ANNUAL REPORT 2017

Solving public health problems through innovative scientific research
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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 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:

[Logos of Government of the People’s Republic of Bangladesh, Canada, Sweden, and UK Aid]
In 2017, I was proud to accept the 2017 Conrad N Hilton Humanitarian Prize on behalf of icddr,b. The prize recognised our commitment to the development of innovative low-cost solutions to key public health challenges in resource-poor settings. Our key role in the development of oral rehydration solution (ORS) for treatment of diarrhoeal disease – an innovation that has saved literally millions of lives – is the most obvious example of this objective, but it continues to drive our work today.

Public health crises naturally call for immediate action. Our humanitarian mission sees us use our knowledge in emergency situations. In 2017, we made important contributions to the response to the Rohingya crisis and to the unfolding catastrophe in Yemen, passing on our knowledge of cholera treatment and prevention. Meanwhile, our hospitals in Dhaka and at Matlab continue to provide life-saving clinical services, free to anyone in need.

But public health crises are also an opportunity to learn – to carry out the research that will generate the evidence to improve responses in the future. In our support for the response to the Rohingya crisis, we have helped to avert a cholera outbreak via the oral cholera vaccine. We have also embedded research studies that will tell us much about the use of oral cholera vaccine in crisis situations.

It is sometimes overlooked that the development of ORS was not simply based on the replacement of lost fluids but depended on a deep understanding of the mechanisms of fluid loss in the gut – it was based on years of careful research. In addition, it needed careful clinical evaluation – early attempts at oral rehydration (not at icddr,b) had high fatality rates. And the therapy had to be practical enough to use at scale locally – which the main alternative at the time, intravenous infusion, was not.

ORS truly showed its worth during the outbreak of cholera in refugee camps during the 1971 Bangladesh War of Independence, when it reduced mortality from 40% to less than 5%. Unusually, therefore, ORS was developed in the global South, in response to the needs of the global South, and as a solution appropriate to the global South.

At icddr,b, we have a commitment to saving lives today, but the true power of research lies in its ability to save lives in the future.
As we seek solutions to bridge global divides, the world can learn a lot from icddr,b – not just about vaccines, but about scientifically researched approaches to public health problems that work.

Peter Laugharn
Hilton Foundation President and CEO

Today, Bangladesh has made great strides in reducing maternal and child mortality as well as food insecurity. But it still faces many of the same challenges as in the 1970s, along with new ones – not least the alarming rise in non-communicable diseases and the potential impact of climate change.

Hence, our approach remains the same – to understand priority health issues, to use our ingenuity and contacts in global knowledge to develop innovative but practical solutions to these challenges, and to carry out the research to evaluate them and ensure the implementation of proven interventions. In that way, we are helping to create a healthier future for the citizens of Bangladesh – and of many other countries in the global South.

PROFESSOR JOHN D CLEMENS
Executive Director
May 2018
icddr,b IN NUMBERS
A snapshot of icddr,b funding, research, training and clinical services

Total income
US$65.92m

208 scientific staff
66% male
34% female

4,069 all staff
51% male
49% female

219,738 patients treated in 2 hospitals and 1 treatment centre
52% male patients
48% female patients
96 new grants
354 ongoing projects

67 national collaborations
178 international collaborations

396 original papers published*
11,671 citations from 2014-2016

$50.3m funding from competitive sources
$11.4m other income
$3.4m funding from core donors
$0.8m other restricted income

141 national policy review committees with icddr,b representation
1,111 attendees of icddr,b training courses
1,040 students hosted by icddr,b’s orientation programme for medical students
11 icddr,b staff contributing to teaching at the James P Grant School of Public Health
4 faculty positions held by icddr,b staff at the James P Grant School of Public Health (a joint venture with BRAC and BRAC university)

* with icddr,b scientists as authors
The USD 2 million Hilton Humanitarian Prize is presented to non-profit organisations judged to have made extraordinary contributions towards alleviating human suffering.

We were selected as winners by an independent panel of distinguished international jurors in recognition of our innovative approach to solving global health issues affecting the world’s most impoverished communities. As well as our key role in the development of oral rehydration solution (ORS) for cholera and other diarrhoeal diseases, icddr,b has been a global beacon demonstrating how high-quality research can address the challenges faced by countries in the global South.

For more than 50 years, icddr,b has been at the forefront of low-cost, innovative health solutions that have resulted in saving tens of millions of lives globally. icddr,b has had a profound impact on health crises and solutions worldwide, and has shown that innovation and breakthroughs can come from all parts of the globe.

Peter Laugharn
Hilton Foundation President and CEO
In 2017, southern regions of Bangladesh were inundated with an influx of Forcibly Displaced Myanmar Nationals (FDMN) following a violent military crackdown. Quickly overwhelming the capacity of official make shift camps, the displaced Rohingyas established temporary dwellings in which the risk of outbreak of diseases such as cholera was extremely high.

Following an initial risk assessment, the Government of Bangladesh convened national and international partners, including icddr,b, to discuss outbreak prevention. icddr,b’s executive director Professor John Clemens identified a need for pre-emptive use of oral cholera vaccine (OCV), and acting senior director, Infectious Diseases, Dr Firdausi Qadri coordinated a joint application, with the Government of Bangladesh and other partners, to the International Coordinating Group (ICG) requesting access to the global OCV stockpile.

The ICG responded within 24 hours, authorising the release of 900,000 doses of OCV. We provided a 150-strong, experienced vaccination team and helped to develop a detailed implementation plan to ensure that the vaccine reached those in need. Some 700,000 FDMN were immunised in mid-October 2017, with a second dose of OCV and oral polio vaccine delivered to the most vulnerable - children under five years - in early November.

With the Institute of Epidemiology, Disease Control and Research, we have been contributing to ongoing surveillance for cholera at seven sites. As an important follow up to the vaccination campaign, we have also been working with UNICEF and other institutions to collect data to assess the long-term effectiveness of OCV and other vaccines among Rohingyas.

Planning has commenced on the establishment of five round-the-clock diarrhoeal treatment centres and over 450 healthcare professionals are to be trained on diarrhoea management to provide support to these vulnerable communities.
Maternal health is a core element of our research (see pages 22 and 23), and has contributed to Bangladesh’s dramatic success in cutting maternal mortality. In addition, our work is addressing numerous key concerns:

**VIOLENCE AGAINST WOMEN**

Our research has documented alarming levels of intimate partner violence against women in Dhaka slums (1) and help-seeking behaviours (2). The groundbreaking SAFE trial found that a programme of interactive sessions on awareness raising and skill building, involving both sexes, had a major impact on intimate partner violence, particularly among younger women (3).

Our researchers also contributed to the UN’s Multi-country Study on Men and Violence in Asia and the Pacific, which identified a cycle of abuse in which early exposure to childhood trauma increases the risk of intimate partner violence and further child mistreatment (4).

In new work, research is focusing on garment workers, exploring the interplay between violence at home and in the workplace. Baseline data suggests that more than half of female garment workers have experienced intimate partner violence and 40% of these women report symptoms of depression. The HERrespect trial is assessing whether a workplace-based intervention can, by generating a more respectful working environment, reduce violence in the workplace and domestic settings.

**MENSTRUATION**

Our research has documented the challenges that girls face when they reach puberty and the detrimental impact it has on their schooling (5). Our earlier work on these challenges informed a Government of Bangladesh decision to commit to improving toilets and sanitation facilities in schools. An ongoing study is examining innovative ways to improve menstrual hygiene management in schools.

**BREASTFEEDING**

In the ongoing Mothers’ Milk project, we are assessing whether a low-cost breast milk pasteurisation machine and 10 breast pumps installed in a garments factory in urban Dhaka enable garment workers to continue breastfeeding their babies.

Our long-running MINIMat nutritional intervention trial has found that, although domestic violence typically reduces the duration of breastfeeding, this can be mitigated by breastfeeding counselling (6).

**SEXUAL MINORITIES AND HIV**

Our long-running programme on HIV prevention has helped to ensure that the prevalence of HIV among sexual minorities in Bangladesh remains extremely low (see page 14).

**DIABETES PREVENTION**

The LIVING (Lifestyle Intervention in Gestational Diabetes) trial is assessing whether a simple lifestyle intervention promoting healthy living can prevent the development of type 2 diabetes in new mothers who developed gestational diabetes. The trial is taking place in three South Asian countries, with work in Bangladesh being led from icddr,b.

**MENTAL HEALTH**

Our researchers are evaluating an innovative intervention designed to protect the mental health of mothers of children with autism (see page 35).

PRACTICAL INNOVATION

Our development of oral rehydration solution (ORS) illustrates how practical innovation can solve local – and global – health challenges. It is a principle that remains a key aspect of our work today.

BUBBLE CPAP

Oxygen can be a life-saver for children with pneumonia, which kills more than 900,000 children a year worldwide. Well-resourced centres can use a technology known as ‘bubble CPAP’ (continuous positive airway pressure) to deliver oxygen to the lungs of infants with pneumonia, but this equipment is rarely available in resource-poor settings. Our researchers have developed a simpler version of the technology, based on readily available materials such as empty shampoo bottles, and shown in rigorous trials that the simple technology is at least as good as WHO-recommended treatment. In 2015, our approach won the People’s Choice Award at the Pneumonia Innovations Summit in New York.

THERAPEUTIC FOODS

icddr,b researchers have developed a range of affordable ready-to-use therapeutic and complementary foods, based on locally available ingredients such as rice, lentils and chickpeas. The therapeutic food has been developed for treatment of severe acute malnutrition and has proven acceptable to children. In addition, in large field trials, complementary foods have proven at least as effective as commercially available products at improving growth and reducing stunting in young infants.

Q-MAT

Most women in Bangladesh give birth at home, and excessive bleeding after delivery is a common cause of maternal death. However, the extent of blood loss can be difficult to assess. icddr,b scientists have developed and tested a birthing mat, known as the Q-mat, that absorbs blood and provides a clear visual indication of excessive blood loss and hence the need for emergency medical attention. The Q-mat has been tested in some 100,000 childbirths and has the potential to have a major impact on maternal mortality in Bangladesh and other low-resource settings.

