

Institution: Bangor University (10007857)
Unit of Assessment: Allied Health Professions, Dentistry, Nursing and Pharmacy
<p>Section 1. Unit context and structure, research and impact strategy</p> <p>Research strategy</p> <p>Building on the success of Bangor's UoA03 submission in REF2014, we integrated our medical and health-related research activities through the establishment in 2016 of the Bangor Institute for Health and Medical Research (BIHMR). BIHMR's remit includes: building on methodological excellence; expanding interdisciplinarity (reflected in grant-winning); prioritising research to enhance patient outcomes (embedding coproduction and participatory methods); prioritising engagement with governmental, regulatory, NHS, local authority, and 3rd sector partners to enhance policy research; and expanding and promoting postgraduate research (PGR).</p> <p>Our research reflects five principal methodologies: pharmacoeconomics and public health economics; trial design and the evaluation of complex interventions; novel secondary research; implementation science with participatory research; and cellular biology. All of these enable interlinking programmes to address psychosocial interventions for dementia, oral health, primary and palliative care research, novel secondary research, and cellular mechanisms of cancer. An important feature of health research in Wales is the Health & Care Research Wales (HCRW)-funded research centres organised around particular policy areas. Bangor's strategy in this REF period has been to build on our strengths, and retain focus on areas of research excellence. This has led to the consolidation of external structural funding from HCRW and our participation in national centres; in turn helping us to drive funding applications and expand our research activities with national and international academic and service partners. This strategy and the cohesion of BIHMR has provided a resilient structure for the prompt production of high-quality research outputs, engagement and impact, and have allowed us to more than double our total research expenditure from GBP14,069,122 in REF2014 to GBP32,189,553 for this REF period.</p> <p>Natural staff turnover and retirements have meant the departure of some senior researchers. In response, we have taken an agile approach to capacity building in areas identified in REF2014, but also exploited new opportunities. Implementation science, realist synthesis and evaluation methods are now firmly embedded across BIHMR's portfolio. These areas have attracted increased National Institute for Health Research (NIHR) funding oriented towards participatory research in trial design, ageing and dementia research, and medical and health economics. Our dementia research group (supported by external funding worth GBP4,401,000) has intensified the development of psychosocial interventions to make improvements in quality of life as illustrated in one of our Impact Case Studies. Similarly, our primary and palliative care research group has focused on the challenges of early cancer diagnosis, leading, for example, to the Wales Interventions and Cancer Knowledge about Early Diagnosis programme (GBP1,111,000), and the NIHR Health Technology Assessment (HTA)-funded trial of carer-administered sub-cutaneous medication in the dying (GBP435,000).</p> <p>Methodological rigour is a cornerstone of Bangor's health and medical research. Our UKCRC-registered clinical trials unit (CTU) has markedly expanded its portfolio and range of trials. Our pharmaco- and health- economics group has focused on applied and methodological research into the economics of medicines, health and social care interventions. This has included making vital contributions to the evaluation of adalimumab for paediatric uveitis across 70 countries, facilitating its approval by NHS England and the treatment of over 10,000 children with uveitis. Further, the group has led on the development of methods for the economic evaluation of public health interventions and has, for example, evidenced the need for "shifting the curve" from cure to prevention and the importance of social value in the consideration of public health and social care interventions. We also bring expertise to the evaluation of complex interventions, leading on policy-based research to determine the benefits of the policy switch to a 'soft opt-out' for organ donation in Wales. This resulted in a new media campaign commissioned by Welsh Government, with lessons learned incorporated into English and Scottish legislation.</p>

An expanding portfolio of dental and oral service-based research has resulted in policy changes and strategic investment in North Wales to support role-substitution and 'skill-mix' in NHS dentistry -- a first of its kind in the UK. Finally, our cancer research group has demonstrated an expanding range of bench and translational research, with current foci including MRC-funded and charity-funded investigations of novel mechanisms in genome stability and repair, and the clinical utility of novel antigens for early diagnosis and patient stratification.

Structure of research across the submitted unit

Bangor's health and medical researchers submitted to UoA03 comprise the membership of BIHMR and are drawn from two Schools within Bangor University's College of Human Sciences: the School of Health Sciences and the School of Medical Sciences. Our researchers are located on the main university site in Bangor and at the University's Health Science campus on the Wrexham Maelor Hospital site. The latter facilitates collaborations involving some clinical services and with Public Health Wales' North Wales office. BIHMR is led by a senior Research Director (**Brocklehurst**, then **Wilkinson** during this REF period). Our research groups include North Wales Organisation for Randomised Trials in Health (**Brocklehurst, Hoare**); the Centre for Health Economics and Medicines Evaluation (**Hughes, Edwards**); Dementia Services Development Centre (**Windle, Seddon**); North Wales Centre for Primary Care Research (**Wilkinson, Lewis, Hiscock**); and Centre for Mental Health and Society (**Poole**). BIHMR also benefits from a long history of implementation research (**Rycroft-Malone**), and also hosts Bangor's Public Health Collaborating Unit, funded by Public Health Wales, with a remit to address national or emerging community health challenges. Bangor's cancer research group operates as the North Wales Cancer Research Institute (**McFarlane, Staples, Cha, Hartsuiker**) connected to a strong research network including the HCRW-funded Wales Cancer Research Centre, North West Cancer Research, the Wales Gene Park and the Wales Cancer Bank.

