ISRCTN18398037 https://doi.org/10.1186/ISRCTN18398037

Taking aim at delays to arthritis treatment

Submission date 29/12/2021	**Recruitment status** No longer recruiting	[_] Prospectively registered [X] Protocol [_] Statistical analysis plan [X] Results [_] Individual participant data
Registration date 14/03/2022	**Overall study status** Completed	
Last Edited 08/04/2025	**Condition category** Surgery	

Plain English summary of protocol

Background and study aims
This study will determine whether artificial intelligence (AI) can help general practitioners' (GPs') decision-making about which patients with arthritis are referred for hip or knee replacement surgery.
More than 1 in 10 people over the age of 45 have arthritis. This can be associated with significant pain and inability to perform normal activities such as walking, getting dressed or going to the shops. Some have described living with the condition as a state "worse than death". Surgery provides an excellent solution but is not a suitable option for all patients.
Currently GPs often have difficulty deciding which patients with arthritis might benefit from an operation. This leads to many referrals for orthopaedic input and prolonged waiting times for surgery.
Planned AI analysis of routinely collected health information about patients with end-stage hip and knee arthritis will allow for the development of a tool that helps predict who is likely to undergo surgery.

Who can participate?
The study will utilise routinely collected health data from patients aged 16 years and over who have previously undergone routine hip and knee replacement surgery within NHS Grampian.

What does the study involve?
The study will use routinely collected health data to try to build a good picture of who might undergo hip and knee replacement surgery in future.

What are the possible risks and benefits of participating?
Development of the tool will help improve future referral pathways, ensuring those likely to benefit from surgery are seen promptly and efficiently. This should see reduced waiting times that helps those needing surgery to get back on their feet again quickly. The risks of participation are very small as there is no direct patient contact. All patient information is managed in a specialised safe environment designed to ensure minimal risk of any details being leaked.

Where is the study run from?
The Centre for Health Data Science within the University of Aberdeen (UK)

When is the study starting and how long is it expected to run for?
August 2020 to March 2024

Who is funding the study?
The Chief Scientist Office (CSO) in Scotland (UK)

Who is the main contact?
1. Mr Luke Farrow, luke.farrow@abdn.ac.uk
2. Prof. Lesley Anderson, lesley.anderson@abdn.ac.uk

Contact information

Type(s)
Public

Contact name
Mr Luke Farrow

ORCID ID
https://orcid.org/0000-0002-1443-5908

Contact details
Institute of Applied Health Sciences (IAHS)
University of Aberdeen
Aberdeen
United Kingdom
AB25 2ZD
+44 (0)1224 272000
luke.farrow@abdn.ac.uk

Type(s)
Scientific

Contact name
Prof Lesley Anderson

ORCID ID
https://orcid.org/0000-0002-1000-3649

Contact details
Institute of Applied Health Sciences (IAHS)
University of Aberdeen
Aberdeen
United Kingdom
AB25 2ZD
+44 (0)1224 272000
lesley.anderson@abdn.ac.uk

Type(s)
Principal investigator

Contact name
Prof Lesley Anderson

Contact details
Institute of Applied Health Sciences (IAHS)
University of Aberdeen
Aberdeen
United Kingdom
AB25 2ZD
+44 (0)1224 272000
lesley.anderson@abdn.ac.uk

Additional identifiers

Protocol serial number
CAF/21/06

Study information

Scientific Title
AI to Revolutionise the patient Care pathway in Hip and knEe aRthroplastY

Acronym
ARCHERY

Study objectives
Primary objectives:
1. Develop a cohort of patients referred by GPs regarding the assessment of suitability for hip or knee replacement and collect laboratory, clinical and imaging data from NHS Grampian via the Grampian DaSH.
2. Determine demographic, clinical and/or imaging characteristics influential in the selection of patients to undergo hip or knee arthroplasty, with the development of a tested and validated patient specific predictive model to guide arthroplasty referral pathways.

Ethics approval required
Old ethics approval format

Ethics approval(s)
Approved 13/10/2021, North Node Privacy Advisory Committee (NNPAC, University Office, King's College, Aberdeen, AB24 3FX, UK; +44 (0)1224 272000; nnpac@abdn.ac.uk), ref: 6/091/21

Primary study design
Observational

Study design
Observational cohort study

Study type(s)
Screening

Health condition(s) or problem(s) studied
Patients undergoing primary elective hip and knee arthroplasty

Interventions
The project will be conducted through two linked work packages designed to deliver on the project objectives.

Work package 1 – Definition of a Grampian regional data source with the establishment and validation of a linked orthopaedic health care dataset utilising routinely collected data

The first work package will utilise ready to access local regional data from NHS Grampian that combines routine administrative data systems with enriched local data. Similar linked datasets have been used extensively by the team at the Aberdeen Centre for Health Data Science, within which the candidate will be hosted. Techniques for data access and processing are described in detail later in the protocol. Patient demographic information (SMR01), prescribing and dispensing (PIS), laboratory data (Apex Haematology/Biochemistry), COVID data, theatre records (Centricity OPERA) and patient-reported outcome measures (PROMs) (Local PROMs database) will be used to develop core algorithms using combinations of relevant clinical codes (e.g. ICD-10 or OPCS-4). Standard Morbidity Record 01 (SMR01) and theatre records (Centricity OPERA) will provide the main resource for identifying joint replacement through relevant ICD-10 codes. Unstructured (e.g. free text) information in clinical letters and radiology image data will be used to validate and enhance these detailed characterisations. Risk factors and outcome measure algorithms will also be developed and validated against electronic clinical records.

