such as climate change and socioeconomic changes. Stressing that undernutrition costs Bangladesh more than US$1bn in lost productivity every year, and far more in healthcare costs, the review calls for additional investment in food security and nutrition, to promote more diverse and nutritious diets, as well as enhanced social protection systems and greater empowerment of women.

https://www.wfp.org/content/food-and-nutrition-security-bangladesh

OLIGOMIX TRIAL

A randomised controlled trial is assessing whether a mix of synthetically produced human milk oligosaccharides (Oligomix) can prevent prolonged or persistent diarrhoea in children. Human milk oligosaccharides are found in breast milk but cannot be digested by infants; their role may be to support healthy bacterial communities in the infant gut, which can be disrupted during severe diarrhoea. By promoting the growth of balanced microbial communities, Oligomix may be able to limit the duration of episodes of diarrhoea.

ZINC DEFICIENCY

A nationwide survey has found that zinc deficiency affects 44.6% of pre-school-age children and 57.3% of non-pregnant non-lactating women (1). Zinc deficiency has multiple impacts on health and makes a major contribution to growth retardation. Deficiency levels were particularly high in rural and slum areas, and showed associations with low income, low intake of animal source zinc and high intake of plant-origin zinc (which shows poor bioavailability). The data provide a clear picture of the extent of zinc deficiency in Bangladesh and suggest dietary and fortification measures by which it could be overcome.

1. Rahman S *et al.* Status of zinc nutrition in Bangladesh: the underlying associations. *J Nutr Sci*. 2016;5:e25.

UNDERNUTRITION

Data from more than 10,000 children aged less than two years of age, collected through the Food Security National Surveillance Project, have revealed factors associated with undernutrition in this key age group (1). Some 30.9% of children were affected by stunting, 9.7% were wasted and 24.9% were underweight. Being male, older age, maternal weight and education, and household food security had the strongest effect on undernutrition, but the risk factors for the different categories of undernutrition varied with age.

1. Choudhury N *et al.* Determinants of age-specific undernutrition in children aged less than 2 years-the Bangladesh context. *Matern Child Nutr*. 2016. [Epub ahead of print]

EVALUATIONS

icddr,b researchers are evaluating two major nutritional interventions in Bangladesh. The first study is evaluating the Suchana initiative, a large-scale and long-term nutrition and female empowerment programme targeting poor households in the Sylhet district of Bangladesh. A cluster randomised trial will provide policymakers with information about the Suchana intervention's capacity to reduce stunting and promote women's economic development and gender equality. The second is examining the impact and potential sustainability of the 'Alive and Thrive' initiative, launched in 2009 to improve infant and young child feeding behaviours in Bangladesh, Vietnam and Ethiopia.

ENTERIC DYSFUNCTION

icddr,b researchers and colleagues in Bangladesh and the USA have begun a major study of environmental enteric dysfunction (EED) – inflammation of the small intestine that affects young infants and accounts for more than 40% of all cases of stunting. A key aim of the US$6.5m study, supported by the Bill & Melinda Gates Foundation, will be to validate non-invasive biomarkers of EED, to facilitate diagnosis, prevention, treatment and research into its causes. The study will focus on undernourished children and adults failing to respond to a nutritional intervention, a potential sign of EED. The team will use histopathological analysis to assess gut damage directly, and identify the non-invasive EED biomarkers that correlate most strongly with the extent of gut damage. The study will also investigate potential infectious triggers of EED and mechanisms of disease, to inform the development of new interventions.

https://clinicaltrials.gov/ct2/show/NCT02812615

Programme lead
DR RASHIDUL HAQUE

Controlling enteric and respiratory infections

We are generating a better understanding of key disease-causing organisms and host immune responses, and developing and evaluating low-cost potentially scalable preventive and therapeutic interventions.

Our work spans the full spectrum of research, from studies aiming to generate a better understanding of pathogenic organisms and the body's responses to them, through the development and testing of new therapeutics and preventive interventions, and evaluation of the implementation of such interventions. We also aim to develop improved diagnostics for efficient and rapid detection of pathogens.

We are also assessing a range of therapeutics and hygiene-based interventions for disease prevention. In addition, we aim to translate our work to support the implementation of existing as well as new affordable vaccines.

We are internationally recognised for the quality of our research in cholera, typhoid, rotavirus and other diarrhoeal diseases, including pioneering molecular-genetic studies of pathogens.

ORAL CHOLERA VACCINES

The affordable oral cholera vaccine Shanchol retains its immunogenicity after storage at elevated temperatures (see page 13).

FLU VACCINE

An intranasal flu vaccine has been found to be safe and effective in children (see page 12).

CHOLERA PHAGE

Signalling between cholera-causing bacteria may enable them to resist phage infection and seed new epidemics (see page 14).

ENTERIC FEVER DIAGNOSIS

A new 'dipstick' assay is a reliable indicator of enteric fever infections (see page 16).

PROTOZOAN PARASITES

Longitudinal birth cohort studies carried out in the urban slum of Mirpur, Dhaka, have identified links between infection with protozoan parasites and growth faltering. Infection with *Giardia* before the age of six months was associated with stunting at age two (1). *Giardia* infections had no impact on weight gain or on the risks of diarrhoea.

By contrast, infection with *Cryptosporidium* during the first two years of life significantly increased the risk of severe stunting (2). More than three-quarters of infants experienced at least one infection and most infections did not lead to diarrhoea. Hence stunting rather than diarrhoea may be the most important consequence of *Cryptosporidium* infection.

In new work, icddr,b and US researchers have begun a phase II trial of auranofin, a drug licensed for use in rheumatoid arthritis, for treatment of gut protozoan parasite infections.

1. Donowitz JR *et al*. A prospective longitudinal cohort to investigate the effects of early life giardiasis on growth and all cause diarrhea. *Clin Infect Dis*. 2016;63(6):792–7.

2. Korpe PS *et al*. Natural history of cryptosporidiosis in a longitudinal study of slum-dwelling Bangladeshi children: Association with severe malnutrition. *PLoS Negl Trop Dis*. 2016;10(5):e0004564.

DR FIRDAUSI QADRI
Acting Senior Director
Infectious Diseases Division

ROTAVIRUS VACCINATION

icddr,b researchers have contributed to studies documenting the burden of rotavirus disease in Bangladesh and factors affecting rotavirus vaccine responses. To provide up-to-date data on the current disease burden and a baseline for assessing the impact of a rotavirus vaccine programme, an icddr,b-led team undertook a hospital-based surveillance project at seven sentinel sites across Bangladesh (1). Rotavirus accounted for 64% of cases of young children hospitalised with acute gastroenteritis – a higher burden than previously thought.

In vaccine studies, delayed dosing of a monovalent rotavirus vaccine led to surprisingly high protection against rotavirus disease, particularly severe disease, with low serum zinc levels being associated with reduced vaccine efficacy (2). Enterovirus infections (but not other enteric infections) have also been found to reduce rotavirus vaccine performance (3). Surprisingly, results from a cohort study suggest that improved nutritional status led to an increased risk of rotavirus infection (4) – implying that rotavirus could become an even greater public health threat as young children's nutrition improves.

In new work, icddr,b researchers have begun a phase I/II study to assess the immunogenicity of a heat-stable rotavirus vaccine. Currently, an estimated half of freeze-dried vaccine and a quarter of liquid vaccines are wasted each year, mostly because of disruptions to cold chain transport.

1. Satter SM *et al*. Hospital-based surveillance for rotavirus gastroenteritis among young children in Bangladesh: Defining the potential impact of a rotavirus vaccine program. *Pediatr Infect Dis J.* 2017;36(2):168–72.

2. Colgate ER *et al.* Delayed dosing of oral rotavirus vaccine demonstrates decreased risk of rotavirus gastroenteritis associated with serum zinc: A randomized controlled trial. *Clin Infect Dis.* 2016;63(5):634–41.

3. Taniuchi M *et al.* Impact of enterovirus and other enteric pathogens on oral polio and rotavirus vaccine performance in Bangladeshi infants. *Vaccine.* 2016;34(27):3068–75.

4. Verkerke H *et al*. Malnutrition is associated with protection from rotavirus diarrhea: Evidence from a longitudinal birth cohort study in Bangladesh. *J Clin Microbiol*. 2016;54(10):2568–74

ANTIMICROBIAL PEPTIDES

icddr,b researchers and colleagues from Sweden and Iceland have identified a class of compounds, aroylated phenylenediamines, able to promote production of antimicrobial peptides (1). Part of the innate response to infection, antimicrobial peptides have direct effects on pathogens and stimulate immune responses more generally. However, pathogens such as *Shigella* have evolved mechanisms to reduce their production. Developed for cancer therapy, aroylated phenylenediamines potently induced antimicrobial peptides and led to more rapid clearance of *Shigella* infections in an animal model.

1. Ottosson H *et al*. Potent inducers of endogenous antimicrobial peptides for host directed therapy of infections. *Sci Rep*. 2016;6:36692.

PHAGE THERAPY

An icddr,b team and colleagues from Switzerland have carried out one of the world's first randomised controlled trials of phage therapy for childhood *E. coli* infection (1). The study in Dhaka found that phage therapy was safe but there was no evidence that phage were infecting bacteria and multiplying in the gut, and the therapy had no impact on diarrhoea symptoms. The results suggest that a deeper understanding of phage–microbe interactions in the gut is required before the viability of phage therapy can be determined.

1. Sarker SA *et al*. Oral phage therapy of acute bacterial diarrhea with two coliphage preparations: A randomized trial in children from Bangladesh. *EBioMedicine*. 2016;4:124–37.

ANTIBIOTICS FOR DIARRHOEA

icddr,b researchers are taking part in the multicentre international Antibiotics for Severe Diarrhoea (ABCD) trial to assess whether antibiotics can reduce the risk of death and growth faltering after an episode of severe diarrhoea in children. Although oral rehydration therapy, zinc and feeding advice have dramatically cut mortality from diarrhoea, it still kills some 500,000 children every year. While antibiotics are not currently recommended except in cases of dysentery and cholera, they may be able to reduce childhood mortality from diarrhoea still further. The trial is being funded by the Bill & Melinda Gates Foundation.

COSTS OF PNEUMONIA MANAGEMENT

icddr,b researchers have contributed to a global study estimating the economic costs of pneumonia management in young children in low and middle-income countries (LMICs). The systematic review of published and unpublished data produced financial estimates for care in the community, in outpatient facilities, and in various types of inpatient facility (1). The analysis will be an important source of data for healthcare planners in LMICs.

1. Zhang S *et al.* Cost of management of severe pneumonia in young children: systematic analysis. *J Glob Health*. 2016;6(1):010408.

Programme lead (acting)
DR SAYERA BANU

Detecting and controlling emerging and re-emerging infections

We work with partners in Bangladesh and internationally to detect, characterise and respond to emerging and re-emerging infectious disease threats.