A Research Leads group, including an Impact Lead (**Hughes**), coordinates these activities and is collectively responsible for the development of BIHMR's portfolio, working with a group of engaged early career researchers (ECRs) as a strategic priority. BIHMR also provides the research backdrop to support Bangor University's expanding provision of medical education for North Wales – the C21 programme, working with Cardiff University – alongside existing excellence in nursing, dentistry, pharmacology, and allied health professions.

Research strategy over the next five years

In addition to strengthening and developing partnerships with researchers across the University (e.g. Bangor's psychologists, sports & exercise scientists, engineers, and environmental scientists), our future objectives include: developing our portfolio to address the COVID-19 pandemic; maintaining and expanding research presence in policy critical areas; continuing to prioritise methodological excellence in research (e.g. statistical treatment of compound outcome measures, implementation frameworks for clinical trials, assessment of high cost medicines, pharmacogenetics, public health economics, methods of measuring social return on investment, co-production and palliative and end-of-life research); expanding further Patient and Public Involvement; facilitating the development of clinician participation in research (see Section 2); and realising commercialisation of research in, for example, cancer drug development.

Enabling and facilitating the achievement of impact

BIHMR's Impact Lead (**Hughes**) coordinates our impact activities, and the interactions between Research Leads and staff facilitate the identification of opportunities to promote benefits in practice and policy. Most of our projects, particularly trials and evaluations, are developed with external partners and stakeholders and this ensures a significant contribution from outside academia. Through established networks of national and international policymakers (from Welsh Government to WHO), impact is intrinsic to our research. Working productively with partners and stakeholders over time, we can proactively identify emerging priority areas to patients, services and policymakers, supporting impact at every point from study conception to delivery and dissemination. All Research Leads have strong links with policymakers in critical areas and opportunities for impact are reviewed regularly. Funding applications are internally reviewed by expert senior colleagues for their practice and policy relevance, and to identify pathways to

impact. In addition, as most of our large-scale projects comprise large multidisciplinary and interdisciplinary teams, perspectives can be shared across disciplines, to aid identifying likely audiences and end users. Opportunities for achieving impact are identified by regular BIHMR group and Research Lead meetings. Funding for impact has been supported by Bangor's ESRC Impact Acceleration Award fund, with a spend this REF period of GBP55,000. All three of our Impact Case Studies demonstrate the above processes in actual outcomes.

Evidence of close-working with research end-users is exemplified in our Innovation in Dementia Care Impact Case Study, where **Windle** and colleagues' AHRC-funded research has demonstrated the value of a visual arts-based intervention to the quality of life of dementia sufferers. This case study involved working closely with Age Cymru and regional care homes, and through team appointments to the Welsh Government taskforce for Implementation of the Dementia Action Plan and Cross-Party Group for Arts and Health. This established programme has now informed national care policy and dementia service delivery, and has highlighted the wider potential for the use of arts to improve health and well-being in social care settings.

Another Impact Case Study provides a further example of close working relationships with policy makers; in this instance, the Chief Dental Officer in Wales. **Brocklehurst** and colleagues' work on NHS dentistry contract reform and role-substitution has significantly influenced policy, workforce development and practice. This work has led to the establishment of the new All-Wales Faculty for Dental Care Professionals (launched in 2020 by the Minister for Health in Wales). These activities address key elements of the Chief Dental Officer's policy document ('*The Oral Health and Dental Services Response to A Healthier Wales*') and have led to two further projects, both funded by the Welsh Government, to evaluate the reformed NHS dental contract programme in Wales. Since then, Brocklehurst has been appointed as Deputy Chief Dental Officer in 2020 in a part-time role that promotes research impact and implementation of evidence-based practice across Wales.

Finally, BIHMR's interactive and collaborative culture along with our established and enduring partnerships with stakeholders and end-users sustains the vitality of future research impacts. One example of emerging impact is seen in **Wilkinson** and **Hiscock's** CARiAD (CARer-ADministration of as-needed sub-cutaneous medication for breakthrough symptoms in home-based dying patients) project. This NIHR pilot trial, completed in late 2019, has demonstrated the acceptability of carer administered as-needed end-of-life subcutaneous medication. With the emergence of COVID-19, the monograph on this work was published early in response to a specific intervention from Wales Government and English Palliative Care Networks, followed by rapid passage into urgent NICE guidelines for palliative care in response to COVID-19.

Supporting interdisciplinary research

One strategic purpose of BIHMR is to act as an interface to promote interdisciplinarity across our research groups and the University. BIHMR hosts a large range of disciplines, from fundamental laboratory-based research through to clinical, health and social care activity. Our portfolio brings together specialists with critical methodologies (e.g. trials, medicines and health economics, and implementation science) and researchers in key clinical domains with international policy relevance (e.g. ageing and dementia research, primary and palliative care research). Therefore, the environment is naturally multidisciplinary. However, BIHMR staff also include medical sociologists (**Seddon, Hiscock**) and anthropologists who, working in collaboration with other experts, have driven the creation of innovative projects to inform new health and care practices.

