Health Translation Queensland

Queensland Cancer Research and Translation Capability Overview 2023

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Document controls

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Glossary

ACRF	Australian Cancer Research Foundation
ACU	Australian Catholic University
AMGP	Australian Melanoma Genome Project
APCB	Australian Prostate Cancer BioResource
ARC	Australian Research Council
BBB	Brisbane Breast Bank
CARP	Cancer & Ageing Research Program
CCB	Cancer Collaborative Biobank
CCQ	Cancer Council Queensland
CHQ	Children's Health Queensland
CRE	Centres of Research Excellence
HTQ	Health Translation Queensland
ICGC	International Cancer Genome Consortium
ISPOR	International Society of Pharmacoeconomics and Outcomes Research
JCU	James Cook University (Brisbane)
MRFF	Medical Research Future Fund
NHMRC	National Health and Medical Research Council
PAH	Princess Alexandra Hospital (Brisbane)
PBAC	Pharmaceutical Benefits Advisory Committee
PCFA	Prostate Cancer Foundation of Australia
PQ	Pathology Queensland
QCR	Queensland Cancer Register
QCTB	Queensland Children's Tumour Bank
QEDDI	Queensland Emory Drug Discovery Initiative
QIMR Berghofer	QIMR Berghofer Medical Research Institute (previously known as the Queensland Institute of Medical Research)
QUT	Queensland University of Technology

RBWH	Royal Brisbane and Women's Hospital
TCGA	The Cancer Genome Atlas (program)
TPCH	The Prince Charles Hospital (Brisbane)
TRI	Translational Research Institute
UICC	Union for International Cancer Control
UniSQ	University of Southern Queensland
UQ	The University of Queensland

Preface

The purpose of this paper is to showcase the capability of Queensland's cancer research community by providing recent examples of research achievements in the cancer field. It does not claim to include every Queensland cancer researcher in its showcase.

The information and journal articles included in this document were generated by searching through the websites of Queensland universities and research institutes and reviewing research profiles of applicants who submitted a response to the Health Translation Queensland (HTQ) statewide survey. While the focus was predominately on recent achievements, older journal articles have also been referenced to demonstrate the long-standing track record of some researchers.

For more information about the HTQ statewide survey and responses please refer to HTQ's Queensland Cancer Research and Translation Funding Analysis Report 2023.

FAST FACTS

QUEENSLAND IS HOME TO:

800+ researchers, research support staff

350+ higher degree research students

COLLECTIVE OUTPUTS SINCE 2017 INCLUDE:

>388 cancer clinical trials with 41% led by Queenslanders (as at 15 July 2022)

217 highly cited papers (2017 – 2021)

$127.7M in NHMRC & MRFF funding (2017 – 2021) *registered on the ANZCTR as at 15 July 2021

Overview

- Cancer remains a leading cause of death in Australia, with one in two Australians expected to develop cancer in their lifetime, and 1 in 5 dying from the disease.

- In Queensland, there are approximately 33,000 cancer diagnoses and more than 9,700 deaths from cancer every year.

- The most common types of cancer diagnosed in Queensland are prostate, melanoma, breast, and colorectal cancer.

- The most common causes of death due to cancer in Queensland are lung, colorectal, hepatobiliary, haematological, and prostate cancer.

- Childhood cancer accounts for more deaths in Australia between the ages of 1 and 14 years old than any other form of illness.

- Advances in cancer screening, diagnosis and treatment have vastly improved overall cancer survival. New research discoveries, technologies and evidence-based care are extending lives and improving the quality of life for people affected by cancer. However, despite these advances, cancer remains a major health problem in Australia.

- An understanding of the state's cancer research capabilities will position Queensland well to implement the Australian Cancer Plan currently being developed by Cancer Australia.

- As a collective, the research community, state government and hospital and health services can:

  o address the disparities in cancer outcomes across cancer types and cultural, geographical, and socio-economic status.

  o provide Queenslanders with the best care across the patient journey, from prevention through to diagnosis, treatment, survivorship, and palliative care.

Queensland researchers tackle cancer from many angles. Queensland has significant capability across the following 5 Common Scientific Outline (CSO) categories, an international cancer research classification system:

- **Biology:** Queensland has an extensive range of quality research across all aspects of cancer biology.

- **Aetiology and Prevention:** Queensland researchers are very active in cancer aetiology and prevention research and translation across skin, gynaecological, breast, pancreatic and HPV/EBV (Human papillomaviruses/Epstein–Barr virus) driven cancers, and lead some of the world's largest cancer epidemiology and genetic studies.

- **Early Detection, Diagnosis, and Prognosis:** Queensland researchers are active in diverse areas and approaches to the early detection of a number of cancers. They are pioneers in the development and implementation of innovative early detection technologies, including using genomic, liquid biopsy and imaging methodologies.

- **Treatment:** Queensland researchers and clinicians are highly engaged in drug, immunotherapy, cell therapies, and theranostic discovery and development. They are leaders in radiation therapy, from discovery research through to innovative treatment in the clinic, and are advancing surgical options for cancer patients internationally.

- **Cancer Control, Survivorship, and Outcomes Research:** Queensland researchers are recognised for their work in cancer epidemiology and nurse-led survivorship research and training; survivorship model of care development; lifestyle and psycho-oncology interventions; and palliative care and symptom management trials and clinical practice. Queensland is home to one of the largest and most impactful First Nations cancer research programs.

Statewide cancer infrastructure and repositories

The Queensland Cancer Register

Cancer Alliance Queensland, on behalf of Metro South Hospital and Health Service, manages the operation of The Queensland Cancer Register (QCR) for the Queensland Department of Health. The QCR operates under the *Public Health Act 2005* to receive cancer information in Queensland. The QCR maintains a register of all cases of cancer diagnosed in Queensland since 1982 (excluding basal and squamous cell carcinomas of the skin). This registry is one of the largest population-based cancer registries in Australia and is a unique data resource, bringing together the most comprehensive set of cancer data elements to provide an accurate picture of cancer in Queensland.

The Australian Childhood Cancer Registry

Cancer Council Queensland (CCQ) funds and manages the Australian Childhood Cancer Registry, a population-based clinical registry that includes information on every child resident in Australia diagnosed with cancer under the age of 15 years, since 1983. It combines information from Australia's state and territory population-based cancer registries with high-quality data from all childhood cancer oncology centres in Australia. The registry is one of the longest-running and most comprehensive national clinical databanks of childhood cancer in the world. New data items are continually being added in response to the rapidly evolving information requirements of childhood cancer researchers and clinicians.

The Australian Cancer Atlas

The Australian Cancer Atlas is an award-winning collaboration led by CCQ and Queensland University of Technology (QUT). It is an open-access digital, interactive atlas that provides a high-resolution, visual picture of national and within-state geographical patterns in cancer incidence and survival by small geographical areas. It provides free access to modelled estimates of cancer incidence and survival at the Statistical Areas Level 2 across Australia, with measures of uncertainty of those estimates that can be used in ecological analyses.

Cancer Biobanks

There are a number of biobanks across the state that are accessed by cancer researchers nationally and internationally. Some examples include:

- Queensland Children's Tumour Bank (QCTB)
  Established in 2008, the QCTB is an openly accessible paediatric tumour tissue bank managed by the University of Queensland (UQ) and located adjacent to the Queensland Children's Hospital. The QCTB has close ties with other tumour and tissue banks through the Australian and New Zealand Children's Haematology Oncology Group and is a member of the Brain Cancer Biobanking Australia consortium. It has established collaboration with more than 45 cancer research teams around Australia, as well as in the USA, Canada, Italy, the UK, and Germany. These collaborations have resulted in practice-changing insights into childhood cancer and contributed to a number of recent landmark publications.

- **QCell**
  QIMR Berghofer's brain tumour and cell culture collection, QCell, includes more than 350 tumour specimens. From this resource, twelve of these models have been characterised in great detail and made publicly available. QCell models have been used in numerous studies globally and have been published in more than 40 articles to date.

- **Brisbane Breast Bank** (BBB)
  The BBB was originally established by UQ/Pathology Queensland (PQ)'s Professor Lakhani in 2005 with the aim of collecting a frozen tumour sample from every patient undergoing treatment at the Royal Brisbane and Women's Hospital (RBWH). It is now a valuable resource for breast cancer research in Australia and abroad. The BBB is unique in that it provides highly detailed curation of the banked tissue samples, and as of April 2017, it included specimens from 2,167 consented donors (*Open Journal of Bioresources*, 2015). The BBB has established collaborations with the Australian Breast Cancer Tissue Bank, Australasian Biospecimens Network Association, Brain Cancer Biobanking Australia, and the International Cancer Genome Consortium (ICGC) and has contributed to more than 180 publications.

- **Australian Prostate Cancer BioResource** (APCB)
  Originally established by Distinguished Professor Judith Clements at QUT, the APCB provides a unique quality-assured facility for the collection, storage and access to biospecimens and annotated clinical data to support research into the treatment and improved clinical management of men with prostate cancer. The APCB manages 4 federated nodes located in Brisbane (led by A/Professor Jyotsna Batra and Professor Ian Vela), Sydney, Melbourne and Adelaide.

- **Cancer Evolution Biobank**
  Established by UQ/Princess Alexandra Hospital's (PAH) Professor Andrew Barbour, this is a specialised biobank that is used as a critical tool to study oesophageal adenocarcinoma, melanoma and pancreatic cancer. The biobank has more than 12,000 blood and tissue samples stored from over 900 patients, that are available to national and international research groups. It currently supports 12 research projects across Australia, encompassing genomics, therapeutic immune response, drug discovery, and biomarker discovery relating to diagnosis and treatment response.

- **Wesley Medical Research Biobank**
  Founded in 2007, this open-sourced and purpose-built research facility provides a diverse collection of ethically-obtained blood and tissue specimen samples for biomedical research. It is one of the largest of its kind in the southern hemisphere, holding more than 40,000 samples.

- **The Prince Charles Hospital (TPCH) Lung Tissue Biobank**
  For more than 20 years, UQ's Thoracic Research Centre, led by Professors Ian Yang and Kwun Fong, has collected over 1,290 fresh frozen lung cancers; 1,900 paraffin blocks of normal and tumour samples; 2,000 blood samples; DNA from nearly 6,000 patients (lung cancer or other non-cancer respiratory conditions); 150 bronchoscopy samples and 100 resected bronchial epithelial maps. All tumours are annotated through a rigorous, well-established process where important clinical, demographics and outcome data are recorded.

- **The Kidney Cancer Biobank**
  Established in 2013 through collaboration between PAH, UQ and the Translational Research Institute (TRI), this biobank contains biofluids, tissue and clinical information for more than 330

participants (*Translational Andrology and Urology*, 2019). It is currently managed by UQ's A/Professor Glenda Globe.

- Cancer Collaborative Biobank (CCB)
  One of a number of tissue banks held by Metro South, the CCB was established under the leadership of A/Professor Paula Marlton with the aim of creating a valuable research resource of samples from patients diagnosed with haematologic malignancies.

- **Mater Gynaecological Cancer Research Collaborative**
  Mater Research-UQ's Professor John Hooper and Mater/UQ's Professor Lewis Perrin co-lead the Mater Gynaecological Cancer Research Collaborative, which collects samples and data from gynaecological cancer patients and distributes to approved projects. The Collaborative is currently supporting Medical Research Future Fund (MRFF)-funded studies from UQ and Griffith University, totalling about $4 million, and other academic and industry studies of more than $1 million.

1. Cancer biology

Queensland researchers are world leaders in cancer biology, immunology, and the application of 'omics' technologies to uncover how cancer starts, progresses, and metastasises. They have advanced the cancer field through the generation of new knowledge and the commercialisation and translation of discoveries towards the clinic. This includes establishing and maintaining a number of valuable cancer tissue biobanks, accessible to the global research community, to accelerate improved outcomes for patients.

> Queensland has an extensive range of quality research across all aspects of cancer biology from identification of novel pathways and targets to access to cutting-edge 'omics' technologies and expertise.

a. Identification of novel pathways and targets

The identification of novel targets, pathways and biomarkers is essential to improving current therapeutic strategies, enabling personalised medicine, and addressing therapeutic resistance. Landmark discoveries by Queensland researchers have advanced global cancer research efforts and have been successfully commercialised and translated towards the clinic.

Examples of successful translation of discovery research towards the clinic include:

- QIMR Berghofer's Professor Kim Kum Khanna established the link between the ATM gene and breast cancer, with testing of ATM mutations now recommended in breast cancer families in Australia. Professor Khanna identified a new cell cycle regulator which has emerged as an important therapeutic target for a wide variety of cancers (*EMBO Molecular Medicine*, 2018). She discovered 2 new ssDNA binding proteins (SSB1, SSB2) (*Nature*, 2008) and showed that SSB1 is critical for tumour suppression, and loss of SSBs leads to bone-marrow failure (*Blood*, 2017).

