Institution:
Unit of Assessment:
1. Unit context and structure, research and impact strategy

Overview

Research in Nursing and the Allied Health Professions is a vibrant area of growth at the University of the Highlands and Islands. This research unit is harboured in The Institute for Health Research and Innovation (IHRI), an entity that has grown enormously since REF2014 when 5.2 FTEs were submitted; IHRI now boasts a membership of ~90, of whom 26 are independent researchers, with the balance composed of research assistants, technical staff, visiting and honorary research appointments and postgraduate research students. The membership is drawn from across the University's Academic Partnership, with the hub located at the Centre for Health Science in Inverness. IHRI's mission is "to conduct world class research and innovation leading to tangible improvements in remote and rural healthcare in this region, which are exportable to rural communities worldwide".

Impactful research requires close integration between multiple agencies to ensure the effective translation of early innovations for end-user application. In our unique extension of the "triple helix" model, collaboration between the three pillars (university, industry and the NHS) to facilitate translation from bench-to-bedside is enabled by the Regional Development Agency, Highlands and Islands Enterprise (HIE), which prizes health and life sciences as one of the sectors of regional significance. The concept is to harness the strengths and complementarity of the various stakeholders to drive implementation of our healthcare innovations so as to not only benefit patients and rural communities, but also to be at the core of regional economic growth through development of a local health cluster.

Central to our philosophy is the inclusion of health service users in research: not only is there sound evidence to support outcome benefits associated with this approach, but co-production of healthcare solutions that involves the community throughout development are much more likely to be freely adopted than those that are perceived to be imposed.

Research Themes

Figure 1 illustrates our research themes, together with the pipeline to tangible impact, utilising the strengths of the University's relationship with HIE, industry and the NHS. The unique characteristic of our University is its distributed nature across the entire Highlands and Islands, ensuring close links with remote, rural communities. Accordingly, much of our research involves rural community engagement, be it associated with co-production of health service solutions through implementation science (Munoz, Bradley, de Kock, Heaton, Hubbard, Carolan, MacGilleEathain, Perrin, Zubala, Beattie), with novel digital interventions (MacRury, Grindle), or health education and physical activity programmes for re/pre-habilitation (Hubbard, Gorely, Crabtree, Muggeridge, Angus). Pedagogical research in the context of healthcare workforce education is led by Smith and Macaden, while Biomedical Science research aligns with the needs of the emerging local cluster of health-related SMEs and multinational healthcare companies, with specialist knowledge in key areas: free radical biology & medicine (Megson, Cobley), Genetics and Immunology (liver cancer and schizophrenia – Wei, McCormick; melanoma – Pritchard), Biomarker Discovery and Systems Biology (Doherty, Husi) and Medical Nanotechnology (Kean).

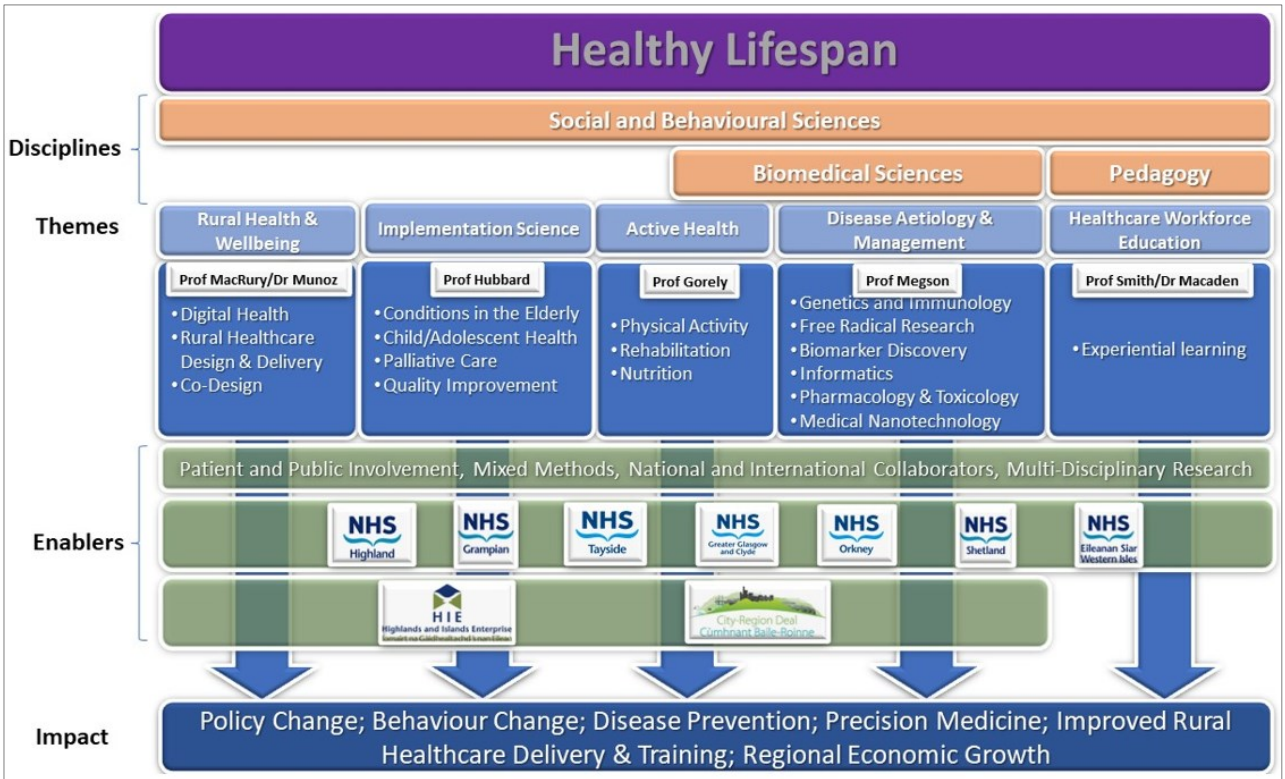

Figure 1. Research themes for the Institute for Health Research and Innovation and impact.

Structure

IHRI is the research and innovation component of the School of Health, Social Care and Life Sciences. Teaching within the School is delivered through the University–wide Applied Life Studies Subject Network and the Department of Nursing and Midwifery (Inverness and Western Isles). IHRI staff members are distributed across three broad entities within the School: The Department of Nursing and Midwifery, the Division of Rural Health & Wellbeing and the Division of Biomedical Sciences. The interdisciplinarity of the units is fundamental to IHRI, with an emphasis on mixed-methods approaches to research in order to extract maximum benefit from complex clinical studies and public health interventions.