Clinical knowledge of key parameters involved in surgeon decision making regarding the determination of who will undergo arthroplasty operations, as well as a planned systematic review, will aid variable selection. Given the standardisation of referral through the national Scottish Care Information (SCI) Gateway system and the widespread similarities in approach to joint replacement selection throughout the UK, the use of Grampian regional data should provide a model that is widely applicable. Furthermore, the close links between iCAIRD sites in Aberdeen and Glasgow will be utilised to ensure that all data sources utilised have relevance regarding potential future suitability for national application.

Subsequent operationalisation and automation of these techniques will allow for systematic and reproducible approaches to characterising the key clinical features of the data relevant to orthopaedics. Algorithms created will be then scaled and utilised to appropriately categorise and construct a linked dataset that covers all relevant hospital episode data covering patients referred to orthopaedics to be used in the subsequent work package.

Work package 2 – Determination of variables influential hip and knee arthroplasty selection, achievement of a meaningful improvement in patient-reported outcomes, and avoidance of complication post-operatively with subsequent patient-specific model development.

Utilising the cohort developed in WP1, probabilistic and classification machine learning will be employed through statistical analysis software (Rstudio, Python and Tensorflow) to predict whether or not a patient would be selected to undergo surgery based on pre-operative clinical data (including imaging data/reports and clinical letters [through natural language processing], patient healthcare information and patient-reported outcome measures).

The machine learning models will utilise data from the predictive variables isolated from pre-operative routine healthcare data described in WP1. Pre-trained convolutional neural networks (a type of machine learning categorised as deep learning) will be used for X-ray images in order

to significantly increase generalisability, with X-ray images providing the foundation for model creation. To facilitate model training, development and internal validation the researchers will use k-folds cross-validation, allowing all data to be used for testing and internal validation purposes without sample attrition.

Intervention Type
Procedure/Surgery

Primary outcome(s)
Dichotomous prediction of whether a patient would be selected to undergo hip or knee arthroplasty based on their baseline electronic health record data at the time of the first orthopaedic clinical review

Key secondary outcome(s)
1. Probabilistic prediction of arthroplasty selection based on baseline electronic health record data at the time of the first orthopaedic clinical review
2. Probabilistic prediction of Minimal Clinical Important Difference achievement in EQ-5D and Oxford Hip/Knee Scores at 1-year postoperatively
3. Probabilistic prediction of the risk of adverse healthcare outcomes (acute kidney injury /hyponatraemia/cardiovascular event/venous thromboembolism/reoperation/readmission /mortality) at 30 days and 1-year postoperatively

Completion date
01/03/2024

Eligibility

Key inclusion criteria
1. Aged ≥16 years
2. Have undergone either elective primary hip replacement or primary knee replacement
3. Surgery performed within NHS Grampian between January 2018 and January 2022

Participant type(s)
Patient

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
16 Years

Sex
All

Total final enrolment
25126

Key exclusion criteria
1. Individuals who have opted out of data sharing at either a local or national level
2. Individuals who have undergone revision hip and knee arthroplasty, arthroplasty at another site or unicompartmental knee replacement
3. Individuals who have undergone hip or knee replacement for trauma (hip fracture or distal femoral fracture)
4. Individuals who have undergone operative management outside of NHS Grampian

Date of first enrolment
01/03/2022

Date of final enrolment
01/06/2023

Locations

Countries of recruitment
United Kingdom

Scotland

Study participating centre
Clinical Research Facility - University of Aberdeen
Polwarth Building
Foresterhill
Aberdeen
United Kingdom
AB25 2ZD

Sponsor information

Organisation
University of Aberdeen

ROR
https://ror.org/016476m91

Funder(s)

Funder type
Government

Funder Name
Chief Scientist Office, Scottish Government Health and Social Care Directorate

Alternative Name(s)
Chief Scientist Office, Scottish Government Health Directorate CSO, Chief Scientist Office, Scottish Government Health Directorates, Chief Scientist Office of the Scottish Government Health Directorates, Scottish Government Health and Social Care Directorate of the Chief Scientist Office, Scottish Government Health Directorate Chief Scientist Office, The Chief Scientist Office, CSO

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
United Kingdom

Results and Publications

Individual participant data (IPD) sharing plan
Individual patient data will not be shared but the metadata utilised in the development of the proposed clinical prediction models will be shared on an open repository (GitHub) in line with good practice on reproducible science methodology.

IPD sharing plan summary
Other

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Results article		01/07/2024	08/04/2025	Yes	No
Protocol article		11/05/2022	12/05/2022	Yes	No
Other publications	Managing class imbalance in the training of a large language model to predict patient selection for total knee arthroplasty: Results from the Artificial intelligence to Revolutionise the patient Care pathway in Hip and knEe aRthroplastY (ARCHERY) project	27/02/2025	03/03/2025	Yes	No
Study website	Study website	11/11/2025	11/11/2025	No	Yes