TB DETECTION

icddr,b has established a successful social enterprise model for detecting undiagnosed tuberculosis (TB) in the community. In 2014, three TB screening centres were established at readily accessible sites in Dhaka. Each site is equipped with state-of-the-art digital X-ray systems and molecular diagnostics to identify drug-resistant TB. The sites work in partnership with large numbers of local public and private providers, who direct patients with suspected TB to the centres. Individuals with diagnosed TB are then referred to TB treatment programmes. In their first three years of operation, the centres screened 65,000 individuals, identified more than 13,000 new cases of TB, and 700 Rifampicin-resistant cases. The model has been incorporated into the National TB Control Programme’s National Public–Private Mix Strategic Plan (2016–2020), and additional centres are being established in Dhaka, Chittagong and Sylhet.
Growing levels of antibiotic resistance are both a national and global threat. As in many countries in the global South, antibiotics are widely available without prescription in Bangladesh, leading to misuse and overuse. Poor sanitation promotes microbial contamination, creating opportunities for bacteria to exchange antibiotic resistance genes. And antibiotics are used extensively in food production.

Our researchers have carried out a range of studies on antibiotic resistance in Bangladesh and how drug resistance might spread.

**BLOODSTREAM INFECTIONS**

An analysis of more than 100,000 blood samples collected at Dhaka Hospital between 2005 and 2014 has revealed the main causes of bloodstream infections, their antibiotic susceptibility and how these have changed over time (1). Although *Salmonella Typhi* was the most commonly identified pathogen, the proportion of Gram-positive organisms has grown markedly. Levels of drug resistance were high in both Gram-positive and Gram-negative bacteria, particularly the former. The data provides useful epidemiological information for clinicians, who typically treat infections empirically.

**GUT MICROBIOME**

A study of the bacterial communities in the gut of healthy children in Dhaka has found that a surprising number harbour multidrug-resistant bacteria (2). More than 75% of bacteria isolated were resistant to multiple antibiotics. Frequent episodes of diarrhoea in children, which disrupt gut bacterial communities, could provide opportunities for colonisation by multidrug-resistant organisms, creating a reservoir for their dissemination.

**ENVIRONMENTAL CONTAMINATION**

Analysis of environmental samples has paints an alarming picture of antibiotic resistance in Dhaka. An analysis of 19 *Klebsiella* and *E. coli* samples from aquatic sources found that more than half carried genes conferring resistance to quinolones (3), among the most commonly used antibiotics in Bangladesh. In addition, screening of sludge samples identified *E. coli* carrying the *mcr-1* gene, which confers resistance to the ‘antibiotic of last resort’, colistin – the first time this gene has been detected in Bangladesh (4).

Ongoing studies are addressing a range of key issues, including the possibility that multidrug-resistant *E. coli* causing urinary tract infections are being acquired from food animal reservoirs, the potential role of poultry farming in the spread of resistant bacteria, and whether exposure to arsenic in drinking water is also contributing to the evolution of antibiotic resistance. Certain genes may provide bacteria with protection against both drugs and heavy metals.

A further study is examining the factors influencing antibiotic use in rural Bangladesh, a first step towards the design of interventions to promote behaviour change and reduce unnecessary antibiotic use.

**HOSPITAL CONTAMINATION**

An analysis of environmental water samples from areas around hospitals in Dhaka has revealed alarming levels of NDM-1-producing bacteria (5) – those carrying the gene conferring resistance to key carbapenem antibiotics. Some 71% of samples tested were positive for NDM-1-producing bacteria, principally *Klebsiella*, but also *E. coli*, *Acinetobacter* and *Enterobacter*.

RESEARCH FOR DECISION MAKERS

icdr,b has begun a five-year implementation research project to generate evidence and promote the use of evidence-based research and policy analysis for health planning and decision making.

Supported by the United States Agency for International Development (USAID), the USAID’s Research for Decision Makers (RDM) Activity covers four thematic areas: maternal, neonatal and child health; family planning and reproductive health; tuberculosis; and nutrition. It also takes into account cross-cutting issues like health systems strengthening, universal health coverage and gender.

The RDM Activity is set to achieve its objective by carrying out implementation research to produce evidence-based research and expand implementation research and expand evidence-based practices.

The RDM Activity puts high emphasis on building strong collaborative partnerships with the Government of Bangladesh (GoB), technical agencies and development partners to identify evidence gaps and prioritise research needs that will support effective implementation of Bangladesh’s Fourth Health, Population and Nutrition Sector Programme.

The project started in May 2017 by holding a five-year agenda-setting workshop that identified broad implementation research areas to guide work during the project period. These were further narrowed down through a series of consultations among icdr,b, GoB and other stakeholders. Finally, 12 high priority topics were selected for implementation research in the first year of the project. In addition, 16 activities promoting policy analysis and dialogue and eight capacity-building activities were begun.

Each year, the RDM Activity will incorporate new research ideas/activities generated by icdr,b researchers in consultation with relevant stakeholders and approved by USAID.
PREVENTING AND CONTROLLING HIV

We have been conducting studies with marginalised and stigmatised populations at risk of HIV, translating evidence into policy, and developing interventions to generate impact at the population level.

HIV PREVALENCE

Surveillance studies have identified an alarming rise in HIV in certain high-risk populations in Bangladesh. icddr,b runs an HIV surveillance system in Bangladesh, in collaboration with the Institute of Epidemiology, Disease Control and Research (ICEDCR) and the national AIDS/STD Programme, focusing on key populations at risk of HIV. Most recent data showed that the prevalence of HIV among female sex workers is still less than 1% (1). However, the prevalence of HIV among people who inject drugs (PWID) in Dhaka increased significantly, from 5.3% in 2011 to 22% in 2016 – and in one area, HIV prevalence leapt from 7.3% to 27.3% (2). The findings highlight the need for urgent policy dialogue to prevent a serious HIV epidemic in Bangladesh. Our surveillance data have contributed to an AIDS Epidemic Model, which informed the development of the Fourth National Strategic Plan for HIV 2018–22.

HIV PREVENTION

Since 2010, as a principal recipient of support from the Global Fund to Fight AIDS, Tuberculosis and Malaria, we have formulated and implemented evidence-based policy and actions for HIV prevention in key at-risk populations, such as PWID, males having sex with males, male sex workers and transgender individuals (hijra). In 2017, we received USD 8.3 million funding to continue this work until 2020. We use an implementation science framework to enhance the support and HIV prevention services provided to key populations by local NGOs. We have introduced HIV testing and counselling for members of sexual minorities through a community-led and community-driven mechanism. Low prevalence levels indicate that interventions are running well among most groups.

HARM REDUCTION

Opioid substitution therapy (OST) has been shown to be effective in preventing HIV among PWID, reducing psychological distress and improving quality of life. Since 2010, icddr,b has been implementing OST in Bangladesh. At present, 950 PWID are under the OST programme, operated through five OST clinics in collaboration with the Department of Narcotics Control and the national AIDS/STD Programme. Along with implementing two OST clinics, we have also been providing technical assistance to three other clinics, run by Save the Children and CARE Bangladesh. Based on our work, a national Operational Guideline for Methadone Maintenance Treatment services in Bangladesh has been published.

ANTIBIOTIC RESISTANCE

With antibiotic resistance a growing global concern, a study has analysed the antimicrobial sensitivity of N. gonorrhoea infections in key populations in Dhaka. Ceftriaxone was the only antibiotic with 100% sensitivity, while 9.5% and 14.3% of strains were resistant to cefixime and azithromycin, respectively. More than 90% of the isolates were resistant to ciprofloxacin and doxycycline while 100% were resistant to metronidazole. Based on these findings, national treatment guidelines have been updated.

HEPATITIS C VIRUS

A study of hepatitis C virus (HCV) treatment among people who use opioid drugs in Dhaka found that an HCV treatment programme using direct acting antivirals is feasible if existing harm reduction programme facilities are enhanced. HCV support for PWID is currently not available, despite high infection rates (39.6% in Dhaka). In the study, run in collaboration with Save the Children and the University of British Columbia with funding from World Health Organization, adherence reached 100% which was achieved by applying interventions such as OST, extensive follow up and engaging family members. These findings will inform the development of strategies for managing HCV in PWID.

2017 at a glance

icddr,b Day celebrations 2017 with Mr Abul Maal Abdul Muhith, MP, Hon. Minister for Finance, Government of Bangladesh

Mr Mohammad Nasim, MP, Hon. Minister for Health and Family Welfare, Government of Bangladesh

Dr Teresa Soop, Senior Research Advisor (Health) and Lisa Zakariasson, Forsk, Research Cooperation Unit, Sida, Sweden

Hon. Marie-Claude Bibeau, MP, Minister of International Development and La Francophonie, Canada and team

H.E. Julia Niblett, High Commissioner of Australia to Bangladesh and team

Rt. Hon. Yasmin Ratansi, MP, Canadian Parliament and Global Affairs Canada team

Oh Joon, Former Ambassador and Permanent Representative of The Republic of Korea to the United Nations in New York

(Late) Dr Mujibur Rahman annual memorial lecture

Team from Korea International Cooperation Agency

Dr Woo Joo Kim, Professor, Department of Internal Medicine, Korea University College of Medicine and team at Matlab

Doctors from Yemen receiving training at the Dhaka Hospital

Conrad N. Hilton Humanitarian Prize celebrations
In 2017, 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 telomeres to large-scale vaccine trials, observational clinical studies on children with severe diarrhoea and health services research to increase use of birth facilities.

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

SECURING A POLIO-FREE WORLD

A polio vaccine trial has generated data that will ensure a polio-free world after eradication.