IHRI constitutes one of four University research clusters that represent the institutional mechanism for a cohesive research and impact strategy across a region that is the size of Belgium, with a population similar to that of Edinburgh. A fundamental principle underpinning the research clusters is the unique need in this University to embrace and overcome the geographical boundaries presented by the region's geography, and to facilitate cohesion amongst researchers with common interests, irrespective of their location in the Highlands and Islands. IHRI fully embraces this philosophy, with researchers from the regional centres of Inverness and Perth joined by those in the remote Western Isles, Orkney, Shetland and Moray. The insights and experiences of researchers who live in the very communities that rural healthcare serves are key ingredients in ensuring needs-driven impactful research and innovation. These established links with our rural communities are essential in building trust amongst the research population.

IHRI is embedded in the governance structure of the University, with the Research strategic and policy decisions taken at Research and Knowledge Exchange Committee (RKEC) level and disseminated to IHRI and the other three research clusters via steering committees, as highlighted in the Institutional Environment Statement. Activity in IHRI is governed according to the University's policies, frameworks and strategy (https://www.uhi.ac.uk/en/research-enterprise/resource/res-policies/), which cover research integrity, ethics, the researcher development concordat and metrics. In line with the University's compliance with the Concordat on Open Research Data, all of those research outputs since April 2016

submitted by members of IHRI have complied with 'green' open access requirements; indeed, ~80% of the outputs included in REF 2 for which this University was the submitting institution have "gold" open access status, ensuring maximum reach. Furthermore, the University has an open repository for research data, accessible to any interested party.

Research and Impact Strategy

The Health Research Strategy was embedded in the vision for a putative School of Health for the University in 2015, in view of the impending transition of the Department of Nursing from the University of Stirling. The strategic aims for the subsequent 5 years were to establish a School with the following characteristics:

- Demand-led entity, delivering impact through workforce development and supporting business innovation and growth
- Providing a strategic leadership and co-ordination role with other stakeholders, delivering on the regional strategic priorities in health, social care and wellbeing
- Based on a strong region-wide presence, working seamlessly within the University's Academic Partnership by way of a critical vehicle to spread economic and healthcare benefits across the region
- An anchor presence in the existing Inverness Campus, including the Raigmore Hospital site
- At the heart of the "Collaborative Campus" development in Inverness
- A nucleus for further HE expansion on the Inverness Campus, driving co-ordinated collaborative activity and working with other HEIs to deliver strategic outputs for the region
- A key attractor for inward investment in the health sector
- A fully integrated regional teaching and research structure, with critical mass in both education and research, providing a lasting and financially sustainable activity
- Nationally significant and able to demonstrate international reach and world-leading impact

The strategy for the School included transition of the Department of Nursing from the University of Stirling, but the key strategic aims for research focused on bringing critical mass to our research teams and building on our collaborative base in themes that resonated with regional development, including disease management, digital health and wellbeing/disease prevention.

Achievement of strategic aims

Nursing transition:

Transfer of the Department of Nursing from the University of Stirling was successfully completed in August 2017, with the first cohort of University of the Highlands and Islands undergraduates (105 students) enrolling in Sept 2017. Students enrolled for subsequent academic years (all >145 students) were joined by 19 midwifery students in January 2019, heralding the re-launch of midwifery training in the region after a 3-year absence. From the research perspective, incorporation of Nursing and Midwifery into the existing Health Research team represented a substantial increase in critical mass (eight additional independent researchers), with close alignment to existing interests, particularly in Implementation Science in a rural context. The development also presented a unique opportunity to form a genuinely interdisciplinary approach that included nurses, allied health professionals, social scientists and laboratory scientists, with strong links to healthcare industry partners and NHS Boards. This development coincided with the University-wide strategic launch of four research clusters, in line with anticipated REF2021 Units of Assessment. The Health and Wellbeing Research Cluster was duly formed, aligned to UoA 3.

Critical Mass and contribution to the Collaborative Campus:

Attaining critical mass was considered to be essential during the REF2021 cycle in order to secure a sustainable future. Further to the successful transition of Nursing and Midwifery, an initiative was

launched with HIE to invest in a cohort of researchers and support staff in order to rapidly achieve critical mass, in the knowledge that a vibrant, research-rich university was central to growth and sustainability of a health industry cluster at the Inverness Campus development (www.invernesscampus.co.uk/). HIE pledged £4m over 6 years from June 2016 to support 8 independent researchers, 6 post-doctoral researchers and associated support staff to help invigorate the collaboration between UHI, the NHS and health-related businesses locating to Inverness Campus. The aims of the investment included the establishment of a School of Health, Social Care and Life Sciences, staff recruitment (16 posts) enhanced research income (+£2.5m), and additional academic collaborations (10), commercial projects (80), PhD studentships (12) and spin-outs/start-ups (2). All of the targets are expected to be achieved or exceeded; notable successes already achieved include collaborations that number >60 and PhD studentships (27), well in excess of the original targets.

Soon after securing this funding from HIE, the University successfully negotiated an additional £9m for Health Innovation through the Inverness and Highland City-Region Deal (IHC-RD). This initiative dovetails perfectly with our innovation and commercialisation strategy, as well as with the ambitions of the HIE-funded programme. IHC-RD funding was further enhanced through award of additional ERDF funding (£3.75m), which increases the size of the innovation and medical nano-technology spaces in a new Life Sciences Innovation Centre, as well as supporting procurement of world-class equipment. Taken together, these initiatives allow the University to expand its Health Research & Innovation ambition, with an expectation to stimulate economic growth through spin-outs, start-ups and inward investment.

The IHC-RD funded building programme is underway on Inverness Campus; our Life Sciences Innovation Centre development is linked to a HIE-run incubator suite to help SMEs with scale-up and a route to market. The development is harmonised with the nearby ~£40m NHS Highland Treatment Centre development. The Innovation Centre will include an active health research gymnasium and laboratory to facilitate research into disease prevention, pre-habilitation in advance of surgery, and rehabilitation in disease management, with an emphasis on remote delivery through digital innovations. In addition, IHC-RD has helped to cement a deep relationship with NHS Highland to ensure needs-driven research for maximum impact in support of stretched rural resources in nursing and the allied health professions (e.g. physiotherapy) region-wide. IHC-RD has also funded a Director of Innovation and Commercialisation, a Project Manager, and a Chair and Research Assistant in Medical Nanotechnology. In addition, the programme has funded several secondees from NHS Highland, including Consultants and medical physics support, as well as an innovation fund to pump-prime collaborative projects, with e-health and health economics support offered.

IHC-RD also includes a ground-breaking scheme that funds five part-time PhD studentships aimed exclusively at nurses and allied health professionals. The concept encourages outstanding healthcare professionals to identify needs within the rural health service worthy of academic interrogation, with a view to implementing service improvements with immediate local impact, and potential for national or international roll-out. The five selected students are engaged in projects in cardiac rehabilitation (Cardiac Physiologist), encouragement tools for self-management of persistent back pain (Physiotherapist), the use of greenspace for cancer recovery (Nurse), virtual reality technology in dementia (Nurse), and co-designed technology for patients with multiple sclerosis (Nurse).

