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QUT ihbi
Institute of Health and Biomedical Innovation

IHBI ADVANCES

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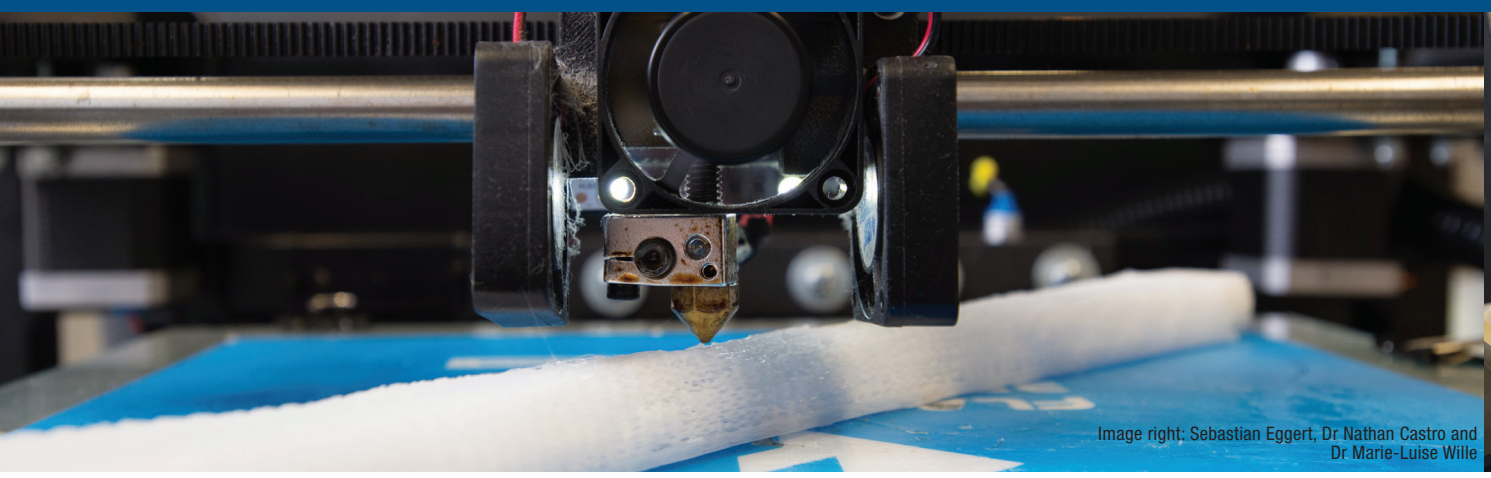

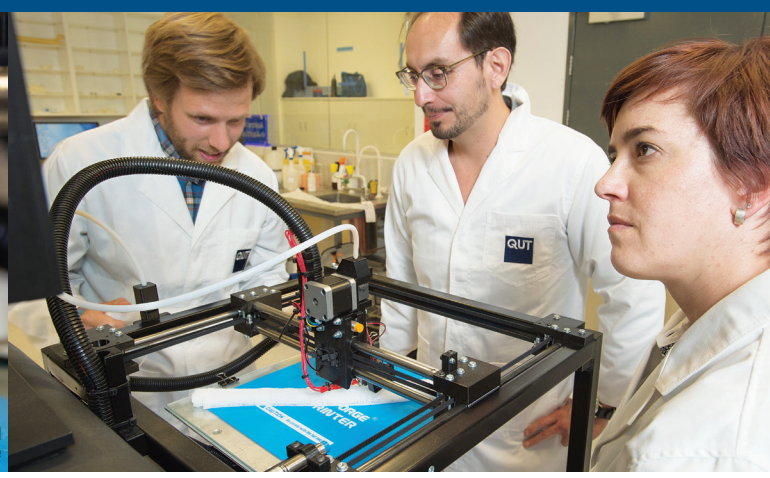

Image right: Sebastian Eggert, Dr Nathan Castro and Dr Marie-Luise Wille

Research collaboration a frontrunner with 3D-printed shin bone implant

Success in medical research is ultimately measured in terms of clinical impact – that is, the improvements made in prevention, treatment and post-operative care for the average Australian. IHBI researchers are making major strides in clinical impact.