- QUT A/Professor Jyotsna Batra and Professor Judith Clements, in collaboration with the large prostate cancer consortium (PRACTICAL), have identified >200 genetic variations associated with prostate cancer risk (*Nature Reviews Cancer*, 2019). Polygenic risk scores derived from these genetic variations are in clinical trial to establish their use in population screening (*Nature Genetics*, 2018). Specifically, this team led the identification of several microRNAs (miRNAs) using the genetic analysis approach, opening the avenues for biomarker discovery and therapeutic targeting of miRNAs in prostate cancer (*Clinical Chemistry*, 2019; *Scientific Reports,* 2018; *Cancers*, 2021; *International Journal of Molecular Sciences*, 2022).

- QUT Professors and Cancer & Ageing Research Program (CARP) Directors, Derek Richards and Ken O'Byrne uncovered the central role of DNA damage repair in ageing and cancer. Specifically, they discovered a novel protein, hSSB1, which is key to the recognition and initiation of repair of DNA damage in cells (*DNA Repair*, 2017; *BMC Molecular Biology*, 2017).

- UQ's Dr Andrew Brooks identified the mechanism by which the Class 1 cytokine receptor, Growth Hormone Receptor, activates its associated JAK2 kinase. Mutations in these receptors can disrupt the important signal pathways that can lead to a variety of diseases, including cancer. Dr Brooks is currently developing new molecules that target this receptor.

- James Cook University's (JCU) A/Professor Ulf Schmitz uses computational approaches to investigate miRNA target regulation mechanisms. Research outputs include identifying miR-638 as one of the most significantly overexpressed miRNAs in metastatic lesions of melanomas compared with primary melanomas (*Oncotarget*, 2015).

- QIMR Berghofer's Professor Steven Lane demonstrated that in vivo transformation of normal stem cells with Cdx2 leads to the development of myelodysplastic syndrome and acute myeloid leukemia (*Nature Communications*, 2020).

- UQ's A/Professor Markus Muttenthaler provided the first evidence that high oxytocin (OTR) levels can promote metastasis in triple negative breast cancer, correlating with reduced patient survival. These findings demonstrate the potential of using high OTR expression as a prognostic biomarker or as a target for therapeutic interventions (*Biomed*, 2022).

- UQ's A/Professor Glenda Gobe conducted the first and largest analysis of the 4 subunits of the NF-kB family in renal cell carcinoma, which provided a greater understanding of the molecular biology and relationship between the subunits of NF-kB to support the therapeutic targeting for renal cell carcinoma (*Pathology*, 2018).

- Mater Research-UQ's Professor Brian Gabrielle has identified a number of cancer targets using in-house functional screens. This has led to formal collaborations with Takeda, Genentech-Roche, Sierra Oncology and AstraZeneca to investigate small molecule inhibitors against these targets.

- QUT's Professor Judith Clements and Mater Research-UQ's Professor John Hooper showed that KLK14 expression is associated with the development of aggressive prostate cancer, suggesting that targeting this protease could offer a novel route to limit the progression of prostate tumours (*Molecular Oncology*, 2020).

- QUT's Dr Brett Hollier, Professor Colleen Nelson and colleagues identified NRP1 as a novel androgen-suppressed gene upregulated during the adaptive response of prostate tumours to androgen-targeted therapies and a prognostic biomarker of clinical metastasis and lethal prostate cancer (*Oncogene*, 2017).

- JCU's A/Professor Lionel Hebbard discovered that targeting both the mTOR and Src pathways may be a novel approach for the treatment of hepatocellular carcinoma (*PLoS One*, 2019).

- QUT's Dr Thomas Patrick, Jenni Gunter and A/Professor Seim Inge discovered that the dysregulated expression of the human long-noncoding RNA GHSROS may influence prostate cancer progression and resistance to docetaxel and are pursuing its potential as a therapeutic target (*Cancer Research*, 2018).

- QUT's Professor Stephen Blanksby has developed novel analytical technologies based on mass spectrometry for the detection and structural characterisation of lipids. Application of these technologies to lipidomic analysis of cancer cell lines and tissues has led to the discovery of new lipids associated with aberrant metabolism in cancer, e.g. prostate cancer (*Cell Reports*, 2021).

- University of Sunshine Coast's Dr Georgia Kafer demonstrated that DNA damage causes the modified DNA base 5-hydroxymethylcytosine to become locally enriched over broad chromosomal domains and that the TET enzymes promote correct chromosome segregation during replication stress (*Cell Reports*, 2016).

- QUT's Professor Erik Thompson discovered epithelial mesenchymal plasticity (EMP) in highly invasive breast cancer cell lines and has highlighted the importance of the EMP hybrid state in cancer progression and therapy resistance (*Nature Reviews Cancer*, 2019).

- UQ's Professor Irina Vetter identified gene signatures in sensory neurons after treatment with vincristine, oxaliplatin, and cisplatin that could be targeted to reduce chemotherapy-induced peripheral neuropathy (*Journal of Pain*, 2019).

- UQ's Professor Di Yu has led a number of landmark discoveries in revealing the differentiation and functions of T cells in human health and disease. He is a highly-cited researcher (2019, 2020) and has publications in *Nature*, *Nature Immunology*, *Nature Medicine* and *Immunity*.

- Mater Research-UQ's A/Professor Allison Pettit revealed recipient resident macrophages as a key targetable mechanism to potentially improve the condition of a patient's bone marrow environment after Hematopoietic stem/progenitor cell (HSPC) transplantation, and also in cases of radiation and chemotherapy cytotoxicity (*Blood*, 2018).

- QIMR Berghofer's Dr Andrea Henden identified interferon-λ (interleukin-28) as a key protector of gastrointestinal graft-versus-host disease immunopathology (*Blood*, 2021).

- UQ's Professor Gabrielle Belz uncovered how innate immune cells drive the frontier protection against pathogens and tumours, such as melanoma, through highly integrated 'sensory' hubs that integrate responses to neuropeptides and metabolic changes (*Nature Immunology*, 2022).

- QUT's A/Professor Larisa Haupt and her team have identified significant changes in CK19/AKT signaling in HER2-positive breast cancer cell proliferation and have demonstrated association with several novel SNPs with increased breast cancer risk.

- UQ's Dr Snehlata Kumari identified essential roles of NF-kB, cytokines, and apoptosis and necroptosis signaling pathways in regulating skin homeostasis and inflammation. These findings advanced the knowledge of skin immunity, and were published in top-tier journals, including *Nature* (2020 x 2).

b. 'Omics' approaches

Queensland is home to world-class 'omics' technology infrastructure and expertise, including genomics, spatial transcriptomics, metagenomics and glycomics, that are advancing cancer biology research and personalised medicine.

This infrastructure and expertise include:

- QIMR Berghofer's Dr Nic Waddell – an internationally recognised expert in the interpretation of next generation whole genome sequence data. Dr Waddell was part of the team that analysed the first whole genome from a cancer patient in Australia and has played a prominent role in Australian ICGC projects and the Australian Melanoma Genome Project (AMGP). She also identified mutational signatures in pancreatic cancer that are linked to germline variants and treatment response (*Nature*, 2015).

- QIMR Berghofer's Professor Nick Hayward has pioneered the field of melanoma genomics, as exemplified by a highly cited paper on somatic mutations in *Nature*, 2017. He has contributed greatly to understanding melanoma susceptibility, including identifying 5 of 7 familial melanoma genes, and being involved in almost all melanoma genome-wide association studies. As part of The Cancer Genome Atlas (TCGA) program and co-lead of the AMGP, he has contributed significantly to melanoma genomics and co-authored the genetic testing guidelines for melanoma.

- UQ's Dr Quan Nguyen is an international leader in spatial sequencing, tissue imaging and machine learning. He pioneered the applications of spatial transcriptomics technologies and machine learning to study cancer at single-cell level and in spatial context. He has led

successful research projects exploring cutting-edge topics in genomics and machine learning, which have been published in *Cell*, *Cell Stem Cell*, *Nature Protocols*, *Nature Communications* and *GigaScience*.

- UQ's Dr Kulasinghe is a pioneer in the field of spatial transcriptomics and has led world-first tissue profiling studies in COVID-19 and lung cancer. He is considered a key opinion leader in the field and has extensive world-first research and development collaborations in the US and Asia Pacific regions with all major spatial biology companies. This program of translational research has led to the identification of predictive biomarkers of therapy in lung cancer (*Cancers*, 2020).

- Griffith University's Australian Cancer Research Foundation (ACRF) International Centre for Cancer Glycomics (ACRF I2CG) was established in 2021 and is the first of its kind in Australia. Using cutting-edge infrastructure, I2CG facilitates the deep mining of the cancer glycome down to a single cell level and translates these discoveries into novel diagnostics and therapies. Dr Arun Everst-Dass leads the advanced mass-spectrometry program in glycomics and glycoproteomics, and recently published evidence supporting the role of glycosphingolipids in correlating and promoting the transition between epithelial and mesenchymal cells in ovarian cancer (*Cell Reports*, 2022). A/Professor Daniel Kolarich leads a program aiming to establish the first comprehensive glycosylation map in ovarian, breast, prostate (in collaboration with A/Professor Jyotsna Batra, QUT), head and neck, colon and gastric cancer, and leukaemia, as part of ongoing national and international collaborations.

- Brisbane-based Microba Life Sciences offers Australia's most comprehensive microbiome testing. Built on leading scientific research by UQ's Professor Phillip Hugenholtz and QUT's Professor Gene Tyson, Microba is a strong contributing force in the development of new pathology services, therapeutics and diagnostics based on the microbiome. The company's cancer immuno-oncology program is targeting the discovery and development of a microbiome therapy to improve response rates in cancer patients receiving immune checkpoint inhibitor therapies.

2. Aetiology and prevention

Queensland has extensive capability and expertise in lifestyle, environmental and genetic factors, and infectious disease associated with the causation of cancer. Queensland researchers are driving innovative chemopreventive strategies and lead, and co-lead, some of the largest cancer epidemiology and genetic studies in the world.

> Queensland researchers are highly active in cancer aetiology and prevention research and translation across skin, gynaecological and breast, and HPV/EBV-driven cancers and lead some of the largest cancer epidemiology and genetic studies in the world.

a. Skin cancer

- QIMR Berghofer's Professor David Whiteman has made seminal contributions in the area of skin cancer, including proposing the 'divergent pathway hypothesis' for multiple causal pathways to melanoma (*American Journal of Epidemiology*, 2006; *Journal of the National Cancer Institute*, 2003; *Journal of Clinical Oncology*, 2006) and identifying risk factors for childhood melanoma (*International Journal of Cancer*, 1997). In 2018, in collaboration with UQ's Professor Peter Soyer and QIMR Berghofer's A/Professor Catherine Olsen, he convened the Sunscreen Summit, which developed a new Australian/New Zealand Sunscreen Policy that has since been adopted on both sides of the Tasman (Whiteman, Neale et al. *Australian and New Zealand Journal of Public Health*, 2019).

- UQ's clinician-researcher Professor Kiarash Khosrotehrani conducted a world-first prospective cohort study (more than 19,000 patients) showing that exposure to thiopurine drugs, commonly used to treat inflammatory bowel disorders, increases skin cancer incidence – which has changed clinical practice. In 2021 he was awarded MRFF funding to conduct a national multi-centre clinical trial (SiroSkin) of 1% topical sirolimus in the chemoprevention of facial squamous cell carcinomas in solid organ transplant recipients.

- UQ's A/Professor James Wells in partnership with the Queensland Emory Drug Discovery Initiative (QEDDI) discovered, patented (WO2021248189) and is commercialising a first-in-class drug (Q2361) in the chemoprevention of skin cancer in immune-suppressed organ transplant recipients.

- UQ and QIMR Berghofer researchers led by A/Professor Michelle Hill showed that *S. aureus* colonisation on precancerous skin may contribute to cancer development and that there might be benefits of eradicating *S. aureus* on heavily photodamaged skin (*Cancers*, 2022).

b. Gynaecological and breast cancer

- QIMR Berghofer's Professor Georgia Chenevix-Trench is internationally recognised for her work on the genetics of breast and ovarian cancers. She has also led/co-led groundbreaking work showing that mutations in the ATM gene confer moderate risks for breast cancer; identified 12 new genetic variants that increase a woman's risk of developing ovarian cancer (*Nat Gen*, 2017) and demonstrated that functional polymorphisms in the TERT promoter are associated with risk of serous epithelial ovarian and breast cancers.

- QIMR Berghofer's Professor Penelope Webb is a world-leading cancer epidemiologist and has led or participated in international studies that have identified novel breast cancer susceptibility loci; the increased risk of specific subtypes of ovarian cancer in women with endometriosis; confirmed that obesity is a risk factor for some types of ovarian cancer (*International Journal of Epidemiology*, 2016); identified new genetic risk factors for endometrial cancer (*Nature*

Communications, 2018); and showed aspirin use may reduce risk of endometrial cancer among overweight and obese women (*Annals of Oncology*, 2019).

- QIMR Berghofer's A/Professor Stacey Edwards was part of an international team that identified and evaluated 2 novel long-noncoding RNAs, CUPID1 and CUPID2, that contribute to breast cancer through modulation of DNA repair pathways (*American Journal of Human Genetics*, 2017) and fine-mapped 150 breast cancer risk regions to identify 191 likely target genes (*Nat Gen*, 2020).