One example of BIHMR's interdisciplinary health research is the integration of clinical medicine, genetics, and health economics in discrete-choice investigations of neurologist and patient thresholds for serious adverse drug reactions in decisions about genetic testing in the context of 'personalised medicine' (**Hughes**). Other interdisciplinary projects have integrated our capabilities in medicine (dementia care) to provide insights into methods of data collection and better ways to measure outcomes in this field (**Windle**). Social care researchers have integrated expertise in criminal justice, mental health services and social care practice and policy, in order to understand risks of anti-social behaviour and to generate policy for carers (**Seddon**). We have

also combined health economics, public health epidemiology and theoretical economics to evaluate exercise physiology interventions and the Wales National Exercise Referral scheme, with an impact on NICE guidelines. The same group (**Edwards**) has developed cross-over methodological work on Cost Benefit Analysis and Social Return on Investment Analysis (SROI) in the context of diverse projects relating to: music in schools, community health promotion, social prescribing, woodland mental health promotion programmes, and librarians in intensive care wards. Finally, interdisciplinary cancer drug discovery projects supported by Cancer Research Wales and the Life Sciences Research Network Wales have involved collaboration with the Cardiff School of Pharmacy and Pharmaceutical Sciences. All of this means that BIHMR has markedly increased interdisciplinary and collaborative activity in Bangor's medical and health research, something also evidenced by the fact that 54% of the research outputs submitted to this REF have been co-authored with external organisations.

Progressing towards an open research environment

We encourage open access publishing through Bangor's institutional policies and the UKRI block grant. Our research is strictly compliant with funders' requirements. For example, our UKCRC-registered CTU adopts the principles outlined in the Medical Research Council's 'Good practice principles for sharing individual participant data from publicly funded clinical trials'. These provide standards that describe how Individual Patient Data are made available for secondary research. This is particularly relevant for Bangor's triallists, who have overseen 25 trials during this REF period with internal policy and Standard Operating Procedures for the management of research data during the trial and at archive. These procedures operate in the way required for the Medicines and Healthcare products Regulatory Agency (MHRA) and are regularly audited. All UKRI-funded studies require the implementation of UKRI guidance on the best practice in data management and all data are deposited with the UK Data Service. For example, the data from our longitudinal study – the Cognitive Function and Ageing Studies Wales – are now publicly available to the wider research community.

How are we supporting a culture of research integrity?

Bangor University complies with the Universities UK Concordat to Support Research Integrity, and has established structures to support effective research governance and ethics. BIHMR's research involves patients with physical or mental health issues, health professionals, individuals drawn from the local community, and other vulnerable groups at elevated risk of harm. Consistent with best practice, we seek to protect all research participants and researchers by mitigating risks appropriately while continuously seeking to enhance ethical and scientific quality. All of BIHMR's practices are fully aligned with Health Research Authority guidelines and requirements. We have developed a research Quality Management System in this REF period, providing a comprehensive series of Standard Operating Procedures that are audited on a regular basis. BIHMR links effectively with R&D functions and research ethics service in our local health board (Betsi Cadwaladr University Health Board). Each Schools' research ethics committee also reports to the University Ethics Committee, and evaluates researcher plans against all other relevant frameworks as set out by the UKRI and appropriate legislation (e.g. data protection). All funding applications submitted by our researchers are scrutinised by expert research support officers in Bangor's Research, Innovation and Impact Office.

Section 2. People

Staffing strategy, staff development and ECRs

Bangor's staffing strategy remains to recruit, retain and develop excellent researchers in all of our teams, building on core strengths to achieve long term structural resilience and growth. Most of our University-funded staff submitted to UoA3 are at least partially supported by HCRW infrastructure funding, and/or project funding. Our research community spans the full range of seniority, offering a vital mix of experience, skills and development opportunities for more junior colleagues: 7 Professors, 7 Readers/Senior Lecturers, 2 Lecturers, 1 Senior Research Fellow, 6 Research Fellows, and 1 Research Officer. In line with University policy, all BIHMR researchers complete a yearly Professional Development Review. The review provides an opportunity to acknowledge achievements and to discuss future plans and ways to address difficulties.

Reflecting the principles within the Concordat to Support the Career Development of Researchers, we are committed to the support of research-active staff and the development of early career researchers (4 out of our 24 submitted Category A staff are ECRs). In 2019, we launched the BIHMR ECR Mentorship scheme, based on the OSCAR model from the Academy of Medical Sciences. It provides the platform for reflective discussion between ECRs and mentors to shape and guide career trajectories. The scheme provides: 'formal mentoring' mechanisms that augment informal or 'spot mentoring'; a focus on developmental action planning; open gateways for PGRs nearing completion and post-doctoral students to access the scheme; and opportunities for Research Leads to support, reflect, encourage and signpost. Mentorship is augmented by the School of Health Sciences Director of Postgraduate Research who, as an additional aspect of the role, facilitates augmented training as required.

We have also enacted an ECR-led 'BIHMR ECR network' that features group meetings and peer-support, often through social media (Facebook and Twitter). This network also links to the wider Bangor University Researcher Development and Research Concordat Group, which includes BIHMR representatives. The ECR network has developed its own strategic aims and held its first annual ECR conference in 2019, with 32 attendees, 10 speakers and a separate poster session. During the COVID-19 pandemic, the BIHMR ECR network has hosted peer support virtual meetings to discuss home working and provide peer support.

