STUDY PROTOCOL

Planning for **F**rai**l**ty: **O**ptimal Health and Social Care **W**orkforce Organisation Using Demand-led **S**imulation Modelling (FLOWS)

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Table of amendments

Version Number	Author	Effective Date	Reason for Change
1.0	BW, CF		Protocol as submitted for final funding approval with minor edits to correct typo, layout and removing content not required in a protocol
2.0	BW,CF		5.3.2.1 – added how members of professional members of networks would be contacted 5.3.2.2 – amended Survey software, added clarification and arrangements for data collection for Survey following ethical review Inserted hyperlink into Ref61
2.2	BW,CF		5.3.2.2 – Further clarification on data Collection for Survey apropos comments from ERGO2 committee
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1. Abstract

Research Question: What is the present, and expected, size and composition of the health and social care workforce required to provide care for the frail older population?

Background: As the population ages, robust workforce planning to meet future demands for health and social care by older people is needed. A lack of evidence in this area has led to a mis-match between the health and social care demand from the ageing population and the current workforce capacity. The proposed study will use demand-led simulation modelling of the workforce required to address the specific challenge of providing health and social care for the growing numbers of older people living with frailty.

Aims & Objectives: The aim of the study is to use simulation modelling to explore long-term trends in frailty-related health and social care use in the ageing population and its implications for future workforce size and competencies to support high quality care. The primary objective of this study is the creation of a simulation model that will inform service and workforce planning to meet health and social care needs associated with frailty.

Methods: The study will use a System Dynamics design to develop and test the simulation model. Work packages comprise a scoping review, gathering of public and professional perspectives on service provision via a survey and stakeholder engagement activities, and analysis of linked health and social care data, all of which inform the simulation modelling work package and development of a workforce planning toolkit.

Timelines for delivery: The scoping review will be completed in year 1. Routine health and social care data specification and extraction will occur in year 1, as will service mapping and classification and survey preparation. Survey data collection and analysis will occur in year 2. Simulation modelling will commence in year 2, with validation, sensitivity analyses and scenario modelling in year 3. Development of workforce guidelines and toolkit will occur in year 3 Stakeholder engagement, including patient public involvement, will run throughout the study, reviewing study results and informing development of the other work packages.

Anticipated impact & dissemination: This study will provide new, direct evidence about the impact of frailty on health and social care workforce requirements within the ageing population The improved understanding of workforce requirements offered by this study will inform workforce planning for frailty services across health and social care, ensuring future benefit for patients through provision of timely and appropriate care and a workforce planning toolkit to support local decision-making.

2. Plain English Summary

The purpose of this research is to aim to predict the numbers and types of health and social care staff that will be needed to care for older adults living with frailty in the future.

Why this research is important: Older people with complex health problems are described as frail. Frailty is more common in older people, affecting 44% of adults aged 65 and older in England. Better care for people living with frailty is essential to improve health and quality of life and help the NHS to be more efficient. The NHS needs to ensure that they have the right number of staff, with the right skills. To do this, organisations delivering health and social care need to know more about what services are required by people living with frailty, and the numbers and type of health and social care staff needed to run those services. In previous research, we developed a tool (a computer model) to predict the numbers of adults living with frailty and their use of health care services. We now need to expand this model to be able to predict the staff numbers and skills that are needed to provide the best care for these patients.

The aim of this research will be met by:
• Reviewing evidence to understand how services for adults with frailty are staffed.
• Analysing routinely available health and social care information from patients and care providers to understand current service use and staffing.
• Gaining input from a variety of people working in frailty and social care, patients, and carers to better understand different care services and the staff and skills required.
• Gaining information on the number and type of staff required through a national survey and consultations with Service(s) and Health and Social Care Commissioning staff.
• Using all this information to expand our current decision tool (computer model) to better predict numbers and type of staff needed in the future.

We have worked with national organisations involved in workforce planning to develop this research. The research will be carried out by a team with expertise in analysis of routine health and social care patient and workforce data.

We will involve the public by continuing to work with our core group of patients and carers to develop our current model and research on frailty. They have highlighted that there are particular services that are helpful for them in living with frailty, but waiting times are often long due to insufficient staff. They have also told us about gaps in services and staffing. This group will continue to work in partnership with us to ensure that services discussed, and decisions made, include their perspectives. They will also help with plans for sharing the research. We intend to ensure that members of the public who are not often heard from are included, and we are working with local and London community groups to achieve this.

We will share the study by creating a toolkit based on the computer model for the people who plan health and social care services, so they can work out what type and number of staff they will need to look after people with frailty in years to come. We will share this through national networks and organisations. In addition, we will work with organisations, voluntary services and support groups relevant to people with frailty to share the work. Our group members have suggested that we use local radio stations to create discussion and reach out to communities that may not otherwise hear about research, and broadcast in other languages.

