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OCTOBER 2014

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change views
on disability*

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*Why developing
cities need a
tailored approach*



COVER IMAGE: PROFESSOR BRIAN COOKE
AND STEVEN MORTON

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Reaching out to a changing world

► In less than 60 years since its foundation, Monash University has grown to become Australia's largest university and one of the country's leading research institutions. It is also Australia's most internationally focused university, with more than 20,000 international students, a campus in Malaysia, graduate and research academies in China and India, a study centre in Italy, and courses offered at Monash South Africa. We also have a path-breaking educational and research partnership with the University of Warwick (UK).

The depth and breadth of Monash University's research provide us with great scope to address the challenges that lie ahead for Australia and our wider region. Much commentary has been dedicated to the enormous economic opportunity presented by the rise of Asia in the 21st century and to the ways in which Australia's capacity to participate in, and contribute to, the growth and development of our region will be key drivers in the continued prosperity and growth of our nation. Yet, in keeping with the vision of Sir John Monash, after whom the university was named, we recognise at Monash that with opportunity comes responsibility – our academic endeavour must be not only for our benefit, but for the benefit of the wider community. For us, the achievement of our academic ambitions should have far-reaching and positive implications not only in Australia but also in regions beyond, where the challenges are often more stark and more intractable.

In a context of shrinking public-sector funding worldwide for university research and increasing



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focus on the importance of research translation, we need to be more outward-focused, more responsive to global challenges, and more responsible for broader economic prosperity and wellbeing. Internationalisation, interdisciplinary research and research translation are the keys to fulfilling Monash University's mission to deliver impact through excellence. It is essential that we transcend the boundaries of disciplines, institutions and nations in order to bring the best minds to bear on complex problems, so that new-generation solutions, such as those we proudly feature in this issue, can be found in areas such as affordable diagnostics and medical treatments, health systems and urban infrastructure, education and sustainable resource management.

Professor Edwina Cornish

PROVOST AND SENIOR VICE-PRESIDENT
MONASH UNIVERSITY



Professor Edwina Cornish

Inclusive innovation through affordable excellence

The phrase "affordable excellence" looks self-contradictory. What is affordable cannot be excellent. What is excellent cannot be affordable. But in recent times, we have seen this impossible-looking feat becoming possible.

Let me begin my explanation of this concept with a personal experience. In my mother's name, I have created the Anjani Mashelkar Inclusive Innovation Award. It is given for designing and developing a technological solution that leads to inclusion – meaning that millions of resource-poor people can benefit from it. But there are two conditions. First, it must belong to the category of affordable excellence. Second, it must be not just "best" practice, but "next" practice.

One of these awards was given to 28-year-old innovator Myshkin Ingawale. He found that women in villages were dying of anaemia because their low haemoglobin levels were not detected in time. He found out why: many of them were reluctant to give their blood. So he decided to create a non-invasive diagnostic tool, something never before achieved. He used photoplethysmography, spectrophotometry and advanced software for photon spectrometry to create TouchHb. This was technological excellence.

Furthermore, he reduced the cost per test from US\$2 to 20 cents. This was affordable.

Making high technology work for the rich is easy. Making low technology work for the poor is easy. But making high technology work for the poor, as the above example illustrates, is challenging. And that is precisely what Professor George Whitesides from Harvard University demonstrated with his paper-based diagnostic. It can do a liver test for a mere two cents, yet another example of affordable excellence.

This concept was first illustrated in a paper the late, legendary C.K. Prahalad and I wrote in *Harvard Business Review*. It was titled "Innovation's Holy Grail" and proposed the concept of getting more from less for more people, rather than just for more profit. Only six months after the paper's publication in July 2010, the World Economic Forum held a special session on "More from less for more".

This concept is now spreading around the world. The emerging economies are going for it, since they see the prospect of creating access equality despite the rising income



Dr R. A. Mashelkar

Making high technology work for the rich is easy. Making low technology work for the poor is easy. But making high technology work for the poor is challenging.

inequality that is creating social disharmony. The multinational companies are going for it, since they see that the next billion-dollar market will service customers who have an aspiration of buying "excellence" that is "affordable". When GE Healthcare created a portable ECG machine that could be priced at US\$600, rather than the conventional machine that was priced at US\$10,000, it found markets in the US and Europe. My recent work with the European Union and the Organisation for Economic Co-operation and Development has taught me that even there, the emphasis is shifting to quality, sustainability and affordability, not just the first two.

Finally, let us remember that "affordable" brings equity and "excellence" brings competitiveness. And "affordable excellence" has the power to put smiles on the faces of all seven billion people in the world, not just a few of them.

Dr R. A. Mashelkar, FRS

NATIONAL RESEARCH PROFESSOR & PRESIDENT,
GLOBAL RESEARCH ALLIANCE,
NATIONAL CHEMICAL LABORATORY, PUNE, INDIA

GLOBAL **MALARIA** OFFENSIVE

A renewed scientific campaign against this devastating disease is offering humanity new hope.

Every minute, a child dies from malaria.

In 2012, 90% of the world's malaria deaths occurred in Africa and about 460,000 African children died before their fifth birthdays.

SOURCE: WORLD HEALTH ORGANIZATION

PHOTO: 123RF.COM

WORDS Dr Gio Braidotti

► **There are parasites – smaller than human cells – that have an unquenchable appetite for human haemoglobin, the bright-red, life-giving molecule that carries oxygen in our blood.**

Transmitted by mosquito bites, these microbial parasites cause malaria, which annually afflicts millions of people through debilitating fever. Every year, the disease kills about a million people – mostly children and mostly in Africa.

Despite malaria's grim status as one of the planet's most devastating diseases, infection rates declined by 25 per cent between 2000 and 2012. A combination of drugs, bed nets and indoor spraying with insecticides has helped keep malaria at historically low levels.

But for doctors, researchers and communities in malaria-prone regions, the respite was always going to be short-lived. The parasite's relentless ability to acquire resistance to drugs is well known, which is why there has been mounting dread as humanity's medicine cabinet comes down to its last effective class of antimalarial compounds – the artemisinins. But now, clinics in Thailand and Cambodia report that even this last drug defence may have been breached.

Should resistance to artemisinin spread – as has resistance to every other antimalarial drug – the consequences could see life expectancy in the tropics once again start to fall, dragged down especially by rising infant mortality rates.

Science alert

This time, however, there is a difference. The loss of this drug defence was predicted, and an unprecedented philanthropic bequest has driven one of the most concerted scientific assaults on the disease ever seen.

More than a decade ago, the World Health Organization, knowing time was ticking on another malarial pandemic, initiated a pre-emptive strike – the Medicines for Malaria Venture (MMV). The funding for this global research effort has come from a range of donors, including government aid agencies in Australia, the US and Europe, private-sector corporations such as Newcrest Mining and ExxonMobil, and the non-profit sector, particularly the Bill and Melinda Gates Foundation.

The outcome 15 years later is being described as one of the most successful drug-development initiatives of the modern era – and one of the centres where some of the most promising drugs have been optimised for clinical use is an inconspicuous laboratory in the leafy Melbourne suburb of Parkville.

There you will find Professor Susan Charman, director of the Centre for Drug Candidate Optimisation, a key component of the Monash Institute of Pharmaceutical Sciences.

Research led by Professor Charman – in collaboration with researchers around the world – has been internationally acclaimed for its pivotal role in the development of some of the most advanced new antimalarial drugs so far – Synriam™ and yet-to-be-named OZ439 and DSM265.

Approved in 2012 and now marketed in India, Synriam™ borrows its anti-parasite chemistry from artemisinin but is much cheaper and easier to make.

Taking antimalarial drugs to the next level, OZ439 reduces treatment times from three days to one, thereby

achieving an MMV “holy grail” – a drug that can be administered as a single-dose treatment that will cost less than one US dollar. It is now in advanced clinical trials.

Then comes DSM265, which is in early clinical trials. This new drug introduces an entirely new and targeted way to attack the parasite.

Another drug candidate, MMV390048, the first developed in Africa, will soon enter clinical trials and a further two drug candidates are in pre-clinical development.

All of these compounds have at one point in their development passed through Professor Charman's laboratory and, in the process, earned her five MMV Project of the Year awards.

MMV CEO Dr David Reddy says that the work MMV does to develop and deliver the next-generation medicines would not be possible without the expertise of partners such as Professor Charman.

“Sue has provided incredible scientific support right across our portfolio of medicines,” Dr Reddy says. “In particular, her group has supported the development of our lead candidate for a single-dose cure, which could be a real game changer for the treatment of malaria.”

Surviving the body

Professor Charman explains that her research at Monash University specialises in optimising the way a drug is processed inside the human body.

It is an area of expertise called pharmacokinetics and recognises, clinically, that the body is not a passive recipient of drugs but rather views a drug as something foreign that it can chemically modify and eliminate at will.

“Our aim is to optimise a compound early in its development, well before the compound reaches clinical trials,” says Professor Charman, whose team works with drug-discovery groups all over the world on many diseases, including cancer.

Professor Charman explains how, once swallowed, drugs must be released from the formulation in the stomach, pass into the intestine, dissolve in the intestinal fluids and be absorbed into the bloodstream. That blood is taken directly to the liver and filtered before it is allowed access to the rest of the body. Enzymes in the liver can “detoxify” (chemically neutralise) drugs before they reach their intended targets.

“We know a lot about the chemical characteristics a drug needs to have to ensure good absorption from the intestine and low metabolism in the liver, both of which are needed to allow it to reach its target in the right concentration and remain there for the right duration of time,” Professor Charman says.

For more than a decade she has used that expertise to identify pharmacokinetic problems with compounds that have promising antimalarial activity, and has worked with chemists to improve them.

While there are many malaria research groups around the world, few have an embedded pharmacokinetic team the way Monash does. As a result, Professor Charman collaborates with a vast network of malaria researchers both within Monash and worldwide, putting her at the front row in the global malaria drug-discovery effort.

In 2014, she described the drug-development pipeline as being in the best condition of its history.

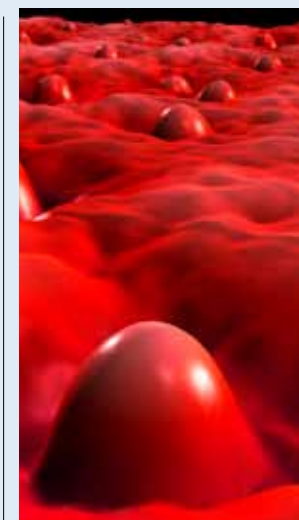


IMAGE: PROFESSOR BRIAN COOKE AND STEVEN MORTON

A view of the surface of a malaria-infected red blood cell at the highest resolution ever achieved.

Why malaria kills

Five microorganism species, all from the *Plasmodium* genus, can cause malaria in humans. These microorganisms invade and take over red blood cells to reproduce. In the process, they vandalise the host cell, making it unfit for human purposes. Within days, the infected cell bursts to release up to 50 new parasites. The resulting biochemical debris induces inflammation that the patient experiences as fever. With each round of parasite reproduction, the fever recurs and people do not acquire long-lasting immunity. The parasite also causes the red blood cells to become stiff and sticky. The cells clump together in the capillaries, where the parasite can hide from the human immune system. When this clumping takes place in the capillaries of the brain the result is cerebral malaria, which causes 80 per cent of malaria deaths.

FROM PAGE 5

Nonetheless, researchers are acutely aware that malaria has developed resistance to every drug ever produced.

“You always need new drugs for malaria,” Professor Charman says. “That means new compounds coming through the pipeline continuously.”

The malaria box

Four years ago, the quest for novel antimalaria compounds received a massive boost when pharmaceutical companies – primarily GlaxoSmithKline (GSK) and Novartis – screened their entire compound libraries for their ability to kill malaria parasites.

The GSK data is especially valuable as all active compounds were also tested for activity against a multi-drug-resistant parasite strain and their molecular structures made publicly available. The work was done in Spain by the GSK malaria unit led by Associate Professor Jose Garcia-Bustos, now at Monash.

The GSK team screened more than two million compounds – mostly without the benefit of high-throughput robotics – in a project that took five years to complete.

“In all, we identified 13,500 molecules that are capable of killing the malaria parasite in test-tube assays,” Associate Professor Garcia-Bustos says.

Despite including many proprietary molecules owned exclusively by GSK, the company has made all the compounds available for use by researchers.

“There have been few media reports about it but companies are finding ways to contribute to these public-good ventures,” Associate Professor Garcia-Bustos says.

In 2011, MMV brought together a representative set of about 400 molecules to produce the “malaria box”.

“To date, more than 160 physical copies of the box have been delivered to researchers around the globe in a bid to stimulate malaria and neglected disease drug discovery,” MMV’s Dr Reddy says.

Professor Charman says that while none of the compounds are drugs in their own right yet, they are a good starting point because they all have reasonable pharmacokinetic properties.

“A good medicinal chemist can optimise the molecules, including the interaction with the target in the parasite – if it is known,” she says. “Unfortunately, with malaria we often do not know the identity of the drug targets, even in the case of artemisinin.”

That, however, is something that scientists at the Monash Department of Microbiology are looking to change.

Malaria as a molecule

The malaria parasite can be viewed simply as an assembly of molecular-driven biochemical processes. Biologists find this perspective helpful because it brings into focus molecules that control either processes essential to the parasite’s survival or processes that cause disease.

Knowledge of such key “regulatory” molecules provides the ability to scan their physical structure for weaknesses and to design small, molecular assassins – usually in the form of inhibitors – to attack them and trigger a domino effect that brings down the parasite.

In his next blockbuster project, Associate Professor Garcia-Bustos is attempting to identify all parasite targets attacked by the GSK antimalarial compounds.

One strategy stands as a masterclass in biomolecular deviousness. First, he helps the parasite to acquire resistance to his compounds. He then scans

Mosquitoes at the pupa stage of their life cycle.

Half of the world's population is at risk of malaria.

There were an estimated 207 million malaria cases in 2012, leading to about 627,000 deaths.

In 2013, 97 countries had ongoing malaria infection.

SOURCE: WORLD HEALTH ORGANIZATION

the parasite genome to identify which genes mutated to create resistance.

“This can often identify the molecule most under pressure by each compound, and so reveals the likely drug targets,” Associate Professor Garcia-Bustos says.

That project is starting at Monash, where he was recruited by the director of the Microbiology Department, Professor Christian Doerig, who is also an accomplished malaria researcher with a reputation for game-changing, big-picture projects.

Drug targets

Professor Doerig’s focus when it comes to drug targets is a class of molecules called kinases. These are regulatory molecules that cells in all organisms use to relay important signals, such as the command to replicate.

Unlike kinase researchers of the past, Professor Doerig does not work on one such molecule. Instead he has mined the entire parasite genome for all such molecules.

“We found 85 genes that encode kinases and that together make up the parasite’s ‘kinome,’” he says. “Importantly, we found that some have no counterpart in any other species and are so different from all other known kinases that we cannot predict their function in the parasite’s life cycle; working on them is like doing exobiology [extraterrestrial biology].”

These differences, however, are a superb quality to have in a drug target because it means a greater likelihood that the drug will selectively inhibit the parasite and not the infected human.

The 85 regulating kinases are being systematically analysed and categorised at Monash on a spectacular genome-wide scale. “These proteins sit at key regulatory junctions in the parasite’s biology,” Professor Doerig says. “By characterising all of them we can assemble a map from which drug targets clearly stand out.”

In the process, the project is creating invaluable research materials – such as genetically modified parasite lines – that are of use to malaria researchers all over the world.