- QIMR Berghofer's A/Professor Tracy O'Mara leads the Endometrial Cancer Association Consortium (ECAC), which consists of more than 12,000 endometrial cancer cases contributed by 14 studies from Australia, UK, USA, Belgium, Germany, Norway and Sweden. ECAC has identified multiple endometrial cancer risk signals by analysis of genome-wide association level data, including the first ever genome-wide association study performed for this disease (*Nat Gen*, 2016; *Human Molecular Genetics*, 2016).

- QIMR Berghofer's Professor Amanda Spurdle is an international leader in the molecular epidemiology of breast, endometrial and ovarian cancers implicated in hereditary cancer syndromes. She co-founded and now leads the ENIGMA international multidisciplinary consortium to develop and apply methods to evaluate variants in breast/ovarian cancer susceptibility genes. Through this role, she has led the development of a suggested framework by the ENIGMA consortium for a common vocabulary to facilitate clinical reporting of germline genetic tests for cancer susceptibility (*J Med Genet*, 2019). She also led the largest ever implementation of the multifactorial likelihood statistical analysis method to classify 734 BRCA1 and BRCA2 variants to support clinical variant classification (*Human Mutation*, 2019).

- UQ/PQ's Professor Sunil Lakhani and UQ's A/Professor Pete Simpson demonstrated the role that whole genome sequencing of matched breast cancer germline/tumour DNA and the somatic mutational signatures can play in the discovery of pathogenic germline variants and in providing supporting evidence for variant pathogenicity (*Annals of Surgical Oncology*, 2019).

- CCQ's Professors Joanne Aitken and Peter Baade lead the study of one of the largest cohorts of women diagnosed with breast cancer. The cohort, including more than 3,300 women diagnosed between 2010–2013 includes information on sociodemographics, clinical characteristics, treatment and psychosocial outcomes, with survival follow up currently available to 2020 (*Psycho-Oncology*, 2020 & 2022; *Breast Cancer Research and Treatment*, 2022).

- QUT's Professor Erik Thompson and Konstantin Momot have optimised a novel portable magnetic resonance imaging (MRI) device for measuring mammographic density in laboratory studies of the pathobiology underpinning the associated breast cancer risk, as well as directly in clinical subjects (*Magnetic Resonance Imaging*, 2022).

c. HPV and EBV-driven cancers

- Mater Research-UQ/PAH's Professor Maher Gandhi and Dr Colm Keane showed for the first time that EBV-associated primary central nervous system lymphoma (PCNSL) in the immunosuppressed is immunobiologically distinct from EBV2^{-} HIV2^{-} PCNSL, and, despite expressing an immunogenic virus, retains the ability to present EBV (*Blood*, 2021). Based on this research, they tested several patients with a combination of ibrutinib and EBV-specific T cells (*American Journal of Transplantation*, 2021), which led to initial MRFF funding for an

early phase clinical trial led by the Australian Leukemia and Lymphoma Group. They have recently been awarded a second MRFF grant to expand the research via another Phase 1 clinical trial.

- Griffith University's Professor Nigel McMillan was the first to show that HPV-driven cancer can be eliminated completely using CRISPR, through showing that CRISPR/Cas9-loaded stealth liposomes effectively clear established HPV16-driven tumours in syngeneic mice (*PLoS One*, 2021).

- QIMR Berghofer's Professor Rajiv Khanna and team discovered new cellular immunotherapy targets for HPV-associated oropharyngeal cancer (*Journal of Experimental Medicine*, 2020). He also manufactured the EBV-specific adoptive T cell therapy that was used in combination with programmed cell death-1 blockade therapy to successfully treat a patient with metastatic nasopharyngeal carcinoma (*npj Precision Oncology*, 2021).

d. Other

- UQ's A/Professor Susan Jordan led a collaboration with QIMR Berghofer and CCQ that showed an association between having a hysterectomy and an increased risk of thyroid cancer (*Cancer Epidemiol*, 2021) and kidney cancer, a decreased risk for breast cancer, and no association for colorectal cancer (*Cancer Epidemiology, Biomarkers & Prevention,* 2021).

- UQ's Dr Aideen McInerney-Leo and colleagues reported the first family with a germline ERBB3 mutation causing heritable non-small-cell lung cancer (*Human Molecular Genetics*, 2021).

- UQ's Professor Liz Eakin has extensive experience in the development and implementation of behavioural interventions to reduce lifestyle cancer risk factors, the effective delivery of health promotion programs, and is a highly cited researcher (2016–2018).

e. World-leading cancer epidemiological and genetic resources led by Queenslanders

- The QSkin Study, established 2010, is the largest research study ever conducted on skin cancer, with more than 45,000 Australians participating to provide long-term information about the burden of skin cancer in Australia. QSkin has generated more than 75 publications, including from national and international collaborators. In 2019, QSkin2 was launched to collect saliva samples from QSkin participants. This enabled large-scale, genome-wide association studies on samples from people diagnosed with skin cancer and people with no history of skin cancer, to understand the genetic causes of skin cancer. QIMR Berghofer's Professor David Whiteman and A/Professor Catherine Olsen co-lead the QSkin study, which has also generated an online risk prediction tool for melanoma (*Journal of the National Cancer Institute*, 2018) and keratinocyte cancer (*Journal of Investigative Dermatology*, 2016).

- Australian Ovarian Cancer Study (AOCS) is the largest study of its kind in the world. A joint study between Peter MacCallum Cancer Centre, Westmead Institute for Medical Research and QIMR Berghofer, it recruited 2,456 women with suspected epithelial ovarian cancer from all Australian states between 2002 and 2006. AOCS has supported more than 120 national and international projects, contributed to more than 241 peer-reviewed publications, and facilitated the registration of new drugs in Australia to treat women with ovarian cancer. Detailed epidemiological data have been collected from cases and demographically-matched control women (1,065 enrolled), allowing the refinement of information about known

environmental risk factors to understand how environmental and genetic risk for ovarian cancer may intersect and guide prevention strategies. QIMR Berghofer's Professors Penelope Webb and Georgia Chevenix-Trench are founding members of AOCS.

- [Australian Melanoma Genomics Project](#) (AMGP) is the largest melanoma research effort ever undertaken in Australia, with a national coalition of more than 50 researchers from the Melanoma Institute Australia (MIA), the University of Sydney, Royal Prince Alfred Hospital, Westmead Institute for Medical Research and the QIMR Berghofer. The project has made major progress by comparing the genetic code of normal cells and melanoma tumours and identifying all the mutations present in nearly 500 Australian melanoma patients. Further, the AMGP was endorsed by the ICGC early in 2015, where all collected data was uploaded to the ICGC data portal to interrogate. QIMR Berghofer's Professor Nick Hayward co-leads AMGP with MIA's Professor Richard Scolyer and Professor Graham Mann.

- [The Breast Cancer Outcomes Study](#) is one of the largest population-based cohort studies of breast cancer in the world. More than 3,300 Queensland women diagnosed with breast cancer between 2010–2013 have been followed for up to ten years (to date) and have provided new understanding of the experiences of women diagnosed with this disease, and of the individual and clinical features associated with better or worse outcomes. The project is led by CCQ with collaboration from the Mater Hospital (*Breast Cancer Res Treat*, 2020 & 2022).

3. Early detection, diagnosis and prognosis

Early detection of cancer offers the greatest potential for transformational improvements in patient outcomes. Queensland researchers and clinicians are pioneers in the discovery, development and clinical implementation of diagnostic biomarkers, liquid biopsies, and technologies to yield earlier detection of disease. We are world leaders in equitable access to screening programs and health services to support closing the gap in cancer outcomes between Aboriginal and Torres Strait Islander peoples (respectfully referred to as Indigenous hereafter) and non-Indigenous Australians. Further, we have improved outcomes for cancer patients through better risk stratification strategies, through the clinical adoption of genomics, and prognostic biomarkers.

> Queensland researchers are active in diverse areas and approaches to the early detection of a number of cancers. They are pioneers in the development and implementation of innovative early detection technologies, including using genomic, liquid biopsy and imaging methodologies.

a. Biomarkers, liquid biopsies and innovative assay technologies

- Griffith University's Professor Chamindie Punyadeera developed and clinically validated a novel saliva-based non-invasive diagnostic tool for oral and throat cancer, based on machine-learning classifiers using metatranscriptomic data from saliva samples (*npj Genomic Medicine volume*, 2021). This technology is currently being commercialised by US-based biotech company Viome, who has recently received Food and Drug Administration approval for the diagnostic test.

- UQ's Dr Mitchell Stark and QIMR Berghofer's Professor Hayward discovered and patented a novel melanoma miRNA panel for the diagnosis of melanoma (*Translational Vision Science & Technology*, 2019).

- UQ's A/Professor Carlos Salomon identified and validated exosomal protein and miRNA biomarkers that combined in the OCRF-7 algorithm showed over 90% accuracy to detect Stages 1 and 2 ovarian cancer in an independent 500-sample retrospective case-control study. He is now conducting an MRFF-funded (2021) study to clinically validate the algorithm in combination with INOVIQ's EXO-NET® technology, through gaining access to data from the world's largest ovarian cancer screening trial led by the University College London. INOVIQ has exclusive rights to the development and commercialisation of UQ's exosome-based early detection test for ovarian cancer.

- QIMR Berghofer and UQ researchers under the leadership of Professor Andreas Moller identified a specific miRNA, miR-3182, in small extracellular vesicles as a biomarker for non-small cell lung cancer diagnosis (*Cancers*, 2022).

- A team of researchers and clinician-researchers led by Griffith University's Professor Punyadeera demonstrated that combining circulating tumour cells and clusters and cell-free DNA levels could improve progression-free survival assessment in non-small cell lung cancer (NSCLC) patients and has the potential to be a prognostic biomarker for NSCLC (*Heliyon*, 2022).

- UQ's Dr Amy Cart-Reed and A/Professor Pete Simpson identified and are clinically validating a prognostic genetic test (called 'LobSig') for lobular breast cancer (*npj Breast Cancer*, 2019).

- PAH/UQ's A/Professor Peter Mollee and Microba Life Sciences A/Professor Michelle Hill are internationally recognised for the development, implementation and evaluation of proteomics-based diagnostics for amyloidosis subtyping (*Clinical Proteomics*, 2016).

- UQ/TPCH's Professors Ian Yang and Kwun Fong and A/Professor Rayleen Bowman are recognised for the identification and evaluation of diagnostic and prognostic lung cancer biomarkers. This includes identifying SOCS6 in primary lung squamous cell carcinoma as a useful prognostic biomarker; showing that miR-218 is a strong candidate tumour suppressing miRNA potentially involved in lung cancer; and demonstrating that plasma extracellular vesicle miRNAs have the potential as a diagnostic biomarker to identify lung cancer, current smoking status, and stable chronic obstructive pulmonary disease (*Int J Molecular Sciences*, 2021).

- Microba Life Sciences A/Professor Michelle Hill and UQ's Professor Matt Trau developed a microfluidic lectin immunoassay, the EndoScreen Chip, that allows sensitive multiplex serum biomarker measurements to enable cost-effective blood screening for early-stage esophageal adenocarcinoma (*Cancers*, 2021), which was recently licensed to Proteomics International Laboratories to commercialise.

- UQ's Professor Matt Trau and team developed Methylscape™, a universal method of detection of circulating tumour DNA that detects the alteration of genomic DNA's methylation landscape during cancer using gold sensors, which has been validated in retrospective breast and prostate cancer cohorts (*Nature Comms*, 2018). UQ licensed the technology to US startup company aiGENE Inc. in 2020, to further develop and commercialise.

- Griffith University's Professor Sally Poulsen designed and synthesised novel gallium-radiolabeled small-molecule sulfonamides targeting carbonic anhydrase IX (CA IX) and demonstrated their potential as a new predictive tool for selection of patients eligible for CA IX-targeting anticancer therapies (*Journal of Medicinal Chemistry*, 2016).

- UQ's Professor Matt Trau and team developed the Extracellular vesicles Phenotype Analyzer Chip (EPAC), as an extremely sensitive method for detecting biomarkers contained in extracellular circulating vesicles released by melanoma cells (*Science Advances*, 2020).

- Mater Research-UQ's Professor Maher Gandhi is internationally recognised as a leader in lymphoma biomarker discovery and development. He has demonstrated that ratios of T cell immune effectors and checkpoint molecules have the potential as prognostic biomarkers in diffuse large B-cell lymphoma (*Lancet Haematology*, 2015). He also showed that plasma miRNA are disease-response biomarkers in classical Hodgkin lymphoma and that viral and host miRNA regulate immune checkpoint expression (*Blood*, 2019).

- Griffith University's Professor Michael Jennings and UQ collaborators demonstrated that sialic acid N-glycolylneuraminic acid (Neu5Gc) serum biomarkers are a promising new tool for early detection and disease monitoring for breast cancer and have developed a Surface Plasmon Resonance-based assay (*BMC Cancer*, 2022).

b. Genomics

Queensland cancer patients have benefited from the state government's $25 million investment into the Queensland Genomics program (2016–2021) to accelerate the adoption of genomics into everyday care for Queenslanders, including in cancer care. Cancer-specific outcomes of the program include:

- Development of Australia's first NATA (National Association of Testing Authorities)-accredited test for haematological cancers.