3. Background & Rationale

Evidence presented here was generated from a literature review of major health and social care databases (Medline, CINAHL-Plus, Social Care Online) and a Google search using terms including workforce, frail, frail elderly, staffing, workforce planning. Registers reviewed for ongoing research included https://clinicaltrials.gov/, https://cordis.europa.eu/, https://www.isrctn.com/ , https://www.clinicaltrialsregister.eu/ and https://fundingawards.nihr.ac.uk/. It is noteworthy that there is no available literature on the topic of demand-based workforce planning for adults living with frailty, nor have we found any ongoing studies in this area.

With a projected increase of adults aged ≥65 in the UK from 12.5 million in 2020 to 18 million in 2050 (Office for National Statistics, 2018), robust workforce planning to meet future health and social care needs of the ageing population is essential. There is evidence of unmet need for health and social care, with significant health inequalities related to deprivation (Marshall et al. 2015; Vernon 2020) and this gap between need and capacity will continue to expand. At the same time, older people are more at risk of poor health care outcomes and poor-quality care. There is, however, a mismatch between workforce capacity and older people's acute and community care provision associated with an ageing population (Donaldson et al. 2019; OECD, 2016; Ono et al. 2013). Current methods used for workforce planning are predominantly supply-led, often failing to account for future changes in demand and associated requirements for skills development and deployment in the existing workforce (Imison et al. 2009; Ahern et al. 2019). Estimating the health care workforce needed to meet this demand is fraught with challenges. Workforce plans are criticised for being based on doing more of the same, using established patterns of service delivery of the past as the basis for planning the future (Ahern et al. 2019; Ono et al. 2013). Birch (2015) highlights the pivotal importance of understanding plans for service delivery (and the assumptions they have been based on) and basing workforce plans on population demand in order to maximise coverage and health gain. This study will use data-driven, demand-led methods. Evidence-based models based on projections of demand will be more reflective of changes in population numbers and in availability of interventions and care models, both of which may alter current and predicted workforce requirements. Simulation modelling approaches have been used successfully in healthcare systems, including for older adult pathways and workforce planning, and are an appropriate approach for the creation of needs-based workforce models to inform health and social care workforce requirements for the ageing population (Taghavi et al. 2020; Cassidy et al. 2019; Desai et al. 2008; Katsaliaki et al. 2005). The proposed study focuses on demand-led simulation modelling of workforce requirements associated with the specific challenge of managing the growing numbers of older people living with frailty.

Older people are more likely to be frail, a condition associated with poor health outcomes and high health and social care service use (Clegg et al. 2016). Frailty is an abnormal progressive biological state associated with ageing and multiple long-term conditions. It is characterised by reduced physiological and cognitive reserves and results in vulnerability to significant health decompensation following stressor events, such as acute illness or injury (Clegg et al. 2013; Gale et al. 2015; Campbell & Buchner et al. 1997). As frailty progresses, there are adverse consequences for functional ability and increased predisposition to acute frailty syndromes such as immobility, falls, incontinence and confusion. Due to its impact on physiological and functional reserves, frailty is associated with increased risk of death, physical dependency, increased health and social care service use including emergency hospital admission, transition to residential care and reduction in quality of life (BGS 2014/15; NHS England 2015; Clegg et al. 2016; Theou et al. 2016; NIHR 2017; Han et al. 2019). For

these reasons, identification and management of moderate and severe frailty is now mandatory in England and is specified in the GP contract (2017/18 GP GMS; Clegg et al. 2016). Targeting of interventions towards older people living with frailty should ensure that resources are directed towards those most in need and reduce avoidable service use (BGS, 2015, 2014; Morley et al. 2013).

It is thought that at least 1.8 million people in the UK aged 60 and over are living with frailty. Although prevalence is highest in people aged 85 and above (NIHR 2017), our recent analyses have demonstrated frailty is already prevalent in people aged 50-60 (Fogg et al. 2021), suggesting that current demand for services associated with frailty could be under-estimated. As the population ages, frailty will become more prevalent (currently 14% in those over 60, rising to 65% of those aged 90+) and frailty-associated health and social care needs will continue to grow. There is, however, evidence of unmet need for management of older people with frailty, and this gap between need and workforce capacity will continue to expand.