Detection of emerging and re-emerging infections is important both locally and internationally, with the potential for rapid and global dissemination of infectious agents. Our work depends on extensive surveillance platforms and close collaboration with local and international partners to identify and respond to disease outbreaks.

We have a long-standing collaboration with the US Centers for Disease Control and Prevention, which has enabled us to build platforms to track infections, through hospital-based surveillance and population-based surveys.

We use our understanding of likely routes of transmission to develop new interventions. We aim to identify methods that are practical and affordable, and so would be suitable for wider scale-up.

We routinely respond to infectious disease outbreaks in Bangladesh in partnership with the Institute of Epidemiology, Disease Control and Research (IEDCR), and in collaboration with the local One Health initiative.

AVIAN INFLUENZA

An analysis of low-pathogenicity avian influenza A viruses has found that poultry from live bird markets and backyard flocks are infected with a wide range of genetically diverse viruses (1). The study, based on seven years of surveillance data, suggests that viruses are constantly circulating through wild and domestic poultry populations in Bangladesh.

1. Gerloff NA *et al*. Genetically diverse low pathogenicity avian influenza A virus subtypes co-circulate among poultry in Bangladesh. *PLoS One*. 2016;11(3):e0152131.

DENGUE PREVENTION AND DETECTION

An icddr,b team has begun a phase II trial of a novel vaccine for dengue virus – the first such trial in an endemic region of South Asia. The safety and immunogenicity of TV005, developed by the US National Institute of Allergy and Infectious Diseases, will be tested first in adults, then adolescents and finally children in a dengue-endemic area of Dhaka (1). icddr,b researchers are also participating in an eight-country study aiming to identify clinical features that can differentiate between dengue infection and other conditions characterised by fever, and that can predict the development of severe disease (2).

1. https://clinicaltrials.gov/ct2/show/NCT02678455

2. Jaenisch T *et al.* Clinical evaluation of dengue and identification of risk factors for severe disease: protocol for a multicentre study in 8 countries. *BMC Infect Dis.* 2016;16:120.

INNOVATIVE SURVEILLANCE

An icddr,b team and their US colleagues have developed a method for evaluating hospital-based surveillance of infectious disease outbreaks. Focusing on two conditions – severe neurological infectious disease and fatal respiratory infectious disease – the team undertook detailed surveys of healthcare service use around surveillance hospitals, to assess the capacity of such hospitals to detect outbreaks. The method, which

could be widely applied, revealed relatively low levels of case detection, particularly of those distant from hospital facilities (1).

Other studies have examined novel ways of obtaining surveillance data, for example by reporting of oral rehydration solution sales at pharmacies to detect diarrhoea outbreaks (2) and liaison with private laboratories to detect hepatitis E outbreaks (3). Researchers have also shown that a nationwide media-based surveillance system developed by the IEDCR is a rapid and highly cost-effective way of detecting outbreaks that could be adopted in other low-income countries (4).

1. Nikolay B *et al*. Evaluating hospital-based surveillance for outbreak detection in Bangladesh: Analysis of healthcare utilization data. *PLoS Med*. 2017;14(1):e1002218.

2. Azman AS *et al*. Tracking cholera through surveillance of oral rehydration solution sales at pharmacies: Insights from urban Bangladesh. *PLoS Negl Trop Dis*. 2015;9(12):e0004230.

3. Sazzad HM *et al.* Surveillance at private laboratories identifies small outbreaks of hepatitis E in urban Bangladesh. *Am J Trop Med Hyg*. 2017;96(2):395–9.

4. Ao TT *et al.* Low-cost national media-based surveillance system for public health events, Bangladesh. *Emerg Infect Dis.* 2016;22(4):720–2.

UNDERSTANDING FAILURE

icddr,b and US researchers have examined two situations in which public health campaigns have been unsuccessful, using ethnographic methods to understand the response of target audiences to public health messages. The first study explored why a communication campaign did not stop villagers consuming date palm sap, putting them at risk of Nipah virus infection. It highlighted the importance of engaging in two-way dialogue with target audiences to build trust, and developing communications strategies that incorporate local understanding of disease (1). The second study identified a range of economic, cultural and practical issues that led backyard poultry farmers not to adopt measures to reduce the spread of avian influenza (2). The lessons learned from such studies could lead to more appropriate and effective communication campaigns.

1. Parveen S *et al.* It's not only what you say, it's also how you say it: communicating Nipah virus prevention messages during an outbreak in Bangladesh. *BMC Public Health*. 2016;16:726

2. Rimi NA *et al.* Understanding the failure of a behavior change intervention to reduce risk behaviors for avian influenza transmission among backyard poultry raisers in rural Bangladesh: a focused ethnography. *BMC Public Health*. 2016;16(1):858.

SAND FLY CONTROL

A trial in Bangladesh, India and Nepal has found that insecticide-treated wall lining is an effective method for controlling the numbers of sand flies (1), which transmit the parasite responsible for visceral leishmaniasis. Insecticide-treated bednets also reduced sand fly numbers but lime washing walls and using bleach on breeding areas was not effective. Insecticide-treated wall lining could therefore play a role in visceral leishmaniasis control programmes, alongside insecticide spraying in houses.

The wall lining option is relatively expensive, but costs could be reduced by covering only the lower part of walls, where sand flies are typically found. A further three-country study found that reduced wall coverage was equally effective at controlling sand fly numbers (2).

1. Mondal D *et al*. Efficacy, safety and cost of insecticide treated wall lining, insecticide treated bed nets and indoor wall wash with lime for visceral leishmaniasis vector control in the Indian sub-continent: A multi-country cluster randomized controlled trial. *PLoS Negl Trop Dis.* 2016;10(8):e0004932.

2. Huda MM *et al.* Entomological efficacy of durable wall lining with reduced wall surface coverage for strengthening visceral leishmaniasis vector control in Bangladesh, India and Nepal. *BMC Infect Dis*. 2016;16(1):539.

LEISHMANIA DIAGNOSIS

icddr,b researchers have evaluated novel methods for detecting *Leishmania* infections, a central aspect of disease control and elimination. One study found that an innovative mobile 'laboratory in a suitcase' for molecular identification of *Leishmania* was as good as standard laboratory tests (1), while a second showed that urine samples could be used to detect antibodies against *Leishmania* with a high degree of specificity and sensitivity (2); urine samples would be easier to collect and analyse than blood samples in remote locations.

1. Mondal D *et al.* Mobile suitcase laboratory for rapid detection of *Leishmania donovani* using recombinase polymerase amplification assay. *Parasit Vectors.* 2016;9(1):281.

2. Ghosh P *et al*. Evaluation of diagnostic performance of rK28 ELISA using urine for diagnosis of visceral leishmaniasis. *Parasit Vectors*. 2016;9(1):383.

Programme lead (acting)
DR MAHBUB ELAHI CHOWDHURY

Achieving universal health coverage

We evaluate gaps in access, delivery, quality, financing, policy and governance in the health sector in Bangladesh, and test interventions to remedy deficiencies.

icddr,b is committed to the principle that all people, irrespective of their social and economic position, should have access to affordable, acceptable, high-quality and responsive healthcare.

We have particular expertise in areas such as urban health, healthcare financing mechanisms, equity in service utilisation, innovative use of new technologies, implementation research and systematic reviews, strengthening capacity building of the national health programme, and demographic surveillance.

A major aim is to provide a clearer picture of the healthcare landscape in Bangladesh and people's care-seeking behaviour. We have also developed a range of interventions to enhance access to healthcare and improve the quality of services.

We are also actively engaged in capacity building of government officials to strengthen management and service delivery. We are working closely with government officials to strengthen Bangladesh's district health information system, and to ensure health systems monitoring and evaluation are in place and that local evidence is used for health planning.

We are developing a road map to establish the practical steps by which universal health coverage can be achieved in Bangladesh and are establishing a 'learning platform' to support sharing of knowledge.

SHARE AND SHARE ALIKE

An icddr,b team and colleagues from the Directorate General of Health Services have run multiple innovative public engagement exercises during 2016, as part of the European Union-funded SHARE (Strengthening Health, Applying Research Evidence) initiative. The overarching aim of SHARE is to give citizens a voice, placing them at the centre of discussions of health policy. Notable impacts include a health dialogue event in Monpura, one of Bangladesh's most remote islands. Nationwide media coverage captured the attention of senior political figures, which catalysed the recruitment of new medical staff and establishment of a community support group for local health facilities. SHARE organised multiple other activities, focused on diverse issues including school-based health, health information systems, the capacity of district-level health managers to use evidence in policymaking, and reporting of medical information in the media.

GAVI EVALUATION

icddr,b has worked with the Institute of Health Metrics and Evaluation in Seattle, USA, and other partners on a Global Alliance for Vaccines and Immunisation (Gavi) Full Country Evaluation for Bangladesh. The evaluation summarises developments in the country's immunisation programme and the impact of Gavi-supported work. Since 2000, Gavi has committed more than US$500m to vaccine and health systems-strengthening programmes in Bangladesh. icddr,b is supporting an evaluation of this programme of work.

www.gavi.org/results/evaluations/full-country-evaluations/

URBAN HEALTH SERVICES

An icddr,b team has undertaken a series of interviews with key stakeholders to identify major issues in primary health care service delivery in urban areas. Although the Ministry of Health and Family Welfare is responsible for healthcare in Bangladesh, in urban areas responsibilities lie principally with the Ministry of Local Government, Rural Development and Co-operatives and city-level bodies. Interviewees suggested that greater collaboration between the ministries could help improve urban services. The icddr,b team also developed a policy brief identifying gaps in collaboration among key stakeholders and suggesting possible ways to address these gaps to strengthen urban healthcare service delivery.

SELF-HELP

An analysis of a long-running initiative in rural Chakaria has found that self-help organisations (SHOs) can make an important contribution to public health (1). In the mid-1990s, icddr,b began a 'participatory action research' project in Chakaria, to help existing SHOs (such as mosque organisations and youth clubs) to identify and solve their own local health problems. By 2015, compared with a matched control area, Chakaria showed increases in immunisation rates, skilled birth attendance, facility deliveries and use of sanitary latrines. The SHOs had set up training programmes for village doctors and new micro-health insurance schemes, and nearly half were discussing health issues on a regular basis. Although significant efforts were required to build trust and establish appropriate relationships to avoid dependency or requests for resources, the project suggests that SHOs can be mobilised to improve public health.

1. Bhuiya A, Hanifi SM, Hoque S. Unlocking community capability through promotion of self-help for health: experience from Chakaria, Bangladesh. *BMC Health Serv Res*. 2016;16(Suppl 7):624.