- Clinical validation of statewide whole genome sequencing (WGS) testing in improving the accuracy of diagnosis and treatment for patients with myeloid blood cancers. RBWH's Dr Cameron Curley (who led the collaborative project between Metro North, PQ and QIMR Berghofer) found that genomic sequencing was clinically useful more than 70% of the time, with 11% of patients having a change in their treatment plan as a result of the sequencing data.

- An implementation study led by Children's Health Queensland (CHQ)/UQ's A/Professor Andy Moore demonstrated the clinical benefits and cost-effectiveness of WGS in paediatric acute leukemias, which has now been translated into standard care in Queensland.

- UQ/PQ's Professor Sunil Lakhani and UQ's Dr Amy McCart Reed along with Metro North, Metro South, Mater Health and Icon Cancer Care clinicians developed and implemented a clinical framework for WGS for breast cancer in Queensland (the 'Q-IMPROvE' study).

- PAH/UQ's Professor Andrew Barbour led the first study to demonstrate that hypermethylated esophageal adenocarcinoma phenotype is associated with poor survival (*Carcinogen*, 2016).

- The Queensland Genomics community advisory group, comprised of representatives from QIMR Berghofer, UQ, Metro North and Health Consumers Queensland, surveyed public opinion on the use of genomic data and developed, delivered (118 participants) and evaluated a training program for medical interpreters (*Frontiers in Genetics*, 2022).

Queensland clinician researchers are driving the application of genomic screening in the clinical setting to enable precision medicine-based treatment. Further examples include:

- UQ's A/Professor Pete Simpson and RBWH/UQ's A/Professor David Fielding received MRFF funding to maximise the utility of specimens for lung cancer genomics when they are collected at biopsy using endobronchial ultrasound. This was instituted by A/Professor Fielding as an Australian first (2003) and is now standard of care for diagnosing lung cancer (*JTO Clinical and Research Reports*, 2022).

- RBWH/QIMR Berghofer's Professor Steven Lane and SA Pathology's Professor Hamish Scott co-lead the MRFF-funded blood cancer genomics screening MOST-LLy Trial, for patients with advanced blood cancers without an established therapeutic option. This trial leverages the Molecular Screening and Therapeutics (MoST) Program led by the Garvan Institute's Professor David Thomas, to match patient's 'tumour' genomic profile with available and promising treatments. Further, the trial enables the researching of biomarkers of response or resistance.

- UQ/PQ's Professor Sunil Lakhani and UQ's A/Professor Pete Simpson were involved in the development of Homologous Recombination Deficiency Detect (HRDetect), a WGS-base prediction algorithm that quantifies BRCA1 and BRCA2 deficiency, predicting sensitivity to PARPi and platinum agents (*Nat Med*, 2017).

- RBWH/UQ's A/Professor Lindy Jeffree is a co-investigator on the MRFF-funded Low and Intermediate Grade Glioma Umbrella Study of Molecular Guided TherapieS (LUMOS) Trial, a pilot umbrella study for patients with relapsed G2/3 gliomas that aims to match patients to targeted therapies based on molecular screening with contemporaneous tumour tissue (*British Medical Journal*, 2021).

- UQ/TPCH's Professors Ian Yang, Kwun Fong and A/Professor Rayleen Bowman are international leaders in the application of genomics to guide treatment strategies for lung cancer (includes *Journal of Thoracic Oncology*, 2017). Further, Professor Yang has led numerous studies that have provided new knowledge based on the analysis of genomic data through TCGA program.

- UQ's Dr Aideen McInerney-Leo has explored Australian human research ethics committee (HREC) members' confidence in reviewing genomic research applications, which showed that even well-educated HREC members lack genomic confidence, which could be enhanced with additional genomic resources (*European Journal of Human Genetics*, 2021). She is also involved in exploring Australian health professionals' views on the genetics and life insurance moratorium, who believe that it falls short of an adequate long-term regulatory solution to genetic discrimination in life insurance (*J Med Gen*, 2021).

Queensland Genomics diagnostic services include:

- [The Australian Translational Genomics Centre](#) (ATGC) is the first genomic diagnostic service in Queensland, and one of the largest programs of its kind in Australasia, providing whole-exome or WGS and microarray services. The ATGC is a partnership between QUT, Metro South Health, and PQ. The facility offers rapid and comprehensive screening for cancer mutations and the identification of specific mutational profiles at patient diagnosis, required for inclusion in frontline therapeutic clinical trials.

- [Genomics For Life Pty Ltd](#) is an Australian-owned, Brisbane-based pathology laboratory, servicing Australian and overseas patients. It is led by leading pathologist Dr Glenn Francis, and offers genomic testing options for cancer patients that may help identify specific mutations unique to each patient's cancer and help health care providers make informed choices on the best treatment options for their patients.

- [genomiQa](#) is a precision analytics company co-founded by QIMR Berghofer's Dr Nic Waddell and Professor John Pearson. It specialises in bringing together whole genome biology, analysis and clinical reporting. It is working with pharma and biotech companies to implement whole genome into clinical development and with health systems to integrate whole genome analysis for cancer (CapeDx) and germline (GulfDx).

- [Genetic Health Queensland](#) (GHQ) is a statewide service that provides diagnosis, counselling, and management advice to individuals and families who have, or are at risk of having, a genetic or inherited condition. They also manage the Queensland Familial Cancer Registry, a Queensland statewide service established to improve the care of those with or at risk of a familial bowel cancer syndrome.

c. Early detection technologies and methodologies

- UQ's Professor Peter Soyer pioneered the dermoscopy of pigmented skin lesions, a non-invasive diagnostic method, and the worldwide morphologic classification system. Further, through $10 million in ACRF funding, Professor Soyer established the Australian Centre of Excellence in Melanoma Imaging and Diagnosis (ACEMID) that is embedding advanced 3D total body photography diagnostic imaging in 15 Australian sites. He also played a key role in the development of a checklist of items that outlined best practices of image-based artificial intelligence development and assessment in dermatology (*JAMA Dermatology*, 2022).

- University of Southern Queensland (UniSQ)'s Professor Jeff Dunn is currently leading the update of the existing (2016) Clinical Practice Guidelines for Prostate-Specific Antigen (PSA) Testing and Early Management of Test-detected Prostate Cancer.

- PAH/UQ's A/Professor Mollee is at the forefront of systemic amyloidosis diagnosis techniques in Australia and established Australia's first dedicated amyloidosis clinic at the PAH.

- UQ/PQ's Professor Sunil Lakhani has influenced international pathology standardisation and quality assurance through the WHO Tumour Classification monographs, that act as gold standard for diagnosis and form the basis for epidemiological studies that influence public spending for cancer worldwide.

- QUT's A/Professor Elizabeth Williams developed an immunohistochemistry assay that has been used in the diagnosis of lymphatic hypoplasia on endoscopic biopsies of the intestine at the Royal Children's Hospital Melbourne.

Queensland is home to world-class clinical research imaging infrastructure and expertise across the Herston Imaging Research Facility, the TRI Innovation and Translation Centre, and UQ's Centre for Advanced Imaging. From the development of new imaging technologies to analysis of molecular structure, and synthesis of PET tracers targeting fundamental biological processes, these leading facilities have been purpose-built to facilitate preclinical and clinical imaging studies and trials.

Examples of exceptional diagnostic imaging research include:

- Mater Research-UQ's Professor John Hooper developed a novel radio-imaging agent to detect epithelial ovarian cancer by PET-CT, which is currently being evaluated in a Phase 1 clinical trial at RBWH's Nuclear Medicine Department with the support of A/Professor Lewis Perrin's Gynaecological Oncology unit at the Mater Hospital. The trial leverages UQ's advanced biomanufacturing capabilities of the National Collaborative Research Infrastructure Strategy (NCRIS) National Biologics Facility, CSIRO facilities, and the Queensland PET Services at RBWH (A/Professor Paul Thomas).

- Griffith University's Professor Carolyn Mountford is internationally recognised for her research in the application of magnetic resonance spectroscopy (MRS) to improve the screening, early detection and preoperative diagnosis of cancer, specifically ovarian and breast cancer (*Journal of Magnetic Resonance Imaging*, 2022). Professor Mountford's research team is currently conducting trials for the use of MRS in breast cancer screening. Further, she is working with industry partners, Siemens and DatChem, to make the developed technology available.

- UQ/RBWH's A/Professor John Yaxley and Dr Mathew Roberts are renowned clinician researchers in the use of imaging (PET, MRI) for the diagnosis and prognosis of prostate cancer. This includes demonstrating that prostate-specific membrane antigen (PSMA) intensity is an independent prognostic biomarker for biochemical recurrence-free survival following radical prostatectomy (*European Journal of Nuclear Medicine and Molecular Imaging*, 2022). And also, that intraprostatic 68Ga-PSMA-11 intensity is prognostic and may be a valuable new biomarker in localised prostate cancer (*Eur J Nuc Med Mol Imaging*, 2021).

d. Equitable access to screening services

Queensland researchers are actively driving more equitable access to Australia's 3 national screening programs (breast, cervical, and bowel), with a strong focus on Indigenous peoples. Furthermore, Queensland researchers are internationally recognised as leaders in the development, implementation, and evaluation of national screening programs to reduce the significant burden of disease from lung and skin cancer.

Examples of world-leading research include:

- UQ's Professor Gail Garvey has dedicated her research career to improving cancer outcomes for Aboriginal and Torres Strait Islander people. Recognised internationally as a leader in this field, her research has demonstrated the significant disparity in cancer outcomes between Indigenous and non-Indigenous people (*JCO Global Oncology*, 2020). Highlights of the research related to cancer screening conducted by Professor Garvey, her team and collaborators (including UQ's Dr Tamara Butler and CCQ's Professor Peter Baade) include showing that Indigenous women's participation in cervical screening is unacceptably low compared to non-Indigenous women (*Cancer*, 2016; CCQ, 2018; *Cancer Epidemiology*, 2020); documenting for the first time Indigenous women's experiences of participation in cervical screening (*PLoS One*, 2020); and developing and evaluating a National Indigenous Bowel Screening Pilot (Menzies School of Health Research, 2020).

- CCQ's Professor Peter Baade and Dr Paramita Dasgupta, in collaboration with UQ's Professor Gail Garvey, led an investigation of cervical cancer screening participation among Indigenous women in Queensland, and found significant geographical variation across Queensland in screening participation and prevalence of high-grade cervical abnormalities. Higher participation in North Queensland was consistent with better access to Aboriginal community-controlled primary health organisations in that region (*J Med Screen*, 2021; *Cancer Epidemiol*, 2020; *Frontiers in Oncology*, 2021).

- UQ's Professors Monika Janda and Peter Soyer are leading a national research program funded by ACRF and National Health and Medical Research Council (NHMRC) (Centres of Research Excellence [CRE] and Synergy grants) to create a blueprint for an equitable national melanoma screening program using 3D total body photography scanners. The program will recruit 15,000 Australians across Queensland, New South Wales and Victoria to co-design an affordable, trusted and effective screening program for the skin cancer.

- UQ/TPCH's Professor Kwun Fong and Professor Garvey were awarded a $2 million ACRF Lung Cancer Screening Centre of Excellence grant to convert a semi-trailer into the world's first mobile lung cancer screening facility, targeting Australians living in rural, remote and Indigenous communities with limited access to lung cancer screening services.

- UniSQ's Professor Jeff Dunn, as President of the Union for International Cancer Control (UICC), leads the new 3-year World Cancer Day "Close the Care Gap" campaign and advocacy program, for the inclusion of cancer care within national universal health care plans (*J Clin Oncol*, 2023) and the inclusion of psycho-oncology guidelines in global, national and local cancer control plans (*Psycho-Oncology*, 2022).

- CCQ's Dr Belinda Goodwin led a team across UniSQ and CCQ that revealed the key barriers preventing people from participating in at-home bowel screening, in an attempt to improve participation rates (*Psycho-Oncology*, 2021).

- UQ/TPCH's Professors Fong, Yang and A/Professors Henry Marshall and Rayleen Bowman led the Queensland Lung Cancer Screening Study and demonstrated that the US National Lung Screening Trial screening protocol that uses low-dose computed tomography (LDCT) is feasible in Australia (*Eur Res J*, 2015). They also showed that identification of individuals for lung cancer screening by accurate prediction models is more efficient than using categorical age-smoking criteria (*Lancet Oncology*, 2021). Further, Professor Fong and A/Professor Marshall were co-investigators on the International Lung Screening Trial (*Annals of the American Thoracic Society*, 2020) and on a national study showing that in people over 40 years with significant smoking exposure, computed tomography (CT) screening reduced deaths from lung cancer by 21% (*Cochrane Database of Systematic Reviews*, 2022). This research contributes to the evidence base underpinning a potential national lung cancer screening program.

4. Treatment

Queensland researchers and clinicians are united in their drive for improved cancer outcomes through the delivery of world-class expertise and infrastructure in drug, immunotherapy and theranostic discovery and development. Clinicians are at the forefront of surgical and radiotherapy innovations to ensure Queenslanders impacted by cancer receive the best possible treatment.