In recognition of our achievements, IHRI was awarded the 2019 Research and Innovation Award for the Highlands & Islands by the Scottish Council for Development and Industry (www.scdi.org.uk/news-item/hiawards2019/) and was one of 3 finalists for the 2019 KE Deal of the Year Award by Praxis Auril for our licensing deal with Qingdao Hailanshen Biotechnology Ltd for cancer immunotherapy technology (Wei; https://keawards.org.uk/finalists).

The IHC-RD ambition is entirely impact-based, both in terms of improved healthcare and socio-economic benefit (Figure 2). The project is on-target to deliver the desired project outcomes, particularly with respect to supported companies and new products and services.

Figure 2. Inverness and Highland City Region Deal targets

Through a combination of these initiatives, we have fully achieved our prime target of increasing the Independent Researcher staff complement in IHRI to 26 (23.6 FTE), which is key to long-term sustainability.

ESF PhD studentships

The Highlands and Islands of Scotland comprise an EU Transition Region, and specific European Social Fund (ESF) resource was targeted to develop the regional workforce. The University spearheaded this initiative and a substantial proportion of the funding was allocated to postgraduate training, to develop individuals to a level capable of filling high-value job vacancies in the region and beyond. In total, the University invested ~£4m of ESF funding in 37 studentships. In recognition of the importance of Health in the University's strategic plans, 12 of the studentships were allocated to Health, taking full advantage of the newly funded additional supervisory capacity. The projects transcend all aspects of our research, including: physical activity in patients with sensory impairment; technology enabled dementia education and support; using the outdoors as a motivator in health management; plasma antibodies for treatment of melanoma; technology-enabled diabetes education to care home staff; and novel nanomaterials for use in interventional cardiology.

Institute Status

The Health and Wellbeing Research Cluster was amongst the first at the University to be awarded Institute status in 2017, in recognition of its cohesive philosophy and achievement of critical mass. IHRI receives core funding to support an annual conference and to help develop early career researchers through training and pump-priming. Leadership of IHRI is provided by a steering group that meets quarterly to discuss strategic direction and responses to funding calls. There is also an annual Institute meeting, with invited speakers and workshops to foster collaboration and strategic dialogue focused on funding opportunities, as well as a seminar series, which has recently translated into a webinar series.

Future strategic aims and goals: structure and how taken forward

It is essential for IHRI to deliver on our ambitious targets in terms of training, innovation and commercialisation in order to maximise impact at regional and global levels. Beyond these immediate targets, it is crucial to build on the growth and achievements during the REF2021 census period in order to capitalise on the substantial investments and to cement our position as world leaders in our specialist themes. Further investment will be required to realise fully the potential generated in the past 7 years and it will be incumbent upon the expanding IHRI team to continue to attract infrastructure and grant funding,

particularly targeting the Global Challenges, Industrial Strategy Challenge and Strength in Places opportunities.

In 2018, the University published its Research, Impact and Knowledge Exchange Strategic Plan for the following five years, with a focus on growth, improved REF2021 performance, research-teaching linkages and knowledge exchange. These strategic goals resonate with those in the School of Health strategy from 2015, particularly with respect to knowledge exchange. IHRI is now in a position to complete its development into the engine for economic growth within the health sector in the region, based on excellence in research and innovation, driven by world class researchers developed within our team, or attracted to the region by our growing reputation.

Looking further ahead, we are focused on the over-arching vision for our research to capitalise on our unique rural location to deliver tangible outcomes for healthcare in this region and beyond. The University will strive to develop entrepreneurs of the future to help drive growth of a local health innovation cluster, with high value jobs and exportable products and services for worldwide healthcare benefit. These are the strategic aims enshrined in the HIE, IHC-RD and ERDF programmes. Below are some of the specific benefits set out in the full business case for IHC-RD, as approved by UK Government:

For UHI

- Significantly enhanced research impact and research power for the University's life sciences, health and wellbeing disciplines
- Strengthened links to industry and the NHS
- Strategically planned contributions to the wider development around the region of key nodes of specialist niche excellence in R&D, new product development with businesses, and commercial outcomes
- Financial diversification from commercial income

For NHS Highland and other Regional Boards

- A major boost to NHS Highland consultant and Allied Health Professional recruitment and retention
- A world-leading digital health expertise in remote and rural healthcare delivery
- The prestige associated with university health board status to help recruitment
- Service quality improvement

For industry

- Strong technical, scientific, and evaluative support for ongoing product development
- Placements to guide and support academic and applied clinical research

For the wider economy

- A significantly strengthened inward investment proposition in life sciences
- Strategic and wide-ranging workforce development
- A multidisciplinary campus acting as a magnet for new industry, inward investment and increased Higher Education activity across the region
- New companies and jobs
- A thriving local life science cluster with a regional distributed presence and impact
- Growth of the Higher Education sector through a sustainable collaborative model

Some specific aims that we will seek to achieve in the immediate future are as follows:

1. Exploitation of new opportunities for clinical and applied research within existing themes, underpinned by the strong partnerships with regional Health Boards, other health providers and our national and international collaborators
2. Continuing development of robust co-production models within an exciting and sustainable research culture that has patients and members of the public at its heart. We will build on our internationally recognised track record in co-production and patient and public involvement, capitalising on the established interactions between service providers, service users, communities and stakeholders in remote and rural areas
3. Capitalisation on the opening of the Active Health Facility in the new Life Sciences Innovation Centre, which will foster interdisciplinary research by linking nurses, allied health professionals, behavioural scientists and exercise physiologists
4. Exploitation of new opportunities for translational research presented by our investments in Biomedical Sciences that have facilitated capacity growth and enabled us to respond to emerging NHS priorities through impactful translational research with global reach. For example, we have devised a kit for screening blood bank stock for samples with high levels of a cancer-fighting antibody (Wei). This technology is undergoing clinical trials in China, which has one of the world's largest rural populations (www.thenational.scot/news/17630338.highland-scientists-liver-cancer-therapy-passes-clinical-trials/)
5. Expansion of our ground-breaking part-time PhDs studentship scheme for nurses and allied health professionals who remain employed within the NHS. In addition, since 2017 NHS Highland and NHS Western Isles have funded >70 places per annum on our Advanced Nurse Practitioner and Allied Health Professions Masters programmes, emphasising the importance of current research to inform evidence-based practice. The strategic appointment of a lead for Internationalisation in the Department of Nursing and Midwifery (Macaden) will develop international connections through staff and student exchanges

Structure

The structure of IHRI has been specifically designed with future direction in mind, particularly with respect to innovation and impact. The posts that were appointed over the past 3 years have been carefully selected to meet the demands of IHC-RD, with digital health, applied rural health research and innovation at the forefront. The current structure of three interlocking Divisions/Departments will persist, and we will continue to invest in early career researchers in order to steadily grow the team, with a focus on adding depth rather than breadth to ensure sustainability.