A young Gold Coast man received the first 3D-printed biodegradable shin bone implant last year, replacing bone that he lost through infection. Now, eight months since the surgery, the patient is able to put some weight on the leg and doctors are seeing signs of bone regeneration.

A transdisciplinary team of IHBI researchers led the design and prototype fabrication of the implant, as well as a 3D printed model of the bone defect for surgical planning.

Distinguished Professor Dietmar W Hutmacher mentored the team, composed of Dr Marie-Luise Wille, Dr Nathan Castro and PhD candidate Sebastian Eggert, and worked closely with plastic surgeon Dr Michael Wagels.

Dr Wagels performed the surgery at the Princess Alexandra Hospital in August, with Professor Hutmacher in attendance. The scaffold was implanted along with a tibial nail for stability using a new technique that involved a tissue flap developed by Professor Hutmacher's research group, including PhD candidate David Sparks.

RESEARCH FIELDS AT THE ARC INDUSTRIAL TRANSFORMATION TRAINING CENTRE IN ADDITIVE BIOMANUFACTURING

Technology: Overcoming challenges and developing the next generation bioprinters capable of using multiple material types and meeting strict processing needs. Moving towards the scaling up of the manufacturing processes.

Materials: Developing bioinks in multiple forms, such as hydrogels, polymers, ceramics, and metals for different biomedical applications. Ensuring they are compatible with both printing processes and biological processes.

Clinical translation: Collaborating with industry partners and clinicians to advance medical applications of 3D printing, particularly in radiotherapy, customised titanium implants and novel therapies for treating cartilage defects.

The tissue flap has been designed to promote bone regeneration, provide a blood supply and include the patient's own cells to facilitate regeneration across the length of the scaffold. The flap comprises the top layer of a bone's surface and surrounding tissue.

Doctors have reported no infection in the eight months since the operation.

Its success has led to approaches from German surgeons seeking to conduct similar operations. IHBI Adjunct Associate Professor Boris Holzapfel led one such operation at the University Hospital of Würzburg in November. In that instance, the patient had a tumour, resulting in a 20cm section of his tibia being surgically resected.

Another operation was conducted in Munich in February, involving another tumour patient.

Professor Hutmacher's research team designed a modular scaffold that could be length-adjusted during the November operation. The process involves developing a computer model and 3D printing a series of physical models from CT scans of the patient's tibia bone. A patient-specific implant can then be designed in the form of a biodegradable scaffold.

`Our team used a 3D printer from the Queensland company 3D Industries to print the anatomical models for pre-operative planning of the surgery and implant placement,' Professor Hutmacher says. 'The final scaffold designs were sent to Osteopore International, an industry partner with a clinical track record for their FDA-approved and CE-marked biodegradable scaffolds.'

In each instance, a hospital ethics committee provides approval and the patient's consent is obtained ahead of the surgery.

Professor Hutmacher is director of the Australian Research Council Industrial Transformation Training Centre in Additive Biomanufacturing (ARC ITTC), based at IHBI.

'The technology enables a 3D printed scaffold to be customised to the patient, with a specifically designed internal architecture guiding the new bone formation and maturation. After the bone has been formed, the scaffold slowly degrades and only the patient's own bone remains.'

ARC ITTC researchers benefit from research and training activities at IHBI's Medical Engineering Research Facility (MERF), based at the Prince Charles Hospital, providing assessment and validation for the biomaterials and surgical techniques. The researchers conducted pre-clinical studies at MERF ahead of the surgery involving the Gold Coast man.

`The needs of both surgeons and patients are important considerations in translational research,' Professor Hutmacher says. 'Our research team consists of engineers and designers. We collaborate with surgeons so we can meet their needs, designing and delivering a scaffold that they can implant easily, using existing equipment and surgical techniques.'

Professor Hutmacher and Dr Wagels have started a PhD training program partially funded by the Princess Alexandra Foundation to train young surgeons to perform cutting-edge research to meet Australia's need to build capacity in 3D printing in medicine.