GAINING TRACTION

Implementation research funded through USAID's Translating Research into Action (TRAction) initiative has influenced several areas of health policy and practice in Bangladesh. A notable example is the recent recommendation from the National Technical Committee of the Directorate General of Family Planning for scale-up of community-based management of severe pre-eclampsia and eclampsia, including administration of magnesium sulphate by family welfare visitors, following icddr,b-run studies. The intervention is being rolled out in multiple districts through the MaMoni Health Systems Strengthening programme, supported by USAID and the Population Council and recently adopted by Save the Children Bangladesh. Some 14 studies have been carried out under the TRAction umbrella during 2011–16.

Programme lead
DR QUAMRUN NAHAR
Acting Senior Director
Health Systems and Population Studies

Examining the health consequences of climate change

We evaluate the impacts of climate change and migration patterns on population health in Bangladesh and ways in which populations can adapt.

Our Climate Change and Health initiative is a developmental research programme. As climate change is of great concern to Bangladesh and other low-income countries, especially those in major river deltas, we plan to build our research capabilities in this area and generate evidence to support national, regional and global policymaking.

As well as infectious diseases, particularly cholera and mosquito-transmitted diseases such as malaria and dengue fever, the programme is building expertise in multidisciplinary fields such as integrated water resources management and environmental science, as well as in social science. This will build on our extensive experience of health and population research in Bangladesh.

We plan to provide the Government of Bangladesh with regular updates on global and national impacts of climate change on health, and also ensure that discussions are relevant to other countries facing similar challenges.

CONTRIBUTION TO NATIONAL STRATEGY

In partnership with the Netherlands Government, the Government of Bangladesh is developing a Bangladesh Delta Plan 2100, a comprehensive and integrated plan for maintaining water security, food security and economic development. The development of this plan has drawn upon some of the research of icddr,b and its international partners in the 'Assessing Health, Livelihoods, Ecosystem Services and Poverty Alleviation In Populous Deltas' (ESPA Deltas) project, a collaboration with the University of Southampton, UK and other UK organisations, as well as numerous academic institutions, government bodies and NGOs from Bangladesh and India.

ESPA Deltas is a multidisciplinary project encompassing disciplines such as hydrology, climatology, earth and ocean sciences, economics, agriculture and fisheries. icddr,b's contributions have focused on population surveys exploring the benefits gained from ecosystem services. Information has been used to define seven social-ecological systems based on characteristic patterns of environmental resource use. Data have also fed into a multidimensional model that can simulate potential future developments to inform policymaking.

WELLBEING AND ECOSYSTEM SERVICES

As part of ESPA Deltas, icddr,b researchers have generated an extensive dataset on more than 1,500 residents of coastal regions of Bangladesh (1). The dataset includes a wealth of measures of wellbeing, spanning economic, health and life satisfaction factors, and use of ecosystem services (including agriculture, aquaculture and other use of natural resources). Data can be stratified according to social-ecological systems and were collected at three points in the year to capture seasonal variation. The data are a major new resource for

those studying the links between use of natural resources and wellbeing.

1. Adams H *et al.* Spatial and temporal dynamics of multidimensional well-being, livelihoods and ecosystem services in coastal Bangladesh. *Sci Data.* 2016;3:160094.

SALT INTAKE

An icddr,b team has begun a trial examining whether use of 'managed aquifer recharge' systems has any impact on blood pressure. These systems inject fresh water into shallow aquifers to reduce drinking water salinity, and therefore could reduce environmental sodium consumption.

WATER CONTAMINATION

Both extreme weather events and changing land use practices have been found to affect *E. coli* contamination of shallow well groundwater – a key source of drinking water in rural Bangladesh. Groundwater has been thought to be a relatively safe source of drinking water, but a 17-month study at two rural sites found that *E. coli* contamination was increased by factors such as the numbers of days of heavy rain and changes in land use (1). The findings highlight how climate extremes and changing land use, such as urbanisation, could impact on the quality of an important source of drinking water and risk of diarrhoeal disease.

1. Wu J, Yunus M, Islam MS, Emch M. Influence of climate extremes and land use on fecal contamination of shallow tubewells in Bangladesh. *Environ Sci Technol.* 2016;50(5):2669–76.

LINKING SCIENCE TO POLICY

Two research policy briefs have been developed based on research carried out comparing populations in different social-ecological systems in coastal Bangladesh. The first policy brief focused on malnutrition in young children, and emphasised the importance of dietary diversity, particularly fish consumption, as well as simple calorie intake.

The second policy brief summarised work on salt intake and its links to high blood pressure. It emphasised the detrimental impact of both environmental and domestic salt consumption, and the potential of climate change to increase salt contamination of drinking water sources. Policy responses could address both drinking water contamination and domestic use of salt.

NETWORKS FOR HEALTH

icddr,b is a member of both national and international networks exploring the intersection between the environment and human health. icddr,b has been associated with the Gobeshona knowledge-sharing platform for climate change research in Bangladesh (http://gobeshona.net/) since its inception, and organises sessions on climate change and human health at Gobeshona's annual conferences. icddr,b has also joined the Planetary Health Alliance (https://planetaryhealthalliance.org), an international network aiming to promote a vision of public health that integrates an environmental perspective, and to strengthen the links between research, education and policy.

Programme lead
DR ALIYA NAHEED

Preventing and treating non-communicable diseases

We aim to assess the burden of non-communicable diseases (NCDs) in Bangladesh, document the epidemiology and risk factors of the most common NCDs in Bangladesh, and evaluate new interventions relevant to low-income countries, with a focus on cardiovascular diseases and diabetes.

As NCDs become an issue of ever-greater importance in Bangladesh and other low-income countries, icddr,b has initiated a developmental research programme dedicated to research on NCD prevention and control.

Our goal is to identify cost-effective strategies for early detection of NCDs and risk factors, and to establish evidence-based best practices for improving health-seeking behaviours and quality of care in Bangladesh.

Our initial priorities are to identify the risk factors for cardiovascular diseases and diabetes, to support the development of targeted interventions. In addition, we have an interest in formative, epidemiological, health systems and implementation research on obesity, chronic respiratory diseases (chronic obstructive pulmonary disease, asthma), cancer, mental health (depression) and neurodevelopmental disorders (autism spectrum disorder).

We also explore healthcare-seeking behaviour to identify patients' preferences for particular providers and obstacles to timely care-seeking. Based on rigorous research, we aim to develop and test interventions suitable for low-resource settings. We also actively disseminate research results to various stakeholders and the Government of Bangladesh.

THE IMPACT OF DIABETES

Diabetes appears to have a disproportionately large impact on individuals in Bangladesh (see page 15).

COMBATING HYPERTENSION

Pilot studies suggest a package of simple interventions can have a major impact on control of blood pressure (see page 14).

RISING OBESITY

A systematic review has identified high and rising levels of overweight and obesity among young people in Bangladesh (1). The prevalence of overweight increased from 3.6% in 1998–2003 to 7.9% in 2010–15, while that of obesity fluctuated markedly but stood at 9.0% in 2010–15.

In light of this evidence, icddr,b researchers have developed a culturally appropriate 'healthy eating and active living' (HEAL) guideline for school children, and shown that the HEAL intervention was feasible to implement and acceptable to parents in an urban setting (2).

1. Biswas T *et al*. Overweight and obesity among children and adolescents in Bangladesh: a systematic review and meta-analysis. *Public Health*. 2017;142:94–101.

2. Pervin S *et al*. Healthy eating and active living (HEAL): Feasibility and acceptability of implementing school-based intervention to control childhood overweight and obesity in urban area of Bangladesh. *Ann Global Health* 2017;83(1): 176.

CARDIOVASCULAR CARE

icddr,b researchers are involved in two new initiatives that may lower the growing burden of cardiovascular disease

in Bangladesh and improve its clinical management. Studies being carried out under the umbrella of the international GEOHealth Hub – a partnership with the University of Chicago, USA, supported by the US National Institutes of Health (NIH) through the Fogarty International Center Global Environmental and Occupational Health (GEOHealth) programme – are focusing on the impact of household air pollution on preclinical markers of cardiovascular, pulmonary and immune system function, including the potential benefits of new types of cooking stove (1).

In addition, a study at Matlab is generating a comprehensive picture of the primary health care services available to people experiencing a stroke or heart attack (2). By assessing health facility capabilities and interviewing key health system staff and patients and their carers, the study will provide a clearer picture of the services available and obstacles to their use, underpinning improved models of service delivery.

1. https://clinicaltrials.gov/ct2/show/NCT02824237

2. Ahmed S *et al.* Access to primary health care for acute vascular events in rural low income settings: a mixed methods study. *BMC Health Serv Res*. 2017;17(1):47.

GLOBAL BURDEN OF DISEASE

icddr,b researchers have contributed to the latest Global Burden of Disease studies on maternal mortality (1), disease risk factors (2) and disability-adjusted life-years (DALYs; 3). The studies provide detailed analyses of global DALYs, risk factors and causes of death, including trends at national, regional and global levels, to inform policymaking.

1. GBD 2015 Maternal Mortality Collaborators. Global, regional, and national levels of maternal mortality, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1775–812.

2. GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1659–724.

3. GBD 2015 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1603–58.

AUTISM SPECTRUM DISORDER

icddr,b researchers have identified relatively high levels of depression among mothers of children with autism spectrum disorder (ASD). In follow-on work, a feasibility study has been launched, in collaboration with Harvard Medical School, to provide mental health support for mothers of children with ASD combined with enhanced parental skills for childcare through a home-based intervention (1).

In addition, an icddr,b research report on ASD formed the basis of a Strategic Plan for ASD and Neurodevelopmental Disorders drafted by the Bangladesh Ministry of Health and Family Welfare in 2016.

1. https://clinicaltrials.gov/ct2/show/NCT03025646

INTERNATIONAL COMPARISONS

icddr,b's population-based studies have contributed data to two international studies examining risk factors for non-communicable diseases. Across four regions – Africa, East Asia, South America and South Asia – different measures of obesity were consistently associated with increased risk of diabetes and hypertension; the consequences of different measures and types of obesity showed some subtle differences between regions (1).

Data from sites in South America and South Asia have confirmed that socioeconomic status is an important determinant of risk for chronic obstructive pulmonary disease (COPD), with COPD being markedly more common among the economically disadvantaged (2). The findings could inform the targeting of interventions to prevent COPD, which affects around one in ten adults.

1. Patel SA *et al*. Obesity and its relation with diabetes and hypertension: A cross-sectional study across 4 geographical regions. *Glob Heart*. 2016;11(1):71–79.e4.

2. Grigsby M *et al*. Socioeconomic status and COPD among low- and middle-income countries. *Int J Chron Obstruct Pulmon Dis*. 2016;11:2497–507.

OUR **PUBLICATIONS**

COMMITMENT TO PUBLICATION

We are committed to the rapid and full publication of research findings in international peer-reviewed journals.

Publication in the peer-reviewed scientific literature is a key indicator of quality, and an important step in the dissemination of new information to scientific, practitioner, policy and programme communities.