Cancer ally

Causing particular excitement is the discovery that to survive and proliferate in humans, the malaria parasite is capable of hijacking human kinases – the same kinases already targeted for drug discovery by cancer researchers. When Professor Doerig tested these potential anti-cancer compounds against malaria-infected red blood cells, the chemotherapy drugs were found to kill the parasite.

“This is interesting for two reasons,” Professor Doerig says. “First, targeting a human enzyme will make it much more difficult for the parasite to become resistant to the drug. Secondly, we can piggyback on the huge investment the pharmaceutical industry has made in the past decade targeting human kinases for cancer chemotherapy.”

Another subset of unique kinases are of particular interest to Professor Brian Cooke, deputy head of the Monash Department of Microbiology and a 25-year veteran of pioneering malaria research, whose primary interest is the surface membrane of infected red blood cells.

He brings up an image (see cover and page 5) on his desktop computer that he took with an atomic-force microscope. It shows, with unprecedented detail, the outer red cell membrane’s exquisite architecture but pricked and marred by molecules and structures inserted there by the parasite.

“The parasite alters the membrane’s properties causing the infected blood cell to become unusually stiff and sticky,” Professor Cooke says. “These disruptions are responsible for the most lethal consequences of being infected with malaria.

“There have been efforts to target these molecules for drug and vaccine development in the past but these efforts were thwarted by the parasite’s ability to switch and change these molecules to avoid detection.”

However, Professor Cooke has identified some of the kinases that regulate the parasite’s membrane-disrupting biology. “If we could inhibit these particular kinases, I strongly believe the inhibitors offer real possibilities for new drugs,” he says.

Additionally, the membrane studies have spurred advances in diagnostic medicine through collaborations with physical chemist Associate Professor Bayden Wood from the Monash Department of Chemistry.

Star Trek diagnostics

Associate Professor Wood confesses that his quest to use light as a diagnostic tool in medicine was based on the same science-fiction series that inspired the smartphone.

“All the great ideas come from *Star Trek*,” he says. “Dr McCoy’s medical tricorder was

the first time I saw someone point a handheld device and use light in diagnostic medicine.”

That light has diagnostic applications in the real world is due to a quirk of matter. When any atom or molecule changes energy state it does so by emitting and absorbing light (or more accurately, electromagnetic radiation, which includes visible light, but also gamma rays, X-rays, microwaves and ultraviolet, infrared and radio waves). Each type of molecule has a unique, telltale way of doing this, which scientists can analyse. This is how astronomers know the composition of matter in distant stars.

The instruments that can “read” light’s telltale signatures are called spectrometers. While spectroscopy has found important applications in astrophysics, chemistry and forensics, Associate Professor Wood is pioneering uses in diagnostic medicine, describing himself as a “biospectroscopist”.

To find an infrared signature typical of malaria, Associate Professor Wood analysed all the different parasite life stages at the single-cell level, initially using the infrared light source at the Australian Synchrotron.

Malaria signal loud and clear

“The breakthrough came when we identified a unique infrared signal associated with the fatty acids that constitute the parasite’s membranes,” Associate Professor Wood says.

The “malaria signal” came through loud and clear even when the parasite was tested in the presence of blood and even at early stages of infections. This is significant because it is currently difficult to diagnose malaria during its early stages.

“We were then able to detect that light signature using a small, cheap spectrometer – a malaria tricorder, so to speak – that can be used in remote locations without the need for healthcare professionals,” he says. Coupled with software that can automatically detect and quantify the presence of malaria parasites in a single drop of blood, the patented technology is extraordinarily sensitive.

With improved diagnostics, antimalarial drugs could be taken sooner after infection and the disease treated more effectively, Associate Professor Wood says.

The new technology would also allow clinicians to identify carriers of the parasite who do not show malaria symptoms. “These people pose a serious risk to communities because as they go about their daily business they pass on the parasite to others via mosquitoes moving from person to person,” he says.

“It is these ‘carriers’ that the medical tricorder hopes to identify so they can be isolated from their communities and treated.”

Know the target – the HIV lesson

The importance of understanding an intended drug’s target was made clear in the fight against HIV/AIDS and the breakthrough discovery that the AIDS virus relies on a protease (a molecule that cuts up other proteins) to replicate. The drugs that work are small molecules that inhibit the HIV protease.

Malaria too has been found to require proteases. The 3-D atomic structure of three such molecules has been ascertained by Dr Sheena McGowan, who runs a laboratory at the Monash University Department of Biochemistry and Molecular Biology.

“My strategy is to starve the malaria parasite by inhibiting specific proteases (called aminopeptidases) that the parasite uses to digest human haemoglobin, which it uses as food,” Dr McGowan says.

She adopted an approach called structure-based drug design that was pioneered in Australia with the development of the anti-flu drug Relenza® by scientists from Monash, CSIRO and the Australian National University. It involves crystallising the protease and using a synchrotron’s X-ray beam to decode the atomic structure of the protease as it interacts with various potential drugs.

Although the drug-development project is just beginning, she has already characterised an inhibitor to each of the targeted proteases.

“We have compounds that inhibit two of the targeted proteases and that work at concentrations that have no toxic effect on human cells in preliminary toxicity studies,” she says. “That makes for a good start.”

Integral to that progress, she says, has been access to the different scientific disciplines she needs at Monash, in particular the Australian Synchrotron next to Monash University’s Clayton campus and the research team at the Monash Institute of Pharmaceutical Sciences (MIPS).

“MIPS makes it possible to move research findings from ‘bench to bedside’,” she says. “It means we can move the project forward and manage all the complexities and subtleties of getting compounds to clinical trials.”

In terms of malaria, we might be unique at Monash in that we can go from basic research all the way through to biomedical engineering, clinical applications and drug delivery.

– Professor Brian Cooke

A pilot study with the device is scheduled for late 2014 in Thailand.

Like all the Monash malaria researchers, Associate Professor Wood attributes his success in part to an extensive network of collaborators across disciplines and institutions, including Professor Leanne Tilley (University of Melbourne) and Professor Cooke.

“In terms of malaria, we might be unique at Monash in that we can go from basic research all the way through to biomedical engineering, clinical applications and drug delivery,” Professor Cooke says.

“That makes sense when you recall that Australia only eradicated malaria in 1981 and that all the vectors are present for malaria to make a comeback. That is why Australia generally, and Monash specifically, never dropped its guard when it came to our antimalaria R&D capacity.”

They may even enable the development of vaccines that currently do not exist – for HIV or malaria.

– Dr Fasséli Coulibaly

COOL CUBES

PHOTO: JAMES BRAUND

WORDS Bianca Nogrady

► **A crystalline structure used by a silkworm virus to protect itself from the elements until it finds a new host to infect may provide similar protection for human vaccines in challenging tropical climates.**

One of the big challenges facing health officials trying to supply, and use, vaccines in remote regions where refrigeration is either limited, unreliable or non-existent is that vital vaccines are sensitive to hot conditions.

Too often vaccines fail to provide the necessary immune protection because the refrigerated supply chain that is supposed to protect them from temperature extremes while they are being transported has broken down.

Now there is a possible life-saving solution in the unlikely form of a crystalline “life raft” built by a silkworm virus to protect its viral “weaponry” from the elements. This pathogenic material is embedded into the protein crystal that, like an armoured safe, protects it (in the soil or on leaves) until a silkworm ingests the crystal and provides the virus with a new host.

Monash University’s Dr Fasséli Coulibaly discovered this structure, which is a crystal formed from a single protein, in 2007 in collaboration with Associate Professor Peter Metcalf from the University of Auckland. Having mapped the crystal using X-ray crystallography – in itself a groundbreaking endeavour – Dr Coulibaly set out to explore what might be done with this discovery. He looked at whether the crystals could be adapted to carry other molecular payloads, such as vaccines.

Dr Coulibaly christened the crystals MicroCubes because of their resemblance to sugar cubes. Their crystalline structure sets them apart from other vaccines, and also means they act in different ways. They are able to mimic the surface of viruses by presenting a regular array of selected viral components, and for this reason he expects them to prove particularly effective. They may even, he says, enable the development of vaccines that currently do not exist – for HIV or malaria, for example, or a universal flu vaccine.

Given the MicroCubes’ ability to protect against extremes of temperature, one of Dr Coulibaly’s first thoughts was their

Microscopic crystals made by a virus have inspired an ingenious way to protect fragile vaccines.



Pathogenic material is embedded into the protein crystal that, like an armoured safe, protects it.

application in hot climates. “Some of my family is from Mali in West Africa, where infectious diseases are a serious problem that contributes to a very low life expectancy,” he explains.

Infectious disease specialist Professor Stephen Kent from the Peter Doherty Institute and the University of Melbourne says the MicroCubes are an exciting development, particularly when it comes to their heat resistance and biological stability, which may overcome some ongoing challenges in vaccine development.

“It offers a great potential for humanitarian benefit but I think it also offers commercial potential in the right setting for first-world vaccines, in other words a pathogen for which there would be a commercial opportunity.”

Health impact

Dr Coulibaly says the research has given him a welcome opportunity to have some direct, positive impact on public health. With funding from the Bill and Melinda Gates Foundation’s Grand Challenges Explorations program, and in partnership with co-researchers Dr Rosemary Ffrench from the Monash Department of Immunology and the Burnet Institute, and the University of Melbourne’s Professor Lorena Brown, Dr Coulibaly has set out to develop the MicroCubes as a vaccine delivery method for a range of diseases, including HIV and influenza.

Dr Ffrench explains that embedding the vaccine material in the crystal means it is protected from both heat and degradation from proteases (enzymes that break down proteins). This may also enable a slow release of the vaccine as the MicroCubes are broken down and released gradually in the body.

Past studies have suggested that a slower antigen release may increase the quality of the immune response.

The MicroCubes are also relatively easy to synthesise compared with conventional vaccines, offering further advantages for vaccine production in developing countries. “We’d probably be able to make them very cheaply: grow in large-scale cell culture and then scale up so that the cost per dose is low,” Dr Ffrench says. ■

BLOOD LINES SPELLED OUT

WORDS Bianca Nogrady

► **The fictional wizardry of J.K. Rowling's *Harry Potter* books is the inspiration for a life-saving medical technology designed for remote regions where climate and lack of trained medical personnel restrict one of the most fundamental clinical procedures – blood typing.**

Giving someone the wrong blood in a transfusion causes the body to go into anaphylactic shock as the immune system is effectively forced to attack itself. Determining a patient's blood type traditionally requires complex and expensive laboratory equipment, careful refrigeration of antibody reagents and a university degree in pathology. It is a test that must be 100 per cent accurate: a mistake can be fatal.

But inspired by the magical *Harry Potter* diary that absorbs ink and prints its own letters, Monash University researchers Professor Wei Shen and Professor Gil Garnier have invented a paper-based test that spells out the correct blood type ... in blood.

Their innovation, which could be a significant boost to medical care in poorer and more remote regions of the world, uses a piece of bioactive paper. The paper can be stored in a variety of conditions, maintains

its efficacy for months, can be manufactured easily and cheaply, and can be used by almost anyone.

The test works by having text and symbols to represent A, B and O blood types as well as Rhesus factor printed on the paper using special inks laden with the relevant antibodies for each blood type. A drop of blood is placed on each symbol, and the paper is washed with a saline solution. If the blood type is A, for example, it will interact with the antibody printed in that letter, causing it to coagulate and give an unambiguous report of the blood type.

"If this blood is specific to that antibody then the drop stays where it is and if it's not specific, it will wash away," says Professor Garnier, a chemical engineer at Monash and director of the Australian Pulp and Paper Institute.

The result can then be easily interpreted according to which letter or letters remain highlighted in red. This seemingly magical technology comes down to relatively simple science that uses the porous structure of the paper, says Professor Shen, also a chemical engineer at Monash.

"When blood cells coagulate, their size increases and they get locked into the fibre structure, whereas in a negative test the cells can be flushed away by a saline solution," Professor Shen explains.

Paper test

As well as making life considerably easier for pathologists, the test has enormous potential for developing countries because it is easy and cheap to produce, does not require a refrigerated supply chain, and can be interpreted by an unskilled person.

Most countries have a printing and paper industry with the capacity to produce large quantities of paper. "And then instead of printing with conventional inks, we can print in inks containing antibodies," Professor Shen says.

The key to this development being put into practice is the need for it to be as accurate as current blood-typing methods. So far, in more than 1000 comparisons between the paper-based and conventional assays, there has not been a single disagreement.

"We have to provide the same safety and that's what the invention has done; we have the same efficacy as modern technology," Professor Garnier says.

Professor Robert Pelton, a chemical engineer at McMaster University in Canada and leading expert on bioactive paper technology, says the test has the added advantage of easy disposal. "Dealing with matter such as blood, it's great to be able to incinerate cleanly and not build up a hospital waste problem," Professor Pelton says.

Professor Shen and Professor Garnier say the greatest appeal for them of the paper-based test is its simplicity and accessibility. "What Wei and I have tried so hard to do is to engineer something that any user without any education, without even being able to read, can use," Professor Garnier says. "We want something that doesn't rely on electronics and is robust, and this empowers the users."

Blood types

Blood types are classified on the basis of molecules inherited from both parents that appear on the surface of red blood cells. These are capable of triggering adverse immune reactions when transfused into people with different combinations of these "antigenic" molecules. The most important for transfusions are the ABO and RhD molecules.

BLOOD GROUP AB

People that express both A and B antigens can receive red blood cells from any ABO group and are called "universal recipients". They can only donate to AB people.

BLOOD GROUP O

Express neither A nor B antigens, making their blood acceptable to any ABO blood group and are called "universal donors". They can only receive group O blood.

BLOOD GROUP A

Express the A molecule and react adversely to B-bearing red blood cells. They can receive only A or O group blood and donate to type A or AB.