2. People

Staffing Strategy and Staff Development

IHRI's staffing strategy has centred on growth in our areas of strength, designed to establish a sustainable research and innovation base that will continue to thrive across the region. The strategy has been fulfilled through attraction of the substantial investment outlined above. The focus now shifts towards a consolidation phase, during which the emphasis will be on attracting competitive funding to support postgraduate studentships and postdoctoral researchers.

Recruitment and Retention Policy

In order to maintain critical mass, all of the research staff appointed to posts at Research Fellow and above have been awarded open-ended contracts, in-line with pre-existing research staff across IHRI. There is a recognition that our remoteness from other universities presents unique challenges in association with short-term contracts, hence the commitment to these open-ended contracts. Support

staff (technicians, core research assistants and administrators) are also all on open-ended contracts. As elsewhere, post-doctoral researchers and research assistants are typically employed on fixed-term contracts tied to external funding, but a mentoring scheme is in place for fixed-term staff, with a view to facilitating the otherwise challenging shift from the research assistant circuit to ECR positions that offer job security. Short-term sabbaticals are available for researchers at all levels to help up-skill individuals and to offer the opportunity of experience in different settings worldwide. An ECR forum has been established across the Institute to instil a sense of community. Active engagement with national and international conferences is strongly encouraged and a fund is available for researchers to facilitate attendance at up to two conference or training events per annum.

Our close links with industry not only offer insights into SMEs and multinational companies involved in health innovation, but also job opportunities: as the health science cluster builds in the region, a vibrant, reciprocal employment market grows between the university and industry.

Our highly applied approach to university research demands that we help to develop a unique skillset amongst our research staff that lends itself to entrepreneurship and business engagement. To that end, both staff and students are exposed to training in these areas, with annual workshop opportunities in entrepreneurship (e.g. Pathfinder Programme, run by HIE) and encouragement to enter entrepreneurial competitions (e.g. Converge Challenge, Royal Society of Edinburgh Enterprise Fellowships and Blavatnik Awards for Young Scientists). Staff and students are also actively encouraged to develop intellectual property (IP) and a supportive IP policy is in place to ensure a fair (33%) return to inventors.

Academic progression through promotion is a crucial element in staff retention and we are fortunate in having an effective, merit-driven promotion process with international scrutiny, that is enshrined in equality and diversity principles. Recent promotions to senior positions include 3 new Personal Chairs in Nursing and Midwifery (Smith, Hubbard, Gorely) and two Readerships (Doherty, Munoz).

Graduate School, Student Support and Monitoring

Following formal award of Research Degree Awarding Powers in June 2017, the University adopted its own quality assurance process for academic areas for research degrees; until 2017, this function had been carried out through an agreement with the University of Aberdeen.

As detailed in the Institutional Environment Statement, the Graduate School is the focal point for the support, development and administration of the University's postgraduate research provision and provides advice and guidance to research students and supervisors on all matters, from application to graduation.

Progress Monitoring

All students are subject to the Graduate School monitoring process. Students are assigned a thesis panel that is external to the supervisory team and can include academics from other HEIs. The panel provides additional scrutiny to all aspects of the studentship and offers advice and suggestions to improve outcome. Recommendations are submitted with the annual progress report to the Graduate School and are fed back to students and supervisors.

PGR student training

Training opportunities for PGRs are provided to enhance the research degree experience, to hone essential skills, and to encourage interaction and socialising with other students from across the University. Generic training includes: presentation skills; writing skills; viva training; writing for international students; and an annual interdisciplinary Postgraduate Research Conference. Subject-specific training is provided by IHRI, making use of the training funds offered by the Graduate School (see below), as well as internal IHRI funds derived from infrastructure grants and REG. Initial induction of PGRs is provided at both Graduate School and local levels. Together, these inductions cover all

aspects of administration, meeting key staff, understanding procedures, as well as project-specific health and safety considerations and provision of the IHRI postgraduate student handbook. In addition, students can access training events offered by the University of Aberdeen and the University of Edinburgh, the Scottish Graduate School for Arts and Humanities and the Scottish Graduate School for Social Science. Each student undergoes a training needs analysis with their Director of Studies, a process that continues throughout their studies. The Division of Rural Health and Wellbeing also run a 'Nuts and Bolts of Research' Programme on a monthly basis; the programme is delivered by research active staff and covers topics such as 'applying for funding' and 'the realities of conducting qualitative fieldwork'. Students from across IHRI are also expected to attend the Institute's quarterly seminar series, weekly Division/Department team meetings and conferences held locally (e.g. Re-thinking Remote, 2017, 2019; Scottish Cardiovascular Forum, 2019; NHS Highland Annual Research, Development and Innovation Conference).

Research Student Conference and Training Fund

All PGRs have access to financial support for conferences and external training events covering 50% of travel and accommodation costs for up to 1 conference and 1 training event per year per student (up to a maximum of 3 conferences and 3 training events during the registration period of the student). The balance comes from internal funds associated with specific projects.

Library and electronic resources

The university has made substantial investment in research-specific e-resources and will continue to do so for the foreseeable future. In addition, there is a specialist library within the Centre for Health Science in Inverness; this is for undergraduate and postgraduate students in Nursing and Midwifery, with a wide variety of subject-specific journals and textbooks. Help is on hand from expert staff to assist with data collection and robust process development associated with systematic reviews.

Student support

The university takes student support extremely seriously, with a range of points of contacts to ensure that all needs are catered-for:

- The Graduate School Office - Supporting students with all aspects of registration, progression, completion and generic training. Also, a first point of contact for any general questions or issues that emerge during studies.
- Supervisors - All students are allocated an experienced team of supervisors with a lead Director of Studies. Supervisors provide support both in an academic and pastoral manner as required.
- Third Party Monitor – All students are allocated a third-party monitor who will provide support and advice associated with academic or pastoral issues, independent from the supervisory team.
- Student support services – available in areas such as careers advice, disability and visas through local student support advisors or via the Graduate School Office.
- Brightspace (virtual learning environment) –provides all documents and guidance necessary for PGRs.
- Hardship Fund – A discretionary fund for those experiencing financial difficulty detrimental to successful completion of studies.

Student Representation

Two PGR student representatives sit on Research Degrees Committee. One of these representatives also sits on RKEC, which shapes wider University research strategy.

The Highlands and Islands Students Association is the representative body for both undergraduate and PGR students. The University is represented at national level with student representatives on the Scottish Graduate School for Arts and Humanities.

Student opinions are taken seriously and the university takes part in the biennial national Postgraduate Research Experience Survey (PRES), which facilitates benchmarking across university sectors. The excellence of our supervision, as perceived by the students themselves is reflected in the most recent PRES return (2019), in which **supervision in Health was ranked number one in the UK, while STEM subjects as a whole also ranked first in the UK for overall student satisfaction**.