Our ECRs are offered support to develop into research leaders. This includes the provision of opportunities for personal development through CPD, conference attendance, and internal research networking opportunities such as research meetings, grant writing groups, journal clubs, and shared thematic workshop series. All ECRs are supported to present their research in posters and seminars to national and international audiences, and to contribute to Masters-level teaching as further training for academic research careers. Nine BIHMR members received promotions in this REF period, including Windle's appointment to a Chair from original ECR status with the dementia research group, illustrating the potential for success. Two ECRs have gone on to permanent positions at Bangor (**MacLeod, Orrell**) and four others have secured HCRW funded 3-year Fellowships (**Bray, Jones, Holmes, MacLeod**). **Staples**, in the cancer biology group, has won a 5-year prestigious UKRI/MRC Future Leaders Fellowship.

Bangor's health researchers have implemented two further staff development processes:

First, we established the Clinical Academic Pathway in 2018. Embedded in BIHMR, this programme seeks to increase the interdisciplinarity of the PGR community to involve health professionals from medicine, dietetics, nursing, paramedicine (linked to a collaboration with Wales Clinical Academic Track) and dentistry. This 'rolling' programme is set within a collaborative framework with two NHS hospitals across the Betsi Cadwaladr University Health Board. The pathway provides scaffolding to allow clinicians to complete MRes, PhD, or Doctorate in Healthcare degrees. Clinicians select an appropriate entry point based on their existing research experience, and progress from either Innovator or First into Research level to Fellowship (MRes) or Senior Fellowship (PhD / Doctorate in Healthcare) level. Academic, clinical and supervisory support are delivered through monthly multidisciplinary seminars and research methods seminars. The Pathway has also generated a peer-based cluster of F2 and F3 clinicians focused on research projects in respiratory medicine, dermatology and trauma.

Second, Bangor health researchers have been instrumental in establishing a Community of Scholars with the Betsi Cadwaladr University Health Board. The Community is based on the Research Capacity Building Collaboration (RCBC) Wales Community of Scholars model designed to facilitate interaction and collaboration. It is currently in a pilot phase (with 28 clinicians to date), following co-production meetings facilitated by design engineers from 'Lab4Living' that identified a need for this network, its potential purpose, and inherent values. The Community is organised on a co-operative basis, where all members are equal, to promote equity in the collaborative provision of research knowledge, skills, and attitudes, which can be shared across both organisations. The Community is intended to provide resources around key

themes including research knowledge, skills, leadership and funding in applied health settings; and to foster a broader and enriched network of clinicians, clinical academics and scientific staff.

PGR community, training and support mechanisms

BIHMR acts as an effective catalyst for excellence in PGR research practice, enhancing PGR experience by sharing innovation, best-practice and governance across research groups. The allocation of PGR awards is strategically aligned with BIHMR areas of ageing and dementia; health economics and social care; implementation and service research; cancer cellular biology; and primary and palliative care. The development, sustainability and growth of the PGR community is supported by a range of structures and mechanisms that are described below. The number of PhD completions has increased 6-fold to 86 in this REF cycle compared to REF2014 and the number of degrees awarded per staff head count is now 3.58 (or 3.88 per staff FTE).

Our PGR programme is supported by diverse funding sources. Over this REF period, studentships have included: 6 Cancer Research Wales awards; 2 HCRW; 1 Tenovus award; 1 MRC and 1 ESRC DTP studentship; 1 Motor Neurone Disease Association award; and 1 North West Cancer Association award. In addition, 17 studentships have been funded by the government of Saudi Arabia and 1 from Iraq. Our engagement in the European Social Fund-supported Knowledge Economy Skills Scholarships (KESS) scheme, which connects academic research capabilities to health and 3rd sector organisations to realise health and societal benefits, has brought support for 15 postgraduate researchers in this REF cycle. Project partners have included Mencap Cymru, Awyr Las (a local umbrella charity to support NHS provision across North Wales), Tenovus Cancer Care and North West Cancer Research. Total expenditure for PGR using KESS studentships in this REF period comes to GBP695,000.

First-time supervisors are mentored by the Director of PGR. Additional supervisory training is provided on a cyclical basis by the University's Doctoral School workshops. A supervisory network involves monthly meetings to discuss relevant issues (progress, international admissions, preparing for submission, and viva examination). The network also provides a peer-support mechanism for supervisors that draws on expertise from outside of their research group. A sense of cohesion is supported through social media with 3 PGR representatives representing different constituencies across the PGR community and having an active role in taking BIHMR's health and medical research – outputs, conferences - to social media audiences. This includes an annual Summer School focused on methodology masterclasses and workshops for PGRs with online resources, and a monthly 'Virtual Study Room @School of Health Sciences' focused on applied research methods, academic writing, theoretical frameworks, viva preparation, transitioning as an ECR, and a range of thematic areas generated by PGRs. This is augmented by peer support including the monthly PGR 'Morning Quick Coffee @School of Health Sciences'.

Bangor's PGR training is underpinned by open, subject-specific seminar series sessions within each research group. These include the provision of external as well as internal sessions on methodology and subject-specific issues and debates. There are dedicated training programmes linked to particular funding programmes such as KESS and the Research Capacity Building Collaboration (RCBC) Wales. The latter provides a high quality and bespoke training scheme for fellows funded by the programme, with additional Bangor events in the RCBC annual programme. These have focused on masterclasses in realist approaches, dementia and social prescribing. Since 2017, we have run an annual 'Bangor University Health Services Research Summer School' with instruction from international experts on complex interventions and evaluation, realist synthesis and evaluation, health economics, implementation science, ageing and dementia and primary care. The Summer School includes sessions on engagement with creative methods in the design of research that explores the service-user perspective.