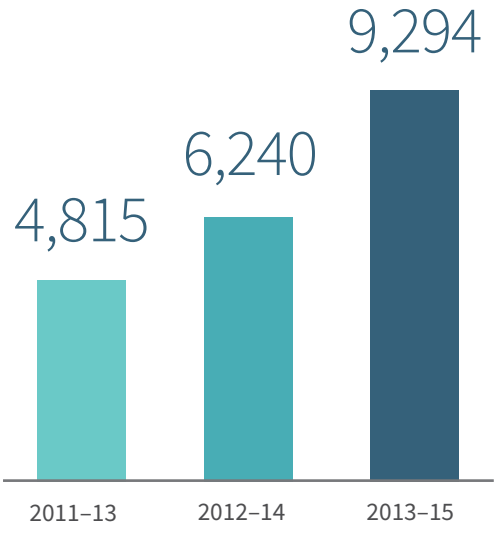
HIGH-PROFILE PUBLICATIONS IN 2016

In 2016, icddr,b researchers were authors on 317 original publications, and also contributed to 28 letters, editorials, book reviews and abstracts. These included outputs in leading journals, such as *Science*, *Science Translational Medicine*, the *Lancet*, *Lancet Global Health*, *Lancet Infectious Diseases*, *Nature Microbiology*, *PLoS Medicine*, *PLoS Neglected Tropical Diseases*, *Scientific Reports*, *Proceedings of the National Academy of Sciences USA*, *Vaccine* and the *New England Journal of Medicine*. The majority of papers were co-authored with national and international colleagues.

2016 PUBLICATIONS

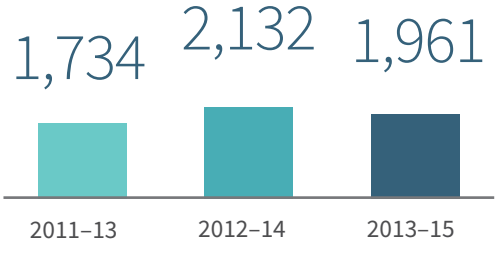
*including review articles and short reports in journals

CITATIONS I: ALL PAPERS



Citations of papers with icddr,b authors published in peer-reviewed journals during three-year periods, up to the end of the following year (e.g. end of 2014 for papers published in 2011–13).

CITATIONS II: PAPERS IN HIGH-IMPACT JOURNALS



Citations of papers with icddr,b authors published in peer-reviewed journals with journal impact factor greater than 9 during three-year periods, up to the end of the following year (e.g. end of 2014 for papers published in 2011–13).

COLLABORATIONS

Collaboration is core to our work. We work with multiple Government, academic and NGO partners in Bangladesh, ensuring a strong focus on local health issues, and have long-standing ties with scientific collaborators in leading research institutions across the world. We are also members of a range of regional networks, and work closely with partners across South Asia and in the global South.

COLLABORATING INSTITUTIONS

NORTH AMERICA

- Academy of Educational Development, Washington DC, USA
- Boston University School of Public Health, USA
- British Columbia Centre for Disease Control, Canada
- Centers for Disease Control and Prevention, USA
- Children's Hospital of Richmond at VCU, USA
- Columbia University, New York, USA
- Dartmouth Medical College, USA
- Duke University Medical Center, USA
- EcoHealth Alliance, New York, USA
- Emory University, Atlanta, USA
- Fenway Institute, Boston, USA
- FHI360, USA
- Food and Nutrition Technical Assistance III Project (FANTA III), USA
- Gynuity Health Projects, New York, USA
- Harvard Medical School, Boston, USA
- Harvard School of Public Health, USA
- Hospital for Sick Children, Toronto, Canada
- Infectious Disease Research Institute, Seattle, USA
- Institute for Disease Modeling, Bellevue, USA
- Institute of Health Metrics Evaluation, University of Washington, USA
- International Food Policy Research Institute (IFPRI), USA
- JHPIEGO, USA
- Jibon Health Technologies, Inc., USA
- Johns Hopkins Bloomberg School of Public Health, Baltimore, USA
- Johns Hopkins University School of Medicine, Baltimore, USA
- Massachusetts General Hospital, Boston, USA
- McGill University, Montreal, Canada
- Oklahoma State University, USA
- Oregon State University, USA
- Pan American Health Organization, USA
- PATH Vaccine Solutions (PVS), USA
- PATH, Seattle, USA
- Pennsylvania State University, USA
- Population Council, New York, USA
- PREVENT, USA
- Public Health Agency of Canada
- Rhode Island Hospital, USA
- Rollins School of Public Health, Emory University, Atlanta, USA
- Seattle Biomedical Research Institute, USA
- Stanford University School of Medicine, USA
- Stanford University, USA
- Texas Medical Center, USA
- The Consortium for Conservation Medicine, New York, USA
- The Peter Gilgan Centre for Research and Learning - SickKids, Toronto, Canada
- University at Buffalo, USA
- University of Alberta, Canada
- University of Arkansas Medical School, USA
- University of British Columbia, Canada
- University of Calgary, Canada
- University of California, Berkely, USA
- University of California, Davis, USA
- University of California, Los Angeles (UCLA), USA
- University of California, San Francisco, USA
- University of California, San Diego, USA
- University of California, Santa Cruz, USA
- University of Chicago, USA
- University of Colorado, Boulder, USA
- University of Denver, USA
- University of Florida, USA
- University of Kentucky College of Medicine, USA
- University of Manitoba, Winnipeg, Canada
- University of Maryland, Baltimore, USA
- University of Michigan, USA
- University of Missouri, USA
- University of North Carolina (UNC), USA
- University of North Carolina School of Medicine, USA
- University of Pittsburgh, USA
- University of Saskatchewan, Canada
- University of South Carolina, USA
- University of Texas at Galveston, USA
- University of Toronto, Canada
- University of Vermont, USA
- University of Virginia Health System, USA
- University of Virginia, USA
- University of Washington, USA
- Vanderbilt University, USA
- Walter Reed Army Institute of Research, USA
- Washington University School of Medicine, USA
- Western Human Nutrition Research Center, Davis, USA
- Yale School of Medicine, USA

EUROPE

- Bilthoven Biologicals, The Netherlands
- DNDi, Geneva, Switzerland
- Eawag, Dübendorf, Switzerland
- Ecole Polytechnique Fédérale de Lausanne, Switzerland
- Education for Health (EfH), UK
- Enfants du Monde, Geneva, Switzerland
- Erasmus MC University Medical Centre, Rotterdam, The Netherlands
- Foundation for Innovative New Diagnostics, Geneva, Switzerland
- GlaxoSmithKline Medicines Research Centre, Stevenage, UK
- Imperial College London, UK
- Institut Pasteur, Paris, France
- Institute of Child Health, UK
- International Atomic Energy Agency, Vienna, Austria
- KalaCORE Program, UK
- Karolinska Institute, Stockholm, Sweden
- Laboratorio de Referencia de Leishmaniasis, Spain
- London School of Hygiene and Tropical Medicine, UK
- Loughborough University, UK
- Ludwig-Maximilians University of Munich, Germany
- Medical University of Vienna, Austria
- Nestlé Research Centre, Lausanne, Switzerland
- Norwegian Institute of Public Health, Norway
- Nutriset SAS, Malaunay, France
- Overseas Development Institute (ODI), UK
- Sahlgrenska Academy of University of Gothenburg, Sweden
- Sheffield Hallam University, UK
- Sint Antonius Ziekenhuis, The Netherlands
- TDR, WHO, Geneva, Switzerland
- The Children's Investment Fund Foundation (CIFF), London, UK
- UCL Institute of Child Health, London, UK
- University College London, UK
- University of Amsterdam, The Netherlands
- University of Basel, Switzerland
- University of Cambridge, UK
- University of Copenhagen, Denmark
- University of Exeter, UK
- University of Glasgow, UK
- University of Gothenburg, Sweden
- University of Heidelberg, Germany
- University of Iceland, Iceland
- University of Manchester, UK
- University of Newcastle upon Tyne, UK
- University of Oxford, UK
- University of Paris, France
- University of Portsmouth, UK
- University of Southampton, UK
- University of St. Andrews, UK
- University of Sussex, UK
- University of Warwick, UK
- Uppsala University, Sweden
- Wellcome Trust Sanger Institute, UK

AUSTRALIA

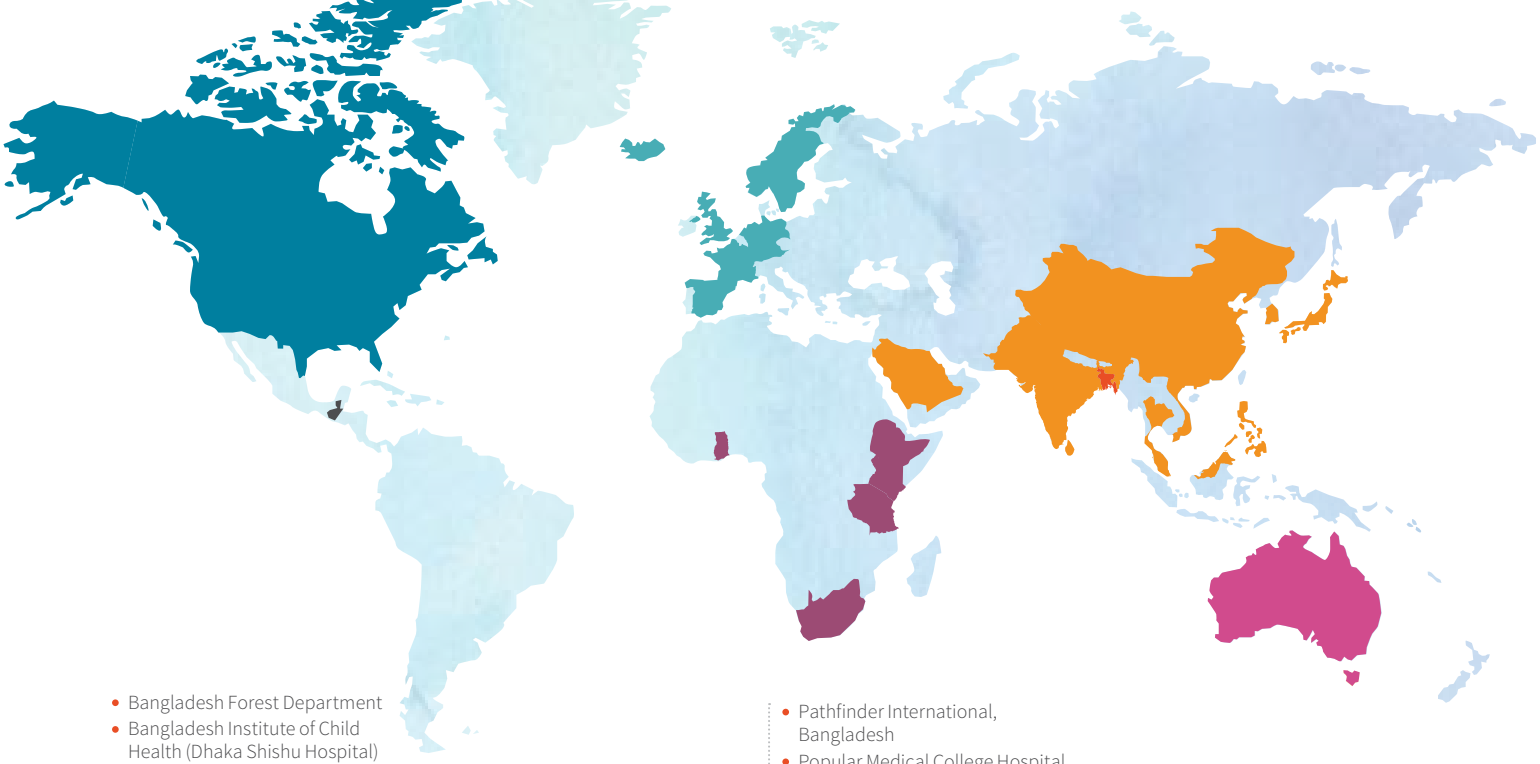
- Charles Sturt University
- Griffith University
- Macfarlane Burnet Institute for Medical Research and Public Health
- Menzies School of Health Research, Darwin
- Royal Children's Hospital, Melbourne
- University of Melbourne
- University of Queensland
- University of Sydney