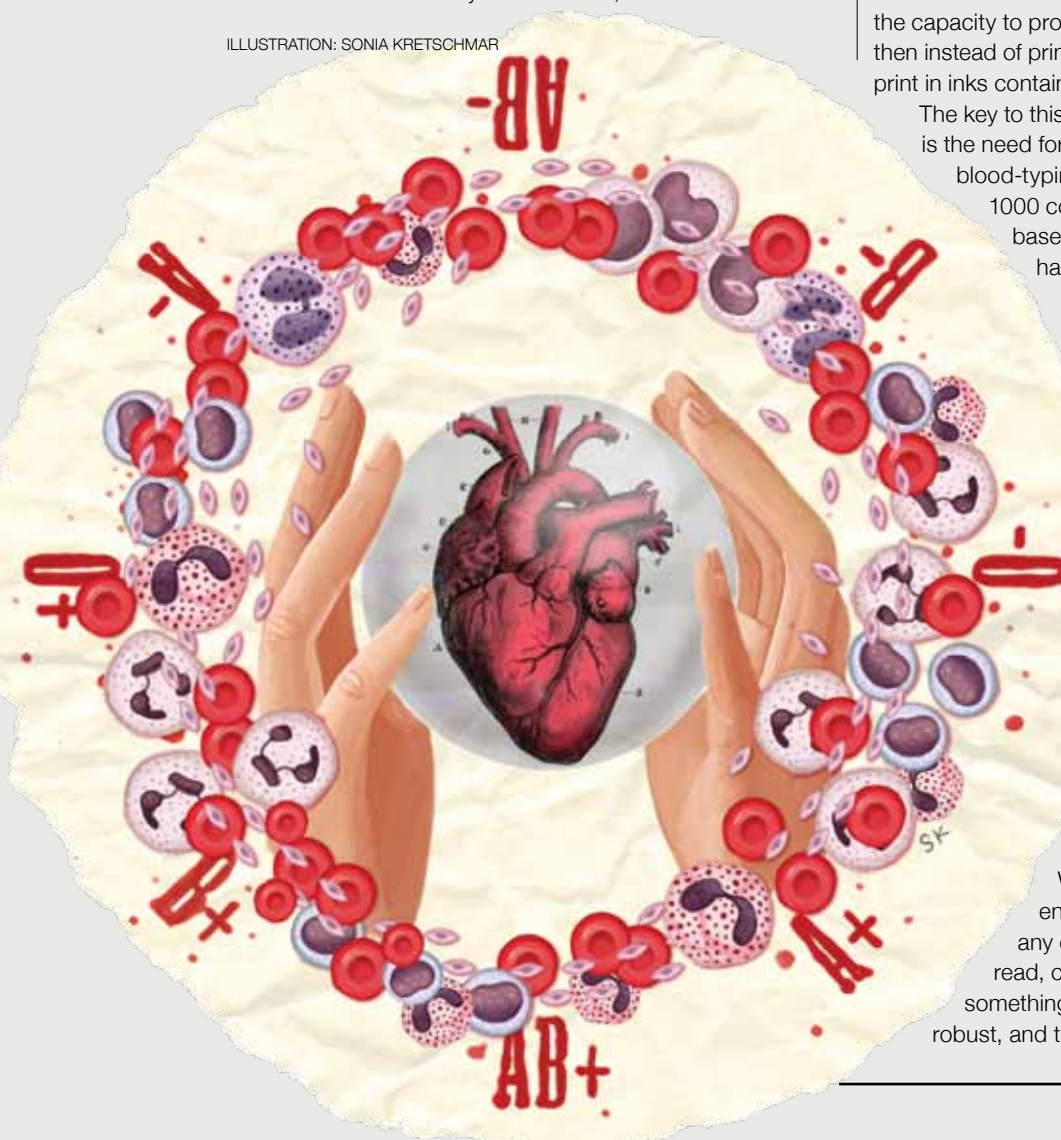
BLOOD GROUP B

Express the B molecule and react adversely to A-bearing red blood cells. They can receive only B or O group blood and donate to type B or AB.

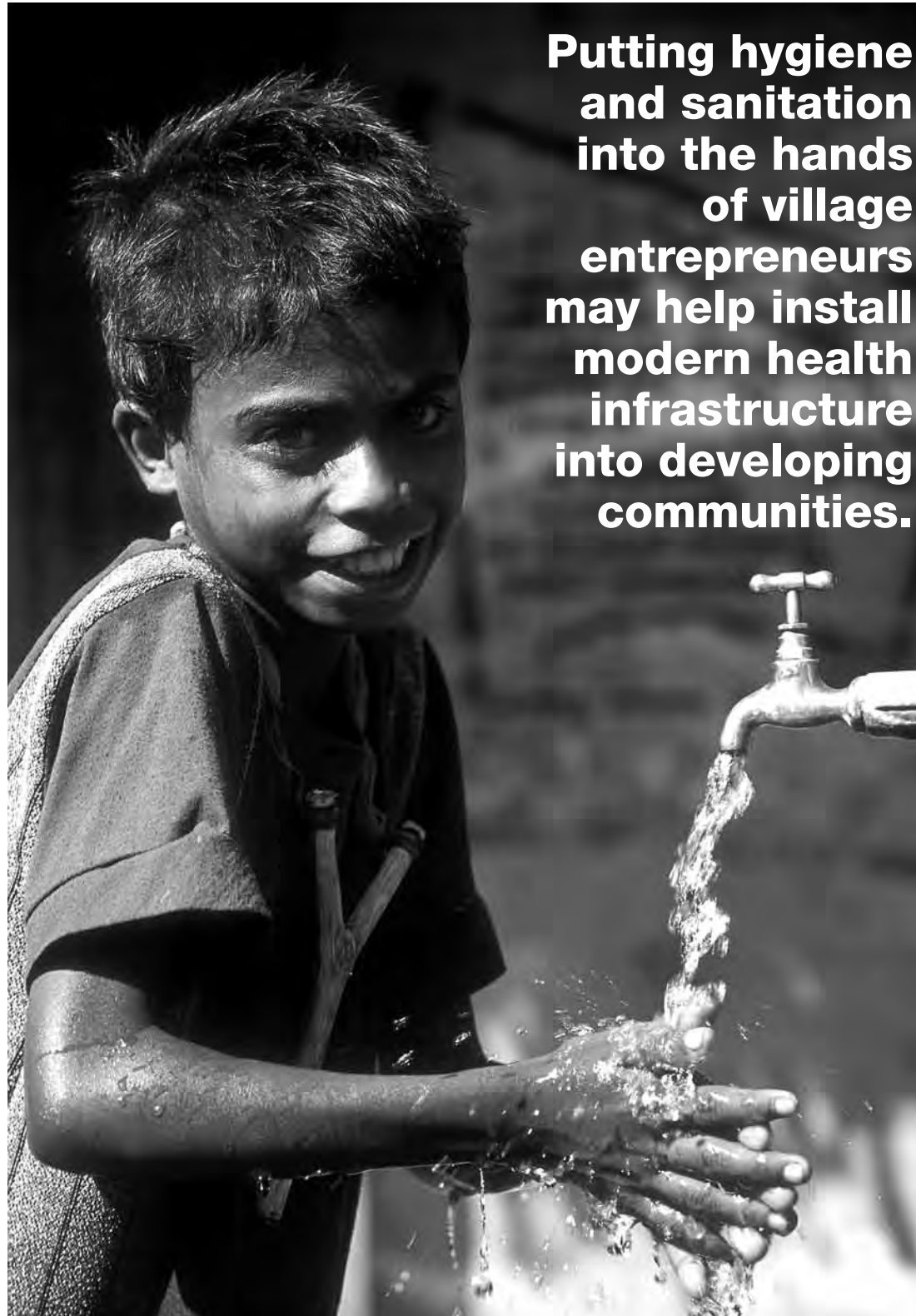
RHESUS TYPE

Blood also needs to be compatible for the presence (+) or absence (-) of Rhesus factor D (RhD) molecules. This is what gives a reading, such as A positive or A negative.

ILLUSTRATION: SONIA KRETSCHMAR



CLEAN BUSINESS



Putting hygiene and sanitation into the hands of village entrepreneurs may help install modern health infrastructure into developing communities.

WORDS Brad Collis

► **A typhoid outbreak in Fiji last year was linked to groundwater polluted by raw sewage. It brought into sharp relief the purpose of a new international research project that is wrestling with the complex cultural and economic factors influencing attitudes towards modern sanitation.**

The development sector has learned that simply providing an amenity – be it a reticulated water supply or toilets – does not work if the “advancement” does not have local buy-in.

So a new Water, Sanitation and Hygiene (WaSH) project involving four Pacific countries – Solomon Islands, Vanuatu, Papua New Guinea and Fiji – is adopting a “sanitation marketing” approach that is looking for ways to make sanitation attractive to local entrepreneurs.

The project’s principal investigator is WaSH engineer Dr Dani Barrington, a research fellow appointed jointly by Monash University and the International WaterCentre (IWC). She explains that sanitation marketing – working with local entrepreneurs to build businesses around the provision of sanitation – is a proven approach in Asia and Africa, but one that faces challenges in the less densely populated Pacific region where the Melanesian culture of sharing can hinder the creation of profit-oriented businesses.

“We are working with local communities and with local enabling bodies [the ministries of health, environment ministries and water authorities] to find out what will work. In effect we are looking for a way to bridge the communities’ needs and priorities with the capacity of authorities or businesses to meet these needs.”

Urban call

Dr Barrington says the project’s main focus is on the large number of informal settlements that have grown up around major towns and cities as a consequence of the population drift from rural areas.

“These are communities that aspire to modern living, including modern sanitation, but are outside established infrastructure,” she says.

PHOTO: BRAD COLLIS

Household and industrial wastewater mixed with tidal inflow permanently inundates areas surrounding houses in this informal settlement near Suva, Fiji.



PHOTO: JAMES BRAUND

The Pacific WaSH markets initiative is a three-year project under the auspices of IWC and Live & Learn, an NGO. It involves researchers at Monash, the University of North Carolina at Chapel Hill (UNC-Chapel Hill) in the US and the University of the South Pacific in Fiji.

The project is in its early fact-finding stages. Dr Barrington and two Monash Department of Marketing colleagues, Associate Professor Srinivas Sridharan and Dr Stephen Saunders, are responsible for researching the communities' needs and priorities. A UNC-Chapel Hill team, led by Professor Jamie Bartram and IWC's Dr Regina Souter, is working with enabling bodies and assessing existing policy frameworks. Professor Bill Aalbersberg and PhD student Semisi Meo from the University of the South Pacific are adding an environmental framework to the project, given that wastewater from these settlements is also polluting reef ecosystems.

Professor Bartram says that in addition to improving coverage rates for sanitation infrastructure the ongoing challenge is maintenance, with high breakdown rates of both water and sanitation systems.

The WaSH research is being funded by an Australian Development Research Award Scheme from the Australian Department of Foreign Affairs and Trade.

Tragic impacts

Dr Barrington says last year's typhoid outbreak illustrates the painful and often tragic impact of a lack of modern sanitation facilities such as toilets and sewage containment. She notes that diarrhoeal diseases caused by contact with faeces are still the most common killer of children under five in developing countries.

"However, for people in these circumstances, the priority is usually water, not sanitation. You can't live beyond a few days without water, but you can live without sanitation ... although it may shorten your life span and your whole family will suffer if you get sick and can't work.

"It means, however, that decisions about water infrastructure tend to be made on a community scale, while decisions about toilets are made more at the household level."

Mr Meo explains that cleanliness is embedded in the region's cultural and spiritual beliefs so the challenge for people is learning how to work with and maintain WaSH technologies. For him the project is about engaging with people to understand their daily living conditions, from the WaSH perspective and in their diverse environmental, social, cultural and economic circumstances.

"This is why communities may choose to explore entrepreneurship models as a way to tackle WaSH issues under various conditions," he says.

Dr Barrington has so far made two field trips and has been fascinated by the lengths to which some people have gone to try to modernise. And their definition of modern is influenced largely by television. "People want flushing toilets. They perceive self-composting toilets as a backwards step. So you will see improvised water tanks – like an old upturned refrigerator I saw on one roof – to provide flushing water. But these toilets generally just empty into old fuel drums, holed to allow the wastewater to escape. This then pollutes the groundwater, or in some coastal communities it is also picked up by the daily tidal inundation."

Over the coming year, the researchers will bring communities and enabling bodies together to find common, workable ground. "It's not about us telling people to use toilets. It's about facilitating their decision-making and their approach to finding a long-term solution," Dr Barrington says.

"My hope for the project is that we can leave the communities with a well-researched understanding of what will work for them, and a clear plan of action."



These are communities that aspire to modern living, including modern sanitation, but are outside established infrastructure.

– Dr Dani Barrington

Technology challenge

- In the Pacific region, use of improved sanitation has remained static at 35% of the population since 1990, lagging behind improvements seen in other regions.
- Open defecation rates in the Pacific region are estimated at 12% of the population, although in the Solomon Islands this estimate jumps to 54%.
- Papua New Guinea is one of only three countries in the world where less than half the population has access to an improved drinking water source.

SOURCE: WORLD HEALTH ORGANIZATION AND UNICEF, 2014

The International WaterCentre builds capacity for integrated water management through education, training and research, focusing on urban communities, river systems and Water Sanitation and Hygiene (WaSH) goals. It was founded by four Australian universities – Monash University, the University of Queensland, Griffith University and the University of Western Australia – and has more than 140 global partners.

Live & Learn works with Asia-Pacific communities to overcome social and economic challenges, from domestic violence to deforestation, poverty, poor health, education and civic infrastructure.

Flowing from the Tibetan Plateau through China's Yunnan province, Myanmar, Laos, Thailand, Cambodia and Vietnam, the Mekong River is under enormous pressure. Its fish provide 70 per cent of the region's protein source; it is a major transport corridor; and it also faces increasing demands from agriculture, industry and intensifying urban growth.

THE CHALLENGE OF Sharing

Wars have been foretold in future scenarios where climate change and population pressures over-stress shared river resources. Scientists believe they can rewrite this grim prophecy.



ing

PHOTO: 123RF.COM

WORDS Brad Collis

► **There has been a surprise omission from the equation used to formulate policy responses to some of the world's most pressing water resource and water-sharing challenges.**

National economics and politics tend to be the dominant influences on negotiations for sharing diminishing, and often contested, water resources. What has been missing is an equal infusion of science: a potentially costly omission that some are pushing hard to rectify.

Dr Paul McShane, chief research officer with the Monash Sustainability Institute, is leading a multidisciplinary effort to provide governments and their agencies with research-backed data to facilitate more informed policies and agreements.

"Our main objective is to identify courses of action which, while inevitably requiring compromise, can also provide mutual benefit," he says.

At the core of the issue is the increase in demand on rivers that are a finite resource and likely to be further affected by climate change.

This is being tackled in a project, now 18 months in, to develop regional collaboration in river basin management as an overarching response to the expected impacts of climate change.

Most countries in the two main regions covered by the project – south Asia and the Indochina Peninsula – have increasingly divergent priorities for their shared river resources. For some, agricultural development for poverty alleviation and economic advancement remains the priority.

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For others the demand is swinging more towards industrial and urban growth and energy generation.

Dr McShane, who has worked extensively in South-East Asia advising governments on sustainable development, says the two main areas of tension are the Mekong, which supplies six countries (Myanmar, China, Laos, Vietnam, Thailand and Cambodia), and south Asia, where Pakistan, India, Bangladesh, China and Myanmar share six key Himalayas-source rivers (the Indus, Brahmaputra, Ganges, Irrawaddy, Yangtze and Yellow rivers).

Putting science into management

Dr McShane's Monash University team is working with several collaborators, in particular the Nepal-based International Centre for Integrated Mountain Development.

"Our task is to explore mutual benefits, because given the asymmetric power of countries such as India and China, there is not a lot of bargaining power for countries such as Bangladesh or Cambodia in asking for equal access to water – for saying 'we would prefer it if you didn't dam rivers flowing into our country'," he says.

"So we have to find a basis for apolitical, whole-of-catchment management, and the science supporting this has to be robust and transparent."

As an example of mutual benefit, he cites China's need for the Mekong as a transport route. "It doesn't want downstream countries over-clearing land and creating

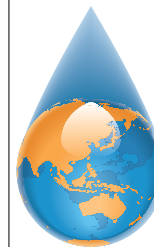
erosion that increases sediment loads in the river. So keeping the river navigable becomes leverage for downstream countries against detrimental upstream activities, such as diversions and dams."

Other examples of emerging cooperation in this region are concerns that Chinese dams in the Mekong's upper reaches might disrupt the breeding patterns of fish, which provide 70 per cent of the region's dietary protein. China was able to show that its dams were too far upstream to have an effect, but the same concerns have led Laos to hold off on some of its planned dams for hydro-electricity.

Dr McShane says the opportunity for a collaborative discourse exists for the Mekong-sharing countries through the Mekong River Commission, and while China is not a member it has shown that it is listening to the concerns of other riparian states.

South Asia does not have this structure and, Dr McShane notes, "the stakes there are high".