Finally, our PGR community includes Bangor's professional doctorate programme (Doctorate in Healthcare) that has been developed from the initial D Healthcare in Implementation to an extended programme in 2019/2020 centred on Public Health, and also Ageing and Dementia. A further D Healthcare in Social Care Practice/Social Work is scheduled to commence in 2021/2022. The new D Healthcare programmes provide an international reach, based on an e-

learning scaffolding, exploring diverse research areas from examining stigma aligned to HIV/AIDS in the hill tribe communities in Thailand, to exploring the challenges for LGBT communities as part of entry into care in Canada. These measures will enrich our PGR environment over the next cycle.

Supporting and promoting equality and diversity

Bangor University has held an Athena Swan Bronze award since 2011 (valid until 2022). BIHMR provides an environment which respects and values the positive contribution of all its members, enabling them to achieve their full potential and to gain benefit and enjoyment from their involvement in the life of the University. BIHMR's research groups comply with the relevant legislation and good practice, and will not tolerate any individual receiving less favourable treatment on grounds of religious or political beliefs, gender, sexual orientation, family circumstance, race or ethnic origin, nationality, age, social or economic class, or disability, nor be disadvantaged by any other condition or requirement which is not relevant to good practice and cannot be shown to be justifiable. Responsibility to ensure staff are aware of and comply with Bangor University policies involving equal opportunities, harassment and bullying, and the Welsh language is cascaded from the Heads of Schools, through Research Leads to all staff and student levels. In addition, and as importantly, we seek to promote a broader "nurturing" culture in which staff are encouraged to identify opportunities to improve how we meet equality and diversity challenges. This is supported by a College Equality & Diversity "champion" who has the responsibility to promote engagement across academic Schools and service departments, and liaise with leaders to facilitate continuous improvement. Other specific steps include ensuring, as far as possible, gender balance in all staff and PGR recruitment processes; increased involvement and visibility of under-represented groups at School Open Days; meetings and seminars scheduled within core business hours (10:00-16:00); and adopting sensitive staff and PGR allocation to office space. While it has been established procedure for standing committees to comprise a mixture of under-represented groups, we ensure that short-term interview panels, selection committees, and task-and-end groups represent this diversity.

3. Income, infrastructure and facilities

Income to UoA3 during the REF period

Overall, Bangor's research spend in UoA3 has **more than doubled** since REF2014 (GBP32,189,553 from GBP14,069,122), with an average of GBP194,620 per headcount (or GBP179,700 per FTE). Our strategy has been to secure infrastructure monies and larger awards from health funders (e.g. NIHR Evaluation, HTA, PHR; PGfAR; HS&DR), cancer charities and other equivalent sources. We can evidence particular increases in expenditure from health-research bodies: GBP15,867,571 compared with just GBP5,392,350 in REF2014. Reflecting our engagement with external partners for health, care and societal benefits, spend was GBP4,855,982 from (competitive) UK-based charities (compared with GBP1,566,635 in REF2014) and GBP5,325,343 from UK central government bodies, local authorities, health/hospital authorities (compared with GBP4,071,887). Finally, in this REF period, we have increased our UKRI spend to GBP3,385,468 from GBP1,205,509 in REF2014.

All funding figures quoted here reflect funded award values to Bangor unless stated otherwise.

Our external income, combined with infrastructure funding from HCRW, has provided a vital, cohesive and impactful infrastructure for BIHMR. Investment is based on Wales' current and emerging health challenges so matches our research themes. BIHMR is represented across all five infrastructure centres in Wales (dementia, primary care, population health and wellbeing, mental health, and cancer) and BIHMR researchers lead one of the three infrastructure support groups (in health economics). HCRW and other infrastructure awards in this REF period amount to GBP8,637,000, of which GBP4,121,000 provide support for the next 3-5 years. This indicates sustainable infrastructure support in areas of immediate and future policy relevance. Breaking these figures down indicates noteworthy successes around our research central themes.

Bangor's Clinical Trials Unit is the **North Wales Organisation for Randomised Trials in Health (NORTH)**, led by **Brocklehurst**, is a UKCRC-accredited CTU working across the UK health research community, with 78% of researchers from outside of Wales, working in a diverse range of clinical areas from treating depression with self-compassion using virtual reality, to reducing race inequality with the Race Equality Commission, to living well with dementia. Over the REF period, NORTH has hosted 25 trials. Many of these (14 of 25; 56%) were projects funded by the National Institute for Health Research (NIHR) valued at GBP18,147,000 with a total value to Bangor of GBP3,800,000. A further 12% of these trials were supported by UKRI. Of 76 outline applications during this REF period, NORTH can show a success rate of 36%, almost double the national NETSCC average. NORTH has been supported by HCRW (GBP1,833,000 for 2015-20 to Bangor University and now GBP1,101,000 for 2020-23), with a return on this investment during the REF period of 14:1. Two of the Bangor-led studies in NORTH's portfolio are further detailed in our Impact Case Studies.