'My vision for the ARC ITCC is to train and mentor an exceptionally talented group of high-tech entrepreneurs who will start high-impact companies, with their roots in globally competitive fundamental and applied STEM research, as well as in manufacturing innovation and new medical devices,' Professor Hutmacher says.

Building evidence base for wound prevention and treatment

Chronic wounds impact on about 400 000 people around Australia and cost the healthcare system an estimated $3 billion. IHBI researchers are part of a collaboration aiming to reduce the costs of wound management and improve outcomes for patients.


Associate Professor Rosanna Pacella

The Australian Centre for Health Services Innovation (AusHSI), based at IHBI, has compiled a solutions paper that outlines barriers, costs, recommendations and strategies.

AusHSI's Associate Professor Rosana Pacella led the research in partnership with the Wound Management Innovation Cooperative Research Centre, Queensland Government, Metro North Hospital and Health Service's Clinical Excellence Division and Brisbane North Primary Health Network.

Associate Professor Pacella says chronic wounds are a silent epidemic in Australia. 'The burden of chronic wounds is often underestimated,' she says. 'Chronic wounds are considered complications of other conditions or a normal part of ageing.

'Venous leg ulcers are frequently hidden within skin and subcutaneous diseases such as infections. Diabetic foot complications are considered part of diabetes.'

Wound management is further complicated because of funding and a multitude of service providers involved. Barriers created as a result include poor coordination and communication between care providers and services; patient difficulties in navigating the web of services; and their lack of awareness of the significance of their wounds.

The research identified access as a major issue, especially for patients in rural and remote areas and those in lower socio-economic demographics. High costs for products and expert services combine with a lack of subsidies and reimbursements and incentives for healthcare providers to become involved in evidence-based care.

'The majority of Australians with chronic wounds do not receive best practice treatment,' Associate Professor Pacella says.

As a result, chronic wounds take longer to heal, she says. 'They have high recurrence rates, require frequent assessment and treatment and often result in hospitalisation through infections and other complications.'

IHBI research shows evidence-based wound care, including compression therapy to prevent and treat venous leg ulcers, is cost-saving and improves health outcomes. 'Such a policy, driven by our research, will save health services $1.4 billion in the next five years and improve health outcomes,' Associate Professor Pacella says.

Associate Professor Pacella was part of the AusHSI team that organised the Chronic Wounds Solutions Forum in Brisbane in August last year, bringing together policy makers, clinicians, private health insurers, the pharmaceutical industry, health economists, academics, consumers and advocates.

The aim of the forum was to discuss solutions, leading to the development of the solutions paper.

'The paper provides the evidence base and the achievable solutions to prevent and treat chronic wounds in Australia as a sustained national effort,' Associate Professor Pacella says. 'We have established the Chronic Wounds Solutions Collaborating Group to support, and monitor action on the implementation of such recommendations.'

Recommendations in the solutions paper cover advocacy and awareness; education and training; accreditation; improving access to wound care products and services; a patient focus in care; surveillance and research. The research provides evidence to support changes to the Australian funding and reimbursement structures for chronic wounds.

The research will be presented at the Wounds Australia conference in October and will inform the peak body's advocacy and promotion of best practice to members such as doctors and nurses working in clinical care.

WHAT ARE HEALTH SERVICES DOING?

- **Metro South Health in Brisbane is demonstrating its focus on improving wound healing and referral pathways, with value-based wound care training being offered to staff.**
- **Brisbane North Primary Health Network showcased the research at the Aged Care Forum in May and, together with Metro North, will follow up with a health forum session dedicated to chronic wounds, with IHBI's Associate Professor Rosana Pacella to present research findings.**

WOUND AWARENESS WEEK

One of Wounds Australia's major initiatives for driving awareness and change is Wound Awareness Week from July 15–21. Visit www.woundaware.com.au

READ THE RESEARCH PAPER

Visit eprints.qut.edu.au/118019


Dr Rebecca Byrne

Focus on feeding practices in early childhood to prevent obesity

Obesity is a major health issue in Australia, with research suggesting nutrition in early childhood has a significant role in creating life-long patterns of eating behaviours. IHBI researchers aim to better understand a substantial influence on such patterns.