Delivery of services to manage frailty among older people is constrained by the available workforce. Shortages of GPs and other professions in primary and community care are having a detrimental effect on quality of care and are jeopardising the shift to home-based care for older people (Beech et al. 2019). In Wales, there is evidence that patterns of demand are changing in favour of care at home, especially for people with complex needs, frailty and dementia, and future strategies for a mix of care provision and budgets need to reflect this (Sion & Trickey, 2020; Older People's Commissioner for Wales, 2014). Additionally, the need for defining workforce requirements to provide appropriate care for people living with frailty in care homes and the challenges of recruiting and retaining qualified staff to maintain older people's best quality of life have been identified (Devi et al. 2021). Meeting the growing health and social care needs of our ageing population will be complex and challenging. Commissioners and service planners must identify methods of maintaining or improving quality whilst optimising their use of resources, including the health and social care workforce, and there is a clear need for increased joint responsibility from the NHS and social care for organising services and adopting new contracting and funding models (Deloitte, 2014). Although guidance (BGS 2014, 2015) provides a framework for individual management and service design, a key barrier to realising the benefits of effective interventions is a lack of evidence on the workforce required for their delivery at scale in both health and social care.

Although there is a growing body of evidence on health care utilisation in older people with frailty, less is known about social care use in this group. It is clear that providing care for older people with frailty is complex, requiring an integrated approach from primary, secondary, community and social services and high levels of interprofessional collaboration (Threapleton et al. 2017; Roller-Wirnsberger et al. 2020). The widespread introduction of frailty screening tools has facilitated systematic identification of moderate and severe frailty to support clinical management of older people with frailty in primary care. However, important questions remain about how services can best be organized, commissioned, and staffed to meet the need for timely assessment and intervention across the health and social care demand associated with frailty within a typical general practice population. Although available information on service use focuses on acute primary and secondary care needs, future services for frailty are likely to expand further upstream, in areas of health promotion and illness prevention, to try and reduce acute care needs (Drennan et al. 2018). Guidance has been provided on the activities to be undertaken by frailty services, however commissioning and configuration of services vary locally, and there is no specific guidance for workforce planning across the frailty pathway, with little known about optimal workforce requirements for high quality frailty care (British Geriatrics Society, 2015; NHS RightCare, 2019).

The need for expansion of frailty services has also been identified (Cornwell, 2019; Tomblin Murphy et al. 2013; Lewis et al. 2020). Despite the predicted increase in need, current information on

demand-based workforce planning for frailty is scarce. A study of combined acuity and frailty for stratifying patient care needs by the community nursing workforce concluded that the gap in the needs identified should be considered in new integrated care models including the nursing and social care workforce (David & Saunders, 2018). NHS Vanguard sites and new models of care demonstrate the potential for success of integrated care for older people, but require multidisciplinary, multiagency teams across sectors with redesigned roles and a wider scope, e.g. involvement of third sector organisations and provision of support to carers, than traditional systems (Athorn et al. 2020). Questions remain about the staff numbers and skills required to provide care for older adults living at home (Lovink et al. 2018; Donelan et al. 2019) and to deliver the level of healthcare service integration required for improving outcomes for older people with complex conditions (Frost et al. 2020). Given the complexity of care needs and methods for care delivery for older people with frailty, modelling approaches such as population to personnel ratios are not sufficient to plan the future workforce (Segal & Bolton, 2009).

Frailty has major resource use implications for the NHS as frailty-associated health care demand continues to grow due to increased frailty prevalence in the ageing population. There are, however, gaps in the evidence relating to the delivery of interventions and services to optimise provision of high-quality individualised patient management across the frail older population, particularly in relation to future workforce requirements. In line with the HS&DR remit, the proposed study on the workforce required to deliver high quality care for older people living with frailty is of significant strategic importance for the NHS and social care services. Sustainable delivery of high-quality care for older people living with frailty is increasingly important and will require new ways of working, involving training and development of a workforce with optimal skills and capabilities to deliver frailty care services. Current workforce skills and volume of staff are not well aligned to patient need, reducing care quality, and affecting staff morale and turnover (OECD 2016; NHSE / Skills for Health, 2018; Sizmur 2018; Oliver et al. 2014).

Whilst improved service provision for older people living with frailty has the potential to reduce unplanned care costs, improve outcomes and enhance quality of life, a lack of evidence on the workforce requirements to provide optimal care for this group is limiting the widespread implementation of effective care. Service providers and commissioners across health and social care will need methods for predicting workforce requirements in relation to frailty. Beech et al. (2019) note that changing patient needs will require workforce planning and development to ensure that new and extended roles can be filled. Although there are guidelines on provision of services for the growing population of frail older people, there is a lack of evidence to inform workforce planning, including current and future demand across health and social care services and the associated staff numbers and type required. A national survey of health and social care stakeholders identified workforce challenges and integration of services to provide care for patients with complex needs including frailty as key priorities (AHSN, 2019). There is also a lack of effective demand-led workforce planning tools for use by service providers and commissioners.