Bangor's **Centre for Health Economics and Medicines Evaluation**, co-directed by **Edwards** and **Hughes**, provides an integral element in clinical trials and health intervention research, with specialisms in public health and social care economics and in medicine and pharmaco-economics. The public health economics group, led by **Edwards**, received infrastructure funding from Welsh Government of GBP1,325,000. This group has undertaken policy research in conjunction with Public Health Wales (GBP271,000), and economic evaluation of trials in public health across the life-course (GBP885,000) in the areas of children and school-based interventions (6 trials), dementia (3 trials), and sight loss (4 trials). Of these, support for NIHR-funded trials comes to GBP788,000. The pharmacoeconomics group, led by **Hughes**, maintains a strong partnership with the University of Liverpool Clinical Trials Centre, which has helped to attract GBP302,000 of MRC funding to Bangor to support trial methodological research, and GBP165,000 through NIHR infrastructure to deliver trial-based economic evaluations in neurology (7 trials), antenatal and paediatrics (2 trials) and cancer (3 trials) (GBP1,123,000). Other awards include a Wellcome-funded study of community outbreaks of diarrhoeal infections (GBP272,000), and an NIHR PGfAR award with Oxford University on medication adherence in type 2 diabetes (GBP112,000). Collectively, through **Hughes**, **Edwards** and their groups' activities, our medicines and public health economics research has generated over GBP7,262,000 for Bangor University during the REF2021 period.

Bangor's **Dementia Services Development Centre (DSDC)**, led by **Windle**, is part of the Wales Centre for Aging and Dementia Research funded by HCRW, attracting GBP772,000 and GBP938,000 to Bangor for 2015-2020 and 2020-25. This group has a strong track record of UKRI funding for dementia research involving clinical and third sector partners including, for example, an EU Joint Programme of Neurodegenerative Disease Research award to investigate timely access to care in dementia patients (GBP223,000). Recently, the group won an ESRC-NIHR Dementia Research Initiative grant investigating the impact of multicomponent support groups for those living with rare dementias, bringing together health psychology, neuropsychology, health economics, and intervention evaluation together with people living with dementia and their supporters (worth GBP4,400,000 with a value of GBP842,000 to Bangor). In addition, the dementia research group has secured Early Career Researcher awards for **Algar-Skaife** to investigate the use of arts in person-centred care (HCRW; GBP183,000) and for an Age Concern Torfaen-funded study of the use of arts in young onset dementia (GBP25,000). In total, this group has brought in GBP4,401,000 during the REF2021 period.

Bangor's **North Wales Centre for Primary Care Research (Wilkinson, Hiscock)** is a core member of Wales Centre for Primary and Emergency (including Unscheduled) Care. The Centre has won GBP3,971,854 for Bangor including infrastructure of GBP333,327 from HCRW for 2015-20, and now GBP835,000 for 2020-25. Over the REF period, they have secured GBP5,500,000 for Bangor from a range of funders, including NIHR HTA, HS&DR, and Cancer Research Wales. This total also includes leadership in the FEMUR III trial for rehabilitation in the elderly (GBP377,000), and a novel network meta-analysis of treatments for sciatica (GBP559,423). A Clinical Research Time award from HCRW (GBP21,000) has allowed the palliative care research programme to grow. Addressing cancer diagnosis in primary care for

Cancer Research Wales (GBP1,111,000), the group has assembled a team including medical general practitioners, sociologists, and health psychologists, and benefits from membership of the Cancer Research in Primary Care International Network. Finally, as noted in Section 1, the group led the national CARIAD NIHR-funded CARer-ADministration trial of as-needed sub-cutaneous medication for breakthrough symptoms in home-based dying patients (GBP435,000) that has facilitated updated NICE guidelines during COVID-19.

Bangor's **North West Cancer Research Institute (Cha, Hartsuiker, McFarlane, Staples)** has secured infrastructure awards of GBP64,000 and GBP179,000 from the Wales Cancer Research Centre for 2012-2020. In 2019, Staples won a UKRI Future Leader Fellowship award to address the role of the replication fork protector, MRNIP, in DNA repair (GBP1,416,000). The Institute is uniquely associated with the strategic aims of a number of regional charities. These have funded projects that address, to take a few examples: the clinical utility of novel cancer/testis antigens (**McFarlane**, Cancer Research Wales; GBP240,000); a genome-wide analysis of topoisomerase removal pathways **Hartsuiker**, Cancer Research Wales; GBP183,000); a novel DNA repair factor in the DNA response to chemotherapy (**Staples**; North West Cancer Research; GBP184,000); signal transduction in mitochondrial DNA replication (**Cha**; North West Cancer Research; GBP200,000) and autophagy survival (**Cha**; North West Cancer Research; GBP196,000). Over this REF period, the group's funding awards come to GBP3,272,000.

Noyes is chair of the National Centre for Public Health and Wellbeing Research and also leads the Welsh Kidney Research Unit at Bangor, both funded by HCRW (GBP653,000 and GBP359,000 to Bangor, respectively). Further Welsh Government awards have supported the evaluation of the Welsh Human Transplantation Act (GBP250,000) and treatment choices in patients with advanced kidney failure (GBP184,416). Finally, the Centre for Mental Health and Society has been supported, as part of the National Centre for Mental Health, by HCRW infrastructure funding of GBP81,000 for 2015-2020. **Poole** is co-investigator on the South Asia Self Harm Initiative (SASHI) funded by the Grand Challenges Research Fund with a value to Bangor of GBP1,459,000. One staff member from that centre, **Krayer**, secured GBP158,000 for a study of policing involving vulnerable individuals.