IHBI research fellow Dr Rebecca Byrne is a dietitian interested in what and how young children are fed, understanding how eating behaviours such as fussy eating develop and improving measurements of behaviours that tend to cause obesity.

She aims to address a knowledge gap related to feeding practices in early childhood education and care (ECEC) centres. 'No studies have evaluated practices in such settings,' Dr Byrne says, 'representing a major gap, given about 30 per cent of Australian children attend ECEC at the age of one, increasing to about 50 per cent of children by the age of two.'

Using a Carla Patterson Memorial grant, Dr Byrne will recruit up to 50 educators in long day care centres in greater Brisbane to a study that involves monitoring a typical lunchtime meal and follow-up telephone interviews. The monitoring will consider verbal cues, interactions and practices that educators use with children during meals. Children are not expected to interact with the researchers.

Demographic diversity will be ensured, with centres in areas of low, medium and high developmental vulnerability included.

Dr Byrne says the typical lunchtime meal may include a combination of those brought from home and those that the centre provides.

She says children are likely to eat a considerable number of meals in an ECEC setting, given their parents' working week.

The research aims to determine if feeding practices in ECEC resemble those of parents. 'Previous studies have shown that parental feeding practices that are not responsive to children's cues of hunger and fullness have a negative impact on child intake, eating behaviour and weight status,' Dr Byrne says.

'Children are born with the ability to self-regulate their energy intake. It means that healthy children offered nutritious food and allowed to follow their own cues of hunger and fullness will eat the required amount needed to grow appropriately.

'Unfortunately, adults tend to ignore or misinterpret child cues. They might make a child finish all the food on their plate, offer food when a child is upset or use treats as reward for good behaviour. The practices may teach children to eat for reasons other than hunger, which is one reason why children and adults become overweight.'

Dr Byrne says most people understand the importance of nutrition in early childhood, but they focus on when and what to feed youngsters. 'People focus on the age to introduce solid foods, optimal fruit and vegetable intake and avoiding discretionary foods. Understanding how a child is fed is equally important.'

Obesity is a priority area for research, with recognition that 20 per cent of Queensland children aged 24–48 months were overweight or obese in 2014–15.

'We know from previous studies that parental feeding practices are not responsive to children's cues,' Dr Byrne says. 'It is important to know about the feeding practices in ECEC because they will also have a substantial influence on a child's eating behaviour and growth.

'Ultimately, the aim is to educate parents and carers alike and transform the health trajectories of the next generation. It is a major health issue that we need to address. We are doing the research so we can correctly understand what drives obesity-related behaviours.'

CARLA PATTERSON MEMORIAL GRANTS

Established in memory of Professor Carla Patterson (pictured left), who dedicated her life to public health research at QUT, the Grants continue her legacy by supporting early- to mid-career public health researchers in their professional development.

The grants will support research in areas such as developing and delivering health initiatives aimed at improving health and wellbeing, including:

- **Men's and women's health**
- **Preventative health**
- **Health determinants**
- **Environmental health**
- **Epidemiology and biostatistics**
- **Health services**
- **Health promotion**
- **Multi-ethnic health, including Indigenous health**


Dr Margie MacAndrew

Australian first study examines dementia and risk of getting lost

Most carers are concerned that people with dementia may become lost if unaccompanied and not find their way home safely. IHBI researchers have investigated the circumstances in which people with dementia become lost as part of an Australian first study.

Dr Margie MacAndrew led the research into 130 reported cases of missing persons with dementia from 2011 to 2015, finding most were men with an average age of 75 years. Results showed 20 per cent were found injured and another 20 per cent were deceased.

The research considered a range of contributing factors, outcomes and possible strategies, including the use of technology for tracking people at risk of wandering and registering them with a peak body. Ultimately, the research recommended a Silver Alert system, similar to Amber Alerts for missing children, be activated when someone with dementia is reported lost.

REAL HEALTH PUBLIC SEMINAR

Presentations from researchers and a chance to ask questions.