AFRICA

- Ardhi University, Dar es Salaam, Tanzania
- Armauer Hansen Research Institute, Ethiopia
- KEMRI-Wellcome Trust Research Programme, Kenya
- MO Resources Ltd, Tanzania
- School of Public health, Moi University, Eldoret, Kenya
- Sokoine University of Agriculture, Morogoro, Tanzania
- South African Medical Research Council, South Africa
- University of Cape Town, South Africa
- University of Venda, South Africa

BANGLADESH

- 500 Bed Mugda General Hospital, Bangladesh
- Advanced Chemical Industries Limited, Bangladesh
- Autism Welfare Foundation
- Apollo Hospitals, Bangladesh
- Bandhu Social Welfare Society
- Bangladesh Atomic Energy commission, Bangladesh
- Bangladesh Customs, Bangladesh
- Bangabandhu Sk. Mujib Medical University and Hospital



- Bangladesh Forest Department
- Bangladesh Institute of Child Health (Dhaka Shishu Hospital)
- Bangladesh Institute of Research and Rehabilitation in Diabetes
- Bangladesh Legal Aid and Services Trust
- Bangladesh Lung Foundation
- Bangladesh Primary Care Respiratory Society (BPCRS)
- Bangladesh University of Engineering Technology
- Bangladesh University of Health Sciences
- BAPSA, Bangladesh
- Border Guard Bangladesh (BGB), Bangladesh
- BRAC
- BRAC Development Institute
- BRAC University
- CARE-Bangladesh
- Central Veterinary Hospital
- Centre for Injury Prevention and Research, Bangladesh
- Chittagong Maa O Shishu Medical College Hospital
- Chittagong Medical College and Hospital
- Chittagong USTC hospital, Pahartoli
- Community Health and Development Program, Bangladesh
- Damien Foundation Bangladesh
- Department of Livestock Services
- Dhaka City Corporation
- Dhaka Medical College and Hospital
- Dhaka North City Corporation
- Dhaka Shishu Hospital
- Dhaka South City Corporation
- Directorate General of Family Planning (DGFP), Bangladesh
- Directorate General of Health Services
- Engender Health
- Faridpur Medical College Hospital
- Food and Agriculture Organization, Bangladesh
- Foundation for Advancement of Innovations in Technology and Health(faith), Bangladesh
- Global Alliance for Improved Nutrition, Bangladesh
- Holy Family Red Crescent Medical College and Hospital
- ideSHi /CMBT (Institute for Developing Science & Health Initiatives), Bangladesh
- Incepta Pharmaceuticals, Bangladesh
- Institute of Chest Diseases Hospital
- Institute of Child Health and Shishu Sasthya Foundation Hospital
- Institute of Epidemiology, Disease Control and Research
- Institute of Public Health Nutrition
- Institute of Water Modelling
- James P Grant School of Public Health
- Khulna Medical College Hospital, Bangladesh
- Kumudini Hospital
- Labaid Specialized Hospital, Bangladesh
- LAMB
- Lepra Bangladesh
- Light House
- Marie Stopes Clinic Society, Bangladesh
- Maternal & Child Health Training Institute, Bangladesh
- Mawlana Bhashani Science and Technology University
- MBM Garments Ltd
- mDoc LLC, Bangladesh
- Ministry of Health and Family Welfare
- Ministry of Home Affairs
- Mohammadpur Fertility Services & Training Center, Bangladesh
- Mymensingh Medical College and Hospital
- National Centre for Tuberculosis and Research
- National Institute for Population Research and Training
- National Institute of Cardiovascular Disease (NICVD), Bangladesh
- National Institute of Diseases of Chest and Hospital
- National Institute of Mental Health
- National Institute of Neurosciences and Hospital
- National Medical College and Hospital
- National Tuberculosis Control Programme
- Obstetrical and Gynecological Society of Bangladesh
- Orbis International, Bangladesh
- Consumers Association of Bangladesh
- Parents Forum for Differently Able
- Pathfinder International, Bangladesh
- Popular Medical College Hospital
- PRAN-RFL Group
- Radda MCH-FP Centre
- Rajshahi Medical College and Hospital, Bangladesh
- Revitalization of Community Health Care Initiative in Bangladesh
- Research, Training, and Management (RTM) International, Bangladesh
- Save the Children, Bangladesh
- Seattle Biomedical Research Institute (SBRI), Bangladesh
- Shaheed Suhrawardy Medical College
- Shimantik
- Shyamoli TB Clinic
- Sightsavers, Bangladesh
- Sir Salimullah Medical College and Hospital
- Smiling Sun Franchise Program
- Society for the Welfare of Intellectually Disabled, Bangladesh
- Sylhet MAG Osmani Medical College and Hospital, Bangladesh
- Tauri Foundation (School for Gifted Children)
- Terre des Hommes, Bangladesh
- The Salvation Army International, Bangladesh
- UChicago Research Bangladesh, Bangladesh
- United Nations Children's Fund (UNICEF), Bangladesh
- University of Dhaka
- University Research Corporation, Banani
- Urban Primary Health Care Project
- Water Aid Bangladesh
- We Can Campaign, Bangladesh
- World Food Programme, Bangladesh
- World Health Organization, Bangladesh

OTHER ASIA

- Aga Khan University, Karachi, Pakistan
- Aichi Medical University, Japan
- Centre for Development Studies, India
- Clinogent, India
- Duke-NUS Graduate Medical School, Singapore
- Futures Group International India Pvt. Ltd, India
- Institute for Human Development, India
- Interactive Research and Development, Karachi, Pakistan
- International Food Policy Research Institute, New Delhi, India
- International Vaccine Institute, Seoul, South Korea
- Korea University Medical Center
- Mahidol University, Bangkok, Thailand
- MSD Welcome Trust Hilleman Laboratories (P) Ltd, India
- National Institute for Cholera and Enteric Diseases, Kolkata, India
- National Institute of Infectious Diseases, Japan
- PATH, India
- Rajiv Gandhi Centre for Biotechnology, Kerala, India
- Research and Training Centre for Community Development (RTCCD), Vietnam
- Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, India
- Serum Institute of India Ltd, India
- Sree Chitra Tirunal Institute for Medical Science and Technology, India
- Standard Diagnostics Inc., South Korea
- SUI Associates Co. Ltd, Japan
- Tokyo University Hospital, Japan
- Tokyo-Kasei University, Japan
- University of Colombo, Sri Lanka
- University of Kelaniya, Sri Lanka
- University of Nagasaki, Japan
- University of Tokyo, Japan
- We Can Campaign, India
- XIAMEN Innovax BIOTECH CO.Ltd, China
- Xiamen University School of Public Health, China
- Yamaguchi University Graduate School of Medicine, Japan

SOUTH/CENTRAL AMERICA

- Institute of Nutrition of Central America and Panama, Guatemala

AWARDS AND OTHER RECOGNITION

EBOLA VACCINE DEVELOPMENT

PROF. JOHN D CLEMENS

icddr,b Executive Director Professor John Clemens was appointed a member of the 'Ebola Vaccine Team B' initiative established by the Wellcome Trust and the Center for Infectious Disease Research and Policy at the University of Minnesota to advise on Ebola vaccine development. The Team released its third report in January 2017, calling for continuing efforts to enhance preparedness for future outbreaks.

http://www.cidrap.umn.edu/completing-development-ebola-vaccines

SHANTI SWARUP BHATNAGAR AWARD

DR NIYAZ AHMED

Dr Niyaz Ahmed, who joined icddr,b as Senior Director of the Laboratory Sciences and Services Division in November 2016, received the Shanti Swarup Bhatnagar Award for Medical Sciences in 2016, the most prestigious award in Indian science. The awards are made annually by the Council of Scientific and Industrial Research for notable and outstanding research in India.

CHOLERA CONTROL

DR MD SIRAJUL ISLAM

icddr,b Emeritus Scientist Dr Md Sirajul Islam received the prestigious SEED (Science, Education and Economic Development) Award 2016 conferred by the Rotary Club of Metropolitan Dhaka for his discovery of blue–green algae as the reservoir of cholera, and the development of 'Siraj Mixture' – a combination of chemicals that can decontaminate surface water.

OTHER RECOGNITION IN 2016

Dr Md Iqbal Hossain received an international healthcare award from the Society of Paediatric Gastroenterology, Hepatology, Transplant and Nutrition at its international conference held in Jaipur, India, in recognition of his contribution to both research and clinical services, particularly in childhood development.

icddr,b consultant **Dr Md Zeaur Rahim** received a certificate for highly cited research from the journal *Tuberculosis*. His article 'Diagnosis of active tuberculosis by e-nose analysis of exhaled air', published in 2013, was one of the five most highly cited articles between 2014 and June 2016.

INDIAN NATIONAL SCIENCE ACADEMY

DR FIRDAUSI QADRI

Dr Firdausi Qadri has been elected a Foreign Fellow of the Indian National Science Academy. Dr Qadri is also a member of the WHO Strategic Advisory Group of Experts (SAGE) on Immunisation and WHO Global Task Force on Cholera Control.

GUT INFECTIONS

DR RASHIDUL HAQUE

Dr Rashidul Haque has been named an Honorary International Fellow by the American Society of Tropical Medicine and Hygiene. The award recognises Dr Haque's landmark work on intestinal parasites, the gut microbiome, and links to childhood malnutrition and impaired neurodevelopment.