Collectively the rivers here support nearly three billion people and the complexity of the situation is why the current research project has to be multidisciplinary. "It's one thing for us to consider the biophysical aspects – the hydrology, sedimentation, land use et cetera – but the real work is in the socioeconomic and political issues – how to reconcile the diversity in culture, religion, ethnicity and poverty that influences the behaviour of people and their governments."



At the core of the issue is the increase in demand on rivers that are a finite resource and likely to be further affected by climate change.



PHOTO: SIMON J. ROWNTREE

The Monash Sustainability Institute is working with the International Centre for Integrated Mountain Development and a range of collaborators including other universities, NGOs and natural resource management agencies from India (Energy and Resources Institute), Pakistan (Water and Power Development Authority), Bangladesh (University of Dhaka), Bhutan (Royal Society for Protection of Nature) and Nepal (Department of Hydrology and Meteorology within the Ministry of Science, Technology and Environment).

Bagmati River, Nepal. Once-pristine rivers are being increasingly polluted by urban development and growing populations.

Dr McShane says there is considerable frustration already with perceived imbalances in water-sharing arrangements.

"You have India wanting to build a dam on the Indus River, which flows into Pakistan, which relies on it for its economic mainstay – agriculture. The whole of Pakistan is, in effect, the Indus Valley.

"Added to this potential conflict, the Indus River sources much of its water from glacier and snow melts in the Himalayas and this is almost certainly going to be affected by climate change. An increased melt may mean more water in the short term, but significantly reduced flows in the longer term. Superimpose over this the cultural, religious and political conflicts between India and Pakistan and you have a scary prospect."

Dr Shreshth Tayal, from India's Energy and Resources Institute, says geopolitical constraints have limited river basin management to governments, and restricted any significant knowledge exchange among the stakeholders from riparian countries. "Now, with increasing water demand due to urbanisation, and impacts of climate change on glacier catchments as well as rainfall patterns, future water security is at stake and likely to affect the geopolitical stability of the region," he says.

"This is why this multidisciplinary research collaboration is such a significant platform for researchers from riparian countries. We can exchange views, research and understanding about river basin management, and develop a shared understanding and mutual trust about water issues to help develop a regional perspective."

Dr McShane says researchers have to function as knowledge brokers: to make sure there is a link between policy and research, not just policy and nationalism.

"We have to bring together the economists, geographers, geologists, anthropologists and engineers and examine the mutual benefits and the trade-offs to come to decisions that balance the needs of people and each country's sustainable economic growth."

Part of the project is also exploring new water-saving technologies, particularly in large and increasingly thirsty cities such as India's Mumbai with its 20 million people. "A few extended dry seasons, and that city could run out of water," Dr McShane says. "So are there innovative ways to collect and store water that is otherwise being lost as storm water? Is there technology we can employ in Mumbai now to avert a water crisis?"

These are questions that researchers know cannot go unanswered. There is no life without water, and that makes water-sharing one of humanity's greatest challenges. ■

A MODERN WATER conundrum

FACED WITH RISING POPULATIONS AND RAPID URBANISATION, DEVELOPING NATIONS ARE KEEN TO ACQUIRE FIRST-WORLD WATER-MANAGEMENT SYSTEMS – BUT THAT CAN MEAN BUYING INTO COSTLY MISTAKES.

WORDS Catherine Norwood

► **Walk the streets of Port Vila, capital of the South Pacific nation of Vanuatu, especially after a rain storm, and you can see why the country is keen to install “modern” sewerage and drainage infrastructure.**

The issue is not so much puddles and gutters swilling with filthy water, but an intriguing challenge to the notion of “modern”. For many developing countries it means having the same infrastructure as a developed country. The problem with this very common perspective is that the developed world has not necessarily “got it right”. Simply adopting first-world systems can also mean emulating the same costly cycles of trial and error.

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For researchers tasked with helping developing countries improve their civic facilities and infrastructures, however, this is not an easy message to sell.

In the case of Port Vila, a 2010 drainage proposal lifted straight from a conventional developed-country model – networks of pipes, pits and pumps that would carry wastewater away from the city as quickly as possible into local waterways – would have been a disaster.

The proposed centralised drainage system might have improved drainage for the city itself, but would have exacerbated coastal pollution and created serious headaches for the tourism on which the local economy relies.

Best of both worlds

Four years later, on the back of an interdisciplinary doctoral research project by Monash University environmental engineer Michael Poustie, Port Vila's drainage plans have been substantially revised to incorporate local priorities.

Mr Poustie's project brought together expertise from the university's Department of Civil Engineering – also home to his supervisor, Professor Ana Deletic – and the School of Social Sciences, through co-supervisor Professor Rebekah Brown.

The resulting plan is a hybrid of conventional pipes and pits, combined with grass swales and infiltration systems to slow and treat stormwater, and the use of composting toilets in districts that do not have access to improved wastewater systems.

The new proposal will be cheaper to build and operate, and more environmentally sustainable.

According to Professor Brown, it is a good example of how mainstream technology in a first-world context is not necessarily the best infrastructure investment in a developing country. Professor Brown is a program leader for Australia's Cooperative Research Centre (CRC) for Water Sensitive Cities and associate director of the Monash Water for Liveability Centre.

"Poor countries can look to rich countries and say 'we want what they have'. What they might not see are the significant environmental and economic impacts of these older systems, which have really only been recognised in the past 20 to 30 years," she says.

"In the so-called first world, many urban environments have highly degraded waterways and river systems. Yes, we have high availability of potable water, but we use a lot of energy to make that water very, very clean, and then we use it to flush toilets. This, in the long term, is not sustainable."

Many developed countries are now investing billions of dollars into water recycling and more sustainable water-management systems.

A matter of trust

Professor Brown says many developing countries are poised to make major water-management investments and it is imperative to avoid decisions that might lock them into financially and environmentally high-cost infrastructure networks for decades, if not centuries.

However, she says, it is not easy: "People in poorer countries aspire to the lifestyle of richer countries. How can we, in a developed country, say 'you can't have what we have'?"

"Why should they trust us when we try to suggest they could have something better? They want to modernise, and we are suggesting a mix of small, decentralised water-management technologies that sound sub-optimal."

Professor Brown says it is not only the decision-makers in developing countries pursuing what they regard as superior systems. Organisations such as the World Bank and Asian Development Bank imply in their

In the same way that many of these countries have adopted mobile phones without the need for a landline network, they can bypass the water and waste-management systems that so-called 'modern' cities are finding unsustainable.

PHOTO: PAUL JONES



– Professor Ana Deletic

Sustainable water program

Monash University will launch its first Graduate Research Interdisciplinary Program in 2015, with a cohort of 10 to 15 doctoral researchers focusing on sustainable water management in Asia. The program will combine engineering and social research to help developing countries adopt "water-sensitive city" strategies.

Professor Rebekah Brown and Professor Ana Deletic will lead the program; both are members of Australia's Cooperative Research Centre for Water Sensitive Cities. Professor Brown says after seeing what has been achieved in Port Vila as a result of Michael Poustie's doctoral project work, she is excited about the possibilities. "Such a large cohort of smart, ambitious researchers tackling water issues in Asia has the potential to have a significant impact and to create real policy punch across the region."

funding frameworks that such conventional infrastructure should be the goal.

This was the case with the initial Port Vila urban development proposal. The alternative, more tailored approach only arose because of Mr Poustie's decision to use Port Vila as a case study for his research into technical and institutional barriers to the adoption of sustainable water technologies in the South Pacific.

"You can't just look at water infrastructure from a technical perspective. You have to incorporate the management, the institutions and the governance structures to enable water technologies to be implemented, used and maintained," Mr Poustie says.

Going local

The former Australian Agency for International Development funded Mr Poustie to run workshops to identify social and institutional challenges facing Port Vila's water planning. He found, for example, that no one organisation or department was responsible for sanitation services.

Mr Poustie modelled seven drainage systems under seven different stormwater and climate scenarios. These included the status quo, two proposals from the Asian Development Bank, two based on international best practice as identified by specialist academics, and two locally developed mixed systems that incorporated different technologies according to the Port Vila geography and socioeconomics.

The local models clearly delivered the best balance of environmental performance and affordability.

Erickson Sammy, the water resources manager with the Vanuatu Department of Water Resources, says Mr Poustie identified simple ways to improve stormwater drainage, particularly in low-lying parts of Port Vila that often flooded due to poorly constructed drains.

"These ideas are now being adopted as part of the Port Vila Urban Development project, funded by the Asian Development Bank. The results of our project can provide a model that can be expanded on or replicated in other urban areas in the developing world," Mr Sammy says.

The potential to change how international development agencies pursue infrastructure development is an important outcome. "We now have a locally developed vision and local desire to meet the goals, rather than just having international consultants say 'this is what you need'," Mr Poustie says.

In the course of his research Mr Poustie says he also found that one of the most crucial elements for improved water management is leadership. In the countries where progress is being made on this issue, there is someone championing the cause.

PHOTO: 123RF.COM



We now have a locally developed vision and local desire to meet the goals, rather than just having international consultants say ‘this is what you need’.

– Michael Poustie

“In Vanuatu, the director of the Department of Environment and Conservation, Albert Williams, has taken up the cause. In Samoa, the Prime Minister’s wife is really passionate about water. In East Timor, the President is interested in wastewater issues – so there is political support for water and wastewater projects, which helps prioritise funding towards these issues.”

Scientists also have an influential role to play. Professor Deletic, who is deputy chair of the Australian Academy of Technological Sciences and Engineering’s water forum, has been discussing possible water-related research partnerships with the Indonesian Academy of Sciences. With expertise in civil engineering, and drainage in particular, she is also a contributing researcher to the CRC for Water Sensitive Cities, as well as a leading researcher in the Monash Department of Civil Engineering.

Urbanisation outpacing infrastructure

Professor Deletic says that while countries such as Australia have invested in infrastructure over 200 years as cities have grown, developing countries, such

as Indonesia, are in a difficult situation because they are urbanising at a rapid rate.

“Only three per cent of Jakarta is sewered. The city relies on septic tanks. This is a ticking bomb of health issues. You look at the modern city on the top – these huge rising buildings – and hidden underneath are all these septic systems. But you can’t go back and dig up all the streets in Jakarta.”

Instead of relying exclusively on centralised solutions, Professor Deletic points to the need for novel approaches, particularly at a neighbourhood level. In new settlements on a city’s outskirts, installing sanitation nodes incorporating septic systems could make a huge difference, while rainwater tanks are a simple option for safe drinking water instead of dubious groundwater or river water.

Professor Deletic hopes that with the support of researchers, civic leaders in developing countries will realise they can leapfrog the systems and mistakes of big cities in the developed world.

“In the same way that many of these countries have adopted mobile phones without the need for a landline network, they can bypass the water and waste-management systems that so-called ‘modern’ cities are finding unsustainable.”

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LIGHTS ON FOR MONEY TRAILS

When Zaire's former dictator Mobutu Sese Seko was governing, the night lights in his hometown grew more intense, reflecting his rise to power – and then faded away as he left the scene.

Dr Paul Raschky from the Monash University Department of Economics says Mobutu's case provides an extreme example of the phenomenon whereby regional areas that are leaders' birthplaces tend to do disproportionately well.

Mobutu spent his vast wealth most lavishly in his hometown of Gbadolite. With fellow researcher Professor Roland Hodler from Switzerland's University of St Gallen, Dr Raschky correlated satellite data showing night-time light intensity with information about the birthplaces of political leaders. Previous research had proved the connection between economic activity and light generated at night. Looking at political systems that ran the gamut from democracy to autocracy, the study of 38,427 regions in 126 countries found the intensity of lights said a lot about the local GDP in leaders' birthplaces.

Countries with weak political institutions and poorly educated citizens were most vulnerable to such fluctuations: the local benefits rarely lasted beyond a change in government.

The study underscores the importance of sound political institutions and good education, not to mention strict enforcement of political term limits. It also sounds an alert to aid agencies. "Our findings suggest authoritarian leaders mainly use foreign aid to the benefit of themselves, their family and clan members, and others living in their stronghold," Dr Raschky says.

Mobutu Sese Seko ruled Zaire for 31 years, amassing an estimated personal fortune of US\$5.2 billion. In 1997, he was overthrown and the country renamed the Democratic Republic of the Congo.

TAKING THE CHILL OFF ICE AGES

► Plants and animals that survived past ice ages appear to have had a little help from a powerful heat source: volcanoes. Researchers who studied tens of thousands of records of Antarctic species found that the closer they got to the location of volcanoes and their warming effects, the more mosses, lichens and invertebrates there were.

As well as helping to explain how species respond to climate change, the research may solve a long-running mystery about how some

PHOTO: 123RF.COM

IS THAT YOUR T-SHIRT RINGING?

Picture a phone so small and so flexible it could be printed on clothing. That idea has shifted into the realm of the possible, thanks to researchers who have modelled a new version of "spaser" technology.

A spaser (or surface plasmon amplification by stimulated emission of radiation) is effectively a nanoscale laser or nanolaser. Unlike a traditional laser, it emits a beam of light through the vibration of free electrons, rather than a space-consuming electromagnetic wave emission process.

Researchers from Monash University's Department of Electrical

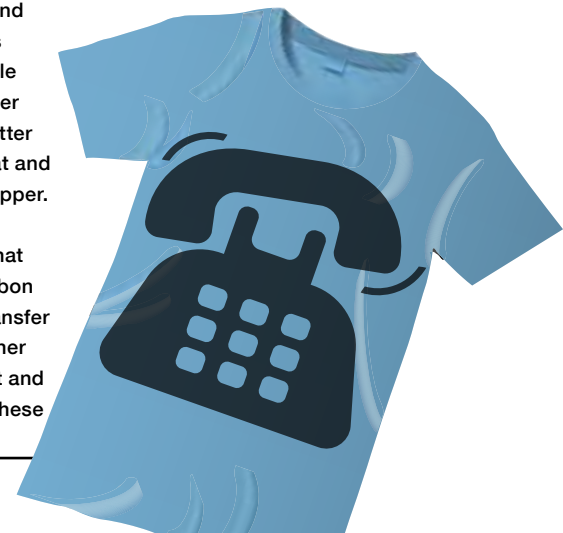
and Computer Systems Engineering have modelled the world's first spaser to be made completely of carbon. The result would be so robust, flexible and eco-friendly, says lead researcher Chanaka Rupasinghe, that "there is the possibility that in the future an extremely thin mobile phone could be printed on clothing".

The researchers chose graphene and carbon nanotubes for their remarkable properties: stronger than steel, and better conductors of heat and electricity than copper.

They showed for the first time that graphene and carbon nanotubes can transfer energy to each other through light. Fast and energy-efficient, these

optical interactions carry potential for many things, from computer chips to next-generation communications.

The carbon spaser could also be used in photothermal cancer therapy. It is possible to move the nanotubes close to cancer cells and use high concentrate fields to destroy them without harming healthy cells.



species survived and continued to evolve despite many habitats being covered by glaciers during ice ages.

“About 60 per cent of Antarctic invertebrate species are found nowhere else in the world,” says Professor Steven Chown, head of the School of Biological Sciences at Monash University, who collaborated with the Australian National University in the research. “This suggests that these species have been present for millions of years. How they survived past ice ages – the most recent of which ended less than 20,000 years ago – has long puzzled scientists.”

The research, published in the *Proceedings of the National Academy of Sciences*, has an eye to the future as well as the past. Knowledge of these diversity “hotspots” in Antarctica will help efforts to protect them from the ongoing effects of human-induced environmental changes.

Dimmer switch for drug delivery

► Researchers are optimistic about bringing the concept of the dimmer switch to the world of medicine, where drugs often work more on the “on/off” principle.