Date: Saturday 21 July

Time: 10.30–1130am, followed by refreshments

Place: Lecture Theatre P514, P Block, Gardens Point Campus, 2 George Street, Brisbane City

Cost: Free

Website: www.qut.edu.au/ihbi/dementia-seminar

READ THE STUDY

https://onlinelibrary.wiley.com/doi/abs/10.1111/ajag.12542

Dr MacAndrew and colleagues from the Dementia Centre for Research Collaboration: Carers and Consumers (DCRC-CC) detailed their findings in the Australasian Journal on Ageing.

She says the study acknowledges the health benefits of wandering, such as exercise and social interaction, but findings point to the risks when it goes beyond safe limits.

'Characteristics of risky wandering include frequent and repetitive walking without resting, which can be very tiring. It also includes walking without knowing where you are and how to get back home without help from another person. In other words, wayfinding problems.'

People identified in the research as most vulnerable to becoming lost include those with disturbed sleep, extroverted personalities, a diagnosis of Alzheimer's disease or those with more advanced dementia, Dr MacAndrew says.

The area of the brain impacted by dementia can also contribute to navigation problems that increase the risk of becoming lost. 'Damage to the temporal and parietal lobes of the brain has an impact on spatial awareness, route learning and memory. Damage to the parahippocampus is associated with inability to navigate and not being aware where you are.'

In Australia, more than 400 000 people have a diagnosis of dementia, a life-limiting syndrome with symptoms such as memory loss, diminished function and altered behaviour. Because more than 100 incurable diseases can be the cause of dementia in a person, manifestations differ.

'Most people with dementia will experience behavioural symptoms that can be disturbing and place them at increased risk of harm,' Dr MacAndrew says. 'Wandering is a common and potentially life-threatening behaviour.'

Findings from Dr MacAndrew's research show the majority of people with dementia reported as missing were on foot, with a smaller number driving a car or travelling by public transport. Most were found within 5km, but one person with dementia was found more than 800km away.

A similar study in the United States found most of the people with dementia who had died after going missing were found less than 1.6km from home.

A Silver Alert system now operates in 18 US states, with media outlets, law enforcement units and departments of transport involved in spreading the message when a person with dementia or cognitive impairment is reported missing.

'There is nothing similar in Australia at this stage despite the proportion of the population with dementia being similar,' Dr MacAndrew says. `We think it could be very effective.

`We also recommend current approaches to coordinating a search and rescue attempt should include careful searching in the immediate vicinity the person was last seen, particularly outbuildings and garden areas.'

The research involved a search of more than 1300 newspapers and news websites for articles published in Australia about people with dementia reported as missing, a comparison to findings from the United States and communication with Australian police department members.

Designing a more sun protective future from the ground up

Compliance with sun protective behaviours is low among all age groups. IHBI researchers aim to change that as part of a multi-faceted approach with a host of collaborators that will consider design and education as well as behaviour.


Louise Baldwin

IHBI's Louise Baldwin is developing a skin cancer prevention program that takes into account the need to provide an environment that supports Australians to be 'sun protective'.

She understands that sports clubs, schools and workplaces often have limited shade at facilities or limited access to resources and funding.

Her research involves collaborating with urban and regional planners, education bodies and workplace health and safety officials. Partners include the Design Institute of Australia, ensuring sun protection is an important consideration in building and landscape design rather than an afterthought.

'A long-term aim of our research is to influence the building standards in Australia to incorporate effective sun protective design elements,' Ms Baldwin says.

LOUISE BALDWIN'S MOTIVATION FOR SKIN CANCER RESEARCH:

'Skin cancer prevention is a major focus of my career. For almost 25 years I've been privileged to have led or been involved with significant skin cancer prevention work across Queensland, including some national roles. Often our passion for work is driven by tragedy. My own father was a victim of melanoma and he was taken far too young. Once I was old enough to realise that the cancer which took my father was preventable or detectable early, that drove me to do something and prevent further tragedy from this all-too-common cancer. We've had some huge improvements in sun protection but we still have a long way to go. At QUT, we're hoping to lead the way and prevent more unnecessary tragedies from skin cancer.'