In the Frailty Dynamics study (HS&DR 16/116/43) we have explored the incidence, prevalence, and progression of frailty within an ageing population and analysed the relationship between frailty, demographic and clinical factors and service demand (Fogg et al. 2021). We have developed a simulation model of the progression and impact of frailty on primary, secondary and urgent care use in ageing populations. It is, however, known that new ways of working will need to be developed in order to address the workforce in primary and community services, particularly in deprived areas (Beech et al. 2019) and that the shift to homebased care will require new skills and capabilities to be developed. Gaps remain in our understanding of the impact of frailty on community and social care use and the relationship between frailty-related demand and health and social care workforce needs. This study will address those gaps and will provide an essential foundation for workforce

planning at a regional and local level via a simulation-based workforce planning tool. Focusing demand-led workforce planning around the health and social needs of older people living with frailty therefore addresses a major challenge for health and social care organisations.

The proposed study will improve understanding of service demand related to frailty, and how the size and competencies of the workforce need to be developed to meet demand. The study aims are therefore in line with the remit of Call 20/115, to develop evidence to support deployment of the right skills and experience for improved quality of care, including informing innovative ways of working in health and social care. The improved understanding of workforce requirements offered by this study will inform workforce planning for frailty services across health and social care, ensuring future benefit for patients through provision of timely and appropriate care and development of a workforce planning toolkit to allow exploration of the impact of different service configuration and demographic scenarios to support local decision-making. The research outputs will be able to guide distribution and deployment of the workforce across different sectors, including primary and secondary health care, but also social care, community health care, voluntary sector organisations, and inform development of new models of care to be implemented through Integrated Care Systems (ICSs).

This research will address significant evidence gaps relating to frailty-related health and social care needs and resulting demand for workforce impact. In previous work (HS&DR 16/116/43 - Frailty Dynamics Study), we have created a simulation model of long-term trends in development and progression of frailty in people aged 50 and over, allowing prediction of frailty-related primary, secondary care and urgent care demand in an ageing population. In this study, we will build on this demand-simulation model to determine frailty-related community health and social care demand and estimate the associated optimal workforce size and skills required to provide services for the growing population of people living with frailty. The research will thus facilitate organisational resilience in the face of changing population needs and support optimal resource deployment. It is likely that the greatest impact of the proposed study will be within workforce planning for ICSs (NSHE, 2021), generating both large scale and localised planning trajectories, sensitive to inequalities of outcome, to enable Integrated Care Boards (ICBs) and other commissioners to judge proportionate investment in key workforce segments across health and social care.

In summary, our proposed research is in line with the Programme remit to provide evidence on the quality, accessibility and organisation of health services, improved delivery of services and Call 20/115. Study outputs will include a simulation model to predict service demand and workforce needs associated with frailty, which can be adjusted to the local and regional context and develop a workforce planning toolkit.

4. Aims & Objectives

This research will address significant gaps in the evidence relating to the health and social care workforce requirements for the increasing numbers of older people living with frailty. Specifically, this study will use simulation modelling to explore long-term trends in frailty-related health and social care demand in the older population and their implications for future workforce and competency requirements to support high quality care. It will inform service and workforce planning to meet the needs of the ageing population.

The over-arching aim is to understand the present, and expected, size and composition of health and social care workforce requirements associated with optimal care provision for the frail older population. This aim will be addressed through addressing the following specific research questions:

1. What is the predicted health and social care demand associated with frailty in the ageing population? (Work package 1,2,3)
2. What is known about the workforce required to deliver health and social care services? (Work packages 1 & 2)
3. What services are currently provided or being developed for prevention and management of frailty and what are the associated requirements in terms of workforce numbers, skills and competencies? (Work packages 1 & 2)
4. What are the optimal community and social care service configurations for providing quality care and meeting expected future demand in the frail older population? (Work package 4)
5. What is the present, and expected, scale of the workforce associated with optimal health and social care provision for the frail older population? (Work package 4)

5. Research Plan & Methods

5.1 Study Design and Theoretical Framework

The study will utilise a System Dynamics (SD) design, drawing on literature estimates of workforce configuration and size for specific services from the scoping review, quantitative analysis of routine health and social care data and exploration of the perspectives of service users and providers, via a survey and extensive stakeholder engagement, to inform simulation of future workforce requirements associated with frailty in an ageing population. Based within Operational Research, SD is a computer simulation modelling approach whose purpose is to analyse changes over time in complex, interacting systems. SD modelling is a well-established approach to describing complex systems and, when used to develop quantitative simulation models, can be used for predictive modelling of service demand, outcomes, or resource needs. SD has been used for decades in many different application areas, and is ideally suited for health and care systems (Brailsford 2004; Northridge 2016).