> Queensland researchers and clinicians are highly engaged in drug, immunotherapy, cell therapies, and theranostic discovery and development. They are leaders in radiation therapy, from discovery research through to innovative treatment in the clinic, and are advancing surgical options for cancer patients internationally.

a. Small molecule drug discovery and development

- UQ's Professor David Fairlie and team have developed potent inhibitors of class 1 histone deacetylases that may be more promising than AR-42, which is currently in clinical trials for a range of cancers (*Journal of Medicinal Chemistry,* 2020).

- Griffith University's Professor Des Richardson developed the anti-cancer and anti-metastatic drug, DpC, which has entered multi-centre Phase 1 clinical trials for the treatment of a range of highly resistant and difficult-to-treat tumours. More recently, Professor Richardson and colleagues showed that DpC is a promising new drug for prostate cancer through inhibiting PSA as well as suppressing both androgen-dependent and independent arms of androgen receptor signalling (*FASEB J*, 2020).

- UQ's Professor David Craik and team designed and synthesised potent peptide inhibitors of the PD-1:PD-L1 interaction that have the potential to be used in cancer immunotherapy (*Journal of the American Chemical Society*, 2021).

- JCU's Professor Norelle Daly combined 2 anti-angiogenic epitopes that act on different pathways of angiogenesis into a single, non-toxic cyclic peptide framework as a form of combination therapy for targeting a wide range of cancers (*Sci Reports*, 2016).

- QUT's Dr Sónia T. Henriques and team designed a potent peptide inhibitor of lactate dehydrogenase (LDH), a cancer biomarker overexpressed in a broad range of tumors and correlated with highly aggressive tumors, drug resistance and poor prognosis (*J Med Chem*, 2021). The optimised peptide inhibits proliferation of triple-negative breast cancer cells (*Cellular and Molecular Life Sciences*, 2022).

- UQ's A/Professor Fiona Simpson led a team of UQ researchers and clinicians (PAH) that demonstrated in a human tumour *ex vivo* assay that the anti-nausea drug, prochlorperazine, has the potential to be repurposed to enhance the efficacy of anti-tumour monoclonal antibodies (*Cell*, 2020). The team are now conducting (i) a Phase 1 study investigating the safety and efficacy of cetuximab and prochlorperazine combination therapy in metastatic head and neck squamous cell carcinoma and triple-negative breast cancer, and (ii) a Phase 1 dose de-escalation study for the addition of prochlorperazine to paclitaxel, trastuzumab, and pertuzumab for previously untreated HER2-positive metastatic breast cancer.

- QIMR Berghofer's Professors Glen Boyle and Peter Parsons discovered and validated 3 anti-cancer agents in preclinical studies. This included tigilanol tiglate (EBC-46), which was licensed to QBiotics and is currently in clinical development for humans after recently being approved by the European Medicines Agency as a veterinary pharmaceutical for intratumoural treatment of non-metastatic, non-resectable mastocytomas in dogs.

- QUT Professor Derek Richards and QUT/PAH Professor Ken O'Byrne co-founded CARP Pharmaceuticals to commercialise their lead asset, DKLS02, a first-in-class inhibitor of hSSB1.

- UQ's Professors Greg Monteith and Sarah Roberts-Thomson identified, characterised and patented a novel calcium-signaling channel as therapeutic target for the treatment of breast cancer, which has informed an active drug development program for an anti-breast cancer therapeutic against this target. They have also made contributions to drug discovery programs against other ion channel targets for the treatment of cancer.

- UQ start-up company, Carsinosa, secured funding from the MRFF's CUREator Scheme to develop a first-of-its kind oral small molecule drug to be used in the treatment of a range of difficult-to-treat cancers, including metastatic prostate cancer, breast cancer, ovarian cancer, and colon cancer. This is based on research initiated at the UQ Frazer Institute and progressed in collaboration with QEDDI.

Queensland is home to a number of drug discovery and development centres and organisations including:

- QEDDI: a fully integrated small molecule drug discovery capability based at UQ. QEDDI's team of industry-experienced scientists collaborates with academics to translate university research across multiple disease areas with the aim of discovering new medicines.

- **Griffith Institute for Drug Discovery (GRIDD)**: dedicated to early stage and preclinical drug discovery, including in cancer, through their Centre of Cancer Biology and Drug Discovery. GRIDD houses Compounds Australia and the Nature Bank and recently received $2 million from the ACRF to establish the new ACRF Centre for Compound Management and Logistics at Compounds Australia – Australia's only dedicated compound management facility.

- **QUT's Cancer and Ageing Research Program**: houses a comprehensive drug discovery centre, which includes Merck and Johnson & Johnson providing access to their large compound libraries (80,000 compounds) to enable large-scale automated screening for potential cancer therapeutic targets.

- **Griffith University's Institute for Glycomics**: the only institute of its kind in Australia and one of only a handful in the world dedicated to research centred around glycomics-based discovery and development of next generation drugs, vaccines and diagnostics in cancer.

b. Immunotherapy research and clinical trials

- UQ's Professor Ian Frazer developed a therapeutic HPV vaccine, AMV002 (*Journal of Immunotherapy*, 2017) to treat HPV-associated oropharyngeal cancer, which successfully completed a first-in-man clinical trial led by Professor Sandro Porceddu (PAH) (*Cancer Immunology*, *Immunotherapy*, 2021).

- Mater Research-UQ's Professor Maher Gandhi has made significant contributions to the understanding of the role of immune evasion within the tumour microenvironment of patients with lymphoma (including *Blood,* 2020, 2018, 2006). These findings have been translated into innovative early phase clinical trials funded by the MRFF, which includes Chief Investigator A (CIA) $1.6 million for the TREBL-1 'chemo-free' study of EBV-driven lymphomas in the immunosuppressed; $3.6 million for the CLARIFY study to provide CAR T cells in relapsed/refractory lymphoma; and $2.8 million for the TREBL-2 study of EBV-driven lymphomas in immunocompetent patients.

- QIMR Berghofer's A/Professor Michelle Wykes developed immunotherapeutic antibodies against programmed cell death 1 ligand 2 (PD-L2), that she demonstrated could be targeted to modulate the immune response (*Immunity*, 2016). These antibodies showed potential in preclinical studies as cancer immunotherapy and have been licensed to Merck (2020) to progress through clinical development.

- QIMR Berghofer's Dr Siok Tey conducted the first-in-human proof-of-principle study using the inducible caspase 9 safety switch to enable deletion of T cell therapeutics in the event of unwanted effects. Further, she opened the first clinical trial in Australia using the T cell engineering method that she helped develop while in the USA to make bone marrow transplantation safer (*Clin Can Res*, 2019).

- QIMR Berghofer's Dr Kyohei Nakamura led research that revealed iNKT cells as a critical player in orchestrating the immune effector mechanisms of CD3-engaging bispecific antibody (BsAb) therapy. These findings rationalise the use of iNKT-based immunotherapy in combination with CD3-engaging BsAbs (*Blood Advances*, 2022).

- QIMR Berghofer/RBWH clinician researchers, including Professor Glen Kennedy and Dr Siok Tey, demonstrated in a Phase 1/2 single-group study that the humanised anti-interleukin-6 receptor monoclonal antibody, tocilizumab (TCZ), could attenuate the incidence of acute Graft-Versus-Host-Disease (GVHD). They then translated this into a multi-centre Phase 3 trial, which showed that TCZ did not significantly reduce the incidence of grade 2-4 acute GVHD, although trends were seen in volunteer unrelated donor recipients, and no improvements were overserved to long term-survival (*Blood*, 2021).

- Mater Research-UQ's Professor Kristen Radford developed a CD141+ dendritic cell vaccine that was translated to a successful Phase 1 clinical trial in metastatic prostate cancer (*J Immunother*, 2015). However, because it required isolation of the patients' own blood cells, it was deemed too expensive to progress further. Instead, the results informed the design of a new vaccine comprising a human anti-CLEC9A antibody fused to WT1. Professor Radford and team have demonstrated in a humanised mouse model that the CLEC9A-WT1 vaccine is a promising candidate immunotherapy for malignancies expressing WT1 (*Clinical & Translational Immunology*, 2020) and is seeking to translate these findings into a clinical trial.

- QIMR Berghofer researchers generated the preclinical research that formed the basis for an investigator-led clinical trial of neoadjuvant immunotherapy in NSCLC, led by RBWH/TPCH/UQ's A/Professor Brett Hughes (*Trials*, 2019).

- UQ's A/Professor Barbara Rolfe and Professor Trent Woodruff discovered that the Complement C3a Receptor (C3aR) contributes to melanoma tumourigenesis by inhibiting neutrophil and CD4+ T Cell responses (*J Immunol*, 2016). Further, they have demonstrated and filed a patent on the use of 3aR antagonists in combination with mobilisers of hematopoietic stem cells and/or progenitor cells as a novel immunotherapeutic strategy for solid tumours.

- QIMR Berghofer's Professor Rajiv Khanna developed a novel human monoclonal-antibody-based therapy for EPV-associated lymphoma and acute infection. He also successfully completed 2 Phase 1 clinical trials on autologous CMV-specific T cells as an adjuvant therapy for primary glioblastoma multiforme (*J Clin Invest*, 2020) and nasopharyngeal carcinoma (*OncoImmunology*, 2017).

- PAH/UQ's Dr Wen Xu, Professor Michael Poulsen and collaborators at the PAH were awarded MRFF funding (2021) to lead a world-first Phase 2 trial across 12 Australian sites to investigate the efficacy and safety of concurrent radiation with adjuvant avelumab immunotherapy.

Queensland is home to several immunotherapy companies, including:

- Microba Life Science: a Brisbane-based biotechnology company, established to commercialise world-leading technology for measuring the human gut microbiome, developed by UQ's Professor Phil Hugenholtz and QUT's Professor Gene Tyson. Microba's cancer immuno-oncology program is targeting the discovery and development of a microbiome therapy to improve response rates in cancer patients receiving immune checkpoint inhibitor therapy, with a specific focus on melanoma and lung cancer.

- Q-Gen Cell Therapeutics: an integrated cell therapy manufacturing facility within QIMR Berghofer that manufactures GMP (Good Manufacturing Practice) grade cellular therapies for cancer trials nationally and internationally. It has more than 1000 square metres of dedicated laboratory and cleanroom space, including an in-house quality control laboratory, GMP storage and up to 13 cleanrooms.

c. Surgical innovation

- UQ/RBWH's Professor Andreas Obermair led the international Laparoscopic Approach to Cervical Cancer (LACC) Trial, which has changed international guidelines by showing that laparoscopic or robotic radical hysterectomy for cervical cancer is more likely to result in disease recurrence and reduced survival rates than open abdominal surgery (*New England Journal of Medicine*, 2018). He also led the feMMe trial, which found that women with endometrial cancer could be treated less invasively through the use of a common intra-uterine device to reduce the need for surgery and in some women, preserve their fertility, with the new treatment more successful when combined with weight loss (*Gynecologic Oncology*, 2021).

- PAH/UQ's Professor Andrew Barbour co-led the GAP trial, which showed that pre-operative perioperative chemotherapy with gemcitabine and nabpaclitaxel enabled more patients to access chemotherapy treatment. Further, approximately half the patients had all the cancer removed with a one millimetre margin and almost all (86%) had all cancer removed with a zero margin (*Annals of Surgical Oncology*, 2020).

- RBWH/UQ's A/Professor John Yaxley and Emeritus Professor Frank Gardiner showed in early results from a Phase 3 clinical trial that robot-assisted laparoscopic prostatectomy and open radical retropubic prostatectomy yielded similar functional outcomes at 12 weeks (*Lancet*, 2016).

d. Advances in radiotherapy

Queensland is home to a number of internationally recognised researchers at the forefront of improved radiotherapy strategies, including theranostics, which facilitates simultaneous targeting of tumour cells with subsequent drug delivery and imaging. Queensland's clinician-researchers are both leading and participating in cutting-edge radiotherapy clinical trials underpinned by world-class infrastructure.

Innovative nanomedicines, biomolecular platforms and infrastructure

- UQ's Professor Kris Thurecht and team have designed and customised nanomedicines to efficaciously deliver therapeutics to a range of tumour types with enhanced safety profiles.

This includes in brain (*ACS Central Science*, 2020; *Biomaterials*, 2022), breast (*Nanotheranostics*, 2018) and prostate cancer (*Biomaterials*, 2017).

- Professor Stephen Rose and Dr Simon Puttick recently transitioned from CSIRO to [AdvanCell Isotope](#), an Australian-based radiopharmaceutical company developing the next generation of targeted alpha therapies for the treatment of cancer with a focus on Lead-212. Both Professor Rose and Dr Puttick are heavily involved in radiopharmaceutical research and development projects across Queensland.