Facilities

BIHMR boasts well-equipped facilities in both its Bangor and Wrexham sites. These support collaborations with social care networks and the NHS (the Betsi Cadwaladr University Health Board similarly spans the breadth of North Wales). Hot desk facilities and distance technologies allow interactions between groups and enhance co-working, and have supported effective working during the COVID-19 emergency. As part of our PGR provision, Bangor University has made new investments in dedicated PGR work-spaces across the School's locations. The cancer research group operates a suite of open-plan laboratories that supports multidisciplinary, interactive research, supported by state-of-the-art equipment including an interconnected cell analytical facility (comprising tissue culture facilities, confocal microscopes, laser microirradiator, X-ray irradiator, flow cytometer and fluorescence high-throughput tissue analytical technology). The group is embedded within the wider cancer and genomics research community of Wales and North West of England, allowing access to all-Wales multi 'omics' and stem cell technologies, a wide range of patient samples, trial activities and clinical partnerships through the Wales Gene Park and the Wales Cancer Research Centre.

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

Research collaborations and partnerships

HCRW infrastructure funding supports participation in large-scale collaborative networks across Wales and internationally. **Noyes** leads Bangor's participation in the Wales Kidney Research Unit and the National Centre for Population Health and Wellbeing Research. Our dementia research team form part of the Wales Centre for Ageing and Dementia Research (**Windle** is Associate Director). As co-director, **Wilkinson's** cancer studies form part of the Wales Centre for Primary and Emergency (including Unscheduled) Care Research, which networks four other Welsh Universities and relevant research groups. Our cancer group has access to the Wales

Cancer Bank and the North West Cancer Research-funded Liverpool Tissue Bank, both of which provide additional underpinning biological infrastructure. The group also has access to patient-derived in vivo models through various regional inter-connections in Wales and beyond (e.g., via an integrated collaboration with the European Cancer Stem Cell Institute, Cardiff University). BIHMR groups working across multiple themes collaborate extensively with our CTU team (NORTH) and with external partners to conduct economic evaluations that have impacted clinical practice. International collaborations, such as via the International Society for Medication Adherence, have led to new paradigms in the definition and reporting of medication adherence. Several staff (**Lewis, Noyes**) are active in Cochrane CRGs and methods groups.

Looking forward, we are also developing new academic networks to build vitality and sustainability. **Noyes**, with Public Health Wales, participates in the existing WHO Collaborating Centre focussing on contract reform and adverse childhood events. **Brocklehurst** has developed links with the WHO Collaborating Centre in Dental Public Health at University College London, linked to a NIHR Public Health Research-funded trial of a community led parenting programme and NIHR Public Health Research-funded and NIHR HS&DR-funded interventions for improving oral health in care residents. **Hughes**, in collaboration with Betsi Cadwaladr University Health Board, has hosted national conferences (Clinical Pharmacology Colloquia) and established the Welsh Medicines Research Symposium to promote this research focus at Bangor University. **Hughes** is Pharmacogenetics champion for the Royal Pharmaceutical Society to lead on a strategy to involve pharmacists in the delivery of pharmacogenetics services across the UK.

Our methodology expertise has led to grant capture from a broad range of funders. The **MRC North-West Hub in Trial Methodological Research** (2009-2019), and the **MRC-NIHR funded Trials Methodology Research Partnership** (2019-24) are good examples. **Hughes** has led the health economic research activities of the former, and is a partner of the latter project, which aims to bring together a number of networks, institutions and partners to establish new collaborations to progress trial methodology, developing capacity and reducing research waste. The **Public Health Collaborating Unit** is embedded in BIHMR, and funded by Public Health Wales. Projects focus on Adverse Childhood Experiences, public engagement in public health issues (e.g. NHS dental contract reform), and health-harming behaviours (e.g. alcohol, gambling and physical inactivity). This group worked with the School of Psychology on a Public Health Wales-funded report on gambling harms across Wales, providing the first national geospatial map of risk factors with policy recommendations that have guided policy developments.

Noyes' methodological work on evidence synthesis with WHO has produced reports and successful collaboration with the US National Academies for Science, Engineering and Medicine, and the US Agency for Healthcare Research and Quality. BIHMR's clinical trials team (**Brocklehurst, Hoare**) works with a broad range of academic partners in the UK and across the range of funding streams in the NETSCC portfolio (HTA, HS & DR and PHR), other NIHR funding boards (Invention for Innovation; i4i, Programme Grants for Applied Research, and Research for Patient Benefit), ESRC, MRC, charities and industry. NORTH has produced joint grants and outputs with London groups based on continuing experience mental health research (i4i GBP1,600,000 and NIHR HTA CALMED GBP1,700,00) and King's College London Clinical Trials Unit. BIHMR's cancer group collaborates with Cardiff University, Lancaster University and the University of Liverpool. **Wilkinson's** NIHR-funded CARIAD study on carer-supported end-of-life palliative medicine administration brings together palliative care physicians, primary care, specialist and community nursing and legal expertise, and shares grants and publications with University of Melbourne. Wales Government and England's Helix Innovation Centre rolled the intervention tested in CARIAD into urgent policy for COVID-19.