Student Supervision in IHRI

Our PhD record since inception in 2006 is exceptional, with all 19 students having submitted their thesis within 4 years of commencement;100% have subsequently been awarded the degree of PhD. Central to the success of our PhD programme is down to the first-class level of supervision provided by the academic staff, as well as the excellent support and range of training opportunities available through the University Graduate School. Dr Pritchard was also awarded the University's Supervisor of the Year award (2020), with Dr Macaden highly commended.

Equality and Diversity

The University was awarded an Institutional Athena Swan Bronze Award in May 2017 (https://www.uhi.ac.uk/en/research-enterprise/staff-dev/athena/). The School of Health, Social Care and Life Sciences includes ~90% female staff, largely on account of the high proportion of women in the Department of Nursing and Midwifery. In terms of independent researchers returned to REF2021, approximately two-thirds are women, a statistic that is matched in the proportion of outputs selected from female independent researchers.

In terms of ethnic and cultural diversity, the research team and the wider School are beacons of diversity compared to the regional demography, where individuals belonging to minority ethnic groups only constitute ~1.5% of the population (2011 Census). IHRI has also embraced the needs of individuals with a wide range of disabilities, not only through careful design of the buildings that it occupies (e.g. including lifts, ramps, adjustable lab benches) and implementation of equality and diversity assessments, but also through recruitment procedures to remove conscious and unconscious bias (e.g. representational interview panels, anonymization of application forms) and formal, compulsory training for all staff on Equality and Diversity issues. Taken together, these measures have resulted in a diverse research community, with staff and students recruited from the international community, including New Zealand, South Africa, India, China, Nigeria and a range of European countries. Table 1 provides a comparison of our staff and student profile, benchmarked against regional and national references.

Table 1: Equality and Diversity metrics benchmarked regionally and nationally (2011 Census data)

	Female (%)	**Minority Groups (%)**	**Disabled (%)**
IHRI PGR students	60	12	12
IHRI staff	66	2.7	0
Region	51	1.5	18
Scotland	51	4	20
UK	50	13	18

The grade breakdown of REF Independent Researcher staff reflects an equitable grading and promotion process (Table 2):

Table 2: Gender distribution across grades for independent and non-independent researchers and support staff

Independent Researchers:

Grade/position	female	male
Head of School	1	0
Professor	3	3
Reader	2	0
Senior Lecturer	3	3
Lecturer	3	0
Research Fellow	5	4

Non-independent researchers and support staff:

Grade/position	female	male
Postdocs/RAs	6	2
Technical/Support	3	2
Admin	8	1

In accordance with the REF Code of Practice, all staff involved in the REF2021 process and output selection underwent unconscious bias training in advance of discharging their duties to this effect.

3. Income, infrastructure and facilities

Income Directly Related to Research Activity

Income spend within the IHRI during the eligible period totals £10.2m, with ~£400k derived from RUK and competitive charity funding bodies, as well as ~£1.5m from EU competitive funding bids. In considering these figures, it should be recognised that 8/23.6 FTE of our current research principal investigators (Nursing & Midwifery) only joined the university en masse in August 2017; all previous funding relating to their research is not eligible here.

Income for Infrastructure and Facilities

IHRI is a virtual Institute, with personnel and infrastructure spread across several of the Academic Partners that constitute the University, but the majority of the research is focused at the Centre for Health Science (occupied 2008), nearby An Lochran (occupied 2016) and the Innovation Centre on Inverness Campus (to be occupied August 2022; Figure 3). These three bespoke modern buildings provide space and facilities for ~100 researchers and are supported by world class IT, particularly with respect to data handling and video conferencing capabilities. The University invested £5.2m in An Lochran in 2015/16 and £9.8m in the purchase of the Centre for Health Science in 2019 – testament to its continuing investment in health research. This flagship building houses undergraduate and postgraduate nursing, midwifery and allied health teaching, as well as the Rural Health and Wellbeing research team and the majority of the Biomedical Sciences Researchers. The Department of Nursing and Midwifery has further invested in state-of-the-art clinical skills equipment for workforce training facilities within Centre for Health Science.

The research equipment available to our research teams is outstanding. In particular, the Biomedical Sciences team have at their disposal over £4m of top-quality equipment. Chief amongst the facilities available is our mass spectrometry suite, with a total of 4 mass spectrometers (Thermo Exactive, Thermo Orbitrap, Thermo GCMS, SciEx Q-trap; total value £2.5m; Figure 4). In addition, flow cytometry is well provided for through both a BD FACSCalibur and a new Macsquant, 5-colour instrument. In addition, we have 2 well-appointed tissue culture laboratories to facilitate both cell line and primary cell culture, a biochemistry laboratory with specialist equipment for free radical research (electron paramagnetic resonance spectrometer, nitric oxide analyser and electrochemical detector, HPLC with electrochemical detection) and functional assays (myography for blood vessel contractility work, platelet aggregometers and a metabolic analyser). Our cell culture work is also supported by a Leica fluorescence microscope, several additional fluorescence microscopes, real time quantitative PCR and standard platereaders, centrifuges and blotting apparatus.

Figure 3: Sites for Allied Health and Nursing Research activity: Centre for Health Science (left; Nursing & Midwifery, Rural Health & Wellbeing, Biomedical Sciences) and An Lochran (middle; Biomedical Sciences) and an artist's impression of the Innovation Centre under construction

Our Active Health Exercise Laboratory was installed in 2019: this laboratory boasts a range of exercise bicycles and treadmills, together with strength-testing kit and impedance body composition analysers. We also have equipment capable of monitoring VO_2max, beat-to-beat heart rate, and ECG in patients and healthy volunteers (Figure 4). In addition, we have all the necessary ultrasound equipment to conduct flow-mediated dilatation experiments to measure endothelial function.

Fig 4: Top panel: Experiential learning for student nurses and midwives; Middle panel: Rural Health and Wellbeing Researchers attending a Scottish parliament Policy event, in-region digital narrative research and workshops to support adolescents with mental health challenges in low income contries; Bottom panel; mass spectrometry, flow cytometry and Active Health Exercise laboratories.

Our Rural and Digital Health teams have access to a £5K interactive touchtable for community engagement, evaluation and co-production work, as well as to a range of virtual reality equipment.

We are in the process of investing a substantial component of the IHC-RD and ERDF funding (£12.6m) in medical nanotechnology, an innovation suite and an active health gymnasium and laboratory. The medical nanotechnology lab will include a bespoke plasma vapour depositor that allows highly sophisticated deposition of nanocoatings on a range of materials, photonic equipment and the full range of electronic equipment necessary to support this initiative. The innovation suite will be equipped with the latest in 3D printers, together with the fundamental equipment necessary to design and manufacture prototypes of medical devices. A substantial component of the Innovation Centre will house a state-of-the art multi-modal pre/re-habilitation gymnasium for research in association with NHS Highland physiotherapy teams. The gymnasium will be equipped with VC equipment to allow classes to be delivered to remote locations across the region.