Of the three types of wild poliovirus, type 2 virus has already been eradicated. Trivalent oral polio vaccine (OPV) provides protection against type 2 poliovirus but, on rare occasions, may generate active type 2 poliovirus that can spread in under-immunised populations. Therefore, in 2016, a coordinated global switch was implemented from trivalent OPV to a bivalent OPV active against types 1 and 3, combined with inactivated polio vaccine (IPV).

Monovalent type-2-specific OPV (OPV2) is being stockpiled in case type 2 poliovirus is ever detected in the future. However, OPVs are live attenuated vaccines, and there is some uncertainty about the likely transmission dynamics of OPV2 vaccine-virus after the global switch.

To address this question, OPV2 was given to a proportion of infants being immunised against polio in Matlab. Notably, OPV2 vaccine-virus could be detected in household contacts of infants given OPV2 but did not spread into the wider community (1). Hence, in a well-immunised population, there is little risk that vaccine-virus will transmit widely if monovalent OPV2 were ever deployed. However, modelling studies suggested that the risk of transmission would be higher as population immunity declined, emphasising the importance of maintaining high population coverage with IPV.

Bangladesh was one of the first low-resource countries to introduce IPV in routine immunisation services. To ensure a smooth implementation and identify areas for improvement, icddr,b researchers and national and international colleagues conducted studies assessing implementation of new schedules (2) with a particular focus on the effectiveness of cold chain transport and storage (3).


Rotavirus kills around 200,000 young children every year – 2,700 of them in Bangladesh. World Health Organization (WHO) currently recommends a two/three-dose vaccination schedule depending on types of rotavirus vaccine, at six weeks and 10 and/or 14 weeks to tie in with other routine vaccinations. However, there is limited data on the effectiveness of this strategy in low-resource populations in Asia.

To address this question, icddr,b and PATH jointly organised an effectiveness study of rotavirus vaccination at Matlab (1). Some 142 villages were randomly allocated to receive either the vaccine through the routine immunisation programme or just routinely used vaccines, and cases of rotavirus disease were monitored at Matlab hospital and two community treatment centres.

The vaccination programme reduced reported cases of rotavirus disease by one third across the entire population; among infants receiving two doses, cases were reduced by 41%. No indirect benefits were seen among unvaccinated infants, which might require higher coverage and longer periods of vaccination.

The trial confirms the moderate effectiveness of rotavirus vaccine delivered through a routine vaccine programme in a low-resource setting, and its potential to significantly reduce cases of severe diarrhoeal disease in vulnerable infants.

Additional valuable data for policymakers has come from a surveillance study of young children with acute gastroenteritis admitted to seven hospitals across Bangladesh. Some 64% of 3,783 hospitalisations were due to rotavirus (2), illustrating the heavy burden of rotavirus disease in Bangladesh and providing baseline data for an evaluation of rotavirus vaccination when it is introduced.

icddr,b researchers have also carried out a cost-effectiveness analysis, modelling universal introduction of rotavirus vaccination (3). This analysis suggests that rotavirus vaccination would be ‘very cost-effective’ according to standard WHO criteria.

OCV IN PREGNANCY

Data from a large-scale trial of oral cholera vaccine (OCV) found no evidence of adverse effects on pregnant women.

Maternal infection with cholera may adversely affect pregnancy outcomes. These risks could in theory be reduced by OCV vaccination, and there are good theoretical reasons why vaccination is likely to be safe. However, there is limited data on the safety of OCV in pregnant women.

Several recent studies have examined pregnant women receiving the OCV. A large-scale OCV trial in Dhaka excluded expectant mothers, but some women received the vaccine unaware that they were pregnant.

An icddr,b-led team identified 286 such women and were able to follow up 69, who were compared with a group of 69 pregnant women randomly selected from those excluded from the trial.

The comparison revealed no significant differences between the two groups in terms of miscarriages, stillbirths and congenital malformations (1). Although the numbers are small, the study adds to the evidence that OCV use is not associated with adverse pregnancy outcomes. Current understanding of the vaccine and evidence from different studies suggests pregnant women should not be excluded from OCV campaigns (2).

IMPROVING CARE OF THE SICK CHILD

Data from Dhaka Hospital on severely ill children with diarrhoea could point the way to improved management of sick children.

Diarrhoeal disease still kills around 500,000 children a year globally, and is responsible for 6% of childhood deaths in Bangladesh. As the world’s largest diarrhoeal disease treatment centre, icddr,b’s Dhaka Hospital has unrivalled expertise in the management of severely ill children with diarrhoea, and is helping to develop a deeper understanding of disease processes that could lead to more refined clinical practices suitable for use in resource-poor settings.

Infants with diarrhoea may show distinctive rapid breathing, a sign of metabolic acidosis (build up of acid in body tissues) due to dehydration. However, rapid breathing is also a sign of pneumonia. Pneumonia requires rapid treatment, which can be delayed while tests for metabolic acidosis are carried out. A study comparing diarrhoeal children with and without pneumonia revealed that coughing and chest wall indrawing were highly specific markers of pneumonia, and could be used to identify a need for immediate treatment (1).

Other research at Dhaka Hospital has identified clinical features of diarrhoeal children associated with the need for mechanical ventilation (2) – a procedure that is costly and labour intensive – and those associated with the risk of death during ventilation (3). Many children with diarrhoea also show signs of respiratory distress, and studies have identified clinical features associated with the risk of metabolic acidosis (4) and death (5).

Although Bangladesh has made great strides in reducing maternal and neonatal mortality, death rates remain high. In part this reflects low use of health facilities for delivery, particularly among the economically disadvantaged.

The Projahnmo project was based in the Sylhet district because it has notably low levels of facility delivery and relatively high maternal and neonatal mortality. It developed a package of measures to increase use of delivery services which enabled the collection and analysis of samples immediately after delivery.

Since multiple factors influence a woman’s choice of place to give birth, the package encompassed both supply-side measures – building the capacity of facility staff, extending opening hours, adding new treatments – as well as demand-side incentives, including emergency transport and expenses.

Combined with extensive community engagement to raise awareness of the value of maternal health services, these measures increased facility use from 25% to 78% in two years (1). The increase was most marked when the demand-side interventions were introduced, emphasising the importance of financial barriers and arguing that supply-side initiatives enhancing services are unlikely to be successful on their own.

Although the intervention would need to be rigorously assessed in terms of its practicality and cost-effectiveness, it represents a potential route to increased use of facility delivery in Bangladesh.

THE LIMITS OF GROWTH

A large-scale trial has found no evidence that integrated interventions spanning water quality, sanitation and nutrition boost infant growth more than individual interventions.

Impaired growth is not just a question of inadequate nutrition, but may also reflect abnormal gut function due to infection. Therefore, interventions that reduce gut infections could potentially add to the impact of improved nutrition.

This idea was tested in the WASH Benefits Bangladesh trial, run by an international team including icddr,b researchers. The trial enrolled more than 5,500 pregnant women in rural Bangladesh, and randomised them to receive individual water-quality, sanitation, handwashing and nutrition-based interventions or an integrated intervention combining all four.

A lipid-based nutrition supplement led to a modest increase in growth, and reduced the prevalence of diarrhoea. However, the integrated intervention led to no further improvements in growth. All the interventions (except water treatment) reduced the prevalence of diarrhoea, but again the combined intervention provided no additional benefits.

The study provides no evidence that an integrated intervention has any additional benefits to growth over single interventions. Nevertheless, children receiving the integrated intervention were 38% less likely to die than children in the control group, suggesting it may have an overall survival benefit.

OVERCOMING PERSISTENT DIARRHOEA

A simple treatment guideline, incorporating use of locally available foods, is proving highly effective in infants with persistent diarrhoea, and could be readily adopted in other resource-poor settings.

Diarrhoea continues to kill half a million children a year. Up to 60% of these deaths are due to persistent diarrhoea, where symptoms persist for 14 days or more.

Malnutrition is a significant risk factor for the development of persistent diarrhoea, so nutrition is a critical aspect of treatment plans. Although a World Health Organization (WHO)-recommended treatment algorithm exists, it is not widely implemented.

icddr,b’s Dhaka Hospital, the world’s largest diarrhoeal disease hospital, deals with numerous cases of persistent diarrhoea, often in malnourished infants.

It has developed a simple management protocol based on the WHO algorithm, incorporating step-wise transitions through low-lactose milk-based diets and locally available foodstuffs. This approach has achieved recovery rates of around 95% (1, 2).

Clinical data also indicated that slower recovery was linked to severe stunting and wasting in infants under six months, and to healthcare-associated infections and antibiotic use in older infants and children, pointing to possible ways to further improve recovery.

More generally, the hospital’s experience suggests that this simple dietary algorithm, combined with other straightforward clinical management guidelines, could be adopted at other treatment facilities yet to implement a algorithm for persistent diarrhoea.

TELOMERE SHORTENING CONUNDRUM

Unexpectedly, improved growth of babies has been found to shorten telomeres in the first year of life.

Exposure to stress is associated with shortening of telomeres, structures that protect the ends of chromosomes. Telomere shortening could affect cell function and be responsible for the long-term adverse effects of stress (although it could also reflect ‘bystander damage’ from some other harmful process).

Either way, there is great interest in the use of telomere shortening as a convenient marker of stress exposure. It is possible that early exposure to adversity, such as poor nutrition or infections, could accelerate telomere attrition in infants, but very little is known about telomere dynamics at early stages in life.

This question has been addressed in the WASH Benefits trial (see page 20), which examined the impact of water quality, sanitation and nutrition interventions on the growth of newborns and their susceptibility to gut infections. A substudy within this trial examined whether improvements in growth or health had any impact on telomere shortening.

Unexpectedly, the study found that, during the first year of life, enhanced growth actually led to increased telomere attrition (1). The researchers speculate that this may be related to improved growth and immune system function rather than biological stress. The findings emphasise how little is known about telomere shortening in early life and caution against assumptions that telomere shortening is necessarily a good indicator of biological stress in infants.