- Mater Research-UQ's Professor John Hooper discovered that elevated CUB-domain-containing protein 1 (CDCP1) levels are associated with poor patient outcomes (*Oncogene*, 2016; *BJC*, 2016; *Theranostics*, 2020; *Cancer Res*, 2021) and demonstrated that CDCP1-internalising antibodies have potential for radiological staging and treatment of CDCP1 expressing ovarian and pancreatic ductal adenocarcinoma cancer cells (*Theranostics* 2020 x 2). Professor Hooper was awarded MRFF funding (2020) to conduct a Phase 1 clinical trial to determine whether CDCP1 is an effective target for diagnosis or treatment of epithelial ovarian cancer.

- UQ/PQ's Professor Sunil Lakhani and UQ's Professor Thurecht are developing a nanomedicine strategy to overcome the limitations of the blood-brain barrier for early detection and treatment of breast cancer brain metastases (NHMRC Project, 2019-2021).

- QUT's Professors Colleen Nelson and UQ's Professor Kris Thurecht demonstrated the potential utility of Miltuximab® as a PET imaging agent and a beta therapy in patients with prostate cancer or other glypican-1 expressing tumours (*EJNMMI Research*, 2020). GlyTherix, an Australian immuno-oncology company and owner of Miltuximab®, and UQ are working together to accelerate the development of novel imaging and therapeutic versions of Miltuximab® for the diagnosis and treatment of a range of solid cancers, including prostate, pancreatic, glioblastoma, bladder and non-small cell lung cancer.

- UQ's Professors David Reutens, Kris Thurecht and collaborators were awarded $1.2 million to establish the ACRF Facility for Targeted Radiometals in Cancer (AFTRiC) for the discovery, development and clinical translation of novel alpha particle-based cancer therapeutics. It builds on other capabilities located at UQ, such as the Australian Research Council (ARC) Training Centre for Innovation in Biomedical Imaging Technology.

- UQ's Professor Thurecht was awarded an ARC Research Hub for Advanced Manufacture of Targeted Radiopharmaceuticals (AMTAR) to establish a manufacturing platform for new medical technologies combining innovations in biotechnology and pharmaceutical science. The program addresses industry-led challenges for translation of biologics as molecular radiopharmaceuticals, building capacity in biomanufacturing, radiobiology and radiochemistry. The program establishes a dedicated manufacturing pipeline, future-proofing production and securing the supply chain of next generation medical technologies.

- The UQ Comparative Oncology program led by Professor Thurecht is the first of its kind in Australia. In 2018, the program accomplished the world's first canine PET-CT scan using a radiotracer ^{64}Cu–nanomedicine, a novel nanomedicine engineered by the Thurecht Group to specifically target prostate cancer. This program is underpinned by the establishment of the ACRF Facility for Molecular Imaging Agents in Cancer in 2014, which brings together cancer researchers from UQ, QIMR Berghofer, the Australian Prostate Cancer Research Centre (QUT) and veterinary oncologists from UQ and the Brisbane Veterinary Specialist Centre.

Cutting-edge radiotherapy clinical trials and innovations

- PAH/QUT's A/Professor Ian Vela and RBWH/UQ's A/Professor Paul Thomas were co-investigators on the landmark proPSMA study across 10 Australian hospitals and led by the Peter MacCallum Cancer Centre, which showed that PSMA PET-CT is a suitable replacement for conventional imaging, providing superior accuracy to the combined findings of CT and bone scanning (*Lancet*, 2020).

- RBWH/QUT's A/Professor Jeffrey Goh was a co-investigator on the TheraP Phase 2 trial across 11 Australian hospitals and led by the Peter MacCallum Cancer Centre, which showed that novel PSMA-targeted radiopharmaceutical therapy, [^{177}Lu]Lu-PSMA-617, led to a higher PSA response and fewer grade 3–4 adverse events compared with cabazitaxel in men with metastatic castration-resistant prostate cancer. This demonstrates [^{177}Lu]Lu-PSMA-617 as a new effective class of therapy and a potential alternative to cabazitaxel (*Lancet*, 2021).

- PAH/UQ's Mark Pinkham and Matthew Foote conducted a study that showed that treatment with combination stereotactic radiosurgery and immunotherapy for melanoma brain metastases generated favourable clinical and radiological outcomes with respect to complete and partial response and a reduced likelihood of progression of disease (*Journal of Medical Imaging and Radiation Oncology*, 2021).

- Sunshine Coast University Hospital/Griffith University's Dr Dharman Dinesh Vignarajah led the first study in Australia to demonstrate the feasibility of concurrent carbogen and nicotinamide with radiation therapy. Results showed that it is a safe and cost-effective treatment that provides a new therapeutic option in the treatment of patients with muscle invasive bladder cancer, particularly those with limited treatment options (*J Med Imag Rad Oncol*, 2021).

e. World-class preclinical models and clinical infrastructure

Queensland researchers have developed a number of world-class preclinical models to accelerate discovery research towards the clinic. Examples include:

- QUT's A/Professor Elizabeth Williams and PAH/QUT's A/Professor Ian Vela have developed clinically-relevant preclinical bladder (*Journal of Visualized Experiments*, 2021) and prostate cancer 'organoid' models (developed with Professor Hans Clever, the 'Godfather' of organoid technology). These have been licensed to international biotechnology companies and have underpinned collaborative research projects with pharma companies.

- Mater Research-UQ's Professor Kristen Radford established Australia's first and only Humanised Mouse Facility at the TRI, enabling Australian researchers access to these cutting-edge models (*Human Vaccines & Immunotherapeutics*, 2021).

- QUT's Dr Nathalie Bock, Professors Judith Clements and Dietmar Hutmacher developed biomaterials-based engineered models of bone metastases for use in vitro and in vivo, for studying the contribution of the bone niche to prostate cancer progression in the bone microenvironment (*Bone Research*, 2019; *Biomaterials,* 2019; *Advanced Healthcare Materials*, 2023) and the effects of antiandrogen therapies in prostate cancer (*Sci Adv*, 2021).

- UQ's Dr Laura Genovesi, Dr Anne Lagendijk and Dr Samantha Stehbens are developing 2 innovative preclinical models of medulloblastoma to overcome the limitations of current patient derived orthotopic xenograft models, which include a lack of a functional blood brain barrier (*Neuro-Oncol*, 2020). They will establish zebrafish models to monitor tumour cell behaviour and blood vessel recruitment to tumours in these models, and 'brain mimetic' 3D models by

combining hyaluronic acid (HA)-functionalised synthetic hydrogels with actual patient cell samples.

- Ex-QUT's A/Professor Mike Doran (now Director of Cell Therapy at AstraZeneca) and Professor Clements developed a microwell platform and surface modification protocol to enable high throughput manufacture of 3D cancer aggregates, which was validated on prostate cancer aggregates (*Sci Reports*, 2018).

- QIMR Berghofer's Professor Steven Lane and team have generated a model of Myelodysplasia that turns into acute leukaemia through acquisition of new changes in the DNA, to understand how normal stem cells turn into leukaemia (*Nat Comms*, 2020).

- QUT's A/Professor Yi-Chin Toh has developed a 3D microfluidic model to facilitate live visualisation and tracking of breast cancer cells migrating across an extracellular matrix barrier in a microfluidic 3D tumour (*Bioengineering*, 2018).

- QUT's Dr Nathalie Bock and the company Gelomics developed a novel gelatin-based hydrogel to facilitate long-term in vitro 3D cell culture, as an alternative to the gold standard Matrigel®, shown to allow enhanced organoid formation of patient-derived cancer cells and more relevant drug testing (*Gels*, 2022; *Pharmaceutics*, 2023).

Queenslanders have access to the best possible cancer care through world-class, statewide clinical infrastructure, including:

- **TeleOncology**: Queensland is leading the way in harnessing the latest technology to bridge the gap between the cancer care delivered in metro areas and what can be offered in regional hospitals. Townsville Hospital/JCU's Professor Sabe Sabesan pioneered the use of telemedicine at Townsville Hospital to provide specialist cancer services closer to home for rural, remote and Indigenous North Queenslanders. Professor Sabesan is also the Program Lead for the Australasian Teletrial Model developed by the Clinical Oncology Society of Australia, which has been operationalised by a collaboration between the Townsville Cancer Centre, Queensland Cancer Clinical Network and Queensland Health. The teletrial model is currently being rolled out across Australia.

- **Queensland Oncology On-Line (QOOL)**: Developed by Cancer Alliance Queensland, QOOL is a web-based, customisable system for staging data and multidisciplinary cancer care in Queensland, which has recently been procured by the Victorian State Government. QOOL provides a centralised platform of patient data for multiple users, accessible anywhere, anytime. As a multisided platform, QOOL connects clinicians to patient data drawn from 60 clinical and administrative systems.

5. Cancer control, survivorship and outcomes research

Queensland researchers are global leaders in lifestyle interventions, psycho-oncology, Indigenous cancer outcomes, palliative care, symptom management and treatment side effects, surveillance and descriptive epidemiology, and cost-effective interventions and health care models – as demonstrated by the impact our researchers have had on Australian health practice and policies. Queensland researchers are highly collaborative and work in multidisciplinary teams to accelerate improved outcomes for people impacted by cancer.

Queensland researchers are recognised for their work in cancer epidemiology and nurse-led survivorship research and training; survivorship model of care development; lifestyle and psycho-oncology interventions; and palliative care and symptom management trials and clinical practice. Queensland is home to one of the largest and most impactful First Nations cancer research programs. We actively contribute to Australian health policy, practice and funding decisions.

UniSQ's Professor Jeff Dunn was elected President of the UICC (2022-2024). The UICC represents the world's major cancer societies, ministries of health, and patient groups, and includes influential policy makers, researchers and experts in cancer prevention and control with a membership base of more than 1,200 organisations in 172 countries. The UICC leads and convenes capacity building and advocacy initiatives that unite and support the cancer community to reduce the global cancer burden, promote greater equity, and to ensure cancer control remains a priority in the world health and development agenda.

a. Living well during and after cancer – exercise, diet and weight loss interventions

- UQ's Professors Liz Eakin and Marina Reeves and Griffith University's Professor Sandra Hayes developed and successfully implemented the 'Healthy Living after Cancer' study, an evidence-based and telephone-delivered lifestyle intervention targeting physical activity, healthy eating, and weight control for cancer survivors, delivered by Australian state-based Cancer Councils (*BMC Cancer*, 2020). The program led to meaningful and statistically significant improvements in cancer survivors' health and quality of life, at a relatively low cost, and is now embedded within Cancer Council's telephone-based cancer support and information service.

- UQ/Mater Health's Professor Alexandra (Sandie) McCarthy led the multisite randomised controlled trial that evaluated the clinical benefits of an e-health enabled 12-week lifestyle intervention (the 'Women's Wellness after Cancer' Program) that delivered improvements in general health, bodily pain, vitality, and global physical and mental health scores (*BMC Cancer*, 2022).

- Professors Eakin, Hayes and McCarthy co-led the development of Clinical Oncology Society of Australia's physical activity and exercise guidelines (*Med J Aust*, 2018; editorial in *Lancet Oncology*, 2018) that were endorsed by more than 25 national health organisations.

- QIMR Berghofer's Professor Penny Webb is leading the national NHMRC-funded Ovarian Cancer Prognosis and Lifestyle (OPAL) Study with collaborators A/Professor Vanessa Beesley and Professor Andrea Obermair. OPAL is a prospective longitudinal study following 960 Australian women newly diagnosed with primary ovarian cancer (recruited between 2012-15) to identify whether potentially modifiable lifestyle choices including physical activity and diet are associated with long-term survival for women with this disease.

- UQ's A/Professor Tina Skinner is leading a randomised controlled trial to evaluate the influence of peer support on moderate-to-vigorous physical exercise and various markers of health, following a brief supervised exercise intervention in cancer survivors (*BMC Cancer*, 2019). This is in collaboration with Professor Jeff Dunn (UniSQ and CEO of Prostate Cancer Foundation of Australia [PCFA]), Professor Joanne Aitken (CCQ) and Professor Suzanne Chambers (Australian Catholic University [ACU]). Professor Skinner is also leading a trial, with collaborators from QIMR Berghofer, PAH and RBWH, evaluating an individualised exercise intervention for improving health-related quality of life for people with multiple myeloma (*Curr. Oncol*, 2022).

- Griffith University's Professor Hayes secured MRFF and CCQ funding for a Phase 2 trial evaluating feasibility, safety and efficacy of an individually tailored telephone/telehealth-delivered exercise intervention during chemotherapy for recurrent ovarian cancer (ECHO-R trial).

- UQ/Mater Health's Professor McCarthy was awarded MRFF funding (2020) for the EnhAnCing treatment oUtcoMes after gynaEcological caNcer (ACUMEN) project. This includes a randomised controlled trial of a targeted exercise and behavioural change intervention for women previously treated for reproductive cancers, and research into how best to implement exercise into clinical practice after cancer treatment.

- UQ's Professor Reeves was awarded MRFF funding (2021) to conduct a Queensland-wide Phase 3 trial of an exercise and dietary intervention to improve the quality of life for women with metastatic breast cancer.

- UQ's Professors Eakin and Reeves conducted the Living Well after Breast Cancer™ pilot trial, a telephone-delivered weight loss intervention for women following treatment for breast cancer – feasible, acceptable, safe and effective for women 1–2 years after a breast cancer diagnosis (*Asia-Pacific Journal of Clinical Oncology*, 2017).