POLIO VACCINES

DR K ZAMAN

A group of icddr,b scientists led by Dr K Zaman and a team from the US Centers for Disease Control and Prevention (CDC) have won the 2016 Charles C Shepard Science Award for their article on polio vaccines published in *Lancet Infectious Diseases* (1).

Dr Zaman has also been appointed a member of the polio immunization working group of the WHO Strategic Advisory Group of Experts (SAGE) on Immunization.

1. Estívariz CF *et al*. Immunogenicity of three doses of bivalent, trivalent, or type 1 monovalent oral poliovirus vaccines with a 2 week interval between doses in Bangladesh: an open-label, non-inferiority, randomised, controlled trial. *Lancet Infect Dis.* 2015;15(8):898–904.

BMJ AWARDS

DR ALIYA NAHEED

Dr Aliya Naheed was a member of the jury panel for the 2016 BMJ Awards South Asia held in New Delhi. The awards recognise the work of outstanding medical doctors in South Asia.

Dr Towfida Jahan Siddiqua received a 2016 Gro Brundtland Award in public health nutrition. The awards recognise the achievements of early-career female researchers from developing countries.

Dr Farhana Khanam has been nominated by the World Academy of Sciences (TWAS) as a 2016 TWAS Young Affiliate, a mark of recognition for promising early career researchers from developing countries.

Md Deen Islam received the best poster award for his master's thesis at an international conference organised by the Bangladesh Society of Microbiologists and the Department of Microbiology, University of Dhaka.

OUR **TRAINING**

icddr,b provides a wealth of training opportunities for researchers, practitioners, policymakers and others, from Bangladesh and globally.

icddr,b scientists, clinicians and research facilities, including its field sites, offer a rich wealth of learning resources for the next generation of researchers, clinicians and practitioners. Participants in training programmes have the opportunity to learn from leading experts, gain valuable field experience and see first-hand how low-cost interventions are developed and implemented in a low-income setting.

In addition to specialist training provided by icddr,b's Technical Training Unit, icddr,b's research divisions also provide training and technical assistance to participants from Bangladesh, the region and globally. icddr,b staff also make important contributions to teaching programmes at the James P Grant School of Public Health.

In 2016, highlights included:

BLENDED E-LEARNING

icddr,b completed a three-year pilot of a blended e-learning course, the International Asthma Module Course. Developed in collaboration with the Bangladesh Primary Care Respiratory Society and the UK-based Education for Health, the course was our first-ever clinical skill building e-learning course based on a blended approach, and was designed to enable more primary care physicians across Bangladesh to develop their skills in asthma management.

RURAL MEDICAL PRACTITIONERS

icddr,b completed the training of more than 600 rural medical practitioners (RMPs), as part of a capacity-building programme supported by ACI Pharma Ltd. RMPs are informally trained practitioners, serving about 65% of people in rural populations in Bangladesh. Addressing their knowledge gaps through training enhances their focus on disease prevention and health promotion as well as medical care, and can improve links to formal health care through appropriate referral.

Since 2006, icddr,b has been testing different interventions to improve the quality of the services offered by RMPs and created a franchise called Shasthya Sena ('health soldier') in Chakaria that has provided a suitable model for wider scale up in Bangladesh. Since 2013, based on the lessons learned, icddr,b has been working to build the capacity of RMPs, reaching its target of 1,800 trained RMPs in 2016.

WHO-TDR TRAINING SCHEME

icddr,b teamed up with the James P Grant School of Public Health and BRAC University on a four-year collaborative initiative to implement a postgraduate training scheme on behalf of the WHO's Special Programme for Research and Training in Tropical Diseases (TDR). The objectives of the scheme, which is focused on implementation research, include building institutional capacity and the skills of TDR Fellows in Implementation Research and others with an interest in implementation.

Countries represented by students attending icddr,b training courses, and field experience and orientation programmes:

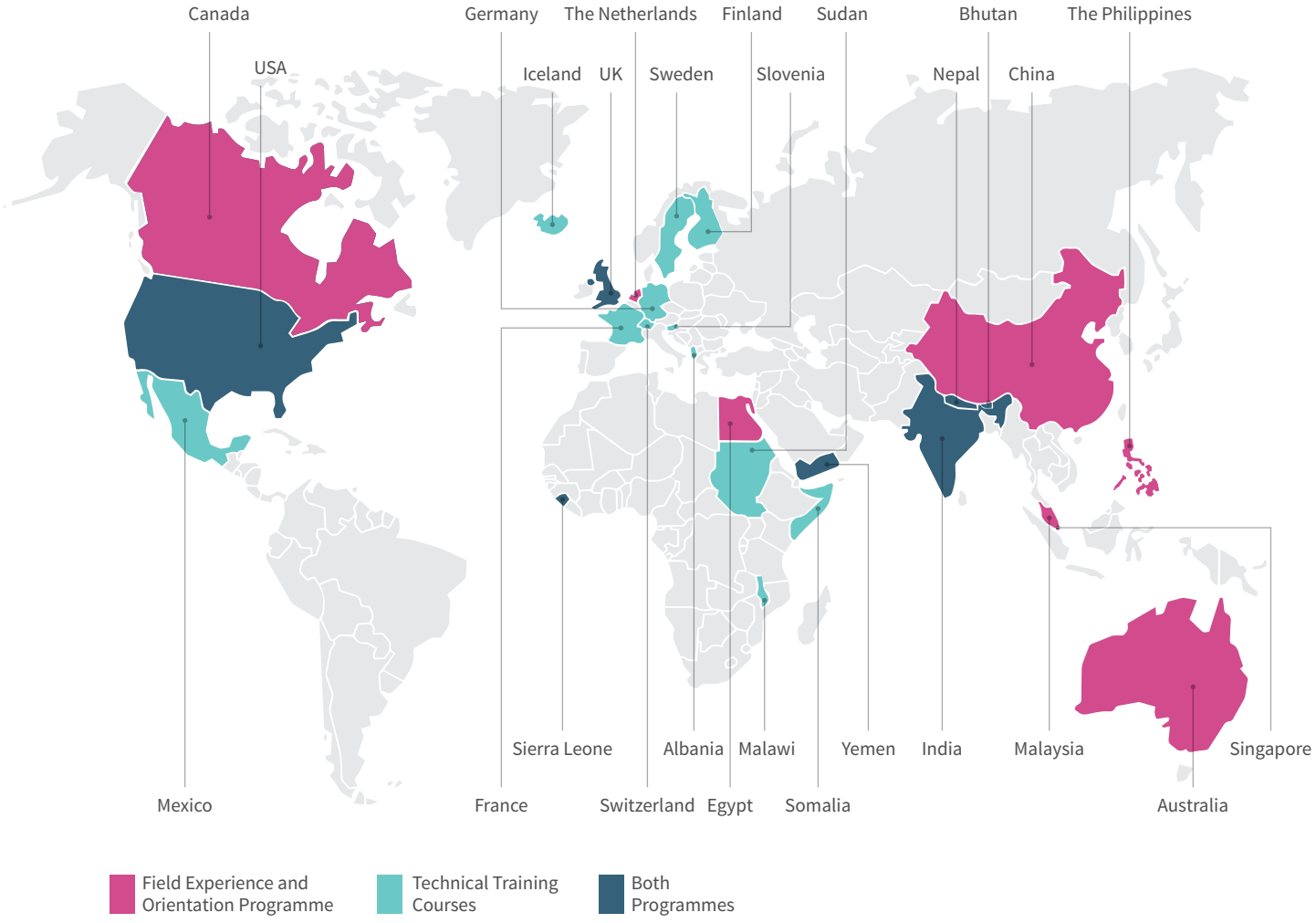
FIELD EXPERIENCE AND ORIENTATION PROGRAMMES:

Bhutan, India, Nepal, Sierra Leone, USA and Yemen [orientation]

Australia, Canada, China, Egypt, Malaysia, India, The Netherlands, The Philippines, Singapore, UK, USA [field experience]

TECHNICAL TRAINING COURSES:

Albania, Bhutan, Finland, France, Germany, Iceland, India, Malawi, Mexico, Nepal, Sierra Leone, Slovenia, Somalia, Sudan, Sweden, Switzerland, UK, USA and Yemen



Technical Training Unit	**46 training events** **2,193 participants**
James P Grant School of Public Health (a collaboration with BRAC and BRAC University)	**15 (11 male and 4 female) icddr,b staff hold academic positions**
Field experience programme: Aimed at master's and PhD students seeking practical insights into, and experience of, public health in a low-resource setting	**176 students hosted:** **109 national, 67 international**
Orientation programme: Tailored to meet specific curricular needs, primarily for medical students interested in research and humanitarian activities	**1,004 students hosted:** **878 national, 126 international**

OUR **SERVICES**

We offer a range of services, nationally and internationally. Our hospitals in Dhaka and Matlab provide high-quality care free of charge to those in need. Internationally, we provide advice to low-income countries on the set up of health facilities and also contribute to international disease control efforts in crisis situations. We also offer paid-for clinical laboratory testing services, the income from which supports provision of care in our hospitals.

For decades, as part of our 'social contract' with the communities with whom we work, we have provided high-quality clinical care through our hospitals at Dhaka and Matlab and at the Mirpur Treatment Centre. In 2016, our clinicians treated more than 200,000 patients, principally at the Dhaka Hospital. More than half of these patients were infants under one year of age.

Being intimately involved in the delivery of care enables our clinical researchers to develop a deep understanding of the key health issues facing local populations, and to identify appropriate interventions with the potential to be implemented locally or in similar facilities if they are shown to be effective. Our clinical facilities also provide a showcase of what can be achieved in a resource-constrained environment in a low-income country.

Our hospital facilities are important sites for surveillance, clinical training and the testing of new interventions. icddr,b also has a duty of care to the local communities who make such an important contribution to public health research.

IBBL, a major Bangladeshi Bank, signed a five-year agreement, totalling more than US$1m to cover the entire cost of treatment for severe malnourished children in our Dhaka Hospital's Nutrition Rehabilitation Unit and including US$100,000 per year to support fellowships for junior Bangladeshi scientists.