4. Collaboration and contribution to the research base, economy and society

Collaborations with NHS

Uniquely, the University Academic Partnership overlaps with six different NHS Trusts across Scotland (Tayside, Grampian, Highland, Western Isles, Orkney, Shetland) and interaction with the NHS is a cornerstone of effective, needs-driven research in nursing and allied health specialties. Our closest relationship is with NHS Highland, supported by a memorandum of understanding that encapsulates our partnership in innovation, research and teaching; in recognition of the close relationship, NHS Highland became a University Board in 2018. In addition, we have a partnership agreement to develop a new, multi-modal model of physical activity support for disease prevention, pre-habilitation prior to surgery and rehabilitation associated with cancer, cardiac and pulmonary conditions as part of the IHC-RD programme. This activity constitutes a self-standing research programme, with ongoing evaluation of the model, alongside specific projects developed within each discrete discipline. The ultimate aim is to revolutionise the utilisation of physical activity as both a preventative measure and a therapy, as well as to optimise physiotherapy services in rural communities, where there is often insufficient demand to support specialist physiotherapists in all of the disease areas, resulting in inequitable delivery of this valuable service.

Scottish Rural Health Partnership

The University hosts the Scottish Rural Health Partnership (SRHP; https://www.uhi.ac.uk/en/research-enterprise/res-themes/school-of-health-social-care-and-life-sciences/srhp/), a membership organisation with the aim of providing a single source of information about rural and remote healthcare and to help shape rural health policy. Members include SFC, Digital Health Innovation Centre, NHS Trusts serving rural communities, NHS Education Scotland, several HEIs (RGU, Aberdeen, The Open University, Aberystwyth) and a number of NGOs (e.g. DeafBlind Scotland) and associations (e.g. Rural GP Association of Scotland). In addition, SRHP has links with several international organisations, including the Rural Doctors Association of Australia and the Vikings Surgeons Association. Hosting SRHP provides our researchers with unparalleled opportunities for collaboration and dissemination. SRHP is currently underpinned by University Innovation Funding and the initiative forms the basis for our proposal to Scottish Government to lead a proposed National Centre for Rural Healthcare.

Honorary and Visiting Positions

In order to help facilitate the collaboration between IHRI and NHS, the University has awarded Honorary Lectureships and Visiting Readerships and Chairs, as well as Honorary Lectureships to 10 consultant physicians, surgeons, GPs and pharmacists in NHS Highland, NHS Grampian and Australia, spanning specialties relevant to our research. The appointees have proved invaluable, not only in ensuring needs-driven research by highlighting real issues that affect their ability to deliver the best care possible, but also in recruiting patients from relevant clinics and leading public and patient engagement.

Causes of Schizophrenia: Immunology & Genetics Network (CoS:IGN)

Substantial (~£2m) legacy funding has facilitated development of a pan-national research network to investigate the causes of schizophrenia. CoS:IGN was launched in 2019/20 and the scientific advisory board includes world leaders in the field from the University of Aberdeen, Strathclyde, UCL, Imperial and Copenhagen, Denmark. The core of activity is in IHRI (led by Wei), but collaboration is central to the ethos of the Network and we will continue to seek world-leading projects to support in this arena.

Collaborations with other HEIs

Given our roots as a small research team that built a reputation from scratch, academic collaboration is our watchword and has been a critical component of the success story of health research at the University. During the REF2021 census period, researchers in IHRI have contributed to >100 collaborative projects with other Scottish, UK and international HEIs. While some of these collaborations

have been part of fully-funded projects and programmes, many others have been *ad hoc* small, but essential pieces of work commissioned by researchers at other HEIs on the basis of our reputation of quality in specific areas (e.g. Edinburgh (Megson, Hubbard, Gorely, Macaden), Newcastle (Doherty), Aberdeen (Hubbard, Wei, Crabtree), Stirling (Hubbard, Gorely, Beattie, Smith, Grindle), RGU (Megson, MacRury), Cambridge (Cobley), St Andrews (Megson), Manchester Metropolitan (Kean), Edinburgh Napier (Crabtree)). Often the research conducted by our team provides the vital evidence necessary to deliver excellent research outputs; examples include Cobley (*Cell Chem Biol*, 2017; Pritchard, *Nature Genetics*, 2014, 2015; Hubbard, *BMC Cancer*, 2018). These collaborations extend well beyond the UK, with robust collaborations into China (Wei), Australia (Pritchard, Munoz, Hubbard), Europe (Husi, Megson, Doherty), Malta (Hubbard), South Africa (de Kock) and USA (Megson, Munoz, Pritchard) featuring prominently in our research outputs. Particularly important at present are our 3 EU Inter-Reg programmes (MacRury, Megson, Munoz, Grindle, Gorely, Muggeridge, Crabtree) that involve partnerships with HEIs across Northern Ireland and the Republic of Ireland. Many of the collaborations are long-lasting, with successive grant funding and planned applications, not least in medical nanotechnology, physical activity, biomarkers and social prescribing. We have also committed to a Memorandum of Understanding with AGH Technical University in Krakow – the link is mutually beneficial in that it provides the opportunity for innovative medical devices developed in Poland to be evaluated using either our *in vitro* assays, or in our 'rural testbed'. There are also opportunities for student exchanges between the two universities. We also have a Memorandum of Understanding with Texas A&M University that facilitates a research collaboration involving staff/student exchanges in the area of rural mental health with their Department of Educational Leadership and Counselling. In 2018, we jointly hosted the first International Conference on Rural Mental Health in Inverness, which will be held again in South Texas in 2021. The international reach of our research is illustrated by our collaborative network (Figure 5).

Our commitment to collaboration with other universities is exemplified by our initiative to advertise four of the twelve ESF-funded studentships as "collaborative" studentships, awarded specifically to projects that had an external HEI partner that promised long-lasting interaction and joint funding opportunities. The projects selected were in partnership with the universities of St Andrews, Aberdeen, Edinburgh and Stirling.