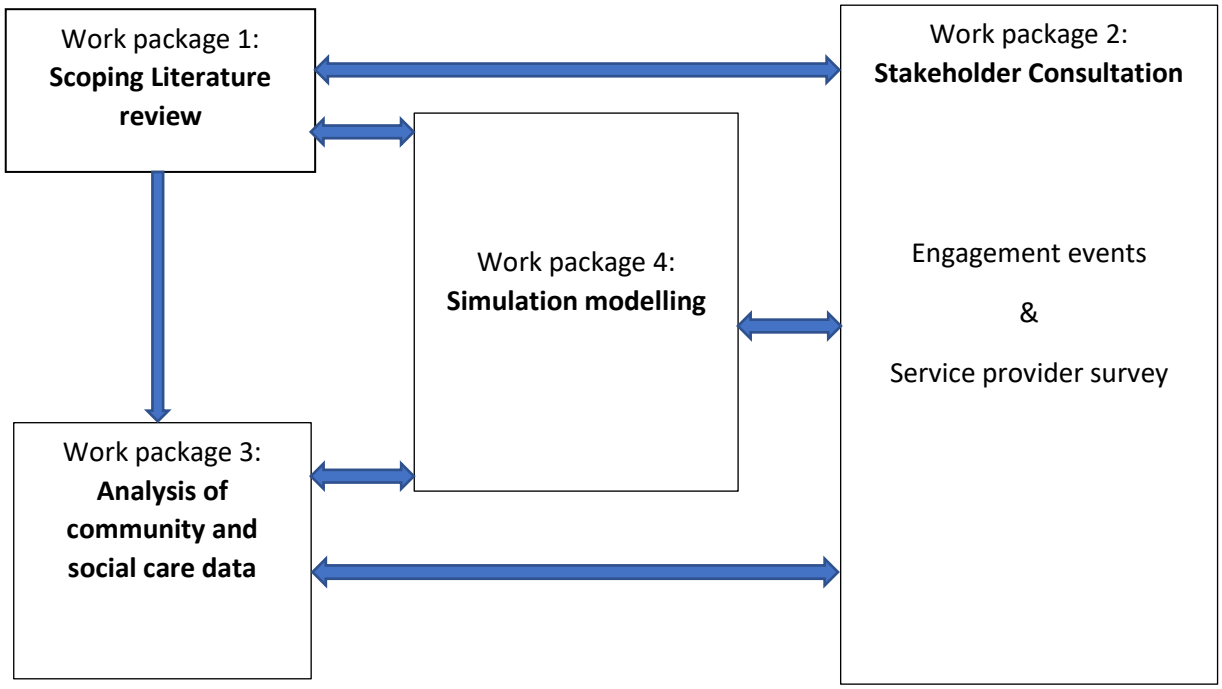
An SD model consists of stocks (accumulations) of material, and flows between them, analogous to a series of water tanks connected by pipes. The rate of flow along each pipe is governed by valves that can be turned up or down. We will use SD to model future frailty-related health and social care demand in the UK and the associated workforce requirements to meet projected demand. We will develop a stock-flow model depicting patient transitions between different frailty states in different age categories. In our case, the 'stocks' are the numbers of patients in different health and social care states, including age and frailty status. The 'flows' are the transitions between states over time, which will be adjusted by those characteristics identified in previous work as significantly impacting on frailty-related demand for services, or strongly associated with specific outcomes. The simulation parameters, including transition rates between states, are largely defined through the Frailty Dynamics study, but with additional data about social care use provided through work packages 1,2 and 3.

The proposed work will allow further refinement of service demand information in relation to integrated health and social care. The current simulation model predicts a set of pre-specified outcomes, including mortality and service use, from each age and frailty-state group at yearly intervals. The proposed work will also allow predictions of workforce requirements from the service use outcomes already embedded within the simulation model, supplemented by new data from work packages 1, 2 and 3. A strength of the simulation modelling approach is that it allows for exploration of different service configurations and projection of future demand, with rapid testing of the impact of different workforce scenarios to aid decision-making. The proposed study will allow service providers and commissioners across health and social care to understand the likely scale of service demand, the impact of different service provision configurations and the consequent impact on workforce requirements.

The data-driven quantitative simulation is informed by the scoping review (work package 1), stakeholder consultation (work package 2), and the analysis of health and social care data (work package 3). In the stakeholder consultation, the intention is for both researchers and participants to develop their understanding of the system and therefore useful insights may emerge from this phase (de Gooyert et al. 2017; Tako & Kotiadis 2015; Bolt et al. 2020). It combines analysis of service organisation with personal accounts of system functioning, planning and barriers to optimal care provision to deepen understanding of problems and generate potential solutions. The consultation phase will be iterative and occur alongside other work packages, both informing their development and providing a resource for review of emerging findings.