Professor Arthur Christopoulos and Professor Peter Scammells from the Monash Institute of Pharmaceutical Sciences are developing a way to treat heart attacks that will allow far more fine-tuning than is now possible.

Many other conditions, from schizophrenia to diabetes, could also stand to gain from their findings.

In research published in *Proceedings of the National Academy of Sciences*, the team gained a game-changing understanding of a heart protein that belongs to the family of G protein-coupled receptors.

These are found throughout the body and are often the target of medications.

Current heart attack drugs work like an on/off switch on that protein. But heart attacks have complex effects. Initially, an artery blockage cuts off oxygen, killing cells, then the blood rushes back, releasing chemicals and free radicals and causing more damage.

Finding a drug strong enough to protect from that damage, but not so strong that it stops the heart altogether, has been very difficult. Based on their research, Professor Christopoulos and Professor Scammells believe they can target the receptors differently. Medication can then be adjusted as required, so the cells are protected while the heart beats on.

More than **80%** of deaths from cardiovascular diseases occur in low and middle-income countries.

SOURCE: WORLD HEALTH ORGANIZATION

Flexing up to a new gold standard

► A wearable pressure sensor made by sandwiching ultrathin gold nanowire-impregnated tissue paper between two polymeric rubber sheets could transform the way vital health signs are monitored.

Sensitive, flexible, robust and able to be produced without expensive equipment, the sensor could be used to take blood pressure or pulse readings, with particular potential as an at-home diagnostic tool for elderly or disabled people.

Researchers from the NanoBionics lab in the Monash University Department of Chemical Engineering used gold nanowire for the sensor because it can be extremely flexible, while maintaining high conductivity, and is robust enough for wearable devices. Yet it is amazingly thin: at about two nanometres – or two billionths of a metre – it is the thinnest gold wire produced.

Unlike conventional pressure sensors, which rely on brittle semiconductor material, the new sensor can be bent or twisted without cracking.

Associate Professor Wenlong Cheng says its potential goes beyond medical devices: the sensor could be used for detecting acoustic vibrations and in flexible displays that stand to supersede hard tablet or phone touch screens. It could also aid in developments as varied as prosthetic skin, touch-on flexible displays and soft robots.

The research was published in *Nature Communications*.

FINGERS HELP POINT TO OSTEOARTHRITIS

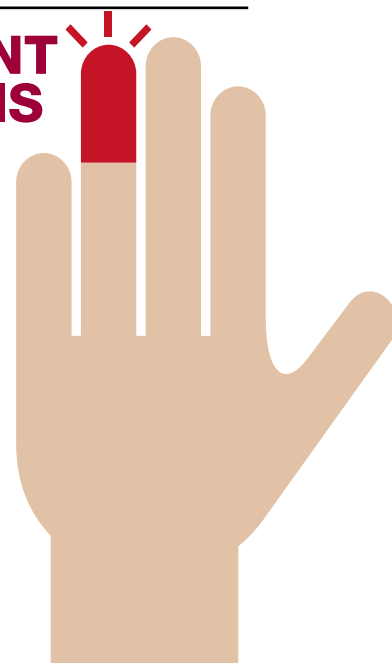
If your ring finger is significantly longer than your pointer (or index) finger, you may have a greater-than-average chance of developing osteoarthritis as you age.

The ratio of the lengths of index finger to ring finger (2D:4D) has been correlated with joint replacement rates in a study led by Dr Yuanyuan Wang from Monash University's Department of Epidemiology and Preventive Medicine.

The study took data collected from more than 14,000 middle-aged and elderly people as part of the Melbourne Collaborative Cohort Study and compared that information with the Australian Orthopaedic Association National Joint Replacement Registry. The results showed that a lower 2D:4D ratio – that is, when the index finger is shorter than the ring finger – was linked to a risk of knee osteoarthritis severe enough to require joint replacement. This was true for both hands, but the right hand ratio was more significant. No such association was observed for hip osteoarthritis.

Dr Wang says the findings support the belief that hormonal factors play a role in the origin, development and effects of osteoarthritis; hormones are also considered to be responsible for the 2D:4D ratio.

Hormonal influences on the growth of bone, cartilage and soft tissue could explain the connection.





Road trauma drives

India's efforts to curb its high road toll are now focusing on hospitals and their capacity to save lives.

WORDS Melissa Marino

► **To drive along any road, anywhere in the world is a risk, but in India this goes to a whole new dimension of heart-in-your-mouth mayhem as every mode of transport fights for space in streets where, well, there isn't any.**

Children play in the shadow of roaring trucks and buses, and pedestrians stride alongside rickshaws, motorbikes, cars, cows and the occasional elephant. The streets are a riot of movement, colour and deafening noise – a road-safety nightmare.

"Pedestrians claim ownership of the road as much as drivers so you have

a lot of people on the street," says Professor Nobhojit Roy, a Mumbai trauma surgeon who every day experiences firsthand the consequences of this clash. "We have cars colliding with children and pedestrians, and a huge number of motorcycles."

The bald statistic behind the mayhem and tragedy is that one person is killed on the roads every two to four minutes in India. The official annual road toll is more than 140,000 and rising: the result of poor road conditions, an increasing number of faster and heavier vehicles, and streets still full of people.

While traffic congestion means speeds often are not as high as in developed



hospital reform

PHOTO: 123RF.COM

countries, people on foot and motorbike are vulnerable in any collision.

Improving this circumstance is going to be a long haul, but doctors and road trauma specialists say the terrible toll can be reduced – not on the roads, but in the aftermath of an accident.

Specialists such as Professor Roy say the high road toll is exacerbated by an inadequate trauma-response system. People who would otherwise survive an accident die because treatment is not good enough.

Professor Roy says many people – in fact, the majority – become fatalities when they should not. Researchers looking for ways to lower the toll have

found that only 36 per cent of people die at the roadside. Eleven per cent die on the way to hospital and a staggering 53 per cent die once they are there.

“This tells us that there is a problem with the system,” Professor Roy says. “We have smart doctors here but obviously we don’t have a smart system ... and we need one.”

Smart systems

Professor Roy, also an epidemiologist, is a principal investigator in Mumbai on a research program involving five Indian hospitals across three cities: Mumbai, New Delhi and Ahmedabad. The program is

being led by the All India Institute of Medical Sciences in New Delhi, and Australia’s National Trauma Research Institute (NTRI), a partnership between Monash University and The Alfred hospital, in Melbourne, Victoria.

The four-year Australia-India Trauma Systems Collaboration (AITSC) is funded through the Australia-India Strategic Research Fund Grand Challenge Scheme supported by both countries’ governments. The A\$2.6 million award is the first major funding of its kind in the world and brings together clinicians, academic partners, industry, governments and the World Health Organization Global Alliance for Care of the Injured.

The mix of slow, fast, old and modern vehicles, plus pedestrians and livestock, contribute to a horrific accident toll in India that is exacerbated by poor trauma care.

CONTINUED PAGE 22

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The collaboration will develop and test innovative pre-hospital, hospital and post-hospital interventions that could improve care of the injured in countries at all levels of development. It builds on evidence that improving systems of care has been effective in reducing injury-related death and disability in high-income countries.

A good example of this is the successful Victorian State Trauma System. It was implemented in 2001 and within 10 years had halved the probability of dying after severe injury.

"I would call it 'penicillinesque'," says Professor Russell Gruen, a trauma surgeon and key AITSC architect, of the impact of Victoria's system, which is considered a world leader and which Monash and The Alfred hospital played major roles in establishing.

Victoria's current annual road toll – less than 300 in recent years – is a quarter of what it was 40 years ago, cut through a combination of prevention and trauma-care initiatives. "The system has almost eliminated preventable deaths in the state," says Professor Gruen, who is also the NTRI director.

The Victorian State Trauma System, he says, transformed trauma care in Victoria through improved policy, infrastructure, ambulance and hospital practices, and response times.

The AITSC will draw on key elements of Victoria's system that are appropriate to trial in an Indian context. These include improving communication with hospitals before a patient arrives and, through quality reviews, providing a more streamlined, better-targeted service once patients are there.

Tailor-made

Professor Gruen hopes the AITSC will find answers that will be broadly applicable to lower and middle-income countries globally – where 90 per cent of the world's injuries occur – as the developing world faces an epidemic of preventable death through injury.

"We are looking at things that are relatively low cost and that can be implemented without wholesale health-system change to improve patient outcomes," he says.

At the same time, AITSC program manager Nathan Farrow says there will be lessons for the Victorian system from other initiatives trialled in the project – through, for example, using new technologies to visually connect specialist trauma centres with remote locations to assist with treatment.

One of the first elements to be trialled is simply advising a hospital in advance that accident victims are on their way. Professor Roy says currently patients often show up without any warning, meaning already overcrowded hospitals are ill-prepared to treat them.

"Nobody radios in advance, so all of a sudden a patient arrives and you don't have any clue what their injuries are and you haven't got a team in place," he says. "It's a proven fact that having a team and equipment in place at the hospital makes a difference."

This is a problem compounded by the fact that most Indian cities are without a comprehensive, centrally coordinated ambulance service. In Mumbai, for example, ambulances are only available on subscription to certain classes of people and are mostly used to transfer people between hospitals.

"A patient coming to hospital would have a very high chance of arriving in a taxi, with police or in a tuktuk, rather than by ambulance," Professor Roy says. And without a dedicated emergency response system, many cities simply lack the infrastructure to call ahead.

But rather than trying to implement entire new ambulance services or radio networks, Mr Farrow says existing mobile phone technology could be used to advise hospitals of incoming patients. AITSC project members will work with existing providers, including police, to develop this and other cost-effective options to help hospitals be better prepared when a patient arrives.

A similar approach will be taken with another program initiative: connecting a specialist trauma centre, such as key AITSC partner the JPN Apex Trauma Center in New Delhi, in real time with regional hospitals for live resuscitation advice and guidance.

Rather than installing expensive new technology, the Australian Centre for Health Innovation is advising on cheaper and equally effective options. "Why install a A\$300,000 video-conferencing system when you might be able to get away with A\$3000 worth of webcams, Google Glass and wi-fi?" Mr Farrow asks.

Of all the program initiatives, the quality-improvement program for hospitals that involves reviewing practices and patient outcomes is the most important, Professor Roy says.

With more than half of India's road victims dying once they get to hospital, it is vital to get a handle on what is happening. "It is very important for us to look at those people who have actually managed to reach the hospital and why we haven't managed to look after them," he says. "We need to fix our hospitals and Professor Gruen's group are the experts in that, and that is the most important thing that I intend to draw from the Victorian experience."

Professor Gruen says quality-improvement programs are now standard practice in every Australian hospital. They allow staff to review errors and deaths, identify where care could be improved and learn from mistakes.

Professor Roy says hospitals are receptive to this type of change. Health professionals have seen the improvements made in Victoria based on this model and – crucially, he says – the timing is right.

Will to change

India is changing as the country shifts from a developing nation to more of a middle-class nation. With that shift come different expectations for societal indicators such as the road toll – and those expectations have an impact on political will.

"The economy is transitioning and there is a whole move from government saying 'we can't be leading the world in road traffic trauma while we become a developed country'," Professor Roy says. "We need to get our safety and trauma-response protocols in place. Just like we need to have a good human rights record, we need a good traffic outcome record."

For Professor Gruen, the importance of political support cannot be underestimated. The ongoing success, he says, of a project is contingent on its sustainability. And its sustainability is reliant on understanding the perspectives and priorities of the key stakeholders, who are often government or financial backers controlling the project's flow of resources.

Building good relationships with those stakeholders – the people who call the shots – is crucial, he says. The AITSC is evidence of a positive relationship between India and Australia, and this will be strengthened through the recent signing of a five-year memorandum of understanding (MoU) between the two governments to run alongside it.

Negotiated by Professor Gruen, the MoU will help develop trauma-response systems,



**NUMBER
OF ROAD
FATALITIES
PER
100,000
PEOPLE
PER YEAR**

**AUSTRALIA
6.1**

**INDIA
18.9**

**UNITED
KINGDOM
3.7**

**UNITED
STATES OF
AMERICA
11.4**

SOURCE: WHO
GLOBAL STATUS
REPORT ON ROAD
SAFETY 2013



**I would call it 'penicillinesque'
... the system has almost
eliminated preventable deaths
in the state of Victoria.**

– Professor Russell Gruen

trauma care and training in India, and has scope to involve organisations such as the Australian Trade Commission and the World Bank to fund specific projects or infrastructure related to the AITSC research.

"In the context of research and development, the AITSC is the 'R' and the MoU the 'D'," he says. "Under this agreement, we can work up projects together with key decision-makers, connecting the expertise in Victoria with the market and business development expertise in India." ■

PHOTO: MELISSA MARINO



Professor Nobhojit Roy: "A patient coming to hospital would have a very high chance of arriving in a taxi, with police or in a tuktuk, rather than by ambulance."

AITSC at a glance

The four-year, A\$2.6 million Australia-India Trauma Systems Collaboration (AITSC) involves five Indian hospitals across three cities: New Delhi, Mumbai and Ahmedabad.

Key research partners are The Alfred hospital's and Monash University's National Trauma Research Institute in Australia and the JPN Apex Trauma Center at the All India Institute of Medical Sciences in New Delhi, India.

The AITSC involves more than 40 international specialists working in four areas:

- improved pre-hospital notification and handover of patients;
- real-time expert advice from specialists to non-trauma hospitals;
- trauma quality-improvement programs and reviews for hospitals; and
- improved home-based rehabilitation after hospital discharge.

Establishing a shared trauma registry between the five hospital sites to compare and ultimately improve patient outcomes and provide the basis for a national registry is also on the agenda.

Surgery a good medicine

Building relationships with key drivers underpins another aspect of Professor Russell Gruen's work on a global level, making surgery more accessible for people in developing countries.

More than two billion people around the world have no access to surgery and millions die from injury each year when surgery could have saved them. "More than 250,000 women die each year because of delivery-related complications that surgery could fix," says the Monash University professor of surgery and public health.

Surgery, he says, is a cost-effective intervention, and his aim – to have safe surgery available to everyone when they need it – is best achieved from the global stage.

The key is to find effective ways to influence ministries of health and finance. For example, Professor Gruen has been working with international colleagues advocating for a World Health Assembly resolution for universal health coverage to include safe surgical services.

If successful, the resolution would direct the World Health Organization and its director-general to act. "So we would be aiming for ministers of health from all countries to have the need for safe surgery brought to their attention and be encouraged to invest to improve surgical services."

Monash research
is *helping stop*
the spread of
Dengue fever by
making mosquitoes
immune to the
disease.

We think that's
brilliant.



MONASH University

BACTERIA *put the bite* ON MOZZIES

Mosquitoes that transmit the dengue virus may soon be rendered harmless under a biological control program that infects them with an insect-specific bacterium.

WORDS Bianca Nogrady

► **As another monsoon season approaches the tropics and subtropics, health authorities are bracing for the cyclical impact of dengue fever, one of the world's most debilitating, and often fatal, diseases – and one of the most difficult to control.**

Authorities in many countries have begun their annual community-awareness programs including, in countries such as Pakistan, enforcing strict laws requiring property owners to eliminate dengue larva breeding grounds.

Controlling dengue fever is mostly about killing the *Aedes aegypti* mosquito

that passes the virus between people. This is done by draining open water in which the mosquito breeds, distributing repellent and doing everything possible to drive the mosquito and its deadly cargo away from areas populated with humans. It is a near-impossible task, as evidenced by the fact that each year almost 400 million people succumb to the disease.