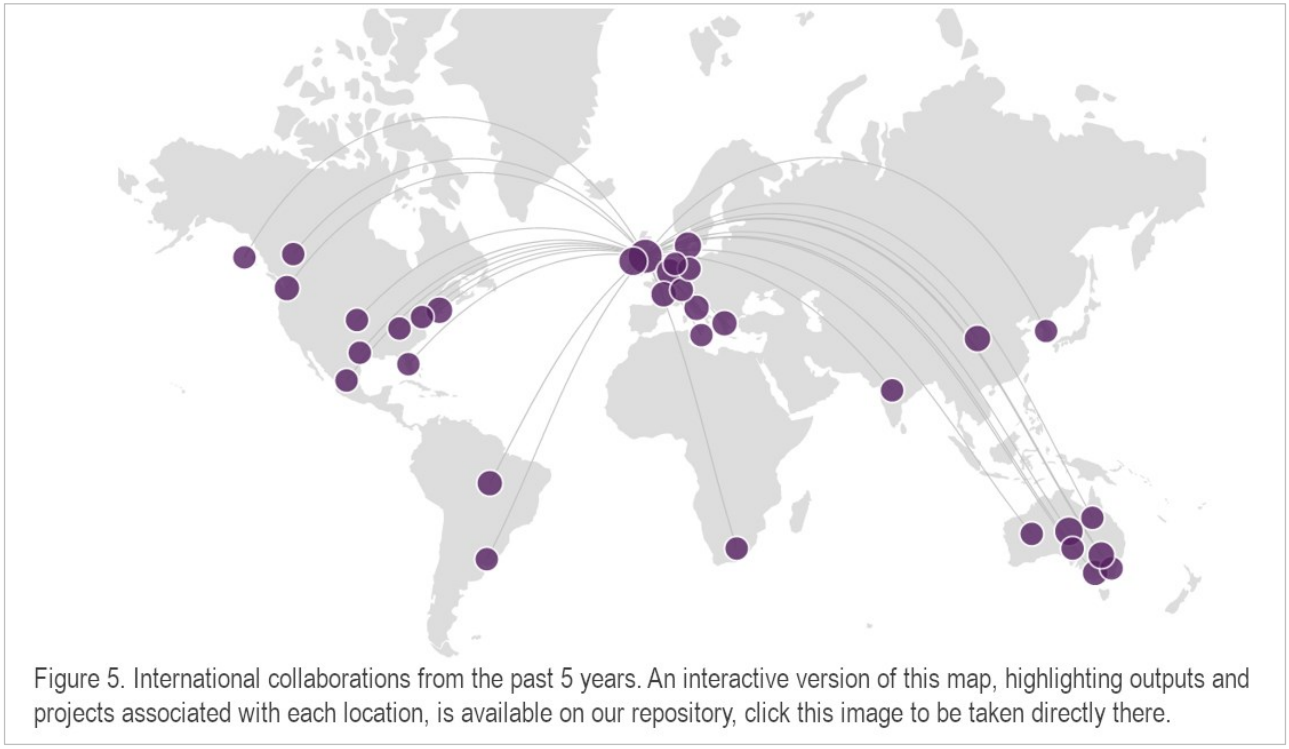

Figure 5. International collaborations from the past 5 years. An interactive version of this map, highlighting outputs and projects associated with each location, is available on our repository, click this image to be taken directly there.

Collaborations with SMEs and multi-national companies

Local, national and international companies regularly utilise our unique skills to support their own R&D. The nature of the interaction varies from joint applications to national bodies (e.g. Innovate UK), to fee-for-service sub-contracts, sometimes funded by a 3rd party (e.g. Innovate UK, SFC Innovation Vouchers), and to partnership agreements and staff and/or student placements. These links are not restricted to UK companies: we have long-established links with international SMEs (e.g. ABC Biosciences, Norway; QHB Biotechnology, China). The popularity of IHRI for business engagement is testament not only to our ability to deliver on time and to contract, but also to our open innovation model, which gives businesses comfort that the University sees its role as a contributor to the overall impact of the project, rather than equity acquisition.

The flagship industrial collaboration success to date relates to a patent that has been filed by the University to protect intellectual property associated with a novel means of screening blood plasma to identify samples which are particularly high in antibodies that destroy liver cancer cells; plasma high in these antibodies can be infused into patients with this particularly aggressive cancer (prognosis is only 1 year survival after diagnosis); an ongoing trial run by QHB Biotechnology (China) has indicated that survival is increased by ~1 year in patients given infusions as an adjunct to standard cancer therapy over those on standard therapy alone. The patent for mainland China has been licenced by QHB with a view to completing large-scale trials prior to implementing the therapy. However, the university has also patented the technology in Europe, USA, Canada and Australia; industrial partners in those territories are now being sought to take the technology forward on a global scale.

SFC Initiatives: Innovation Centres, University Infrastructure Funds

The SFC Innovation Centres were launched in 2012, with a view to encouraging innovation and entrepreneurship to help drive demand-led innovation in key sectors across Scotland. Several of the Innovation Centres are directly relevant to our research, not least the Digital Health and Care Institute (DHI). The Rural Health and Wellbeing team at IHRI has seen a number of successful projects launched through DHI, not least in relation to technology-enabled housing for supported rural living and remote and rural diabetes management. We have also received funding from the Scottish Aquaculture Innovation Centre (£514k for mass spectrometry equipment) to support collaborative projects with Scottish aquaculture companies with a view to improving productivity and/or quality.

We have also recently become members of the Innovation Centre for Sensor and Imaging Systems (CENSIS), on account of IHRI's strength in digital health technologies, together with our newly acquired expertise in nanotechnology and photonics. Discussions are ongoing with CENSIS with a view to this organisation occupying space in our new Innovation Centre.

IHRI also contributes to a number of SFC University Innovation (UIF)-funded initiatives. As well as the SRHP described above, IHRI is heavily involved in three other UIFs: Aquaculture, The Water Quality Innovation Group and Active Health & Wellbeing. All three of these initiatives illustrate our inter-disciplinary approach to research: our mass spectrometry expertise is invaluable to the aquaculture community within and beyond this university, while a collective approach to water quality that involves environmental, animal and human health ("One Health") is essential to tackle a fundamental crisis that is developing on a global scale around water quality. An excellent example of this inter-disciplinary approach is the recently awarded Hydro Nation Scholarship (October 2020) to determine the scale of pharmaceutical contamination of water effluent from hospitals and to design and test nanotechnology-based novel remediation solutions that extract pharmaceuticals from effluent at source. This has the potential for a major public health and environmental impact. The Active Health and Wellbeing UIF brings together social scientists and physiologists to work with companies in the health and wellbeing sector. The pump-primed projects funded to date include an innovative rehabilitation project with a local

professional football club and several smart wearables projects in collaboration with digital health companies.

Inter-Reg Programmes

IHRI is the Scottish representative in three Inter-Reg programmes, totalling €25.3m (https://mpowerhealth.eu/; https://www.ulster.ac.uk/cpm; https://www.ecme-research.com/). Collaboration is the founding principle for these Cross-Border initiatives and all involve a number of Irish and Northern Irish HEIs, as well as industrial partners and Health Trusts in Scotland and on both sides of the Irish Border. By way of example, IHRI leads the Cardiac Rehabilitation work package in ECME, involving 5 PhD students from 3 different institutions, with collaborative input from companies involved in wearable technologies. The PhD projects led by the University of the Highlands and Islands are wide-ranging and include novel biomarkers for risk of contrast-induced nephropathy, antibody biomarkers to stratify risk of myocardial infarction, health education and assisted living in smart homes. This programme draws on the strengths of a total of five cross-border universities to provide expert training, not only in research methods, but also in commercialisation and intellectual property.