This study will build on the existing SD model created in previous work (NIHR HS&DR 16/116/43 - Frailty Dynamics Study). The study will comprise 4 inter-linked work packages, all of which will inform the development and testing of the workforce simulation model in work package 4.

Figure 1: FLOWS Study – Information and Data Flows



5.2 Work package 1 - Scoping Review

A scoping review, to include literature, policy and health and social care data sources, will inform preliminary simulation model development, data specification in work packages 3 and the survey component of work package 2. The scoping review will be conducted to map current evidence on workforce and competencies for frailty interventions and services for adults aged 50 and over, as well as to identify knowledge gaps and future priorities for research in this area. This will be supported by review of relevant policy on frailty services and workforce and review of sources of social care use and workforce data required for simulation model development. The synthesised evidence will inform preliminary simulation model development and primary analysis data specifications for the study.

5.2.1 Scoping review protocol development and registration

A protocol for the scoping review will be registered on the Open Science Framework (https://osf.io/registries). The review protocol will utilise the Joanna Briggs Institute (JBI) template (downloadable from https://jbi.global/scoping-review-network/resources) and will follow recommended methodologies (Arksey & O'Malley, 2005; Colqhoun et al. 2014; Levac et al. 2010; Peters et al. 2015)

5.2.2 Scoping review questions

1. Which health and social care services for adults aged ≥50 living with frailty are described in the literature?
2. What is the related workforce required to run the services – i.e. which types and numbers of health, allied health or social care professionals - are involved?
3. What competencies are the workforce delivering the frailty services required to have?
4. Which specific interventions to address frailty have been developed for people living with frailty, and what workforce is required to deliver them?

5.2.3 Search strategy

The inclusion criteria are:

- Literature concerned with the description and/or evaluation of health or social care services designed to assess, treat, or support adults aged ≥50 living with frailty.
- Type of evidence will include (but not be limited to): quantitative and qualitative research, quality improvement projects, service evaluations, service design descriptions, audits, reports, lived experience and campaigns.
- Services designed or provided in the last 10 years to maintain relevance with current workforce qualifications and configurations.
- Evidence originating from any country, written in English, to be able to assess transferability to a UK setting.

The review will consider both the services provided and the workforce providing the services as participants in the scoping review. The context for service provision will encompass any facet of the care needs of the older adult relating to frailty, including information on the associated workforce requirements where this is available. The scoping review will also include any available policy and evidence on workforce requirements and supply factors, which will then feed into the stakeholder work exploring constraints on meeting demand.

Search terms will include concepts such as: frailty, workforce, adult, older adult, health care, social care, nursing, carers, occupational therapy, physiotherapy, pre-hospital care, community care, mental health services, frailty referrals, falls, third-sector care, commissioned charity services.

The following research databases will be systematically searched: Medline, CINAHL, CENTRAL, study and review registries, NHS Evidence, Social Care Online, Social Care Institute for Excellence and Web of Science. Forward citation searching of key articles and screening of reference lists of included articles will be performed. Tables of contents for Key journals including Journal of Integrated Care, Age and Ageing and Health and Social Care in the Community, Journal of the Operational Research Society and European Journal of Operational Research will be hand-searched. Grey literature will be sourced through reviewing websites of relevant organisations e.g. NHS Trusts, Local Authorities, the Care Quality Commission, the Kings Fund, the Health Foundation, the Health Service Journal, Age UK, Centre for Ageing Better, International Longevity Centre – UK, and Academic Health Science Networks, contacting teams involved in relevant activities for further information where necessary.

5.2.4 Strategy for reviewing the literature

As per the JBI guidance, an initial limited search of a selection of databases will be performed, followed by an analysis of words contained in the title and abstract and of index terms for the article. The search terms will then be updated, and a further search performed, including all

databases. Two reviewers will review all identified articles and extract the characteristics of included articles and key evidence relating to the research question(s) on a pre-specified chart designed to capture data appropriate for each of the four research questions.

Findings will be charted using tables, figures, and narrative summaries, under each of the four questions highlighted above. They will be used to inform the preliminary simulation model development and identify further data needs which may be met through further data analyses, sourcing of data from organisations or through the survey (work packages 2, 3 and 4). The findings will feed into work package 2, where the results of the scoping review will be discussed, and we will work with our stakeholders (i.e. health and social care professionals, third sector organisations, commissioners and public members) to generate outputs summarising the findings that are tailored to their needs.

5.3 Work package 2 – Stakeholder Consultation on Frailty Services and Workforce

We will engage service users, carers, and professionals in identifying current and future frailty service provision and workforce requirements, skills required for different frailty services and service organisation scenarios for 'what if' simulation modelling. This will be achieved through a series of workshops with collaborators, patients and carers and other stakeholders including professionals and service commissioners. This work will inform, and be supported by, a survey of providers of services for older people living with frailty. WP2 will be integral to embedding impact and implementation into the study, informing the initial stages of the benefits realisation work that will ensure study outputs can be taken forward into service planning and commissioning (Section 5.2).