Apparel is another important consideration, with design options in popular sports such as netball exposing significant areas of skin and increasing skin cancer risk. Protecting the skin with clothing that extends the sleeve to the elbow and shorts to the knee has been shown to reduce mole count, a risk factor for skin cancer, in pre-schoolers in tropical Queensland.

QUT colleagues from the Faculty of Health and Creative Industries will provide important insights in apparel design and health behaviours as part of this aspect of the research.

Ms Baldwin says ineffective use and over-reliance on sunscreen is prevalent and too many people become sunburnt because of inadequate preparation with protective clothing, hats and shade.

Fabric choice is important, she says. 'Look for close weave fabrics in slightly darker colours such as reds, blues and greens. Hold a hat to the light. If you can see light through the weave, it means ultraviolet (UV) rays can get through as well.'

UV radiation that causes skin cancer is different to the heat rays from the sun, also called infrared rays. Temperature does not affect UV rays so exposure and risk are not reduced in winter. The UV radiation is a Group 1 carcinogen, the same as tobacco and asbestos.

Skin cancer is the most common cancer in Australia, with at least two-thirds of people diagnosed before the age of 70 years. More than 13 000 people in Australia are diagnosed each year.

It cost $137 million to the Medicare system in 2014 and diagnosis accounts for immeasurable costs such as psychological stress, time off work, disfigurement, scarring and the risk of recurrence.

'This is a largely preventable cancer and it has a huge burden on Australian society. We know how to prevent skin cancer and detect it early. Prevention can be effective with simple steps of individual and environmental behaviours. 'We can't tell Australians to be sun protective without creating environments that support the behaviours. It's is not just research. It's changing how we live.'

Beyond applying sunscreen and wearing protective clothing, Ms Baldwin advocates moving outdoor activities to times that avoid peak UV exposure.

Ms Baldwin says the collaboration will gather information about barriers to sun protective behaviours, facilitate better design, develop a five-year action plan and work with organisation to take incremental steps to overcome common barriers.

An online portal will be developed as a repository for innovative sun protective designs and resources for best practice that consider both apparel and the built environment. Behavioural change will be measured using an evaluation and monitoring tool.

"We hope we can ultimately have a long-lasting and positive impact on preventing skin cancer and saving people from illness, treatment, stress and disfigurement,' Ms Baldwin says.


Dr Shivashankar Nagaraj

Genetic study aims to improve vital blood group knowledge

Blood grouping and matching is complex, beyond considerations of whether a person is A, B, AB or O and either positive or negative. There are known to be at least 36 blood groups and variants, with genetic underpinnings and differences between ethnic groupings.

IHBI's Dr Shivashankar Nagaraj is using his expertise in population genomics to understand the genetics of blood groupings and identify variations that will ultimately enable the Australian Red Cross Blood Service to more closely match donors and recipients from all ethnic backgrounds.

The research is important, especially for Indigenous Australians, who are up to 25 times more likely to develop end-stage renal disease requiring kidney transplantation. The patients are more likely to require blood transfusions, and transfusion-induced immune responses against protein molecules called antigens can significantly increase the risk of transplant rejection.

Dr Nagaraj is using an Advance Queensland Mid-Career Research Fellowship and associated funding to partner with the Australian Red Cross Blood Service and hospitals in Brisbane, Toowoomba and Townsville on a project that links genomics to clinical diagnostics.

He says modern genomic technologies offer an ideal opportunity to comprehensively characterise blood groups from Indigenous Australians, ensuring accurate donor matching.

Aboriginal and Torres Strait Islander community healthcare organisation Carbal Medical Services and Toowoomba Hospital will contribute patient samples and the Queensland Genomics Health Alliance will provide an ethical framework for the management of culturally sensitive patient samples.

`The blood donor base in Australia is largely Caucasian,' Dr Nagaraj says. 'There is published evidence that blood from donors with mismatched antigen profiles results in poorer outcomes for patients.'

The differences in blood groupings are due to the presence or absence of antigens. The antigens are found on the surface of the red blood cells and antibodies against antigens are in the blood plasma.