An international research team is trying a dramatic new approach – deliberately seeding dengue-plagued areas with mosquitoes.

But these are no ordinary mosquitoes. They are carrying a bacterium called *Wolbachia* – one of the most prolific bacterial parasites on earth, hosted by

about two-thirds of all insect species. When *Wolbachia* infects a mosquito it prevents the dengue virus from taking hold and being transmitted to humans.

Using the bacterium as a control agent for dengue began as an idea of Professor Scott O'Neill when he was working on *Wolbachia* in mosquitoes as a PhD student. He has since enjoyed what he terms “the privilege” of seeing something grow from a concept to an international collaborative research program – Eliminate Dengue – that could be the first real opportunity to reduce the spread of this virus.

Having proved in small field trials that the release of *Wolbachia*-infected mosquitoes

into the wild leads to the spread of *Wolbachia* through mosquito populations, the challenge for the research team is to expand this control method across large urban areas.

"At the moment we're focusing on developing methods to scale up so we can deploy over whole cities of 500,000 people," says Professor O'Neill, who is the program leader and Dean of Science at Monash University.

To begin with, researchers are working towards a full-scale deployment by the end of this year in the city of Townsville, in tropical north Queensland. Following the current small-scale trials in Yogyakarta, Indonesia, and a small island off Nha Trang in Vietnam, it is hoped these cities will also support a full-scale deployment of *Wolbachia* mosquitoes in 2015.

Professor Cameron Simmons, an infectious diseases specialist at the University of Oxford and the University of Melbourne and a collaborator on the program, says community involvement and acceptance is one of the research program's greatest strengths.

The biological control message

"The research program has been exemplary in the way it's gone around engaging communities and treating the communities as being very important stakeholders in delivering the *Wolbachia* dengue control method," Professor Simmons says.

This has required communicating a complex concept: that the release of infected mosquitoes will serve as a biological control that does not itself eradicate the *Aedes aegypti* mosquito, but does prevent dengue transmission.

"This is quite a challenging message to get across to communities who for decades have been told that the way to control dengue is just to kill all mosquitoes," Professor Simmons says.

As well as testing the feasibility of enlisting community participation, the three city-based field trials will investigate the most sustainable method of deployment. Past studies of *Wolbachia* deployment have released mosquitoes every four houses, to ensure coverage would be successful. The next question is how to do this more efficiently.

Professor O'Neill points out that it is one thing to cover an area of 1000 houses and release mosquitoes every four houses, but covering 150,000 houses with a small team, in a short period of time, and cost-effectively, is a considerable challenge.

This is why collaboration with the broader community is a key feature of the *Wolbachia* project. In the future it is hoped that schools will be included.

"We'd like to move to school-based competitions, science-based experiments, science projects around mosquitoes – we could have school children do deployment and also have them involved in monitoring how the *Wolbachia* invasion is going," Professor O'Neill says.

The *Wolbachia* dengue control method has the advantage of being a short-run intervention. Unlike previous mosquito-control efforts, which relied on constant vigilance and ongoing eradication, in theory no further action is needed once *Wolbachia* has established itself in a mosquito population.

Greatest challenge ahead

The Yogyakarta and Nha Trang trials will also allow researchers to more clearly assess the impact that such a release has on the rates of dengue infection. While northern Australia suffers periodic dengue outbreaks, these are dwarfed in scale by the devastation that dengue wreaks in other parts of the world, in particular South-East Asia, India and Latin America.

"Part of our work in Indonesia and Vietnam is scaling up the whole-city deployment to get the first direct measurements of efficacy," Professor O'Neill says.

This means the *Wolbachia* intervention is yet to face its greatest challenge – to prove whether it does lead to a drop in dengue infections. But there is every indication that it will.

"We haven't had a direct test of efficacy yet, but models and the predictions that come from these say we should be able to completely stop dengue transmission where we can deploy the *Wolbachia*-carrying mosquitoes," Professor O'Neill says.

Professor Simmons says there is a long history of using old-fashioned mosquito control to reduce the burden of dengue fever around the world, but these approaches have by and large been unsustainable, with little evidence that they have reduced dengue transmission.

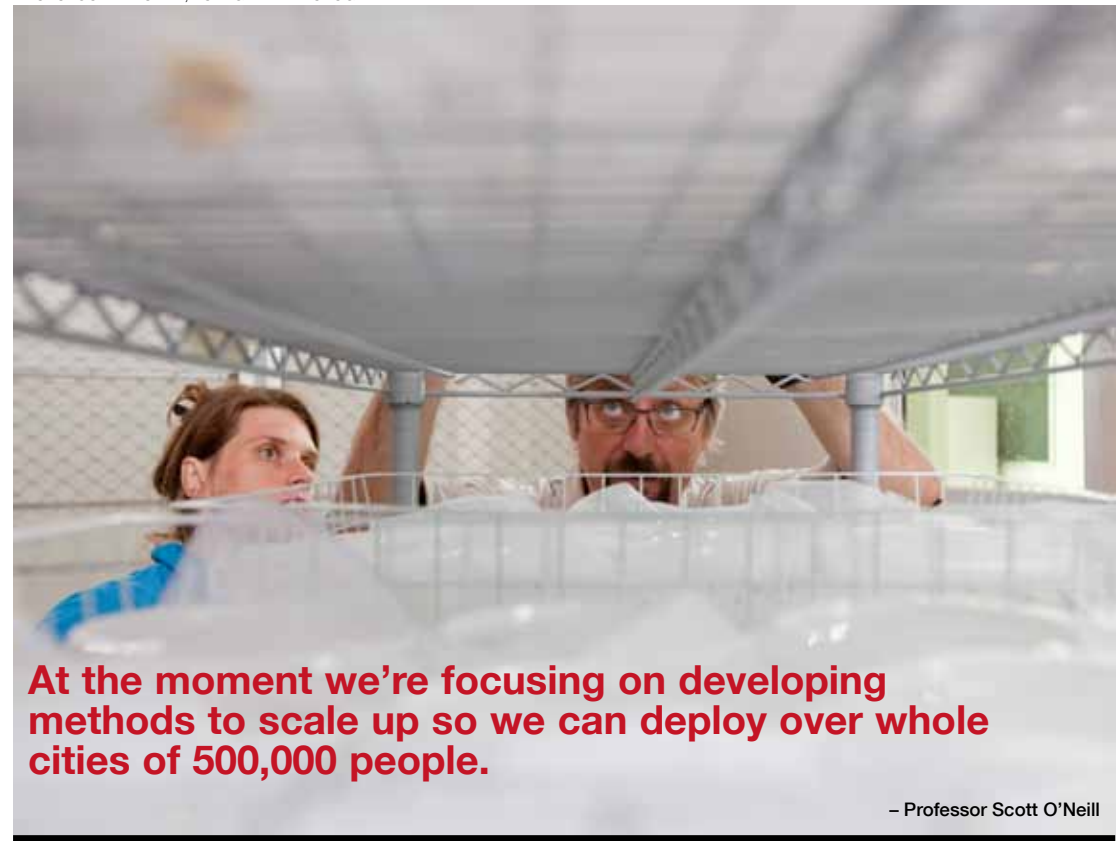
"The mosquito that transmits dengue is highly domesticated so it lives among humans. It prefers to rest inside a house, it prefers to feed on humans and so it's a really well-adapted mosquito particularly with respect to transmitting dengue, and it's really tough to get rid of," Professor Simmons says.

However, he says the *Wolbachia* initiative, using biological control to stop dengue transmission, is an exciting prospect and the speed at which the research has progressed is testament to its potential.

"It's gone from the lab to field trials in northern Australia to field trials [now underway] in Indonesia and Vietnam; and very soon trials in Brazil, Colombia and then a whole suite of countries where dengue is endemic will be putting their hands up to find out more about the *Wolbachia* control method and how they can get involved." ■

www.eliminatedengue.com

PHOTO: COLYN HUBER, LOVEGREEN PHOTOGRAPHY



At the moment we're focusing on developing methods to scale up so we can deploy over whole cities of 500,000 people.

– Professor Scott O'Neill

A PATCH

OF

Life





A version of a stick-on patch already in use to offset common jet lag could become one of the most potent weapons against birth complications caused by lack of oxygen.

WORDS Melissa Marino

► A simple melatonin patch – similar to that used by weary international travellers to combat jet lag – may save the lives of millions of babies and prevent countless more from suffering irreparable brain damage.

Melatonin is a powerful antioxidant that researchers have found can neutralise the effects of birth asphyxia, a lack of oxygen caused by complications such as umbilical cord entanglement or obstructed delivery.

Every year, almost four million babies die before they are a month old. Some 1.5 million of these deaths occur in India alone – and more than half are due to asphyxia at birth.

The patch, not much bigger than a bandaid and stuck gently onto a baby's back, could offer a simple, cheap miracle in countries that do not have the luxury of modern maternity and neonatal care.

The exciting thing is that it doesn't require intensive care. The melatonin patch doesn't even need refrigeration. It is literally applied like a bandaid.

– Dr Suzie Miller

PHOTO: JAMES BRAUND

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In a hospital such as Melbourne's Monash Medical Centre, doctors would treat five or six cases of birth asphyxia each year from about 4000 births.

For an equivalent-size hospital with 8000 births a year in a city such as Lucknow, in India's poorest state, Uttar Pradesh, that number is more like five or six a week. This is due to a lack of fetal monitoring equipment and the lack of capacity for emergency caesareans if babies get into trouble. Many newborns are also taken to Indian hospitals following birth asphyxia after being born at home.

It is a tragedy on a large scale and has spurred researchers such as Associate Professor Michael Fahey to find an answer. "We've got millions of babies dying every year within their first month of life because they are in a low-resource country," he says.

Associate Professor Fahey, who is head of paediatric neurology at Monash Children's Hospital in Melbourne, is also a clinical research scientist. He has been working with a multidisciplinary team from the Ritchie Centre (at Monash Institute of Medical Research-Prince Henry's Institute and Monash University) on new therapies to improve survival rates and outcomes for babies who have suffered birth asphyxia. One of the potential therapies is the melatonin patch, which researchers are confident will significantly reduce brain damage and fatalities caused by severe lack of oxygen at birth.

The research has advanced to the point that the team hopes to start a pilot study soon with Indian partner hospital King George's Medical Centre in Lucknow.

Alongside that trial are training clinics, already being established in rural areas surrounding Lucknow, where health workers are being taught to recognise birth asphyxia so that melatonin patches can also be used out in the community.

"We've got an opportunity to bring into this setting something that is cheap, easily translatable, stable, safe and doesn't require high technology to make a massive impact both in India and around the world," Associate Professor Fahey says.

Free-radical scavenger

The ability of melatonin to reduce brain damage was first confirmed almost a decade ago by team co-leader Dr Suzie Miller, an international specialist investigating brain development and neuroprotection.

Working with Ritchie Centre deputy director Professor Graham Jenkin and director Professor Euan Wallace, Dr Miller showed for the first time that melatonin, a naturally occurring hormone and powerful antioxidant, was an efficient scavenger within the fetal brain, mopping up dangerous oxygen free radicals that flood the system and cause brain injury after asphyxia.

As babies do not produce melatonin until they are three or four months old, this hormone, which also dictates

A sticky solution

As training to identify asphyxia is rolled out across rural Uttar Pradesh in India, a different challenge awaits King George's Medical Centre in Lucknow, which could soon host the first melatonin patch clinical trials: a supply of reliable patches is required.

"We must provide a patch with a specific concentration of melatonin to be released over a known period," Professor Graham Jenkin says.

Work with UK and German collaborators is nearing completion on the development of a suitable patch, containing uniform levels of melatonin and providing a consistent release rate.

Associate Professor Michael Fahey says the ultimate success of the project will also depend on enlisting local partners to manufacture the patch.

Key support in this phase came from Supreet Khosla, who as a Delhi-based Australian Trade Commission business development manager assisted Australian businesses to grow internationally and promoted the transfer of technology and R&D solution from Australia to India.

Ms Khosla introduced the Monash University team to staff at the Stanford-India Biodesign Center in New Delhi, which teams up doctors and entrepreneurs to develop cost-effective health innovations in India.

Ms Khosla says there is desperate need for such an innovation in India, which has a wide health care divide between rich and poor. "Rural India often gets ignored because all of the private hospitals run in and around cities where people have the ability to pay," she says.

Professor Euan Wallace says that, unlike many medical technologies, the melatonin patch is "dirt cheap". It might cost only one or two Australian dollars to save a life or prevent a lifelong disability.

PHOTOS: ASSOCIATE PROFESSOR MICHAEL FAHEY



Dr Atul Malhotra with villagers from Shivgarh, Uttar Pradesh

These are culturally sensitive communities so you need to gel and work with them before they will accept a therapy that has not been used previously.

– Dr Atul Malhotra

Awaken to free radicals

It would not come as any great surprise to new parents to learn that babies do not produce melatonin – the hormone responsible for a regular sleep–wake cycle – until they are three or four months old. But this biological developmental delay that allows them to feed through the night on a 24-hour cycle when they are very young has a major pitfall besides the sleepless nights it gives parents.

Melatonin is the antidote to chemically reactive molecules (free radicals) formed as a consequence of asphyxia that can damage the structure of cells and cause them to die. For babies who have suffered birth asphyxia this absence of natural melatonin can be potentially deadly.

Oxygen free radicals are a normal part of life. We produce them as we breathe as part of the process of getting energy from oxygen, but Monash University PhD candidate James Aridas explains that when oxygen is returned to a baby after it has experienced asphyxia, it floods the system, creating too many free radicals for the body to remove. Babies who to that point have been reliant on melatonin via their mother in utero have limited in-built defence.

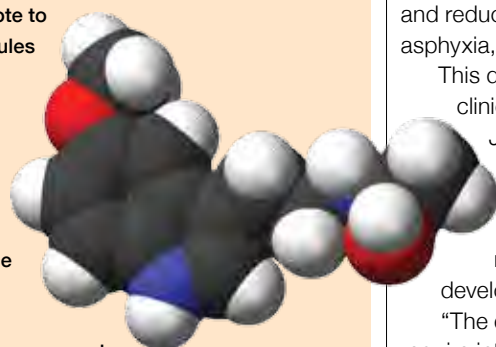
“This is why giving melatonin to babies could make such a dramatic difference,” he says. “The patches would rebalance the system.”

Dream clinic a step closer

The ultimate “dream” for Associate Professor Michael Fahey is to establish a permanent centre for cerebral palsy (which can be caused by birth asphyxia), in Lucknow, India. Extending beyond the scope of the current projects, it would provide ongoing training and education as well as operating as a monitoring facility for babies treated with melatonin and as a therapy centre for children with cerebral palsy. While this is very much a work in progress, and may be some years before it comes to fruition, it has the support of the Australian High Commissioner to India, Patrick Suckling. And so Ritchie Centre MIMR–PHI Institute researchers are daring to dream. “We are all hoping that it becomes a dream come true,” Professor Graham Jenkin says.

Ritchie Centre

- The Ritchie Centre is part of the Monash Institute of Medical Research–Prince Henry’s Institute (MIMR–PHI) and is the principal research centre for Monash University’s Departments of Obstetrics and Gynaecology, and Paediatrics.
- It is also the principal research partner of Monash Women’s Services and Monash Children’s Hospital at Monash Health.
- It is located within the Monash Health Translation Precinct at Monash Medical Centre, in Melbourne, Victoria, which is home to the MIMR–PHI Institute, Monash Health and Monash University’s School of Clinical Sciences.
- There are 150 research staff and students, including fetal physiologists, immunologists, stem cell biologists, neonatologists, paediatricians, obstetricians, gynaecologists and radiologists.