5.3.1 Stakeholder Engagement Workshops

We will conduct six stakeholder engagement workshops, working closely with our core collaborator group from Academic Health Sciences Network (AHSN), Applied Research Collaborations (ARC), Health Education England (HEE) (Section 6.3.1.1). The core collaborator group will facilitate access to a broad network of leaders in health and social care workforce planning. In addition, the project team have considerable experience in successful stakeholder and PPI engagement and link to extensive networks from health, social care, commissioning, public health, patient and carer groups, professional bodies for the stakeholder events and development of simulation scenarios. These organisations will provide input to the stakeholder engagement activities throughout the project. With the extensive professional networks and implementation experience available to the research team, we will be well placed to deliver implementation across relevant services.

In addition, we will involve Patient & Public Involvement (PPI) contributors, health and social care professionals from provider organisations, service commissioners and workforce leads. The Stakeholder Engagement events will have an integral role in the development and completion of the modelling phase of the study These workshops will focus on: framing terminology for the project; reviewing evidence from other work packages; description and categorisation of current service models and interventions; mapping of workforce requirements for service delivery; mapping services against the Frailty Capabilities Framework (NHSE, 2018); identifying information needs and participants for a survey of service models; simulation model development; exploration of perspectives on preferred models and identifying service configuration scenarios for simulation 'what if' scenario experiments.

5.3.1.1 Contributors

Stakeholder engagement event attendees will represent commissioners, health and social care provider organisations and patients and the public. Attendees will meet in person in Southampton, or virtually; the team is experienced in running virtual engagement events. Stakeholder engagement and exploration of professional and public perceptions will be supported by the Study Collaborator Group (SCG). This group is comprised of professionals with specific interests in frailty, health and social care commissioning for older people with frailty and workforce planning. The SCG have contributed to conceptualisation and development of the proposed study and members of this group include: the PPI representative, Mrs Vivienne Windle; Simon Fuller, Head of Workforce Planning & Intelligence South West Region, Workforce Planning & Intelligence Directorate, Health Education England; Kathy Wallis, Associate Director, Strategic Programmes (Healthy Ageing), Wessex Academic Health Sciences Network; Mark Allen, Director of Adult Services, Hampshire County Council; Matt Hutchinson, Social Care Commissioner, Hampshire County Council; Cheryl Davies, Programme Manager Healthy Ageing, Wessex AHSN; Prof. Jackie Bridges, Deputy Lead Ageing & Dementia, Wessex ARC.
The project has been developed with collaborators including Simon Fuller, Head of Workforce Planning & Intelligence South West Region, Workforce Planning & Intelligence Directorate. Health Education England; Kathy Wallis, Associate Director, Strategic Programmes (Healthy Ageing), Wessex Academic Health Sciences Network (AHSN); Mark Allen, Director of Adult Services, Hampshire County Council; Matt Hutchinson, Social Care Commissioner, Hampshire County Council; Cheryl Davies, Programme Lead Healthy Ageing, Wessex AHSN.

5.3.1.2 Engagement Process

Stakeholder consultation and engagement is an integral component of the SD modelling approach and engagement events will be organised at key points in the study to inform model development and testing (de Gooyert et al. 2017; Tako & Kotiadis 2015; Bolt et al. 2020). We will present emerging findings from each stage of the data analysis and ask participants to reflect on implications for service delivery and organisation. At each stage, the engagement events will contribute to decision-making around data needs, model building, scenario development and future priorities. The engagement events will ensure that patient/carer and professional experience in relation to service structures and care trajectories is central to model development. At the final stakeholder engagement event, we will present the draft workforce planning toolkit and simulation findings and explore their implications for future research and practice. 'What if' scenarios will be developed to explore the impact of different demographic factors, service models and service use on workforce demand.

5.3.1.3 Engagement Event Outputs

The engagement events will be used to inform the scoping review strategy, the sampling and data collection for the survey and sampling and data collection from health and social care sources. Outputs from work packages 1, 3 & 4 will be discussed by the engagement event participants, ensuring that data emerging from component parts of the study will be reviewed by key stakeholders, in turn informing the on-going simulation model development and identification of 'what if' scenarios for exploration. Outputs from the engagement events will be fed back to the Study Management Group (SMG) at key points in development of the simulation model and outputs. The leads for Work Package 2 will collate the information gathered from the events in the form of contemporaneous notes and graphics. The information gathered will be shared with participants to ensure a sense check and prior to sharing with the wider research team.