- UQ's Professors Jeff Coombes and A/Professor Skinner conducted a randomised controlled trial evaluating a 12-week structured high-intensity interval training (HIIT) exercise program in men with prostate cancer. The program was found to be feasible and safe, and preliminary results show improvements to erectile function, cardiorespiratory fitness, exercise capacity and vascular health (*Journal of Sexual Medicine*, 2022).

b. Psycho-oncology

- RBWH/UQ's Professor Jane Turner is the Chair of the International Psycho-Oncology Society Guidelines Committee. Professor Turner conducted the PROMPT study: a stepped-wedge, cluster-randomised controlled trial that evaluated the feasibility and effectiveness of a brief psychosocial intervention for depressed cancer patients, delivered by trained front-line health professionals in routine clinical care. In collaboration with Professors Patsy Yates (QUT) and Chambers (ACU), the trial showed that the intervention was feasible but insufficient as a stand-alone treatment for depression in cancer patients (*Support Care Cancer*, 2017).

- UniSQ/PCFA's Professor Dunn is the President-elect for the UICC and was awarded an NHMRC Partnership Grant (2021) to trial the clinical and cost effectiveness of a tailored nurse-led survivorship care program for improving the health and wellbeing of men on hormone therapy for prostate cancer. The project is supported by 8 cancer research, consumer and clinical groups: PCFA, CCQ, Australian Prostate Centre, Ipswich West Moreton Hospital Health Service, GenesisCare, Icon Group, Healthy Male, and the UICC. The project will vastly

increase understanding of how specialised support can improve quality of life and survivorship outcomes for men on hormone therapy. More than 230 men will participate in the trial, which will use an evidence-based survivorship framework, developed by UniSQ, in collaboration with the PCFA and NHMRC's Centre of Research Excellence in Prostate Cancer Survivorship.

- Professor Dunn, in 2020, led the development of a Position Statement on Screening for Distress and Psychosocial Care for Men with Prostate Cancer, which has been widely endorsed by key prostate cancer and urological groups. This position statement provides recommendations to systematically implement screening for distress and referral to evidence-based psychosocial care in prostate cancer care.

- ACU Professor Suzanne Chambers and UniSQ Professor Jeff Dunn co-authored 'The Health Professionals Guide to Delivering Psychological Care for Men with Prostate Cancer' in 2021. This resource was developed to bridge the gap in care for the many men with prostate cancer who do not receive psychological interventions in a timely manner, if at all. The guide shows how to construct a tailored intervention centred on increasing a man's personal agency in self-managing the challenges of prostate cancer. It is appropriate for use by a range of health professionals, and allows for cost-effective, flexible support that is men-centred and strengths-based and incorporates an understanding and responsiveness to masculine values in the design of care.

- UniSQ Professor Jeff Dunn and ACU Professor Suzanne Chambers led a feasibility pilot of a virtual prostate cancer survivorship care model in partnership with West Moreton Health Service (2020-2022) which established the acceptability of virtual post-surgical care, delivered via videoconferencing in a regional setting (*Psycho-Oncology,* 2023).

- ACU's Professor Chambers until recently lead the NHMRC CRE in Prostrate Cancer Survivorship (previously administered by Griffith University). Professor Chambers has extensive experience in leading survivorship studies and trials, including identifying the supportive needs of men with prostate cancer (e.g. *Psycho-Oncology*, 2022). QUT's Professor Natalie Bradford developed the 'Oncology Family App' to provide information and support for families caring for their child with cancer. Family and caregiver feedback showed that the app was an efficient and convenient way to provide much needed information (*J Ped Oncol Nurs*, 2018).

- QIMR Berghofer's A/Professor Vanessa Beesley was awarded MRFF funding (2019) to conduct the trial of PRoCESS: Pancreatic cancer Relatives Counselling and Education Support Service in partnership with the Avner Pancreatic Cancer Foundation. The trial will assess the effect of nurse-led telephone counselling, compared to information alone, on participant-reported outcomes and use of medical services.

- Griffith University's Professor Tamara Ownsworth collaborated with PAH's Professor Mark Pinkham and ACU's Professor Chambers and colleagues to conduct a randomised trial that evaluated the clinical efficacy and cost-effectiveness of a telehealth psychological support intervention for people with primary brain tumour and their family members – the 'Making Sense of Brain Tumour' program delivered via telehealth (Tele-MAST). The results supported the feasibility and acceptability of remote delivery of psychological support (*Neuropsychological Rehabilitation*, 2020).

- ACU's Professor Chambers led a qualitative phenomenological study aimed at understanding how brain tumour influences people's ability to manage, maintain, and rebuild their social networks. Findings highlighted the importance of early psychosocial support to address

barriers to social participation and facilitators/strategies to enhance individuals' ability to maintain or rebuild their social networks (*Neuropsych Rehab*, 2022).

- Professors Turner (RBWH/UQ), Yates (QUT), and Lis Kenny (RBWH) conducted the ENHANCES study, which showed that a single-session nurse-delivered intervention is insufficient to improve the quality of life in head and neck cancer survivors compared with usual care, and provision of detailed written information about head and neck cancer survivorship is associated with improved physical wellbeing (*Support Care Cancer*, 2019).

c. Indigenous cancer survivorship, outcomes and epidemiology

Queensland is home to the largest Indigenous cancer research program in Australia, which includes UQ's Professor Gail Garvey, a proud Kamilaroi woman from New South Wales' mid-north coast.

Examples of research impact include:

- UQ's Professor Gail Garvey developed and validated a new culturally-specific tool to measure the unmet support needs of Indigenous cancer patients (*Rural Remote Health*, 2019), which is now a recommendation in the Optimal Care Pathway guidelines. Professor Garvey played a leadership role in the development of a national Indigenous cancer framework with Cancer Australia (*Int J Environ Res Public Health*, 2018). Professor Garvey also conducted the first Roundtable to identify research priorities in cancer for Indigenous Australians; established the National Indigenous Cancer Network; and in collaboration with Cancer Council Australia, the Lowitja Institute, the Indigenous Health InfoNet and Menzies School of Health Research, instigated and convened the inaugural World Indigenous Cancer Conference (Brisbane, 2016).

- QIMR Berghofer's Professor Patricia Valery and Professor Garvey, in collaboration with PAH's Professor Euan Walpole, have conducted a number of studies to identify the cancer care needs of Indigenous cancer survivors (including *Australian Journal of Primary Health*, 2018; *Cancer Nursing*, 2020). They also conducted a feasibility study of an Indigenous patient navigator intervention in Queensland, to identify factors that need to be considered for successful implementation (*Eur J Cancer Care*, 2018).

- QIMR Berghofer's Professor Patricia Valery, Dr Christina Bernardes and Professor Garvey conducted an exploratory study to identify service utilisation and unmet supportive care needs of end-of-life Indigenous cancer patients (*Supportive Care in Cancer*, 2021).

- Professor Garvey developed a new method for measuring the care experiences of Indigenous people with cancer: the Indigenous People's Experiences of Cancer Care Survey, that privileges patient voices (*Patient Experience Journal*, 2020). She has also explored the support needs of informal carers of Indigenous people with cancer (*Inter J Environ Res Public Health*, 2021).

- Professor Garvey leads the NHMRC CRE – Targeted Approaches to Improve Cancer Services (TACTICS) for Aboriginal and Torres Strait Islanders, which focuses on emerging priorities in cancer-related health services research and actively promotes the translation of research knowledge into Australian public health policy and practice. The CRE also focuses on building research capacity through training the next generation of researchers in Indigenous cancer control.

- CCQ's Professor Peter Baade and team, in collaboration with Professor Garvey, showed that Indigenous peoples diagnosed with any type of cancer have a consistently higher probability of dying from cancer, or from other causes, within 5 years of diagnosis compared to other Australians (*Cancer Causes Control*, 2021). Further, this disparity in survival equated to nearly 20% of the observed cancer deaths among Indigenous Queenslanders (*PLoS One*, 2022). Recent data has highlighted an inequality across the first 5 years after diagnosis. Access to services and socioeconomic factors are unlikely to be the main causes of the lower Indigenous survival, as patterns were similar across remoteness and area-socioeconomic disadvantage (*Cancer Causes Control*, 2023). In addition, they recently determined that cancer mortality accounted for about a quarter of the disparity in remaining life expectancy for all cancers combined, while non-cancer mortality accounted for the remaining three quarters of the disparity in remaining life expectancy (*Cancer Epid Biomarkers & Prevention*, 2022). A systematic review highlighted that while some of the poorer survival faced by Indigenous cancer patients can be explained, substantial disparities likely to be related to Aboriginal determinants remain, increasing the importance of considering innovative study designs and strength-based approaches (*Front in Oncol*, 2022).

- A multidisciplinary team, led by CCQ's Professor Joanne Aitken and A/Professor Danny Youlden, and co-investigators, CHQ's Ms Angela Young, Dr Craig McBride and A/Professor Andy Moore, UQ's Professor Jason Pole and QIMR Berghofer's Professor Patricia Valery, reported on the change in cancer incidence and survival in Indigenous children in Australia (1997-2016). The results showed that the incidence of cancer among Indigenous children had increased, most likely due to improvements in reporting on Indigenous status. Trends in incidence also varied with remoteness of residence (greater increase among those from major cities) but overall incidence rates remain lower than for other Australian children. In relation to survival rates, while there was little difference for blood or tumours of the central nervous system, survival for solid tumours was considerably lower among Indigenous children (*Pediatric Blood & Cancer*, 2022). The authors concluded that culturally appropriate solutions are required to further improve outcomes for Indigenous children with cancer. Other evidence has also been published showing that the gap in survival rates is narrowing (*Global Oncol*, 2021).

- JCU's A/Professor Emily Callander and UQ's Professor Garvey conducted a study that showed that Indigenous people with cancer had lower out-of-pocket expenditure, but also accessed fewer Medicare services compared to their non-Indigenous counterparts. Indigenous people with cancer were less likely to access specialist attendances, pathology tests, and diagnostic imaging through the Medicare Benefits Schedule, and more likely to access primary health care, such as services provided by general practitioners (*Int J Equity Health, 2019*).

d. Palliative care, symptom management and treatment side effects

- QUT's Professor Patsy Yates has led a number of randomised educational intervention trials in cancer pain management, including a randomised controlled trial of a nurse-administered educational intervention for improving cancer pain management in ambulatory settings (*Patient Education and Counseling Journal*, 2004). Professor Yates also led the first national study of digital health in Australian palliative care providers, to guide policy and education and inform future directions for research and palliative care providers' use of digital health (*BMC Palliative Care*, 2021).

- QUT's Professor Jane Phillips co-developed the Australian National Palliative Care Clinical Studies Collaborative 'Integrating Qualitative Research into Clinical Trials Framework' (*J Palliative Medicine*, 2021). Further, she led the 'Optimising care for People with palliative care needs, and their families, in the Australian hospital setting' Project. This study identified the domains of care that are most important to inpatients with palliative care needs and their families, to generate key practice points to inform optimal clinical care provision (*International Journal of Nursing Studies Advances*, 2021).

- Mater/UQ's Professors Phillip Good and Janet Hardy were awarded 2 MRFF grants (2018, 2021) with Professor Yates and colleagues to support clinical trials in the use of medicinal cannabinoids to relieve system burden:

  I. Medicinal Cannabis (MedCan 3) Trial – a randomised, multicentre, double blind, placebo-controlled trial to assess the effectiveness of 1:1 delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD) to relieve symptom burden in patients with cancer (*Trials*, 2020)

  II. Medicinal cannabinoids to relieve symptom burden in the palliative care of patients with advanced cancer (*Trials*, 2019).

- CHQ/QUT's Dr Anthony Herbert and collaborators were awarded MRFF funding (2021) to assess the effectiveness, safe dosage and side-effects of THC and CBD for managing symptoms in children with advanced cancer – the first trial of its kind in Australia.

- CHQ/QUT's Dr Herbert is co-investigator on an international study to achieve international clinical consensus on best-practice end-of-life communication with adolescents and young adults with cancer, to directly inform the implementation of best-practice end-of-life communication across adolescent and young adult cancer in Global Accord countries (*PLoS One*, 2022).

- Professors Hardy (Mater/UQ), Good (Mater/UQ), Yates (QUT) and Emeritus Professor Geoff Mitchell (UQ) have conducted a number of randomised trials in cancer-related side effects, including cancer-related nausea (*BMJ Open*, 2019; *BMC Cancer*, 2018) and dyspnea (*Frontiers in Oncol*, 2020).

- UQ/CHQ's Professor Amanda Ullman, CHQ's Ms Tricia Kleidon and collaborators conducted the Prevention of Occlusion of cEnTral lInes for Children with cancer (POETIC) study, which included the co-development and implementation of central venous access device occlusion resources to guide the identification and management of occlusive episodes at CHQ. The pre-post implementation study led to a significant decrease in occlusive events (pre: 59.7/1000 catheter days compared to post: 31.6/1000 catheter days) (*J Paed Child Health*, 2020).