Foreign antigens cause the immune system to create antibodies that, in turn, attack cells that the immune system determines are a threat. People with type A blood will generate antibodies that attack type B antigens and vice versa.

Dr Nagaraj says researchers have made marked advances in blood typing and genetics in some ethnic groupings, but little has been done to advance understanding in Indigenous communities.

The study of blood serum, called serology, can detect common blood group types and the methods work well for most patients in need of a single transfusion. Patients in need of repeated transfusions require more extensive serological investigation to avoid serious complications.

'There are higher rates of diabetes, blood diseases and renal disorders in indigenous patient groups,' Dr Nagaraj says. 'Taken together, this can lead to higher rates of organ and tissue transplantation—which in turn requires effective transfusion support.'

Dr Nagaraj and PhD candidate Sudhir Jadhao will work closely with clinical partners to collect 500 donor samples, with the help of a designated clinical nurse to prepare a catalogue of blood group variants.

'We expect the project to produce valuable insights into the distribution of blood groups in Indigenous Australians.

`The long-term outcome of the project may be the development of serological antibodies against blood group antigens associated with Indigenous Australians. The Red Cross Blood Service has tremendous strength in blood matching. The antibodies could be used to ensure more accurate matching of donors and patients.

'The research aims to dramatically improve transfusion safety for 700 000 Indigenous Australians and the underlying genomics has the potential to offer future opportunities to transform healthcare worldwide.'

BLOOD GROUPS

The groups are A, B, AB, and O. They are grouped together by the presence or absence of antigens.

ANTIGENS

Cause the immune system to create antibodies that attack other blood groups. People with type A blood will have antigens that attack type B and vice versa. Those with both antigens have type AB and those with no antigens have type O.

POSITIVE OR NEGATIVE

Blood groups are separated by the presence of another type of antigen: rH factor. People with the rH antigen are positive and those without are negative.

EXECUTIVE DIRECTOR'S REPORT

Medical research is not just about understanding a disease, its genetics, cellular make-up and how it progresses. Important considerations in the research are human behaviour and the seamless integration of knowledge in clinical practice. In other words, it is understanding whether patients, clinicians and policy makers will adopt the measures that we know from our research will improve health and healthcare.

Human behaviour is a major aspect of Dr Rebecca Byrne's research in obesity. Dr Byrne knows nutrition in early childhood has a significant role in creating life-long patterns of eating behaviours, but she is working to understand if and how interactions between staff at early childhood education and care centres and children contribute.

Similarly, Louise Baldwin is interested in behaviour in understanding how best to address skin cancer prevention. She is collaborating widely with the aim of educating people about taking protective steps, while also designing more suitable apparel, buildings, landscaping and sports grounds to support the behaviour.

Awareness, education and training are important to Associate Professor Rosana Pacella's efforts to improve patient outcomes and reduce the incidence and costs of chronic wounds. Working with clinicians, policy makers, industry and advocates, Associate Professor Pacella aims to provide an evidence base that will inform doctors and nurses about best practice.

Patient outcomes are a primary consideration of research that Dr Shivashankar Nagaraj is conducting in collaboration with hospitals and the Australian Red Cross Blood Service. He aims to understand the genetics of blood groupings and identify variations that will ultimately enable precise matching of blood donors and recipients from all ethnic backgrounds.

Distinguished Professor Dietmar W Hutmacher's research is already having a direct impact on the lives of patients, with 3D-printed biodegradable implants replacing bone lost through disease and infection in Australia and Germany. Clinicians are reporting no infection in the eight months since Australia's first such operation and the recipient is now able to put some weight on the leg.

Dr Margie MacAndrew is among the IHBI researchers studying dementia, aiming to understand its impact on the lives of patients and their families and develop strategies to improve quality of life and minimise the risk of being reported as lost.

I would like to invite you to join us for our Real Health Public Lecture at QUT's Gardens Point campus on Saturday 21 July, providing an opportunity to gain a greater understanding of dementia, what can be done to slow progression and how researchers aim to improve the lives of patients.

I look forward to seeing you at the public lecture. Meanwhile, enjoy reading IHBI Advances.

Professor Lyn Griffiths
Executive Director, IHBI

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