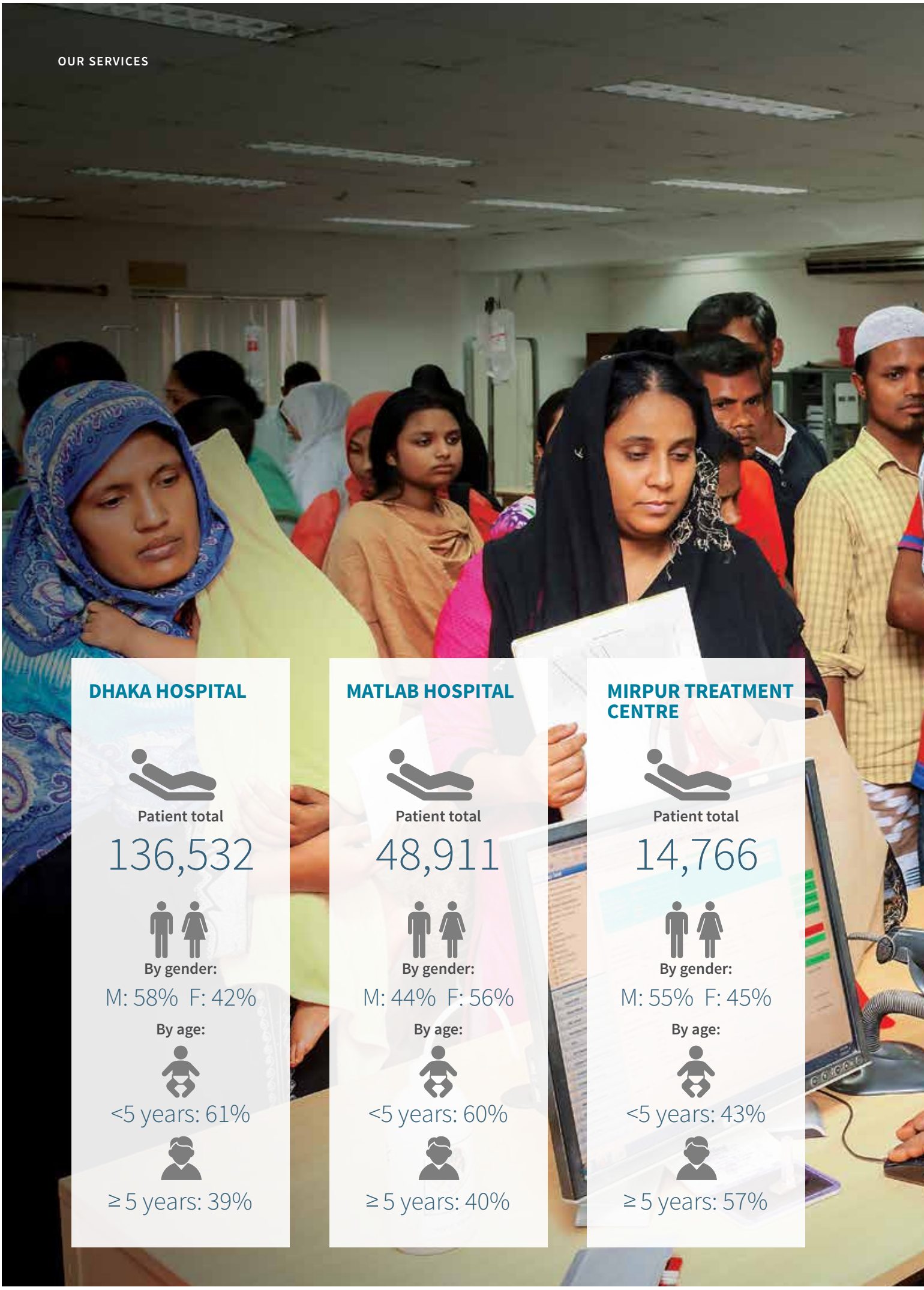
200,209

Patients treated

119,014

(59%)

Number of children <5 years



DHAKA HOSPITAL

Patient total

136,532

By gender:

M: 58% F: 42%

By age:

<5 years: 61%

≥ 5 years: 39%

MATLAB HOSPITAL

Patient total

48,911

By gender:

M: 44% F: 56%

By age:

<5 years: 60%

≥ 5 years: 40%

MIRPUR TREATMENT CENTRE

Patient total

14,766

By gender:

M: 55% F: 45%

By age:

<5 years: 43%

≥ 5 years: 57%

INTERNATIONAL CAPACITY BUILDING

In 2016, icddr,b staff continued their long-standing commitment to supporting infectious disease-control efforts in crisis-affected regions, and also joined a partnership helping to establish high-quality neonatal intensive care facilities in The Gambia.

In 2016, an icddr,b team undertook two week-long 'training of trainers' visits to Iraq and to Syria to build the countries' capacity to prevent and manage diarrhoeal disease, including cholera outbreaks. In Iraq, some 42 doctors and nurses received training in the province of Duhok and Sulaimania, while 38 health workers were trained in the Syrian province of Latakia.

The visits were organised by the WHO's Eastern Mediterranean Regional Office and represented joint initiatives between icddr,b and the WHO's Global Outbreak Alert and Response Network (GOARN). icddr,b was a founder member of GOARN and icddr,b's Dr Pradip Bardhan is a member of the GOARN Steering Committee.

In July 2016, icddr,b researchers and colleagues from Bangabandhu Sheikh Mujib Medical University in Dhaka travelled to The Gambia to advise on the development of a neonatal intensive care unit at the general hospital in Farafenni. The visit was coordinated by the Islamic Development Bank, which had received a request from the Government of The Gambia for support to establish a neonatal intensive care unit at the hospital. The visit's key aim was to identify the capacity development needs of the hospital and ways in which they could be addressed to support the set up and running of the unit.

The project illustrates icddr,b's commitment to the Islamic Development Bank's 'reverse linkage' projects, designed to promote South–South collaboration. It built on a 2015 visit to icddr,b by officials from the ministries of health and public hospitals in The Gambia and other African countries, brokered by the Islamic Development Bank, which provided an opportunity to showcase icddr,b expertise and innovations in areas such as diarrhoeal disease management and maternal and neonatal care.

LABORATORY TESTING SERVICES

icddr,b offers a range of high-quality clinical laboratory diagnostic services to patients referred by different clinics, as well as supporting icddr,b research studies and generating an income that supports the life-saving work of our hospitals in Dhaka and Matlab.

icddr,b operates an internationally recognised clinical diagnostic laboratory service which is accredited under ISO 15189/15190 and meets global standards. The service offers a wide range of diagnostic tests, spanning routine assays of physiological function, serological and microbiological screening as well as more complex haematological and molecular diagnostics. The laboratories provide an important service to icddr,b researchers, and close contact with research laboratories ensures that they are able to offer the most up-to-date tests. Our high-quality laboratory services are also made available at a reasonable cost to healthcare providers, so patients can also benefit from our expertise and accredited laboratory tests and diagnostics. Profits from these activities are fed back to support work at our hospital facilities in Dhaka and Matlab.

1,563,789 number of tests carried out

385
number of tests offered

4
number of new tests introduced

2,435
number of tests carried out as part of hospital surveillance studies

153,690
number of paid users

15
number of icddr,b projects supported

OUR **CORPORATE SERVICES**

The year has seen us make significant progress towards the goals outlined in our recently published Strategic Plan – investing in our people, improving organisational efficiency and cost-effectiveness, and ensuring financial sustainability.

The year has seen several changes in our approach to developing our staff. Our recruitment is now focused on functional and behavioural competencies, enabling internal as well as external candidates to better align their abilities and experience to vacancies. We continue to encourage external learning, with a number of scholars undertaking studies in Australia, the UK, the USA, Canada, India and Thailand, among others. Our two training departments have become more closely aligned, improving the delivery of both technical and non-technical training. We are also moving forward with a review of icddr,b's attitudes to diversity, and a new project is looking at wellness and health across the organisation.

During 2016, our corporate services teams worked across functions to improve the efficiency of our operations and to enhance our communications to ensure that we continue to meet internationally recognised standards of governance, compliance and transparency. The professionalism and flexibility of staff, as well as a willingness to modernise, has enabled us to strengthen our key functions and identify areas of improvement. This has included the conclusion of our 'Process Optimisation' project, which has seen the redesign or creation of 163 processes that have significantly enhanced our operations.

We have benefited from the work of our Internal Oversight function, which has undertaken a range of departmental audits, and offered advice and made recommendations for improvements. We have continued to ensure international business standards are maintained through good risk management. As well as this focus on internal business functions, we have also carried out significant work to strengthen the infrastructure of our buildings.

In 2016, we completed an overhaul of our branding and communications activities, launching a new website with additional functionality and enhancing our social media coverage, ensuring that we achieve wider recognition for our work and greater impact. Interactions with international media have also ensured that our work is reported to wider global audiences.

Controlling costs while maintaining quality is a continuing strategy for ensuring our long-term financial sustainability. This year, we have made good progress towards total cost recovery work for projects. Our sustained efforts during 2016 will allow us to move forwards with a stronger, focused corporate services team providing excellent support and guidance across the organisation.

We aim to create a workplace that ensures people are always treated with dignity and respect. We believe that different ways of thinking complement each other, and that diverse teams are more creative and inclusive, better reflecting the communities we serve. We aim to recruit and nurture the best qualified people to ensure the sustainability of icddr,b into the future, and to continue embedding a culture that affirms equal opportunities for all staff, regardless of gender, race, religion, marital or family status, sexual orientation or disability.


icddr,b

OUR **PEOPLE**

Our 4,000 plus staff are led by Executive Director Professor John D Clemens and the Senior Leadership Team. Together they are responsible for the day-to-day running of the organisation and are accountable to the Board of Trustees.

SENIOR LEADERSHIP TEAM

AS OF 1 MAY 2017

Professor John D Clemens
Executive Director

Mr Syed Monjurul Islam
Deputy Executive Director

Dr Firdausi Qadri
Acting Senior Director, Infectious Diseases Division

Dr Shams El Arifeen
Senior Director, Maternal and Child Health Division

Dr Tahmeed Ahmed
Senior Director, Nutrition and Clinical Services Division

Dr Niyaz Ahmed
Senior Director, Laboratory Sciences and Services Division

Dr Quamrun Nahar
Acting Senior Director, Health Systems and Population Studies Division

Ms Catherine Spencer
Principal Communications Lead, Communications

Mr Duncan Strutt
Director, Human Resources

Mr Thomas Barry
Director, Finance

OBSERVERS

Mr Anthony Flynn
Director, Development

Ms Armana Ahmed
Head, Research Administration

Mr Nagarajan Nagarajan
Acting Director, Internal Oversight

Mr Nizam Ahmed
Acting Director, Supply Chain and Facilities Management

SLT SECRETARIAT

Ms Loretta Saldanha
Executive Assistant to the Executive Director

BOARD OF TRUSTEES

AS OF 1 MAY 2017

icddr,b's Board of Trustees comprises 16 health professionals and researchers representing both developed and developing countries.

The Board was created by an Ordinance of the Government of the People's Republic of Bangladesh. Three members are nominated by the People's Republic of the Government of Bangladesh, with the WHO and UNICEF nominating one member each. icddr,b's Executive Director serves as the Member Secretary.

The Board operates under the icddr,b Ordinance and the accompanying Board of Trustees Bylaws. The Board of Trustees' roles and responsibilities include fund oversight; approving and monitoring the budget; setting broad institution-wide policies, as well as monitoring adherence to the Strategic Plan 2015-18; employing, evaluating and supporting the Executive Director; maintaining the line between governance and management; and evaluating the Board's own performance.