Public engagement and participation in research

BIHMR brings service providers and stakeholders together to shape future research directions. **Windle's** group host the Wales Dementia Network, a dementia-supportive practice community with over 500 members (people living with dementia, their supporters, service providers, university research staff, carers, health and social care staff). The network works to

increase understanding of challenges and future priorities, encouraging grass roots reforms and innovations at local and national levels. **Windle** is also part of the Welsh Government Dementia Action Oversight Implementation and Impact group to support advocacy on national and international platforms. To ensure we develop relevant, useful, and beneficial research, BIHMR engages with patients and the public at the outset of all its projects, to identify areas of concern that lead to priority areas for research development. Our local **Population Advice for Research Committee (PARC-Bangor)** consists of 15 female and 7 male patients and members of public (including Welsh speakers) who offer their experiences to shape new research. We have run regular 'Have your Say' events, and regularly audit our activities against the 'National Standards for Public Involvement' audit tool. CABAN (est. 2019) are a group of people living with dementia and their carers who, with our researchers, give voice to public priorities. CABAN members have also made significant contributions to the education of the current and future health and social care workforce through awareness sessions, consultations and presentations in small groups, training events and conferences. Co-production is core to BIHMR's research. Stakeholders and end-users have helped to shape innovative ways to commission and deliver meaningful short breaks for carers that support inter-dependent caring relationships. Our clinical trials group has conducted a range of studies where interventions or services are complex or politically sensitive. These include evaluation of NHS Wales dental contract systems, an NIHR HS&DR-funded redesign of the Northern Ireland NHS dental contract, an NIHR PHR-funded trial of a community parenting intervention, and an intervention to improve oral health in care homes. The latter involved working with ENRICH-Cymru; a network linking care homes in Wales with researchers.

Sustainability of the discipline and responsiveness to national and international priorities

BIHMR staff contribute to the sustainability of the discipline in a variety of ways. **Brocklehurst** has recently been appointed Deputy Chief Dental Officer for Wales, was a NIHR HS&DR Board member (2015-2020) and is now a NIHR DF Panel member (2015-date) NIHR HTA Prioritisation Panel (2018-2020). **Hughes** is Executive Editor for the British Journal of Clinical Pharmacology; Editorial board member for Clinical Pharmacology and Therapeutics and PharmacoEconomics; Fellow of Faculty of the Royal Pharmaceutical Society (FFRPS) 2014; Fellow of the British Pharmacological Society (FBPhS) 2013; Chair of the pharmacogenomics test evaluation working group for the Genomics Programme in NHS England and NHS Improvement; and is a member of the UK COVID-19 Therapeutics Taskforce.

McFarlane is a member of the International Advisory Board for Elsevier Translational Oncology (2020-date). **Windle** is a member of UK Alzheimer's Society taskforce (2017-date), has provided international or national key note lectures on dementia, and is a funding committee member for the UKRI Healthy Ageing Challenge Fund. **Hughes** and **Edwards** hold honorary chairs at Liverpool and **Wilkinson** at Cardiff. **Noyes** has given evidence to public hearings for US National Academies of Science, Engineering and Medicine regarding synthesised qualitative evidence and provides consultancy work with WHO. She is also a member of the US Committee on Evidence-Based Practices for Public Health Emergency Preparedness and Response (US CDC). **Poole** is a Project board member of the UK National Confidential Inquiry into Suicide and Safety in Mental Health and gave the RCPsych Prestigious Presidential Lecture 2020 on prescribed opioids. **Wilkinson** was Chair of HTA Commissioning Panel – Primary Care, Community, Preventive Interventions (2013-18). She was also a member of the NIHR Prioritisation Panel (2013-15). She serves on the Marie Curie Grants funding Committee member (2020-date).

The interdisciplinary and cooperative aspect of BIHMR positions it to mobilise diverse teams to respond to calls and policy initiatives. Some of these have been described above. Examples include **Brocklehurst's** work on NHS dentistry contract reform and role-substitution and **Windle's** AHRC-funded work with Age Cymru, regional care homes, a Welsh Government taskforce and the Cross-Party Group (CPG) for Arts and Health to implement visual arts-based interventions in dementia sufferers. **Algar-Skaife** is the Wales national coordinator for Join Dementia Research, a service that enables people to register their interest in participating in dementia research and matches them to suitable studies. To date, over 1,000 people are

registered in Wales. Responding to the COVID-19 emergency, **Hughes** used experimental models to understand better the safety and risks associated with Hydroxychloroquine use, while **Wilkinson's** extension of the CARIAD programme supported the updating of NICE guidelines for palliative care during COVID-19. Other BIHMR activities look to inform the formation of policy directly. In this REF period, and working with Public Health Wales and an advisory panel, **Edwards** and her team have produced a series of reports on the economic evaluations of interventions to support the health and wellbeing of the workforce within Wales, as well as on the health and economic benefits of investment in peoples' early and later years. These reports – Wellness in Work (2019), Transforming Young Lives across Wales (2016) and 'Living well for longer: The economic argument for investing in the health and wellbeing of older people in Wales (2018) – are intended to inform relevant stakeholders (Welsh Government, employers, NHS, members of the public, and higher education institutions) about the evidence-base in relation to educational, employment and prosperity policies. Other work from this group used social-return-on-investment methods to measure the different values derived from Codi'r To, a regeneration project that uses music in schools, for children and communities.