Facility Delivery
An intervention combining supply-side and demand-side measures increased facility delivery by more than 50 percentage points (see page 19).

The Burden of Injury
Data from the Saving of Children’s Lives by Drowning (SoLiD) project, involving icddr,b researchers and US and local collaborators, have shed light on the huge burden of injury in rural Bangladesh. Data from 1.2 million people suggest that injury accounts for around 44,000 deaths in rural Bangladesh each year, with 21 million people suffering major injury (1). Drowning was the leading cause of death in all age groups and accounted for 92% of injury deaths in children aged 1–4 years and 67% in children aged 5–9 years (2); while child mortality from many other causes has fallen dramatically in recent years, drowning-specific mortality rates have not declined (3). The SoLiD data have also highlighted high rates of burn-related injury, with children aged 1–4 years again at high risk of fatal injury (4).


Emergency Transport
icddr,b researchers and colleagues in Canada have used Geographic Information System (GIS) technologies
to design an efficient emergency referral transport system for pregnant women and young children with suspected sepsis (1). A GIS database was developed mapping features within the study area of the Interrupting Pathways to Sepsis Initiative. An algorithm was created to calculate travel times to health facilities from villages using different modes of transport, to identify the quickest routes. An emergency call-in centre used these tools to advise patients and drivers on the best point for local pick up and route to health facilities. These tools increased usage of transport services, particularly from outlying villages. The model could be adopted for any emergency transport system in rural low-income settings.

RESPIRE
icddr,b is one of 11 international partners from four Asian countries of the newly launched RESPIRE initiative, led by the University of Edinburgh, UK. Focusing on respiratory health and long-term lung conditions, the initiative will adapt evidence-based approaches for reducing disease burden for use in local settings, and develop and test new interventions to fill key evidence gaps. Specifically the initiative is funding two icddr,b projects that aim to improve the out-patient and in-patient management of childhood pneumonia.

CORD CLEANSING
Neonatal mortality of facility-born babies is halved when chlorhexidine is used to cleanse the umbilical cord stump, icddr,b researchers and US and Nepalese colleagues have discovered. Since 2013, World Health Organization (WHO) has recommended chlorhexidine cord cleansing for babies born at home in resource-poor settings, but not for those born in facilities. By re-analysing data from trials in Bangladesh and Nepal on more than 3,000 facility deliveries, the researchers showed that survival benefits were as great for facility as for home deliveries (1), arguing that the WHO recommendation on chlorhexidine should be extended to all sites of delivery in resource-poor settings with significant neonatal mortality rates.


HEALTH INEQUALITIES
A large-scale intervention has been found to reduce inequalities in the use of maternal and neonatal health services. A significant socioeconomic gradient exists in take-up of such services, contributing to increased maternal mortality among socially disadvantaged groups. The Maternal and Neonatal Health Initiative in Bangladesh (MNHIB), launched in 2007, was specifically designed to address iniquities. An evaluation of the MNHIB initiative found that it increased the use of services and reduced iniquities (1). For three of six indicators these reductions exceeded those seen in districts where MNHIB was not implemented.

**ILEUS RISK**

A study of more than 300 severely malnourished children under-five admitted to icddr,b’s Dhaka Hospital identified key factors associated with ileus, a condition characterised by abdominal distension (1). Ileus affected 15% of such children and was associated with a markedly high risk of death (22% children with ileus versus 8% children without). Ileus was connected with reluctance to feed, septic shock and low blood potassium levels, while risk of death of severely malnourished children was strongly linked to septic shock. The findings highlight important factors for clinicians to consider when caring for severely malnourished children with diarrhoeal disease.


**POLICY AND PRACTICE**

A policy analysis has found that Bangladesh has a reasonably well-developed policy environment covering infant and young child feeding, although some significant gaps remain (1). The study used a matrix developed by the South Asian Infant Feeding Research Network to map the policy landscape and stakeholder network analysis to identify key stakeholders. A range of measures were proposed to strengthen the policy environment, improve implementation and population coverage, and to enhance engagement with diverse stakeholders.

A separate study examined the extent to which the integration of new National Nutrition Services into existing antenatal care and child healthcare delivery

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**Preventing and treating maternal and childhood malnutrition**

We study the biological and non-biological mechanisms underpinning maternal and childhood malnutrition. We also 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 evaluating 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), 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 policymaking is based on high-quality evidence.
systems had improved the quality of nutrition services (2). The study identified significant flaws in the implementation of the new strategies and recommended measures to improve the quality of nutrition services.


ROTAVIRUS

An analysis of 20 years of monthly data on the causes of diarrhoeal disease, collected at icddr,b’s Dhaka Hospital, has found that a reduction in underweight and wasting among children under-five has been associated with a doubling in the proportion of cases due to rotavirus – from 20% in 1993 to 43% in 2012 (1). Notably, the study adjusted for climate factors, which also affect rotavirus prevalence. The findings highlight an important consequence of improving nutrition, and reinforces the case for mass rotavirus vaccination.


SUPPLEMENTATION

Lipid-based supplements given to pregnant women and their offspring – covering the critical first 1,000 days from conception to age two – have been found to enhance both physical and mental development. A trial involving more than 4,000 women, run by icddr,b researchers and US colleagues, found that children grew faster when they and their mothers received lipid-based nutritional supplements (1), and showed improved motor skills and language development when receiving such supplements (2). There was no evidence of increased risk of birth complications associated with use of the supplements (3). Importantly, the trial was integrated into a community-based health programme, emphasising its relevance to real-world settings.


ENTERIC DYSFUNCTION

Enrollment has begun into the Bangladesh Environmental Enteric Dysfunction (BEED) study (1), which aims to validate non-invasive surrogate markers of environmental enteric dysfunction – abnormal gut function thought to be a major cause of growth faltering. Candidate biomarkers will be assessed in blood, urine and fecal samples from children and adults with malnutrition who fail to respond to a nutritional intervention; endoscopic examination will provide a gold standard diagnosis against which the surrogate markers can be compared. The study will identify convenient markers that could be adopted as standard measures for the field, and also reveal possible targets for intervention to correct gut dysfunction.

In newly funded work, icddr,b researchers will also be assessing potential markers of EED in samples collected in the WASH Benefits trial (see page 20). In addition, a pilot trial is assessing the impact of the nutritional intervention PTM202, a product that contains bovine colostrum and egg from vaccinated hens, on EED in young infants.


ZINC SUPPLEMENTATION

Although micronutrient powders are recommended by World Health Organization for nutritionally vulnerable groups, there is little evidence that they actually improve the growth of young infants, or that zinc supplementation has the expected impact on diarrheal disease prevention. A major new trial is systematically assessing the effect of higher concentrations of zinc and different micronutrient supplements on growth and incidence of diarrhea in young infants.

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 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 VACCINE**

An analysis of trial data has found no evidence that oral cholera vaccine harms pregnant women (see page 18).

**ROTAVIRUS**

Programmatic delivery of rotavirus vaccine confirms its potential to save considerable number of infant lives (see page 17).

**POLIO**

Studies have examined the implications of the switch from trivalent to bivalent oral poliovirus vaccine (OPV) (see page 16).

**VACCINE BENEFITS**

Vaccines may have impact beyond the specific infection they are designed to prevent, and icddr,b researchers have contributed to two notable studies documenting such non-specific effects.

The first involved a re-analysis of an extensive collection of immunisation data from Matlab. Although WHO recommends Bacillus Calmette-Guérin (BCG) vaccination at birth and diphtheria, tetanus and pertussis (DTP) vaccination at 6, 10 and 14 weeks, and BCG and DTP are often administered together. A re-analysis of data on nearly 38,000 children born between 1986 and 1999, with different vaccine schedules, found that a ‘BCG-first’ schedule was associated with twofold higher mortality in the first nine months of life (1). The findings argue for the need for randomised trials to assess alternative vaccination schedules.

A second study examined the impact of trivalent OPV, currently being phased out in favour of bivalent OPV and inactivated polio vaccine (IPV). However, a study comparing trivalent OPV and IPV found that...
the former offered some additional protection against bacterial (but not viral) diarrheal disease (2), potentially because of non-specific immunity-boosting effects. A full understanding of OPV’s non-specific effects will be important in order to mitigate the impact of its withdrawal.


CHOLERA PHAGE

icddr,b researchers have shone new light on the properties of phage, bacterial viruses, that target Vibrio cholerae – insight that could underpin novel forms of disease control.

V. cholerae can survive in aquatic reservoirs, forming biofilms of bacteria embedded within a polysaccharide matrix. Bacteria within biofilms enter a dormant state, but can resuscitate into active planktonic forms that may trigger new outbreaks. Studying how phage act on different forms of V. cholerae, icddr,b researchers identified one that could disperse biofilms, releasing active planktonic forms, but had little impact on bacterial survival (1). Two other phage showed strong bactericidal activity against different strains of V. cholerae. The results hint at unexpected complexity in the role of phage in controlling V. cholerae dynamics, but suggest that a cocktail of phage could be effective in dispersing and killing V. cholerae biofilms.

A second study characterised phage CRISPR-Cas systems – an anti-phage defence mechanism that, remarkably, has been acquired by cholera phage and used to inactivate host cell anti-phage defences. An analysis of CRISPR-Cas systems in five distinct but related phage has provided new insight into its acquisition and evolution, driven by an ongoing arms race between V. cholerae and its phage adversaries (2).


ENTERIC FEVER

icddr,b is playing a major role in an international programme to map the disease burden and transmission dynamics of Salmonella Typhi and Paratyphi, the causes of enteric or typhoid fever. The Strategic Typhoid Alliance Across Africa and Asia (STRATAA) study is carrying out a comprehensive exploration of the natural history of Salmonella in three endemic settings, including icddr,b’s study sites at Mirpur in Dhaka (1). The data will feed into models to assess the impact of different vaccination strategies, to guide the deployment of new improved typhoid conjugate vaccines. The research falls under the umbrella of the Typhoid Vaccine Acceleration Consortium (TyVAC), of which icddr,b is a member.