Chair

Dr Richard S W Smith
Adjunct Professor
Imperial College Institute for Global Health Innovation
London, UK

Member Secretary

Professor John D Clemens
Executive Director, icddr,b
(ex officio)

REPRESENTING THE GOVERNMENT OF BANGLADESH

Kazi Shofiqul Azam
Secretary-in-charge,
Economic Relations Division,
Ministry of Finance

Md. Sirazul Islam
Secretary, Ministry of Health and Family Welfare

Dr Abbas Bhuiya
Chief Editor, International Journal for Population Development and Health, Partners in Population and Development (PPD)

REPRESENTING UNICEF

Sanjay Wijesekera
Associate Director and Chief of Water, Sanitation and Hygiene Programme Division, UNICEF, New York, USA

REPRESENTING THE WHO

Dr G B Nair
Acting Regional Advisor of the Research, Policy and Cooperation Unit, Department of Communicable Diseases
WHO Regional Office for South-East Asia (SEARO)

INDEPENDENT MEMBERS

Rajesh Agrawal
Assistant Director General of Finance (Chief Finance Officer), International Crops Research Institute for the Semi-Arid Tropics, India

Professor Zulfiqar Ahmed Bhutta
Husein Laljee Dewraj Professor and Founding Chairman, Division of Women and Child Health, Aga Khan University, Karachi, Pakistan

Kenneth M Dye
International Development Consultant on governance and accountability; former Auditor General of Canada

Professor Thein Thein Htay
Former Deputy Minister for Health, Senior Public Health Advisor, University Research Co., Myanmar

Professor Ann Marie Svennerholm
Professor of Infection and Immunity, Department of Microbiology and Immunology, Sahigrenska Academy at the University of Gothenburg, Sweden

Dr Jeannette Vega
Managing Director, Rockefeller Foundation Santiago, Chile

Professor Maxine Whittaker
Dean, College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Australia

Dr Demissie Habte
The African Academy of Sciences and Honorary Fellow of the London School of Hygiene and Tropical Medicine, First President of the Ethiopian Academy of Sciences, Ethiopia (Since November 2016)

Professor Abdullah H Baqui
Professor, Department of International Health
Director, International Center for Maternal and Newborn Health, Johns Hopkins University, USA

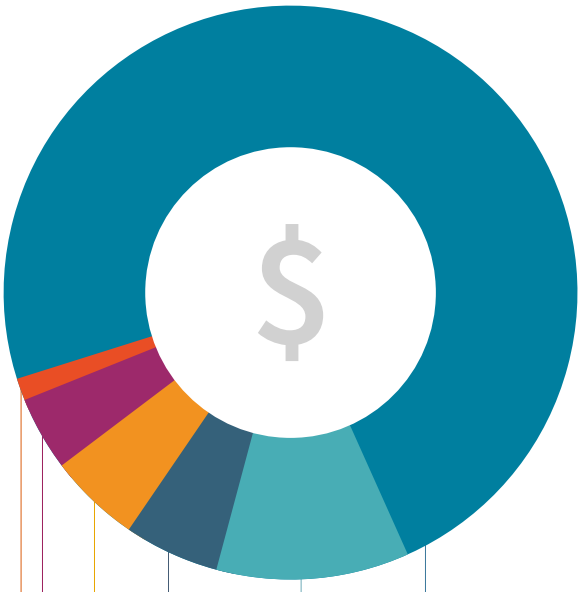
We would like to thank former board members Professor Md. Suhrab Ali, Professor Zhongwei Zhao and Syed Monjurul Islam for their service in 2016.

OUR **FINANCES**

icddr,b's overall revenues for 2016 amounted to US$68.5m compared with a total expenditure of US$67m, generating a gross surplus for the year of US$1.45m. However, actual net surplus was US$136,000 after exchange losses of US$1.3m (US$1.2m is unrealised) mainly as a result of Brexit.

REVENUE

Our overall revenue for 2016 of US$68.5m (see below) represented a decrease of US$0.2m compared with 2015 (before exchange gain of US$204,000). Restricted grant contributions fell slightly, by US$0.3m to US$50.1m. Unrestricted grant contributions decreased by US$0.8m, due to reduced core donor funding.



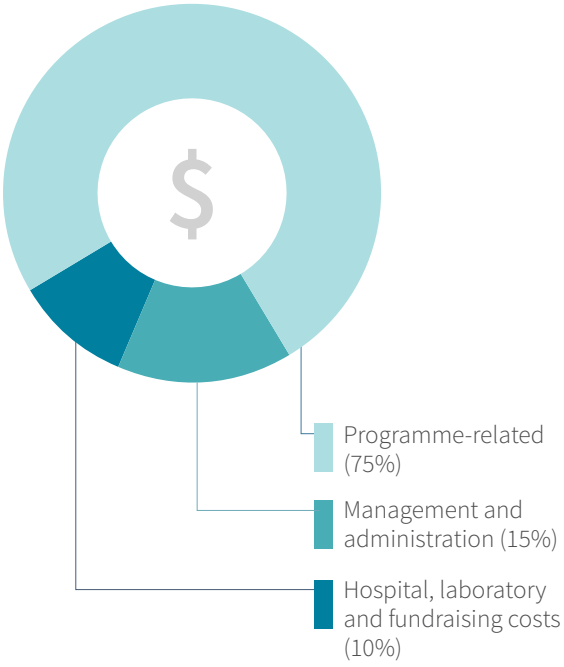
Breakdown of revenues 2016

Restricted grant contributions	US$50,157,400 (73.2%)
Unrestricted grant contributions	US$7,495,941 (10.9%)
Income from laboratories	US$3,595,424 (5.2%)
Deferred income on land	US$3,557,194 (5.2%)
Other unrestricted Income	US$2,852,268 (4.2%)
Other restricted income	US$848,967 (1.2%)

EXPENDITURE

- Total expenditure for 2016 amounted to US$67m, a decrease of US$1m compared with 2015.
- The majority of expenditure (75%) related to programme-specific activities. Management and administration accounted for 15% of all total expenditure and hospital, laboratory and fundraising 10%.

Breakdown of expenditure for 2016



Detailed expenditure for 2016:

Salaries and benefits	US$37,082,036
Supplies and materials	US$8,351,201
Collaborative partnership costs	US$4,260,354
Depreciation and amortisation	US$5,886,983
Travel and vehicle hire charges	US$3,600,716
Consultancy fees	US$1,218,169
Rent, communication and utilities	US$1,737,741
Training, dissemination and staff development	US$1,720,630
Hospital patient expenses	US$700,994
Cleaning and security charges	US$794,017
Mandatory committee meeting expenses	US$253,714
Doubtful debt expenses	US$24,906
Other operational costs	US$1,419,743

OTHER KEY FINANCIAL STATISTICS FOR 2016

1. At the end of the year, icddr,b had US$73.8m in net assets.
2. Cash and cash equivalents amounted to US$24.6m at the end of the year.
3. Accounts receivables (debtors) increased by 15%, since more grants were awarded on a cost reimbursable basis in 2016, many of which submitted invoices due for payment in 2017.
4. Accounts payables decreased by 6% as payment processes improved.
5. Provisions also decreased by 11% as result of a reduction in capital provisions for work not completed and project provisions.
6. The current ratio (liquidity) has improved by 2% from 1.33 in 2015 to 1.36 in 2016, reflecting overall reduction in current liabilities.
7. Stock inventories have increased by 28% following approval of new projects which began implementation in the last quarter.
8. Investments fell by 65% as a result of the transfer of staff pension funds of US$23.4m to the Provident Fund.
9. Loans and advances rose by 32% due to increased supplier and project advances.
10. The workforce reduced from 4,444 in 2015 to 4,041 or by 9% in 2016. The total number of scientific staff at the end of the year was 222.
11. Indirect costs (expenses that are not readily identified with a particular grant, contract, project function or activity, but are necessary for the general operations of the organisation) fell from 33% (32.9%) to 31% (31.21%); this figure includes hospital and laboratory costs of 10%.
12. Overall expenditure was lower by 6% against the approved annual budget for 2016. This result is within normal expectations and represents a considerable improvement on 2015 budgetary performance.

icddr,b received an unqualified (healthy) audit opinion from ACNABIN chartered accountants in respect of its financial statements for 2016. These statements are available at **www.icddrb.org/about-us/reports/financial-reports**.

RECOGNISING OUR **SUPPORTERS**

We are indebted to the foundations, institutions, corporations, development agencies, NGOs and multilateral bodies that support our work.

Top 10 donors during 2016

	Donor partners	Restricted (US$)	Unrestricted (US$)	Total (US$)
1	Bill & Melinda Gates Foundation	11,495,244	-	11,495,244
2	Department for International Development (DFID) - UK Aid	5,161,270	3,394,072	8,555,342
3	USG - Centers for Disease Control and Prevention (CDC)	5,195,643	-	5,195,643
4	USG - National Institutes of Health (NIH)	3,617,918	-	3,617,918
5	Global Fund for AIDS, TB and Malaria (GFATM)	2,891,766	-	2,891,766
6	Global Affairs Canada (GAC)	106,947	2,686,178	2,793,125
7	USG - United States Agency for International Development (USAID)	2,423,413	-	2,423,413
8	Government of the People's Republic of Bangladesh	731,214	1,415,691	2,146,905
9	United Nations Development Group (UNDG)	1,085,702	-	1,085,702
10	Gavi Alliance, Switzerland	1,043,671	-	1,043,671

A complete list of donors is provided in Note 22 to the financial statements: **www.icddrb.org/about-us/reports/financial-reports**

CORE DONOR FUNDING

We are grateful for the core support provided by the governments of Bangladesh, Canada, Sweden and the UK.

The Core Donors provide funding that:

1. Enables us to focus on and pursue strategic research objectives, aligned with the new global development agenda, including increased capacity building, advocacy and policy development activities
2. Enhances our financial stability, reducing our vulnerability to changes in the volatile research-funding environment, and giving us more independence to prioritise our own research agenda and to support worthwhile activities that are not funded by other donors
3. Facilitates our investment in maintaining and improving our core infrastructure essential to scientific advances, such as disease surveillance networks, state-of-the-art laboratories, and humanitarian services at icddr,b hospitals and clinics, which provide care free of charge to the poorest communities
4. Allows us to continue to modernise our operations – financial, human resources, communications, and monitoring and evaluation– to improve our organisational efficiency and cost-effectiveness.

Together, these and future investments will ensure that icddr,b continues to generate high-quality research knowledge.

ANNUAL REPORT 2016

icddr,b

Postal address: GPO Box 128, Dhaka 1000, Bangladesh
Delivery & visitors: 68, Shaheed Tajuddin Ahmed Sarani, Mohakhali, Dhaka 1212

T (88 02) 9827001-10, **F** (88 02) 9827075, 9827077, **E** info@icddrb.org
www.icddrb.org @icddr_b /icddrb icddr,b