Melatonin molecule

our circadian rhythms, needs to be administered if asphyxia has occurred.

Since her initial discovery, Dr Miller and her colleagues have worked to advance those findings and develop them to the point that they can become part of medical practice. Their recent work, proving a patch is effective in delivering melatonin and reducing brain damage following birth asphyxia, has significant implications.

This discovery, proved through pre-clinical research by PhD candidate James Aridas, means that melatonin could be administered cheaply and simply in community settings as well as in hospitals, making it ideal for use in developing countries such as India.

“The exciting thing is that it doesn’t require intensive care,” Dr Miller says. “The melatonin patch doesn’t even need refrigeration. It is literally applied like a bandaid.”

For Dr Miller, it is the fulfilment of a dream: “From 10 years ago to get to a point where it’s almost ready to go in a clinical situation really is amazing.”

India connection

Lucknow is considered an ideal destination for the next advancement of this research, not only because birth asphyxia is a major problem there, but also because of the existence of important research ties.

Dr Atul Malhotra, a neonatal paediatrician at Monash Children’s Hospital and fellow Ritchie Centre team-member, is from India. He trained with Dr Vishwajeet Kumar, head of the Lucknow Community Empowerment Lab, who is collaborating to inform patch development and introduce the rural training package.

The Community Empowerment Lab has long-established links with more than 3400 villages around Lucknow, an area that Dr Kumar describes as among the most dangerous in the world for babies and mothers.

The lab works within the community to tackle issues including neonatal and maternal health, often in partnership with international institutions, to help develop low-cost but effective technologies and innovations to lift long-term prospects for people.

Dr Kumar says that a melatonin patch is potentially the single most important innovation developed to reduce deaths from birth asphyxia.

People therefore need to be made familiar with the concept and trained how to use a patch, but it is also crucial that they learn how to recognise birth asphyxia in the first place.

Families in the region often see infant mortality as “fatalistic”, or an inevitable part of life. But deaths could

be prevented if people could identify birth asphyxia symptoms, Dr Kumar says.

“What your mind doesn’t know your eyes don’t see,” he says. “In most cases they don’t realise firstly the early warning signs of a fatal event and secondly that they can actually do something about it.”

Dr Malhotra, a senior lecturer at Monash, Associate Professor Fahey and Professor Jenkin visited Lucknow, developing training materials and guides for health workers. These materials will be distributed throughout the region and ongoing training and monitoring will be conducted with the help of the Community Empowerment Lab and its networks.

First steps

The first six hours after a baby is born with asphyxia are crucial, Dr Malhotra says. “Treatment needs to begin as soon as possible to lessen the consequences, so correct diagnosis is vital. The first step is identifying an infant at risk. The next is to apply the melatonin patch and then head for hospital for further care ... although, of course, it’s not necessarily that simple.”

Applying a melatonin patch out in a community is not just a matter of explaining its medical purpose, but also making it acceptable, he says. A bandaid-style patch might be commonplace in the west, but quite foreign in a small village in Uttar Pradesh.

“These are culturally sensitive communities so you need to gel and work with them before they will accept a therapy that has not been used previously,” he says.

Another example of a simple, but real, obstacle is the practice in some areas to oil newborn babies – something that could interfere with the patch’s ability to stick to the skin and the penetration of melatonin.

“So you can’t just go into a community and say ‘let’s go’. You have to get to know the people. It’s not something you can rush.”

Future growth

The pre-clinical research in Melbourne and training work in India has been funded through the National Health and Medical Research Council and the Bill and Melinda Gates Foundation in an initiative spearheaded by Ritchie Centre director Professor Wallace. Further funding is now being sought for the clinical trials.

“While melatonin as a therapy could be used anywhere, it will be particularly applicable and effective in low-resource settings, such as India or other parts of Asia or Africa,” Professor Wallace says.

“If this is successful, we are going to need to develop a whole suite of training materials in Vietnamese, Khmer, Swahili,” he says. “This is just the starting point.” ■

PHOTO: SIMON O'DWYER-FAIRFAX SYNDICATION



SCIENCE GIVES BABIES TIME TO BREATHE

WORDS Melissa Marino

► **The debate over the best time to clamp a baby's umbilical cord has been around forever. In about 350 BCE, Aristotle, reputedly the world's first genuine scientist, advocated delaying clamping until placenta delivery.**

Some 2100 years later, English physician – and Charles Darwin's grandfather – Erasmus Darwin weighed in. "Another thing very injurious to the child is the tying and cutting of the navel string too soon," he wrote.

By the 1970s and after the passage of almost another two centuries, the health of the mother had become the priority and, in western hospitals in particular, an immediate umbilical cord cut became the norm to prevent post-partum haemorrhage.

Today, technology has delivered a little more flexibility through the administration of the drug oxytocin, which mitigates the risk of blood loss at birth. International guidelines currently recommend delaying umbilical cord clamping for at least one minute in healthy infants.

But Monash University research now shows that cord clamping should be determined not by a time frame but by the baby's physiology. This adds to a body of new international evidence that could change, once again, the

The latest thinking on the best time to clamp the umbilical cord has special implications for people in developing countries.

The heart can only pump the blood it receives, so delaying cord clamping until a baby is breathing is simply a matter of sustaining the input to the pump.

– Professor Stuart Hooper

approach to our arrival in the world. Norwegian researchers recently analysed 15,000 births in Tanzania and found if cord clamping occurred after a baby was breathing (not according to whether a minute had passed) the likelihood of the baby dying or being admitted to intensive care was significantly reduced.

"It is true that if you clamp the cord after the infant has started breathing the outcomes for babies are significantly better," says Monash physiologist Professor Stuart Hooper of the study. "And this is particularly important for low-resource countries."

This is because delayed cord clamping is a simple intervention. "There is no expense and no equipment needed. All the attendant has to do is pause, let the baby breathe and then clamp the cord," he says.

Blood flow critical

Professor Hooper, who is the head of the Ritchie Centre at Monash Institute of Medical Research-Prince Henry's (MIMR-PHI) Institute of Medical Research and Monash University, has recently published research demonstrating the physiology on which the Tanzanian study was based.

He says babies do better if cord clamping is delayed because a continuity of blood flow is maintained while they experience the seismic shift in heart and lung function that occurs in the transition from fetus to newborn.

In a fetus, much of the blood pumped by the heart comes from the placenta, via a shunt bypassing the lungs, which are filled with liquid.

At birth, the shunt closes and the baby's physiology changes as blood begins passing through the lungs, which become the primary source of blood (known as venous return) for the heart to pump.

But blood can only be passed efficiently through the lungs once they are functioning. And at the same time, when the umbilical cord is cut, blood supply from the placenta ceases.

"The heart can only pump the blood it receives, so delaying cord clamping until a baby is breathing is simply a matter of sustaining the input to the pump," Professor Hooper says. "It allows the input to immediately switch from the placenta to the lung when the cord is cut because the lungs are already aerated."

Otherwise, reduced blood flow from the heart combined with oxygen restriction can result in brain damage, other tissue damage or death.

Professor Hooper's research is supported through the Australian National Health and Medical Research Council and undertaken with colleagues from MIMR-PHI Institute of Medical Research, the Royal Women's Hospital in Melbourne, the University of Sydney, the University of Western Australia and the Leiden University Medical Center in the Netherlands.

Now that the physiology has been proved through laboratory trials, the next step is to take the research to the clinic. One trial delaying cord clamping in preterm babies born vaginally is already under way at the Royal Women's Hospital and, in the future, Professor Hooper hopes to extend the research to preterm caesarean babies. ■

CHILDBIRTH MADE SAFER IN A SINGLE PUFF

WORDS Melissa Marino

► **For women in developed countries, the likelihood of dying from blood loss in childbirth is very slim owing to the routine administration of oxytocin – an injected hormone that stimulates continued contractions to aid blood clotting where the placenta has detached.**

It is a different story, however, in developing countries where conditions make it difficult to keep the drug at the consistent cold temperature required and where sterile syringes are not always available.

This is particularly problematic in countries where many babies are born in remote community locations. An estimated 100,000 women in developing countries die each year during childbirth from post-partum haemorrhage.

But these mortality rates might soon be dramatically reduced through the development of a new, more climatically stable form of the life-saving drug. Researchers from Monash University in Melbourne have recently signed a co-development agreement with global pharmaceutical company GlaxoSmithKline (GSK) that will bring an inhaled form of the drug a step closer to reality.

The agreement will allow for the conduct of clinical trials, which, if successful, will lead to manufacture of the product at scale for use in developing countries.

Dr Michelle McIntosh, the project leader and a senior lecturer at the Monash Institute of Pharmaceutical Sciences (MIPS), says inhaled oxytocin is ideal for low-resource settings because it remains stable in the heat; it is cheap, portable and, as pre-clinical trials have shown, simple to administer; and it is effectively absorbed through the lungs. In a best-case scenario, an inhaler product could be in use by 2018, she says.

Dr McIntosh and her Monash team have been involved in the product's design and development since its beginning seven years ago. "Now we really feel we could achieve our aim to prevent post-partum haemorrhage in women, wherever they live," she says.

Technology marriage

GSK's inhaled oxytocin project leader Susie Fowles says the collaboration combines the company's knowledge in respiratory medicine and dry powder technology with Monash University's technical expertise in pharmaceutical research.

The goal is to provide a product that is effective when used by minimally trained health workers in homes, communities and primary clinics, and that has the potential to save the lives of vulnerable mothers in resource-poor settings.

"Improving health care for women during childbirth is an important part of GSK's mission and aligns strategically with the objectives of the newly formed Maternal and Neonatal Health R&D Unit," she says. "The GSK team is extremely passionate about working with MIPS to develop an innovative life-saving medicine and distribute it to the women that need it so desperately."

A commercial partner has been in Dr McIntosh's sights since 2011 when Hillary Clinton, then US

Secretary of State, presented the MIPS team with a Saving Lives at Birth award for the "innovation most likely to be transformational in maternal health".

"That was the day we realised 'this could be big' and we needed to find a way to make it work so that it could achieve its potential to save women's lives," Dr McIntosh says. "At Monash we bring the product concept, pre-clinical research and scientific development to the table but we don't bring manufacturing, commercialisation and distribution – that's why we needed to form a partnership."

In-country strategy

In support of the new collaboration, Dr McIntosh and her team have received significant funding from donor organisations including the Planet Wheeler Foundation, Geneva-based McCall MacBain Foundation and Grand Challenges Canada. These funding partners support the core research program and enable the Monash team to investigate cultural, logistical and training issues in countries where they hope to introduce inhaled oxytocin.

This in-country strategic work being undertaken in India, Tanzania and Uganda, and slated for Papua New Guinea and Indonesia, will ensure the product can be successfully implemented following regulatory approval.

"We could make the best possible oxytocin product that is stable for years and works brilliantly but if we don't educate people to use it, it will sit on the shelf and gather dust," Dr McIntosh says. "We need to map out a clear implementation and access strategy to ensure the product gets into the hands of the women who need it, and they can use it effectively."

PHOTO: LUKA KAUZLARIC / BILL & MELINDA GATES FOUNDATION

Post-partum haemorrhage is defined as the loss of more than 500mL of blood during childbirth.

99.4% of all maternal deaths worldwide occur in developing countries.

Women in the developing world are 160 times more likely to die from pregnancy-related complications than those in developed countries.

Post-partum haemorrhage accounts for a third of all pregnancy-related deaths in Africa and Asia.

SOURCE: MIPS

New drugs

Furthering Dr Michelle McIntosh's research in this field is another partnership developed with two scientific equipment companies, and with major philanthropic funding from the Helen Macpherson Smith Trust. This will establish a new A\$3.5 million translational research laboratory at MIPS to support the design and development of new drug products aimed at improving global health and access to medicines. New treatments for tuberculosis and pneumonia that are suitable for conditions in developing countries are in Dr McIntosh's sights. Fittingly, it was the Helen Macpherson Smith Trust that donated to Dr McIntosh her first A\$50,000 to help establish the laboratory from which inhaled oxytocin has emerged.



Dr Michelle McIntosh: Now we really feel we could achieve our aim to prevent post-partum haemorrhage in women, wherever they live.

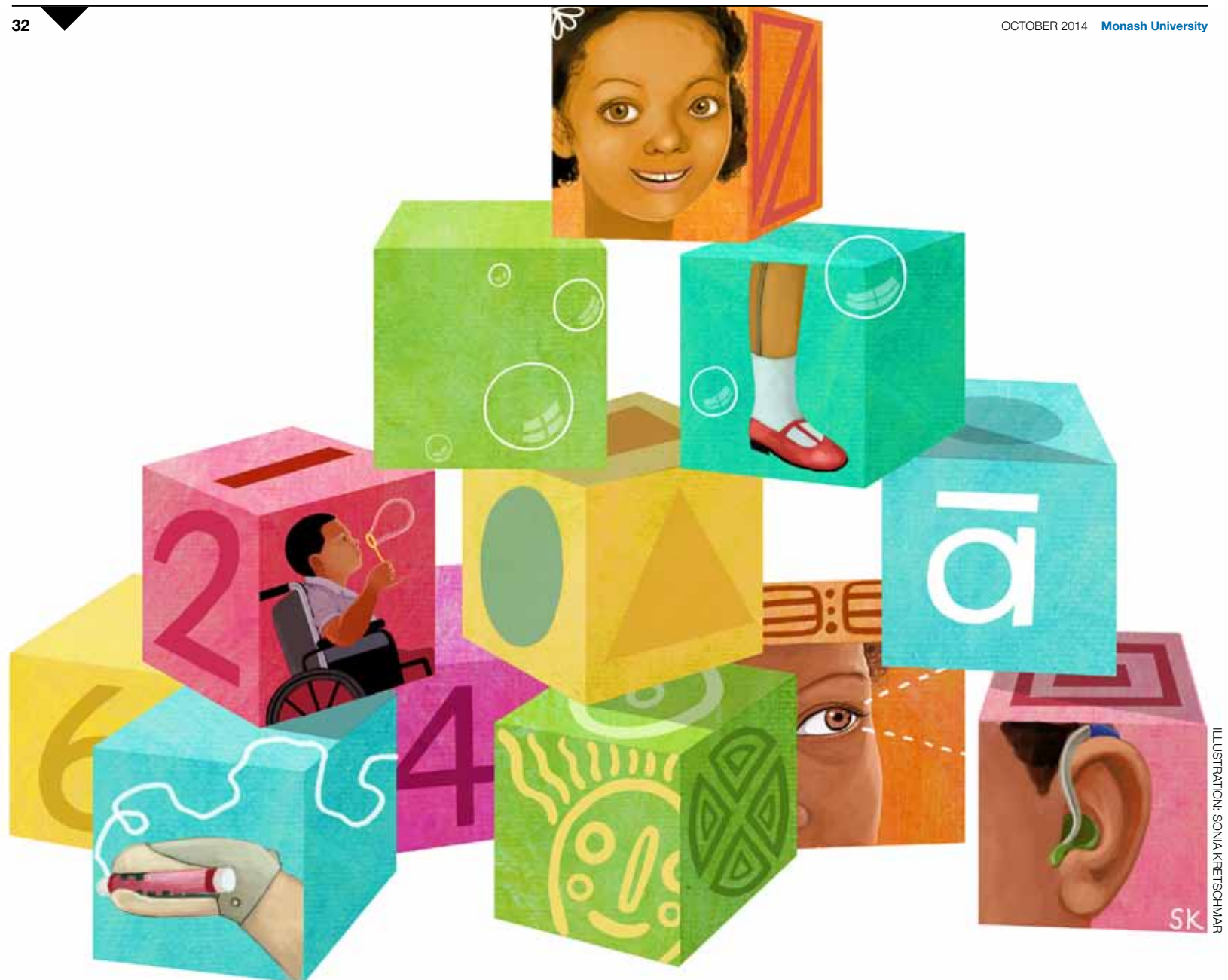


ILLUSTRATION: SONIA KRETSCHMAR

CLASSROOMS *without* BORDERS

AN ESTIMATED 650 MILLION CHILDREN WORLDWIDE ARE DENIED EDUCATION BECAUSE OF DISABILITIES. THE CULTURAL AND INSTITUTIONAL OBSTACLES TO OPENING UP THESE YOUNG LIVES ARE BEING ERODED BY A HOLISTIC APPROACH TO INCLUSIVE EDUCATION.