WASH BENEFITS

An integrated WASH and nutrition intervention has been found to be no more effective than individual interventions at promoting infant growth (see page 20).

WASH INTERVENTIONS

Two studies involving icddr,b researchers have examined ways to improve communal toilets, used by some 4.3 million people living in Dhaka’s urban slums. An intervention combining behaviour change materials and activities with new hardware for waste disposal and cleaning significantly improved toilet cleanliness (1). A second study worked with communities to identify reasons for improper waste disposal in communal toilets, which impedes the removal of fecal sludge. In a pilot intervention, trash bins and behaviour change communication was used to enhance proper disposal of waste and toilet cleanliness (2).

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.

PESTICIDE POISONING

Investigation of an acute encephalitis syndrome (AES) outbreak, which led to the deaths of 13 out of 14 affected children in northern Bangladesh, identified pesticides as the likely cause (1). Regular AES outbreaks near lychee orchards occur across Asia, but the precise cause of illness is unclear. An outbreak investigation carried out by icddr,b, IEDCR and US colleagues found that visiting a lychee orchard or a garden using pesticides was associated with AES but consuming lychees was not; several powerful pesticides, including some banned in many countries, were used in the orchards investigated. The results are not consistent with a recent suggestion that toxins in lychees themselves are responsible for AES outbreaks.


UBIQUEOUS DENGUE

A study has found that dengue virus infections are remarkably common in Dhaka, and identified a range of factors increasing the risk of infection, including the cultivation of indoor potted plants which provide breeding opportunities for mosquitoes (1). icddr,b researchers and colleagues from Canada and the US tested for antibodies to dengue virus in Dhaka residents before and after the monsoon season. Around 80% of participants showed signs of infection in the pre-monsoon survey, while more than half of those not previously infected tested positive after the monsoon, suggesting widespread circulation of the virus in the intervening period. The results suggest that many cases of dengue-associated
illness may be going unreported, and that mosquito control measures such as removing indoor potted plants could reduce the spread of the virus. 1. Dhar-Chowdhury P et al. Dengue seroprevalence, seroconversion and risk factors in Dhaka, Bangladesh. PLoS Negl Trop Dis. 2017;11(3):e0005475.

GUILLAIN-BARRÉ SYNDROME

A small pilot study has explored the feasibility of a low-cost treatment for Guillain-Barré syndrome (GBS), a rare neurological disorder triggered by infection with Campylobacter jejuni. GBS appears to be particularly severe in Bangladesh (1). However, conventional treatments are generally out of reach for financial reasons. icddr,b researchers have developed a practical and low-cost alternative, small volume plasma exchange (2). A pilot feasibility study suggests it may be a safe and cost-effective alternative.


NIPAH TRANSMISSION

Contaminated towels and bed sheets have been shown to be a potentially important route by which Nipah virus is transmitted from hospitalised patients (1). Although most cases of Nipah infection are linked to consumption of contaminated date palm sap, nearly one-third of patients are infected by patient-to-patient transmission. The results point to possible targets for improved infection control to reduce the risk of transmission.

The team is currently testing infection control packages in public hospital settings to the reduce risk of person-to-person transmission from suspected Nipah patients to healthcare workers and caregivers.


AVIAN FLU

Nomadic ducks – domestic ducks moved between feeding grounds during the year – have been identified as a potentially important conduit for the spread of H5 or other avian influenza viruses from wild bird to domestic poultry populations. Some 30% of egg yolks tested were positive for H5 antibodies and 94% of flocks had at least one egg with such antibodies (1). In other studies, a recently introduced H5N1 avian influenza sub-strain was found to be responsible for an outbreak that killed substantial numbers of wildfowl, chickens and geese in northeastern Bangladesh in 2011 (2). Furthermore, population-based surveillance identified two cases of human H5N1 infections (3), suggesting that undetected infections may be occurring in Bangladesh and emphasising the need for surveillance for mild respiratory disease among populations exposed to infected poultry.


DRUG-RESISTANT TB

icddr,b researchers completed a six-year drug-resistant tuberculosis (TB) surveillance project in 2017 – the first undertaken in the WHO South-East Asia region (1). The surveillance sites spanned 20 districts across all Bangladesh. The overall rate of drug resistance was found to be 3.2%. The rate was lower (2.3%) among the patients with no prior TB history and significantly higher (13.8%) among patients previously treated for TB. Although the percentage of drug-resistant primary TB cases is relatively low (2.3%), this still translates to around 5,000 cases, representing a significant public health challenge. These findings, together with those from the national drug resistance survey conducted by the National Tuberculosis Control Program, will inform future policies to contain this epidemic.

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.

icdrr,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.

DIARRHOEAL DISEASE

A study of the full societal cost of diarrhoeal disease – costs incurred by households as well as the health system – has found that the annual economic burden of diarrhoeal disease in Bangladesh is around USD 172 million, 12.3% of total health expenditure (1). The findings are based on interviews with 800 patients attending six district hospitals. Total societal costs for each episode, including indirect costs such as loss of income, were USD 111 for in-patients and USD 24 for out-patients, with the cost burden being proportionately highest for the poorest households.


OUT-OF-POCKET EXPENSES

Analyses of data from the nationally representative Household Income and Expenditure Survey 2010 have found that the costs of medicines represent the largest single factor in out-of-pocket healthcare expenses, accounting for 61% of total expenditure (1). Expenditure varied significantly with age, sex, urban or rural location, and socioeconomic status. The data also suggest that 14.2% of households faced catastrophic health expenditure, with the poorest households being at significantly higher risk (2).
CHRONIC DISEASE

An analysis of Household Income and Expenditure Survey data has revealed that out-of-pocket healthcare expenditure imposes a significant financial burden on those with chronic disease and disability, particularly individuals from low-income households (1). The findings emphasise the need for financial risk protection for older people and those of lower socio-economic status.


INSURANCE SCHEMES

icddr,b studies have examined factors influencing enrollment in health insurance schemes, risk-pooling mechanisms designed to reduce the risk of catastrophic health expenditure. A range of factors, including family size and sex of the head of the household, were found to influence the likelihood that households would join a cooperative-based scheme for informal workers (who make up the vast majority of the Bangladesh workforce) (1). More generally, as cooperatives are being promoted in Bangladesh and have already enrolled more than 10 million members, cooperative-based schemes could provide an important stepping stone towards universal health coverage (2).

icddr,b is running its own pilot health financing scheme, Amader Shasthya, in Chakaria. Nearly 20% of households have enrolled in the scheme and 38% have renewed membership during the first three years (3), figures that compare well with those from schemes in other settings. The findings provide insight into the factors influencing renewal, which is essential for the long-term sustainability of such schemes.


mHEALTH USE

A mobile-enabled online Blood Information Management Application (BIMA) system has been found to reduce the time between identification of the need for blood and an actual transfusion by a clinically relevant 24 minutes (1). The system was developed by icddr,b researchers and local and international colleagues, and piloted at a public hospital in Dhaka. BIMA had a particular impact at night, when traditional supply routes may be slow, and for treatment of post-partum haemorrhage, a major cause of maternal mortality.


ESSENTIAL SERVICES

icddr,b researchers have used WHO’s ‘One Health Tool’ to cost an Essential Service Package (ESP) for Bangladesh. Through consultation, the study identified 132 components of the ESP and calculated baseline costs for 2016 and estimated costs for 2017–2022 for rural and urban areas. The study findings are being used by policymakers and programme managers to plan and implement the ESP.

URBAN HEALTH ATLAS

A project has been launched to institutionalise the use of Urban Health Atlas, a GIS-based tool developed by icddr,b that provides an interactive visualisation of the location of health facilities with respect to population centres. Health facilities have been mapped in seven city corporations and two municipalities. In new work, icddr,b and the Government of Bangladesh are exploring how the Atlas can be integrated into central planning of maternal, neonatal and child health services at three field sites.
Examining the health consequences of climate change

We evaluate the impact 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 on climate-health nexus research and generate evidence to support national, regional and global policymaking.

The programme is building expertise on infectious diseases, particularly cholera and mosquito-transmitted diseases such as malaria and dengue fever in relation to climate change. We have a young team from diverse backgrounds such as environmental science and water recourse management, and social science.

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.

ECOSYSTEM SERVICES

icddr,b researchers have contributed to a deeper understanding of the health implication of ecosystem services, through synthesising the research carried out in the ‘Assessing Health, Livelihoods, Ecosystem Services and Poverty Alleviation in Populous Deltas’ (ESPA Deltas) project (1). ESPA Deltas, a collaboration with the University of Southampton and other UK organisations, as well as numerous academic institutions, government bodies and NGOs from Bangladesh and India, is a multidisciplinary project encompassing disciplines such as hydrology, climatology, earth and ocean sciences, economics, agriculture and fisheries.

The final project publication provides a policy-orientated analysis for the future of populous delta regions, focusing on the Ganges–Brahmaputra delta in Bangladesh.

icddr,b contributions have focused on links between ecosystem services and poverty, nutrition, health and wellbeing.


WATER SALINITY

A large-scale study funded by DFID and carried out under the umbrella of the ESPA Deltas project has found a significant association between the salinity of drinking water and high blood pressure in adults living in coastal regions of Bangladesh (1). People exposed to moderate or high saline drinking water, women, and people over the age of 35 were at particular risk. In addition, a systematic review identified an association between drinking water sodium levels and high blood pressure,
although the evidence base is limited (2). Salt-water intrusion into drinking water is likely to increase in coastal Bangladesh, due to climate change and other changing patterns of water use, and these studies highlight a potentially major impact on human health.


ADAPTATION TO SALINITY

icddr,b researchers and colleagues from Emory University, Stanford University and elsewhere have begun a cluster randomised controlled trial to assess whether managed aquifer recharge systems have any impact on high blood pressure levels in coastal Bangladesh (1). Managed aquifer recharge systems add filtered water from rainwater and ponds to aquifers, potentially reducing exposure to saline-contaminated water. Such systems are expensive, however, and data on health would enable policymakers to make more informed decisions about their introduction.