- UQ/CHQ's Professor Ullman, QUT's Professor Samantha Keogh and A/Professor Natalie Bradford, and CHQ's Ms Tricia Kleidon are leading the world's first clinical trial of a central line lock (T-EDTA) compared to usual care (heparin and normal saline) to reduce infections, thromboses and blockages for children being treated for cancer. The multi-site trial includes more than 800 children from across Queensland, and is a collaboration involving clinicians, scientists from 5 hospitals, and 3 universities.

- UQ/Metro North's Professor Claire Rickard led the secondary analysis of a global, cross-sectional study (127 hospitals in 24 countries) showing that at least 1 in 10 peripheral intravenous catheters (PIVC) in cancer units present with complications. This provides strong

evidence that PIVC assessment and improved dressing integrity is likely to reduce risk and improve outcomes (*Australian Journal of Cancer Nurs*ing, 2022).

- UQ/Metro North's Professor Rickard and PAH's Professor Geoff Playford conducted a landmark clinical trial to identify the optimal duration of infusion set use to prevent life-threatening catheter-related bloodstream infections (6007 patients across 10 Australian hospitals) (*Lancet*, 2021). In addition, they are conducting the Peripherally Inserted CEntral catheter dressing and Securement in patients with cancer: The Pisces trial, to evaluate the effectiveness (and cost-effectiveness) of 4 types of dressing and securement combinations (*BMJ Open*, 2017).

- PAH/UQ's Dr Amanda Pigott and ex-PAH Professor Sandro Porceddu conducted a pilot study to examine a therapeutic therapist-led care and participant self-management intervention for head and neck lymphedema, which showed promising results in reducing head and neck lymphedema that warrant further investigation (*Head and Neck*, 2018).

- QUT's Professor Samantha Keogh, UQ/Metro North's Professor Rickard and RBWH/UQ's A/Professor Nicole Marsh and colleagues conducted an implementation and evaluation trial that demonstrated the effectiveness of post-insertion PIVC flushing according to recommended guidelines, providing evidence for the education, surveillance and products for post-insertion PIVC management (*BMC Medicine*, 2020).

- A multidisciplinary team led by ex-PAH's Professor Porceddu, including PAH/UQ's Professor Elizabeth Ward, UQ's A/Professor Anne Hill and PAH's Dr Laurelie Wishart, conducted a trial to explore the most effective delivery of intensive, prophylactic swallowing therapy to patients with head and neck cancer during (chemo)radiotherapy. Results showed that delivery via a new telepractice application, "SwallowIT", is as clinically effective as clinician-directed face-to-face therapy (*Head and Neck*, 2020) while delivering significant cost savings to the health service and consumers (with Griffith's A/Professor Joshua Byrnes; *Dysphagia*, 2018).

e. Surveillance and descriptive epidemiology

Cancer Council Queensland are at the forefront of generating new insights into the burden of cancer across Queensland, nationally and internationally. The Viertel Cancer Research Centre, led by Professor Joanne Aitken, is internationally recognised for its cancer surveillance and descriptive epidemiology research, particularly in childhood cancer and geographical disparities. Through extensive collaborations with researchers and clinicians across Queensland and internationally, CCQ leverages resources and expertise to deliver essential data that underpins evidence-based public health planning, implementation and evaluation.

Examples of impact include:

- CCQ's Professor Peter Baade and QUT's Distinguished Professor Kerrie Mengersen co-developed The Australian Cancer Atlas that provides a national overview of the burden of cancer based on geographical location. Launched in 2018, the atlas has been accessed more than 50,000 times across more than 100 countries. The atlas has led to ongoing collaborations with international organisations, including the New Zealand Ministry of Health, the IKNL (the Netherlands Comprehensive Cancer Organisation, who launched their similar atlas in early 2023) and a similar project in Ontario, Canada.

- In collaboration with QUT's Centre for Data Science led by Distinguished Professor Kerrie Mengersen, CCQ's Dr Jessica Cameron and Professor Peter Baade are leading efforts to develop novel statistical methodology, and then applying those methods to provide unique

insights into the extent of spatial variation in cancer outcomes across Australia and how that spatial variation changes over time (*Cancer Epidemiol*, 2021).

- CCQ's Professor Peter Baade, in collaboration with the Karolinksa Institute in Sweden and others, has led efforts to apply novel statistical methods to measures of population-based cancer survival, providing alternative methods of communicating cancer prognosis, and more tangible understanding of the inequities faced by specific population groups following a diagnosis of cancer. These measures include crude probability of death (*Cancer Epidemiol*, 2019; *Cancer Med*, 2021), loss of life expectancy (*Cancer Epidemiol*, 2020) and avoidable deaths (*PLoS One*, 2022; *Cancer Epidemiol Biomarkers Prev*, 2020).

- In collaboration with QUT's Centre for Data Science, and with funding from the Australian Urban Research Infrastructure Network (AURIN) initiative, CCQ's Professor Peter Baade is leading a large data linkage study of women diagnosed with breast cancer in Queensland. This includes information from the Queensland Cancer Register linked with the Queensland Hospital Admitted Patient and Breast Screen Queensland Data Collections, along with additional area-level information from the Australian Bureau of Statistics and the Social Health Atlas of Australia.

- CCQ has developed and hosts the Queensland Cancer Statistics Online, a free online resource containing the latest cancer statistics sourced from the Queensland Cancer Register. CCQ also developed and hosts the Australian Childhood Cancer Statistics Online, a free online resource that provides incidence, survival and mortality data by sex and age group for the most common cancers among children in Australia. The website was developed to enable free, easy and rapid access to data for medical professionals, parents and families, using the latest information available from the Australian Childhood Cancer Registry.

- CCQ's Professor Joanne Aitken, A/Professor Danny Youlden and Ms Leisa O'Neill, in collaboration with lead researchers from the Dana-Farber Cancer Institute/Harvard Cancer Center and the Hospital for Sick Kids, Toronto, have been at the forefront of international efforts to develop and test rules for the standardised collection of childhood cancer stage by cancer registries (including *Lancet*, 2016; *Lancet Child Adolesc. Health*, 2018). The Childhood Cancer Research team at CCQ developed a detailed protocol to assist population cancer registries to collect and assign stage for childhood cancer using available medical records, which has been translated into 6 languages and is in use in many countries around the world. It was also used to inform the International Benchmarking of Childhood Cancer Survival by Stage Project (BENCHISTA), conducted in Europe by the University College London and the Istituto Nazionale dei Tumouri in Italy.

- The Childhood Cancer Research team at CCQ have analysed national trends to show that the number of children aged under 15 diagnosed with cancer is likely to increase by almost 40% over the next 20 years, and by 7% after adjusting for population growth. This real increase has important implications for the specialised health services required for the diagnosis and treatment of children with cancer into the future.

- CCQ's A/Professor Danny Youlden showed that increases in childhood cancer survival rates have reduced (by almost 40%) the number of childhood cancer deaths that would otherwise have occurred within 5 years of diagnosis in Australia between 1995–2016. CCQ has published Australia's first estimates of stage-specific survival rates for childhood cancer on a population basis, and the first estimates of long-term childhood cancer survival rates.

f. Cost-effective interventions and health care models

The development and implementation of cost-effective interventions and health service models underpins the long-term sustainability of Australia's health system. Queensland is home to world-leading health economists and health services researchers that have had a significant impact on Australian health policy, practice and funding decisions.

Examples of impact include:

- QUT's Professor Steven McPhail serves on the Health Economics Services Panel for the federal Australian Department of Health. He has extensive experience in implementation, health economics and evaluation research. Professor McPhail was a chief investigator on the Phase 2 EMINENT Trial, which aims to test the feasibility and efficacy of the implementation of a nurse-coordinated shared-care model involving specialists and general practitioners in breast cancer post-treatment follow-up (*Trials*, 2020). He also led the development of a Multi-Criteria Decision Analysis Framework in Integrated Health Care (*International Journal of Integrated Care*, 2022), which has been influential in guiding innovation investment decisions in 17 health services.

- UniSQ's Professor Jeff Dunn led the development of the Prostate Cancer Survivorship Essentials Framework developed by leading clinical, nursing and allied health groups and agencies and consumer groups in Australia and New Zealand (*BJU Int*, 2020). This unique consumer-practitioner model provides a road map for improvements for men with prostate cancer, that can be expressed in multiple policy and programme initiatives to suit different communities and different patient scenarios. The framework has been endorsed by 15 leading clinical, cancer, community and academic/research organisations.

- Griffith University's Professor Paul Scuffham developed the Australian Chapter of the International Society of Pharmacoeconomics and Outcomes Research (ISPOR-AC) and was the foundation president. He is currently the Chair of the ISPOR Asia Consortium. He is a global leader in research that identifies the value for money of healthcare interventions, with a major emphasis on translation into health policy. Cancer-specific examples include being a chief investigator on the NHMRC CRE in Prostate Cancer Survivorship, and leading the cost-effectiveness analysis that showed the significant cost savings associated with clinically-indicated versus routine replacement of PIVCs, with UQ's A/Professor Haitham Tuffaha.

- QIMR Berghofer's A/Professor Louise Gordon has significant experience in cost effectiveness of health interventions (including psychological supportive care interventions), the financial burdens of cancer survivors and the economics of disease prevention. She is the Australian Scientific Committee Member for the International Agency for Research in Cancer and has authored 3 health economic chapters in Australian Clinical Practice Guidelines for skin cancers, Barrett's oesophagus and oesophageal cancer. Her economic modelling of the health and economic impacts of regulating solaria was referenced in state parliaments and led to state legislation to ban commercial sunbeds across Australia from 2016, leading to prevention of skin cancer and early-onset melanomas. A/Professor Gordon also has significant experience in evaluating industry submissions for government subsidy through the Pharmaceutical Benefits Advisory Committee (PBAC) and Medical Services Advisory Committee.

- UQ's A/Professor Haitham is the Chair of the Clinical Oncology Society of Australia's Epidemiology Group, the Australian Clinical Trials Alliance's Research Prioritisation Group, and the ISPOR Oncology Group. He has significant experience in health technology

assessment and pioneered the application of value of information analysis as an innovative approach to ensure clinical trials are efficiently designed and prioritised to maximise return on investment. He has supported work that led to 2 new Medicare items for genetic testing in breast and ovarian cancer (MBS#73295 & 73296) and the adoption of cost-effective and less aggressive strategies in prostate cancer (e.g. multiparametric magnetic resonance imaging [mp-MRI]), which led to the Prostate Cancer Foundation of Australia advocating for mp-MRI on Medicare (MBS#63543). A/Professor Haitham has been involved in a number of cancer-specific trials and studies, including leading the first modelled economic evaluation of exercise for men with prostate cancer, which suggests that supervised exercise is cost-effective in reducing the risks of falls and fractures in this population (*Supportive Care in Cancer*, 2022).

- Griffith University's A/Professor Joshua Byrnes is the current President of the Australian chapter of ISPOR. He has significant experience in measuring and demonstrating value in health and has led the analysis supporting the re-imbursement of a number of novel pharmacotherapies and services. Cancer-specific examples include leading the cost-analysis component within the pilot trial of heparin versus saline as a routine catheter lock solution in paediatric cancer care (*Cancer Nurs*, 2022) and contributing to the cost-effectiveness analysis of a skin awareness intervention for early detection of skin cancer led by QIMR Berghofer's A/Professor Louise Gordon (*Value Health*, 2017).

- Griffith University's Dr Hansoo Kim has more than 17 years working in pharma, including in the areas of outcomes research and pricing and reimbursement and PBAC submissions. He played a key role in the listing of several anti-cancer therapies on the Pharmaceutical Benefits Scheme, including ipilimumab and nivolumab. He has conducted and contributed to a number of cost-effective analyses of oncology therapeutics, including the cost-effectiveness of (i) nivolumab for the treatment of renal cell carcinoma based on mature survival data (*J Med Econ*, 2021), and (ii) nivolumab compared with ipilimumab for the treatment of BRAF wild-type advanced melanoma (*Value in Health*, 2016).

g. Rural cancer survivorship

- CCQ and UniSQ have collaborated to conduct a comprehensive 5-year longitudinal examination of the health behaviours, experience with the health care system, and psychosocial health and cancer outcomes of more than 1,000 Queensland regional and rural cancer survivors and their caregivers. Findings have highlighted a range of challenges to be addressed including a lack of survivorship care information and guidance for rural cancer survivors (*BMJ Open*, 2021; *J Cancer Survivorship*, 2022) and unmet needs and declines in quality of life for rural cancer caregivers (*Current Oncol*, 2021; *Eur J Cancer Care*, 2022).

- CCQ's Dr Lizzy Johnston is conducting a program of research investigating how caring for someone with cancer impacts health and wellbeing, with a focus on caregivers in rural areas. Starting with an examination of how and when rural caregivers seek support (*ANZ J Public Health*, 2022), the program of research aims to co-design interventions that support rural caregivers to improve and maintain their own health and wellbeing while caring for someone with cancer.

- CCQ's Dr Belinda Goodwin and her team are working in collaboration with cancer survivors, oncologists, and general practitioners in regional and remote Queensland to develop and implement standardised, evidence-based clinical guidelines for the delivery of survivorship care information and appropriate referrals for people returning home from treatment in the city.