WORDS Rebecca Jennings

► **Finally, 12-year-old Damina Buira has a reason to smile. Born with cerebral palsy, the young Solomon Islands girl had been rejected by numerous schools, forced to stay at home and face a life of exclusion. But this year, Damina was welcomed into the Emmaus Christian School, Honiara – and not into a “special” class, but a regular classroom.**

Damina is among the first children in the Pacific region to benefit from an official change in attitude towards children with disabilities. It follows tireless efforts by education researchers to demonstrate how and why classroom inclusion benefits a community.

In the Solomon Islands, for example, only two per cent of children with disabilities have access to education. Until recently, most disabled children were not enrolled in the first place, or dropped out shortly after

starting – side-stepped by communities and schools that do not accept that these children have the right and ability to learn. Contributing to this has been a lack of appropriate teacher training.

The Solomon Islands is one of the first Asia-Pacific governments that have been part of a Special Education Program within Monash University's Faculty of Education to take the formal step towards disability-inclusive education.

For the program's coordinator, Associate Professor Umesh Sharma, this has been a passionate quest. He was a special-education teacher in India, where many people believe a disability is a consequence of a misdeed in a former life and therefore deserved (the doctrine of karma). Associate Professor Sharma has been on a determined campaign to change this, and he now coordinates disability-inclusive projects in the Pacific, India, Bangladesh and China.

His projects begin by examining why teachers in developing countries are apprehensive about working with students with disabilities. He says the discrimination is often the result of a deep-rooted cultural aversion to the disabled.

"It's a complex, sensitive issue that requires a deep understanding of local culture," Associate Professor Sharma says.

For example, Hindus, who make up about 85 per cent of India's population, believe disability stems from a previous life and people are reluctant to interfere with a deity's will. It is a similar case with beliefs in countries such as Cambodia, where disability is also seen as "god's punishment", making inclusive education a difficult challenge.

Taking a holistic approach

To address the issue and improve the lives of millions of children who would otherwise miss out on an education, Associate Professor Sharma and his team (which purposely includes in-country researchers with disabilities) is beginning with education policymakers. "Working with individual teachers won't, on its own, bring change. We must also work with policymakers, teacher trainers and parents," he says.

His message is backed by studies in developed countries showing that students with disabilities who are educated in regular schools are more likely to achieve academically, live independently, earn a higher salary and be married, than those educated in segregated settings.

Associate Professor Sharma's work falls within UNESCO's global goal of "inclusive learning" and has been helped by developing nations signing international conventions such as the 2007 *Convention on the Rights of Persons with Disabilities* and landmark legislation such as India's *The Persons with Disabilities Act* (1995). However, while such policies intend to integrate disabled students into mainstream education, implementation has proved difficult. This is why Associate Professor Sharma's team has been working directly with schools, teachers and parents.

There remain substantial practical barriers to inclusive education: extreme poverty, under-resourced and overcrowded classrooms, lack of disability access, and teachers who are not motivated to devote time to students they do not believe will achieve the desired results.

Overarching this is inadequate teacher training. "Most teacher training programs in developing countries really only pay lip-service to preparing teachers for inclusion," he says. "If certain students are difficult to teach it's simply easier to exclude them ... so it's the education system and teachers themselves – not the child – that are the actual barrier to inclusion."

This has made teacher training a central focus for Associate Professor Sharma and his team. They are identifying and promoting resources such as braille materials and group teaching strategies so disabled and non-disabled students can work together, and social inclusion strategies that reassure parents about sending their children to a regular school.

Head, heart and hands

Associate Professor Sharma says the goal is to help teachers become confident and capable practitioners, equipped with strategies to meet the needs of all learners.

"We need universities to prepare graduates who have the head (skills to teach all students), heart (a belief that everyone has a right to learn in a regular classroom) and hands (including everyone when teaching)."

Associate Professor Sharma worked directly with the Solomon Islands' Ministry of Education and Human Resources Development to draft a national plan for inclusion, and runs workshops for school principals and teachers.

The Solomon Islands National University is rewriting its curriculum using a policy document drafted by Associate Professor Sharma. This document also articulates the teaching skills needed to manage inclusive classrooms. From here on, 600 to 700 graduates a year will enter classrooms with this enhanced capability.

As dean of the School of Education and Humanities within the Solomon Islands National University, Janine Simi has been involved in developing a new curriculum to equip teacher trainees with inclusive education skills and knowledge.

She says the curriculum has shifted from teacher-centred to student-centred learning: "In the Solomon Islands, students with special needs are now entering regular classrooms and teachers are being prepared for that."

Ms Simi says the partnership with the Monash Faculty of Education has included workshops and field trips to inclusive

If certain students are difficult to teach it's simply easier to exclude them ... so it's the education system and teachers themselves – not the child – that are the actual barrier to inclusion.

– Associate Professor Umesh Sharma

schools and has helped change the negative perceptions about inclusion, although she acknowledges that attitudes in the classroom will still take time to change fully.

Similar shifts are also occurring in other countries where Associate Professor Sharma's team is working. The University of Pune in India, the University of Dhaka in Bangladesh and the East China Normal University in Shanghai are now reviewing teacher training and modifying curriculums to incorporate inclusive teaching strategies.

At the University of Dhaka, Associate Professor Sharma, working with his doctoral students, has established the Asian Centre for Inclusive Education to promote local research into the outcomes of including children with disabilities throughout Asia. ■



Navigating inclusive education

Educating children with special needs in what he describes as the "confused, careless and chaotic society" of the Solomon Islands is no easy feat but George Saemane, principal of the Florence Young Christian School, has risen to the challenge.

Mr Saemane and 38 teachers at the Honiara preparatory to secondary school are working to develop the "head, hands and heart" of inclusive educators. There are 894 students at Florence Young, including 25 with a disability. The school has always accommodated students with mild physical and learning difficulties, but teachers are changing how they respond to these students' needs.

Mr Saemane, who participated in an "Including the Excluded" program run by Monash University in Melbourne in 2013, says the benefits of inclusive education are far-reaching.

"Students with a disability will feel accepted, loved and cared for and it will give them a sense of belonging within their own school, community and their country. Other students will also benefit by developing new social skills to accommodate and appreciate the capabilities of students with disabilities. They will build their own capacity to accept people with disabilities in their communities."

Mr Saemane, who is on the committee developing the Solomon Islands' Inclusive Education Policy, is seeing a positive impact from the Monash projects. "The Solomon Islands is a pristine area of research in inclusive education," he says. "Research will show the gaps and help decision-makers and teachers adopt methods that are socially acceptable."

Only **4.1%** of deaths in Vietnam are now caused by infectious diseases. Heart disease accounts for 29.9% of deaths, cancer 22.2% and injury 13.6%.

A doctor of the Vietnamese Army examines an elderly man in the Bac Ninh province of Vietnam.

HEALTH ON THE RECORD

WORDS Catherine Norwood

► **In the mountainous region of Vietnam's southern Lam Dong province, the local commune health station is little more than a tiny, bare hall offering the most basic healthcare services. It is one of almost 11,000 such stations across the country overseeing the life and death of many of the country's 90 million people.**

As well as covering everything from basic treatment to family planning and infant welfare, the stations are also responsible for recording all deaths in their communities. Doctor-issued death certificates are not required in Vietnam, but nonetheless, a record of who has died and why is dutifully noted in what is known as the "A6" book.

The simplicity of Vietnam's A6 mortality reporting system is one of its greatest strengths, says epidemiologist Professor Mark Stevenson, who is based at Monash

University in Melbourne. For the past six years he has been working with colleagues at the Hanoi Medical University as part of a project to evaluate the A6 system's accuracy and completeness. The project was funded by the former Australian Agency for International Development (AusAID).

He says despite being very low-tech, the A6 books form a remarkably robust and low-cost reporting system. From commune health stations, information is forwarded monthly to district-level services. Quarterly summaries are sent to the provincial governments and these reports are collated annually by the central government.

Diseases of development

A major finding from the study is the fundamental shift in the causes of mortality from infectious diseases, which most commonly afflict low-income countries, to "diseases of development" such as cardiovascular disease, diabetes,

A major finding from the study is the fundamental shift in the causes of mortality from infectious diseases, which most commonly afflict low-income countries, to "diseases of development" such as cardiovascular disease, diabetes, cancer and road trauma.

cancer and road trauma. Professor Stevenson says that after investing successfully in services to address infectious diseases, Vietnam now has these new challenges.

Dr Le Tran Ngoan from the Hanoi Medical University worked with Professor Stevenson on the A6 validation and says the study identified that three causes now contribute to almost two-thirds of deaths: circulatory conditions such as heart disease (29.9 per cent), cancer (22.2 per cent) and injury (13.6 per cent, with a third of this figure related to road trauma). Infectious diseases now account for only 4.1 per cent of deaths in Vietnam.

The validation project was a massive undertaking. Dr Ngoan says more than 5200 verbal autopsies were conducted as part of the research in three representative provinces: Bac Ninh in the northern Red Delta River region, Lam Dong in the southern highlands and Ben Tre in the Mekong Delta.

Health station staff from the 140 communes received training and visited families to confirm, first, that someone in the household had died and, second, the cause of death. Almost two-thirds of those who had died (3684 of 5613 cases) had visited hospitals for treatments and hospital medical records provided the most accurate data in determining actual causes of death. Verbal autopsies were crosschecked with the cause of death recorded in the A6 system and validated by two doctors.

A6 accuracy verified

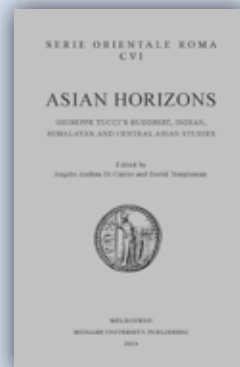
The study found that 93.9 per cent of all deaths within the three provinces during the 2008-09 period of the study were captured in the A6 system, with the cause of death accurately identified in 75 per cent of injury cases, 67 per cent of cancer cases and 63 per cent of circulatory-related cases.

Dr Ngoan says following the project, AusAID provided further funds to establish an online nationwide mortality registration. Injury statistics from the study have been published as part of the national health report, and information on Vietnam's cancer mortality rates was included in the international report GLOBOCAN 2012.

For Professor Stevenson and Dr Ngoan, verification of the A6 reporting system means it can be used confidently and quickly to identify the greatest health issues facing Vietnam's population and to direct investment in the appropriate services.

Professor Stevenson says the findings from this project suggest that international aid agencies and NGOs should be encouraged to support existing reporting systems such as the A6 system, rather than investing in their own project-specific surveillance as they have in the past.

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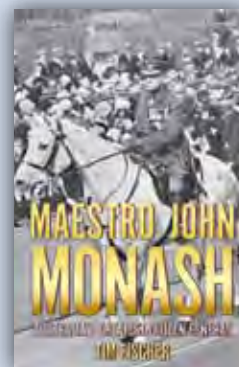
Asian Horizons: Giuseppe Tucci's Buddhist, Indian, Himalayan and Central Asian Studies

Edited by A.A. Di Castro and David Templeman

Asian Horizons is published in honour of the great scholar of Asia, Professor Giuseppe Tucci (1894–1984) as the final volume of the long-running *Serie Orientale Roma*, of the Istituto Italiano per l'Africa e l'Oriente.

Through the work of present-day scholars, both senior and emerging, this book represents efforts to maintain the impetus of the profound legacy left by Professor Tucci. Renowned to this day as a founding scholar in an extraordinarily wide variety of disciplines, as well as being an explorer of hitherto largely unknown lands such as Tibet, Professor Tucci gained a deep knowledge of Asia through a familiarity with its people, places and literature.

His contribution to modern scholarship is nothing less than remarkable. The volume reflects the broad variety of topics in which Professor Tucci displayed deep interest and serves as a homage to his work.



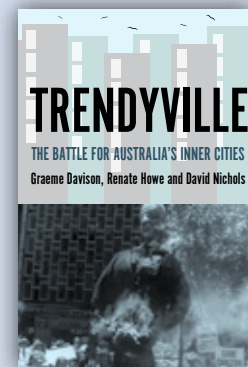
Maestro John Monash: Australia's Greatest Citizen General

Tim Fischer

A perfected modern battle plan is like nothing so much as a score for an orchestral composition, where the various arms and units are the instruments, and the tasks they perform are their respective musical phrases. Every individual unit must make its entry precisely at the proper moment and play its phrase in the general harmony. – John Monash

Who was the most innovative general of World War I? For Tim Fischer, the answer has to be Australia's John Monash, a man who, for all the recognition he received in his lifetime and after, has arguably not been given his proper due within the major military histories of that conflict.

Mr Fischer also considers why Monash was never promoted to Field Marshal, as international precedent suggested was appropriate. He points the finger primarily at the Australian prime minister from 1915 to 1923, Billy Hughes, within a wider context of establishment suspicion towards Monash as the son of a German-Jewish migrant. He asks whether a posthumous granting of the Field Marshal rank might now constitute a due reward for this great servant of the Australian nation and a salutary reminder of his legacy.



Trendyville: The Battle for Australia's Inner Cities

Graeme Davison, Renate Howe and David Nichols

Australia's inner-city areas experienced an upheaval in the 1960s and 1970s that left them changed forever. But people from all walks of life valued suburbs such as Sydney's Balmain and Melbourne's Carlton, Battery Point in Hobart and Indooroopilly in Brisbane, Perth's Subiaco and North Adelaide, and were able to resist large-scale development projects involving freeways, "slum clearance" and mass-produced high-rise buildings.

Many suburbs kept their village qualities; shopping strips were revived and cultures celebrated. While areas such as Fitzroy in Melbourne were derided as "Trendyville", the fate many American cities suffered – a "hollow core" – had been avoided. In the process, heritage conservation, party politics and Australian assumptions about domestic life, education and lifestyle had all been transformed.

This in-depth examination of the causes and consequences of urban protest in a democracy shows how this protest changed the built environment as well as its participants and continues to resonate within institutionalised forms of politics, public communications and multiculturalism.



A global initiative for the
UN has chosen Monash
to play a lead role in
developing *sustainable
solutions* for our future.

We think that's
brilliant.

In 2012, the UN Sustainable Development Solutions Network (SDSN) was launched by the UN Secretary-General to help find solutions for some of the world's most pressing environmental, social and economic problems. Monash has been chosen as the Australia/Pacific Regional Centre for the SDSN and will mobilise researchers, industry and community organisations to develop ways to end extreme poverty and protect the environment. It's a brilliant responsibility that will help pave the way for a bright future.

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