The study will monitor salinity levels and blood pressure in adults in 16 coastal areas in which managed aquifer recharge systems are being gradually introduced. Baseline results have already identified a potential further harm of drinking water salinity – heightened risk of increased protein levels in urine, a marker of progressive kidney disease (2). More than half of participants showed signs of mildly or moderately impaired kidney function.


MIGRATION

icddr,b researchers have published a summary report of qualitative research on maternal healthcare and family planning practices among women and families following migration to urban slum areas (1). The study, focusing on migration to Dhaka and Chittagong, extends quantitative work carried out for the 2013 Bangladesh Urban Health Survey, to which icddr,b provided technical assistance, and provides detailed insight into migration patterns and the coping strategies, practices and attitudes of a vulnerable and growing group.


DEVELOPING PARTNERSHIPS

In 2017, icddr,b signed a memorandum of understanding with the International Centre for Climate Change and Development (ICCCAD). The two centres will work together to raise awareness of climate change, including its potential impact on human health and wellbeing.

icddr,b is part of the Gobeshona collaborative knowledge sharing network, which is led by ICCCAD. icddr,b is also a member of the global Planetary Health Alliance, a consortium of over 70 dedicated universities, NGOs, government entities, research institutes, and other partners around the world committed to advancing planetary health education and research. In 2017 we forged new links with North South University in Bangladesh and the Government of Bangladesh’s Climate Change and Health Promotion Unit.
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, and evaluate new interventions relevant to low-income countries, with a focus on cardiovascular diseases and diabetes.

NCDs are becoming an issue of great importance in Bangladesh and other low-income countries. 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, including the Government of Bangladesh.

NCD RISK FACTORS

A study of more than 500 adults living in slums in Dhaka has identified a high prevalence of risk factors for NCDs (1). Although one-third of the urban population in Bangladesh now lives in slums, little is known about their NCD risk factor profile. Some 36% reported smoking, 96% were eating too little fruit and vegetables, and 23% were overweight or obese. Individuals reporting multiple risk factors were typically younger and less educated. The findings could help to shape the design of interventions to promote NCD prevention in this at-risk group.


DIABETES PERCEPTIONS

Two studies have explored the knowledge, behaviours and perceptions of patients with type 2 diabetes, a growing public health challenge in Bangladesh. A study at two tertiary hospitals in Dhaka found a reasonable understanding of diabetes among patients, although one in five had poor knowledge; these patients were more likely to be female and of low education and income (1). In addition, in-depth interviews with 12 patients provided rich information on understanding and perceptions of diabetes and reasons for non-adherence to medication (2). This insight could be used to inform the design of public health interventions to promote adherence.
OBESITY IN WOMEN

Obesity is emerging as a significant public health challenge in Bangladesh, particularly for women of reproductive age, as obesity increases the risk of birth complications as well as risk of NCDs in offspring in adulthood. An analysis of nationally representative data from the 2011 Bangladesh Demographic and Health Survey found that, driven by Bangladesh’s rapid demographic and epidemiological transition, overweight and obesity now co-exist with underweight – although 30.4% of adults over 35 were underweight, 23.5% were overweight or obese (1). Young people, women, the better educated and wealthier and urban residents were more likely to be overweight.

A further analysis of data from 2004 to 2014 revealed increases in the prevalence of both overweight and obesity in women of reproductive age – from 11.4% to 25.2% for overweight and from 3.5% to 11.2% for obesity (2).

Excess weight was again associated with education levels, wealth and urban living. Maternal obesity increases the risk of NCDs in both women and in their children in later life, as well as birth complications, threatening Bangladesh’s impressive gains in maternal, neonatal and child health.

POLICY CONTEXT

icddr,b researchers have identified significant shortcomings in the NCD policy framework in Bangladesh. A mapping exercise of all policy documentation produced since the 1970s against the six objectives of the WHO Action Plan for the Global Strategy for the Prevention and Control of NCDs identified multiple documents but little by way of strategic coordination, implementation and monitoring (1). A further analysis, focused on NCD drug policy, identified numerous shortcomings that limit access to medicines for treating NCDs, and proposed a series of measures to enhance access and reduce the burden of NCDs in Bangladesh (2).

MENTAL HEALTH AND AUTISM

icddr,b researchers have begun a feasibility study of a mental health support programme for the mothers of children with autism spectrum disorder (ASD) (1). Burden of depression is high among mothers of children with autism, but there is no mental health service available for these mothers in Bangladesh. The programme, being run at two schools for children with ASD in Dhaka, combines support from a female psychologist for women experiencing depression as well as training to enhance home child care skills. The pilot study will assess the acceptability and practicality of the intervention, its cost implications for school providers and mothers, and its impact on maternal mental health and child behaviour.


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 2017

In 2017, icddr,b researchers were authors on 396 original publications, and also contributed to 90 letters, editorials, book reviews and abstracts. These included outputs in leading journals, such as the Lancet, Lancet Global Health, Lancet Infectious Diseases, PLoS Medicine, PLoS Neglected Tropical Diseases, Scientific Reports and Vaccine. The majority of papers were co-authored with national and international colleagues. icddr,b researchers were also invited to contribute articles in leading journals including the New England Journal of Medicine and the Lancet.

2017 PUBLICATIONS

- **396** original papers*
- **5** reports/monographs
- **1** book chapter
- **90** letters, editorials, abstracts, etc.
- **74** abstracts in conference proceedings

*including review articles and short reports in journals
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 2015 for papers published in 2012–14).

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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 2015 for papers published in 2012–14).
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
- Albany Medical College, USA
- Binghamton University, USA
- Boston Children’s Hospital, USA
- British Columbia Centre for Disease Control, Canada
- Brown University, USA
- Centers for Disease Control and Prevention, USA
- Children’s Hospital Oakland Research Institute, USA
- Children’s Hospital of Eastern Ontario, Canada
- Children’s Hospital of Richmond at VCU, USA
- Columbia University, USA
- Consortium for Conservation Medicine, USA
- Duke University Medical Center, USA
- EcoHealth Alliance, USA
- Emory University, USA
- FHI360, USA
- Harvard Medical School, USA
- Harvard School of Public Health, USA
- Hospital for Sick Children, Toronto, Canada
- Institute for Disease Modeling, USA
- International Food Policy Research Institute, USA
- Jhpiego, USA
- Johns Hopkins Bloomberg School of Public Health, USA
- Johns Hopkins University School of Medicine, USA
- Massachusetts General Hospital, USA
- McGill University, Canada
- National Academy of Sciences, USA
- Nationwide Children’s Hospital, USA
- Oregon State University, USA
- Ottawa Hospital Research Institute, Canada
- PATH Vaccine Solutions, USA
- PATH, USA
- Pennsylvania State University, USA
- Peter Gilgan Centre for Research and Learning, Canada
- Population Council, USA
- PREVENT, USA
- Rollins School of Public Health, USA
- St Michael’s Hospital, Toronto, Canada
- Stanford University School of Medicine, USA
- Stanford University, USA
- TechLab Inc., USA
- Tufts University School of Medicine, USA
- United States Department of Agriculture, USA
- University of Alberta, Canada
- University at Buffalo, USA
- University of Arkansas Medical School, USA
- University of British Columbia, Canada
- University of Calgary, Canada
- University of California, Berkeley, USA
- University of California, Davis, USA
- University of California, Los Angeles, USA
- University of California, San Diego, USA
- University of California, San Francisco, USA
- University of Chicago, USA
- University of Colorado, USA
- University of Denver, USA
- University of Florida, USA
- University of Georgia College of Veterinary Medicine, USA
- University of Houston College of Pharmacy, USA
- University of Kentucky College of Medicine, USA
- University of Maryland, USA
- University of Michigan, USA
- University of North Carolina, USA
- University of North Carolina School of Medicine, USA
- University of Notre Dame, USA
- University of Pittsburgh, USA
- University of Saskatchewan, Canada
- University of South Carolina, USA
- University of Southern California, 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, USA
- Yale School of Medicine, USA

EUROPE
- Antoni van Leeuwenhoek Hospital/the Netherlands Cancer Institute
- Bangor University, UK
- Bilihoven Biologicals, The Netherlands
- Children’s Investment Fund Foundation, UK
- Drugs for Neglected Diseases initiative, Switzerland
- Durham University, UK
- Eawag, Switzerland
- Erasmus MC University Medical Centre Rotterdam, The Netherlands
- Foundation for Innovative New Diagnostics, Switzerland
- GlaxoSmithKline Medicines Research Centre, UK
- Imperial College London, UK
- Institut Pasteur, France
- Karolinska Institute, Sweden
- Katholieke Universiteit Leuven, Belgium
- Laboratorio de Referencia de Leishmaniasis, Spain
- Liverpool School of Tropical Medicine, UK
- London School of Hygiene and Tropical Medicine, UK
- Loughborough University, UK
- Max Planck Institute for Evolutionary Anthropology, Germany
- Ministry for Social Affairs and Health, Finland
- Nestlé Nutrition, Switzerland
- Nestlé Research Centre, Switzerland
- Newcastle University, UK
- Norwegian Institute of Public Health, Norway
- Overseas Development Institute, UK
- Sahlgrenska Academy of University of Gothenburg, Sweden
- Sheffield Hallam University, UK
- TDR, WHO, Switzerland
- UCL Institute of Child Health, UK
- Umea University, Sweden
- Universitat de Barcelona, Spain
- University of Aberdeen, UK
- University of Basel, Switzerland
- University of Bristol, UK
- University College London, UK
- University of Copenhagen, Denmark
- University of Exeter, UK
- University of Glasgow, UK
- University of Gothenburg, Sweden
- University of Oxford, UK
- University of Portsmouth, UK
- University of Southampton General Hospital, UK
- University of Southampton, UK
- University of St Andrews, UK
- University of Stirling, UK
- University of Sussex, UK
- University of Warwick, UK
- University of York, UK
- Uppsala University, Sweden
- Wellcome Trust Sanger Institute, UK
- World Health Organization, Switzerland

AUSTRALIA
- Macfarlane Burnet Institute for Medical Research and Public Health
- Menzies School of Health Research
- University of Melbourne
- University of Queensland
- University of Sydney
AWARDS AND ACHIEVEMENTS

BMJ AWARDS

DHAKA HOSPITAL
Dr Tahmeed Ahmed, Dr Mohammod Jobayer Chisti and colleagues from Dhaka Hospital were recognised as Quality Improvement Team of the Year at the BMJ Awards South Asia 2017 for their work on improving clinical care and management, infection control, and low-cost innovative clinical research.