Contribution to Research Base, Economy and Society

The key focus of our internal (REF2014-derived REG) and stakeholder (HIE, IHC-RD) investments is to make a substantial and sustainable impact on the regional economy, through attraction of inward investment and high value jobs in innovation, together with improved, cost-effective healthcare in the most challenging geography in the UK. The vision of the University and of stakeholders, is for our strength in research and innovation to be the fundamental basis upon which sustainable economic growth in the regional healthcare sector can develop. This philosophy is founded on worldwide evidence showing that innovation success stories are underpinned by a vibrant university research and innovation foundation.

A critical element of future success in the community is effective PPI, not only to encourage participation in research, but also to celebrate our successes and to disseminate our findings both to the local community and beyond. This is achieved on a daily basis through social media feeds (twitter, linked-in, Facebook), but also through regular presentations to pertinent patient support groups (Diabetes UK, Arthritis UK, Alzheimer's Scotland, Highland Hospice). The national audience is reached through media coverage. Some notable relevant examples include contributions to "Trust me I'm a Doctor" (BBC2 season 3, episode 19 – audience 3.4m), "Fit in 5" (Radio Scotland) and the Adventure Show (BBC Scotland).

Impact Case studies

The Impact Case Studies that we have submitted for REF2021 capture the essence of the intended impact on society, not only in this region, but also on a global scale. The three studies selected provide a good representation of the type of work that we conduct with the specific aim of impacting on society; the savings in healthcare costs associated with the research outcomes also impart a significant impact on the national economy. Below are brief synopses of the 3 case studies submitted, with an explanation as to how they exemplify IHRI's impact on society:

Case Study 1 - Sustaining remote and rural community health services

Rural healthcare is intrinsically expensive and notoriously difficult to deliver in an equitable fashion, not least because of the acknowledged difficulty in recruitment and retention of key staff in remote locations. This case study describes a co-production approach to sustaining remote healthcare, leading to the development of innovative models to help recruitment and retention of staff. The impact has the potential to be realised on an international scale, as well as in the Highlands and Islands of Scotland. Clearly, the research will have a substantial impact not only on the level of service that will continue to be provided in remote locations, but also the cost of providing equitable healthcare to rural communities.

Case Study 2: Sensory impact awareness
Sensory impairment is highly debilitating and can affect individuals of any age. Community provision of services to support patients with sensory impairment is vital and nurses are ideally placed to identify patients impacted by sensory impairment and liable to injury. This case study describes a nurse-led education programme for healthcare workers to raise awareness of sensory impairment amongst the elderly patient population, leading to a revision of practice, increased referral to specific sensory services and improvement of client assessment tools provided by the statutory community sensory provider (Sight Action).

Case study 3: Teenage cancer education, awareness, help-seeking and early detection
This case study describes the impact of a public health project designed to help young people identify the risks of cancer and to recognise the early signs of various manifestations of the disease in the knowledge that early detection vastly improves outcome. The underpinning research has resulted in changes to Scottish Government policy and key aspects of the programme have been adopted in Australia as part of an education programme. The fundamental impact is on the lives of young individuals with cancer who will benefit from improved prognosis on account of early diagnosis: in addition, this cost-effective public health initiative will reduce the ensuing healthcare costs as a result of the improved patient outcomes.

While these are examples of relatively mature research impacts, it is important to note that a number of research programmes are at the early stages of development in our young Institute, but will ultimately bring substantial impacts in time. Foremost amongst these is the work from our Genetics and Immunology team that has resulted in a patent being filed in a total of 6 territories for the immunological intervention highlighted earlier. In addition, we have recently filed another patent for technology that has the potential to revolutionise detection of free-radical mediated damage in ageing and a wide range of disease profiles.

Response to COVID-19
IHRI responded rapidly to the COVID-19 crisis, not only through re-deployment of research active staff back into the NHS to help on the frontline, but also through immediate activation of ~15 projects across the Institute, ranging from development of novel antiviral materials for use in PPE, through research into SARS-COV2 antibodies to epidemiological research in collaboration with Public Health at NHS Highland. IHRI researchers were also successful in two research bids to CSO: one in collaboration with the University of Aberdeen to monitor and assess compliance with national distancing guidelines, the other to assess the impact of the crisis on the mental wellbeing of frontline workers. Part of the uplift from SFC is being utilised to broaden and extend these projects with a view to mitigating the impact of future waves of COVID-19.

Wider Influence

- MacRury: Diabetes UK Council of Healthcare Professionals: 2014-2016, Digital Health Institute board member 2013-2016, President, Scottish Society of Medicine 2016-2017; Faculty of Remote and Rural Health Care, RCSE executive committee and advisory board: 2017- present; Scottish Rural Medicine Collaboration Board 2018- present; Scottish Diabetes Technology Group 2019- present).
- Hubbard: Co-Director, Scottish School of Primary Care, Advisor for CanTeen, Australia; National Expert Advisor for Breast Cancer Now, Bowel Cancer UK; Scottish Government – Transforming Care After Treatment, Breast Cancer Care, National Cancer Research Institute; Editor - *Behavioural Med, Eur J Cancer Care*.

- Kean: Adviser to Joint Institute for Innovation policy (Brussels) on nanotechnology. Invited talks (2020-21); Nano4Health advances in combatting COVID-19; antimicrobial surfaces; adviser to International Society for Optics and Photonics (2021).
- Munoz: International Centre for Integrated Care Advisory Board; Scottish Government Cross Party Group on Rural Policy; Texas A&M visiting Fellow)
- Megson: awarded Fellowships with British Pharmacological Society, Royal Society of Biology and Higher Education Academy; Editor - *Antioxidants, Frontiers Cardiovasc Med*; Chief Scientist Office Translational Panel Member; UK Research and Innovation Future Leaders Fellowships Programme Peer Review College Member.
- Doherty: Invited presentations at: Core Technologies for Life Sciences 2017, Lisbon; Outstanding Woman in Academia (Swiss National Science Foundation).
- Husi: Keynote lecture, 2nd NanoBioEngineering International Congress, Mexico, 2020, Panel Member, Life Sciences, Human and animal Non-infectious Diseases, Ministry of Science and Higher Education, Poland.

Some notable achievements on the national and international stage by individuals at earlier stages in their careers include:

- Beattie (Lecturer): member of Excellence in Care Academic Advisory Group
- Heaton (Research Fellow): Carnegie Trust for Scotland Grants Panel, International Scientific Advisory Board Member of DIME-SHS.
- MacGilleEathain (Lecturer - ECR): Supported the Scottish Parliament team developing the Young People and Pregnancy Strategy
- Carolan (Lecturer – ECR): Contributed to Scotland's National Education Framework to support learning and development in palliative care; systematic review on end-of-life care used to inform commissioning recommendations, pathway and service specifications on psychosocial support for adults affected by cancer through Transforming Cancer Services Team (TCST) for London, in partnership with Macmillan Cancer Support.