BMJ AWARDS

DR KAMRUN NAHAR KOLY
Dr Kamrun Nahar Koly and her team led by Dr Aliya Naheed received the ‘Best Mental Health Team’ award at the BMJ Awards South Asia 2017 for their work promoting mental health care for mothers of children with autism spectrum disorders in Bangladesh (see page 35).

PROFESSOR ABDULLAH H BAQUI
icddr,b Board of Trustees member Professor Abdullah H Baqui was awarded the 2017 Carl E Taylor Lifetime Achievement Award by the American Public Health Association in recognition of his contribution to international health, particularly newborn, child and maternal health.
PROFESSOR JAN HOLMGREN

icddr,b Scientific Advisory Group chair Professor Jan Holmgren received the 2017 Albert B Sabin Gold Medal Award in recognition of his pioneering work in mucosal immunology and leadership in the development of the world’s first oral cholera vaccine. The award was presented to Professor Holmgren by icddr,b Executive Director Professor John Clemens (who was recipient of the award in 2010) at the National Academy of Sciences in Washington, DC.

DR RUCHIRA TABASSUM NAVED

Dr Ruchira Tabassum Naved has been appointed a member of WHO’s Technical Advisory Group on Violence against Women.

DR MOHAMMAD AMINUL ISLAM

Dr Mohammad Aminul Islam has been appointed a member of the WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance.

DR K ZAMAN

Dr K Zaman has been invited to become a member of WHO’s Polio Research Committee.

DR FIRDAUSI QADRI

icddr,b emeritus scientist Dr Firdausi Qadri has been appointed one of ten members of the Scientific Advisory Board of the Islamic Development Bank.

Dr Qadri was selected as the next president of the Asian Conference on Diarrhoeal Disease and Nutrition (ASCODD) to be held in Dhaka in 2020.

DR NIYAZ AHMED

Dr Niyaz Ahmed has been elected a Fellow of the American Academy of Microbiology.

MD. SAIFUL ISLAM

Md. Saiful Islam was selected to be a Society for Healthcare Epidemiology of America International Ambassador in 2017.

DR RUCHIRA TABASSUM NAVED

Dr Ruchira Tabassum Naved has been appointed a member of WHO’s Technical Advisory Group on Violence against Women.
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 settings.

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, BRAC University.

During 2017, more than 2,000 public health and allied professionals, students, medical interns and researchers from 13 countries participated in our technical training, public health orientations, and field experience programme activities. We introduced 10 new courses and launched a user-friendly online system for student services.

In October 2017, 20 doctors and nurses from Yemen spent a week at icddr,b and Dhaka Hospital, gaining hands-on training in cholera and malnutrition case management. Civil conflict in Yemen has led to one of the worst recorded cholera outbreaks, affecting hundreds of thousands of people. The training, supported by the Kuwaiti Women’s Philanthropic Team, provided guidance on key areas such as outbreak control and prevention, surveillance and case management.

For the past decade, we have been organising training to improve the skills of rural medical practitioners, informally trained practitioners serving about 65% of people in rural populations in Bangladesh. Working with a local NGO, faith Bangladesh, and with the support of Orbis International, in 2017 we launched a new initiative for rural medical practitioners, developing the skills of 400 practitioners in primary eye care.
Countries represented by students attending icddr,b training courses, and field experience and orientation programmes:

**FIELD EXPERIENCE AND ORIENTATION PROGRAMMES**

**Orientation:** Bhutan, Canada, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Uganda and USA

**Field experience:** Australia, Canada, India, Kenya, Malaysia, Sweden, Thailand, UK and USA

**TECHNICAL TRAINING COURSES**

Bhutan, Finland, France, Germany, Iceland, India, Japan, Kenya, Nepal, Slovenia, Somalia, Sweden and UK

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**Technical Training Unit**

James P Grant School of Public Health
(a collaboration with BRAC and BRAC University)

11 (9 male and 2 female) icddr,b staff hold academic positions

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**Field experience programme**

Aimed at Master’s and PhD students seeking practical insights into, and experience of, public health in a low-resource setting

134 students hosted:
104 national, 30 international

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**Orientation programme**

Tailored to meet specific curricular needs, primarily for medical students interested in research and humanitarian activities

1,040 students hosted:
856 national, 214 international
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 including X-ray, ultrasonography and gastrointestinal endoscopy, 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 in Dhaka and Matlab and at the Mirpur Treatment Centre. In 2017, our clinicians treated more than 200,000 patients, principally at the Dhaka Hospital. More than half of these patients were infants under five years 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. The hospitals train doctors and nurses in clinical care as well as provide a platform for them to engage in clinical research. 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. We also have a duty of care to the local communities who make such an important contribution to public health research. Our hospitals in Dhaka and Matlab cost USD 5 million a year to operate, placing a considerable strain on resources. In 2017, we launched a Hospital Appeal (http://donate.icdbr.org) to raise funds to cover the cost of our hospitals. Donations will help to support the doctors, nurses, support staff, in-patient and out-patient wards, intensive care unit and nutrition rehabilitation unit that save the lives of thousands of children every year.

219,738
patients treated

133,580 (61%)
number of children <5 years
DHAKA HOSPITAL
Total patients: 152,380
By gender:
M: 54%  F: 46%
By age:
<5 years: 62%
≥5 years: 38%

MATLAB HOSPITAL
Total patients: 52,721
By gender:
M: 45%  F: 55%
By age:
<5 years: 61%
≥5 years: 39%

MIRPUR TREATMENT CENTRE
Total patients: 14,637
By gender:
M: 57%  F: 43%
By age:
<5 years: 47%
≥5 years: 53%
icddr,b offers a range of high-quality clinical laboratory diagnostic services to patients referred by different clinics. The laboratory facilities make an important contribution to icddr,b research studies and generates an income that contributes to the life-saving work of our hospitals in Dhaka and Matlab.

We operate 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.

1,662,266
number of tests carried out

432
number of tests offered

27
number of new tests introduced

2,763
number of tests carried out as part of hospital surveillance studies

28
number of icddr,b projects supported

155,796
number of paid users
COMMUNICATIONS AND CHANGE MANAGEMENT

National and international media coverage included over 500 news reports. Among the highlights were articles in the New York Times, Science magazine, BBC and Al-Jazeera. In the digital space, stories of icddr,b’s research and innovation were viewed and shared over six million times, compared with 2.15 million views and shares in 2016. Nine in-house video productions were developed. Social media coverage increased significantly. Internal communication was strengthened; an employee engagement survey was undertaken and a new intranet launched.

DEVELOPMENT

An impressive array of visitors in 2017 included representatives from DFID, Global Affairs Canada, the Canadian High Commission, the Australian High Commission, Sida, Canadian Parliamentary Delegations, Minister of International Development and La Francophonie. New donor relationships were established with Green Tree, KOICA, the Kuwaiti Women’s Philanthropic Team, the Government of Kuwait and Islamic Bank Bangladesh. The Government of Bangladesh provided unrestricted funding. A memorandum of understanding was signed with DFID, a proposal has been approved by Sida (2017-2019), and a proposal was submitted to Global Affairs Canada for renewal of core funding and for climate change research. In addition, a proposal was submitted to Prince Mahidol Foundation (Thailand), a memorandum of understanding was signed with the Green Climate Fund and Green Tree International, and USAID funding was secured for the Research for Decision Makers Activity. Development secured the Hilton Humanitarian Prize which was awarded to icddr,b in 2017 (see page 8).

Complementing Science

In 2017, the Central Management Services Division enhanced staff capability and support systems, increased cost recovery to address reduced core funding support, and implemented improved business automation to enhance business efficiency.

The Division is led by Syed Monjurul Islam, who was appointed as Deputy Executive Director in February 2017. He also took over the responsibilities previously held by the Chief Operating Officer. The re-organisation has enhanced coordination across the departments supporting the scientific divisions and reduced management costs.

The Central Management Services implemented a series of actions in 2017 to improve the work environment, enhance productivity in science and resources, improve risk management efficiencies, adjust policies and procedures, improve audit compliance, and strengthen partnership with the Government of Bangladesh, donors and collaborators. The Employee Engagement Survey conducted in 2017 indicated an increase in percentage of staff who are satisfied working at icddr,b and agreed that the processes and procedures in the organisation are efficient.
FINANCE
Despite a tough year for unrestricted funding, the Finance department managed to achieve a marginal surplus of USD 106,000 through improved financial management of resources, together with a successful unqualified audit report for 2017. The department implemented cost control measures where management and administration costs were reduced and income generation measures were supported, leading to an increase of 53% in other income compared to 2016.

Financial sustainability has been maintained by efficient budgetary management and cost controls. Finance also implemented revised policies and procedures and automated 56 business processes, improving efficiency in service delivery and reducing payment schedules from 30 days to 25 days. icddr,b was also identified as a ‘low risk organisation’ in its audit report for the second consecutive year. An automated time management system was also initiated in 2017 and will be fully operational by July 2018.

HUMAN RESOURCES
Hiring processes were streamlined through a revised e-recruitment system, which delivered error-free documentation and a paperless hiring process. Initiatives were taken to enhance the health insurance offered to national staff and their dependants. The Technical Training Unit introduced 10 new training courses and continued to build the capabilities of icddr,b’s early-career and mid-level researchers.

INFORMATION TECHNOLOGY
Cost-effectiveness and efficiency were increased by optimisation and automation of 138 business processes. More than 90% of IT projects were completed on time and within the budget. A software-defined data centre with virtualisation, replacing hardware servers, was implemented without any new purchase or additional cost.

REGULATORY AND LEGAL AFFAIRS
Almost 600 legal documents were processed in 2017, a 9% increase over 2016. Pre-emptive action was taken to minimise organisational legal risks and ensure consistency with legal requirements. Process lead times of grant management and agreement execution were reduced.

RESEARCH ADMINISTRATION
Knowledge management support was provided to our scientists in developing new partnerships with collaborators and designing research protocols. New research protocols were reviewed and approved by the Institutional Review Board, including representatives from the Government of Bangladesh, academic institutions and icddr,b. In 2017, the number of research protocols and value of the grants was increased by 21%.

SUPPLY CHAIN AND FACILITIES MANAGEMENT
Approximately 56 long-term agreements were established through a competitive sourcing strategy and pro-active market engagement. Extensive renovation works were completed, including new air-conditioning in the hospital building, upgraded lifts, security gates, and demolition of the former library building.
Our staff of over 4,000 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 2018**

![Professor John D Clemens](image)

Professor John D Clemens
Executive Director

![Mr Syed Monjurul Islam](image)

Mr Syed Monjurul Islam
Deputy Executive Director

![Dr Firdausi Qadri](image)

Dr Firdausi Qadri
Acting Senior Director, Infectious Diseases Division

![Dr Shams El Arifeen](image)

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

![Dr Tahmeed Ahmed](image)

Dr Tahmeed Ahmed
Senior Director, Nutrition and Clinical Services Division

![Dr Niyaz Ahmed](image)

Dr Niyaz Ahmed
Senior Director, Laboratory Sciences and Services Division
SECRETARIAT

Ms Loretta Saldanha
Executive Assistant to the Executive Director

OBSERVERS

Mr Anthony Flynn
Director, Development

Ms Armana Ahmed
Head, Research Administration

Mr Nagarajan Nagarajan
Director, Internal Oversight

Mr Mohammad Noushad Chowdhury
Director, Supply Chain and Facilities Management

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

Mr Thomas Barry
Director, Finance

Ms Catherine Spencer
Director, Communications and Change Management
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, 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 of Global Health Innovation, UK

Member Secretary:

Professor John D Clemens
Executive Director
icddr,b

Syed Monjurul Islam
Deputy Executive Director (Observer)
icddr,b

REPRESENTING THE GOVERNMENT OF BANGLADESH

Kazi Shofiqul Azam
Secretary, Economic Relations Division
Ministry of Finance

Md. Sirazul Islam
Secretary, Health Services Division
Ministry of Health & Family Welfare

Md. Serajul Huq Khan
Secretary, Health Services Division
Ministry of Health & Family Welfare

Dr Abbas Bhuiya
Chief Editor, International Journal for Population, Development and Health, Partners in Population and Development
Former Deputy Executive Director, icddr,b
REPRESENTING 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

INDEPENDENT MEMBERS

Rajesh Agrawal
Assistant Director General, Finance, International Crops Research Institute for the Semi-Arid Tropics, India

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

Kenneth M Dye
International Development Consultant on Governance and Accountability
Former Auditor General of Canada

Dr Demissie Habte
Honorary Fellow of the London School of Hygiene and Tropical Medicine, UK
First President of the Ethiopian Academy of Sciences

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

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

Dr Jeanette Vega
Director, National Chilean Public Health Insurance Agency, Chile

Professor Maxine Anne Whittaker
Dean, College of Public Health, Medical and Veterinary Sciences and Deputy Director of the Australian Institute of Tropical Health and Medicine, James Cook University, Australia
icddr,b’s overall revenues for 2017 amounted to USD 65.92 million compared with a total expenditure of USD 65.81 million, generating a net surplus for the year of USD 106,000.

REVENUE

Our overall revenue for 2017 of USD 65.92 million (see below) represented a decrease of USD 1.27 million compared with 2016. Research grant income for 2017 rose slightly, by USD 0.2 million or 0.4% compared to 2016. Unrestricted funding fell by USD 4.09 million or 55%, due to reduced core donor funding.

Breakdown of revenues 2017

- Restricted grant contributions 50,356,908 (76.4%)
- Unrestricted grant contributions 3,403,459 (5.2%)
- Income from laboratories 4,546,137 (6.9%)
- Deferred income 3,557,194 (5.4%)
- Other unrestricted income 2,657,732 (4.0%)
- Other restricted income 768,953 (1.2%)
- Foreign exchange gain/(loss) 631,389 (1.0%)

Total revenue 65,921,772 (100%)
Expenditure

- Total expenditure for 2017 amounted to USD 65.81 million, a decrease of USD 1.24 million compared with 2016.
- The majority of expenditure (76%) is related to programme-specific activities, with only 14% related to management and administration; 10% of total expenditure relates to hospital and laboratory costs.

Breakdown of expenditure for 2017

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>National staff</td>
<td>USD 30,944,165</td>
</tr>
<tr>
<td>International staff</td>
<td>USD 4,465,808</td>
</tr>
<tr>
<td>Emeritus staff</td>
<td>USD 870,072</td>
</tr>
<tr>
<td>Supplies and materials</td>
<td>USD 8,868,562</td>
</tr>
<tr>
<td>Collaborative partnership costs</td>
<td>USD 3,358,187</td>
</tr>
<tr>
<td>Travel and vehicle hire charges</td>
<td>USD 3,375,825</td>
</tr>
<tr>
<td>Consultancy fees</td>
<td>USD 929,307</td>
</tr>
<tr>
<td>Rent, communication and utilities</td>
<td>USD 1,703,338</td>
</tr>
<tr>
<td>Training, dissemination and staff development</td>
<td>USD 1,502,831</td>
</tr>
<tr>
<td>Other operational costs</td>
<td>USD 9,797,425</td>
</tr>
<tr>
<td><strong>Overall expenditure</strong></td>
<td><strong>USD 65,815,520</strong></td>
</tr>
</tbody>
</table>

Other Key Financial Statistics for 2017

1. At the end of the year, icddr,b had USD 71.3 million in net assets.
2. Cash and cash equivalents amounted to USD 25.1 million at the end of the year.
3. Accounts receivables (debtors) decreased by 23%. Regular monitoring and follow-up has increased the timely collection of accounts receivables.
4. Accounts payables increased by 10%, as expenditure on several projects could not be fully recognised at the year-end.
5. Provisions decreased by 21%, as more controls over the provisioning mechanism were implemented and some significant long-pending provisions were adjusted.
6. The current ratio (liquidity) has declined from 1.36 in 2016 to 1.24 in 2017. This year, the increased accounts payables limited our cash inflow and the reduction in provisions resulted in more cash outflow. Both these factors led to a less favourable current ratio.
7. Stock inventories have increased by 7%. In terms of volume, there was a marginal increase in inventories.
8. Investments increased by 8% due to an increase in the market value of endowment fund investments.
9. Loans and advances rose by 16% due to an increase in advances to vendors and pension fund provisions.
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 31.21% to 29.00%; this figure includes hospital and laboratory costs.
12. Overall expenditure was 3% lower than the approved annual budget for 2017. This is within normal expectations and represents a considerable improvement on 2016 budgetary performance.

icddr,b received an unqualified (healthy) audit opinion from ACNABIN chartered accountants in respect of its financial statements for 2017.

icddr,b also qualified as a ‘low-risk auditee’ for the second consecutive year under the audit performed in accordance with US Government Auditing Standards (2 CFR 200, Sub-Part F – previously OMB A-133). Financial 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 2017

<table>
<thead>
<tr>
<th>Donor partners</th>
<th>Restricted (USD)</th>
<th>Unrestricted (USD)</th>
<th>Total (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill &amp; Melinda Gates Foundation</td>
<td>12,448,466</td>
<td>-</td>
<td>12,448,466</td>
</tr>
<tr>
<td>UKaid – Department for International Development (DFID)</td>
<td>4,298,721</td>
<td>771,606</td>
<td>5,070,327</td>
</tr>
<tr>
<td>US Government – Centers for Disease Control and Prevention (CDC)</td>
<td>4,652,190</td>
<td>-</td>
<td>4,652,190</td>
</tr>
<tr>
<td>US Government – United States Agency for International Development (USAID)</td>
<td>4,309,042</td>
<td>-</td>
<td>4,309,042</td>
</tr>
<tr>
<td>Global Fund to Fight AIDS, Tuberculosis and Malaria</td>
<td>3,822,776</td>
<td>-</td>
<td>3,822,776</td>
</tr>
<tr>
<td>US Government – National Institutes of Health (NIH)</td>
<td>2,417,907</td>
<td>-</td>
<td>2,417,907</td>
</tr>
<tr>
<td>Government of the People’s Republic of Bangladesh</td>
<td>292,401</td>
<td>1,401,492</td>
<td>1,693,893</td>
</tr>
<tr>
<td>Swedish International Development Cooperation Agency (Sida)</td>
<td>892,725</td>
<td>502,749</td>
<td>1,395,474</td>
</tr>
<tr>
<td>Commission of the European Communities</td>
<td>851,371</td>
<td>-</td>
<td>851,371</td>
</tr>
<tr>
<td>Global Affairs Canada</td>
<td>27,577</td>
<td>727,612</td>
<td>755,189</td>
</tr>
</tbody>
</table>

A complete list of donors is provided in Note 20 to the financial statements: [www.icddrb.org/about-us/reports/financial-reports](http://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, giving us more independence to prioritise our research agenda and to support worthwhile activities that are not funded by other donors

3. Facilitates our investment in maintaining and improving our infrastructure and research platforms 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, supply chain and facilities management, 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.