5.3.2 Survey of frailty service provision and workforce

5.3.2.1 Sample

The survey will be informed by the initial stakeholder engagement events and will provide additional information on the range of frailty-specific services currently provided in health and social care organisations and how these are staffed, with additional data gathering on relative frequency and volume of different services/models of provision, an estimate of unmet need and additional services required, or what constitutes 'optimal provision'. The aim of the survey is to expand the stakeholder consultation to provide information from professionals who are involved in a broader range of organisations and localities. We will utilise our extensive frailty networks to survey a range of health and social care professionals who are engaged in frailty service provision in health, integrated and social care organisations, via organisations such as AHSN Frailty Network, BGS Acute Frailty Network and Specialised Frailty Network (https://www.acutefrailtynetwork.org.uk/ and https://www.scfn.org.uk/), National Care Forum (https://www.nationalcareforum.org.uk/), Royal College of Nursing (RCN), Association of Directors of Adult Social Services in England (ADASS) (https://www.adass.org.uk/), and other relevant professional organisations. These organisations will contact their members by e-mail, providing the study information, PIS and consent form and the link to the anonymous on-line survey. The study team will not have access to participant personal details.

5.3.2.2 Data Collection

Using Qualtrics, we will survey opinion from health and social care and integrated care professionals, building on Work Package 1 & the stakeholder engagement events. The initial stakeholder engagement events and scoping review will inform survey development through discussion of classification of service types (e.g. prevention, admission avoidance, etc.), providers and staff types.

Potential survey participants will be approached via professional network organisations with an interest in frailty. The eligibility criteria for completing the survey are that the participants should be a professional in health or social care with an involvement in delivering or planning services for those living with frailty. The survey participants will be asked to complete the anonymous on-line survey in relation to their service. Survey data will be confidential, and no personal data will be gathered on the respondent or their staff.

Data will be gathered on their role type, sector, service type(s), service size/caseload, provider type according to the pre-identified typology developed from the scoping review and stakeholder engagement. Data on specifics of the participants' roles, employers or other potentially identifiable information will not be collected and, for this reason, survey responses will be closed categories. Information on the workforce types for each service, including professions, numbers and vacant posts will be requested.

Data collection will occur following the scoping review and first phase of stakeholder events. We will allow 6 months for completion of survey data collection. With the assistance of study collaborators, will use Frailty networks across the AHSN and other relevant organisations to identify frailty services and potential respondents. Collaborator experience with the AHSN frailty audit suggests that we can realistically expect a minimum of 200 responses across our networks.

5.3.2.3 Data Analysis

Descriptive analyses will be used to summarise the range of services, service configurations and pathway alignments, including location, type, caseload, staffing and provider types. Summary data on the average and range for caseload, staff numbers, and types will be calculated for each service category and provider type. Information from the survey will inform choice of baseline simulation model assumptions and service scenarios for simulation.

5.4 Work package 3 - Analysis of social and community care service use

Analysis from this work package will inform parameterisation of the simulation model. Data on primary, secondary, and urgent care service use by frailty category has already been established for the Frailty Dynamics study. These data will be supplemented by patient-level analysis of community, mental health, and social care service use from the Discover-NOW dataset, filling current knowledge gaps with estimates of use from real-world data to have more complete picture of service use. This dataset also holds information on the type of health and social care staff providing community services which will help inform attribution of workforce type and required skills to the workforce demand model. Lastly, the dataset is derived from a socioeconomically and ethnically diverse population which will enable the team to explore potential differences in service use in well-recognised underserved populations in more detail.

5.4.1 Data Source

Data on primary, secondary, and urgent care service use by frailty category has already been established for the Frailty Dynamics study. There are, however, gaps in our knowledge of community and social care use and we have sought out a data source that can provide linked data to inform simulation development to cover these areas. The current simulation will therefore be supplemented by patient-level analysis of community, mental health, and social care service use from the Discover-NOW dataset. Discover-NOW is a depersonalised dataset which includes linked primary, secondary, acute, mental health, community health and social care records for over 2.6 million patients who live in and are registered with a GP in Northwest London (NWL). The dataset is one of Europe's largest comprehensively linked longitudinal datasets, capturing a population of around a third of London and including an ethnically diverse population. Discover is accessible via the Discover-NOW Health Data Research HDR) Hub for Real World Evidence, hosted by Imperial College Healthcare Partners (ICHP). Analysis from this work package will inform parameterisation of the simulation model. The Discover-NOW databank is derived from one of the largest integrated care records in the country. It links data from four acute, two mental health and two community Trusts across North West London, 380 GP practices and social care data from eight boroughs. As of 2020 Discover, one of the largest deidentified linked health and care datasets in Europe, held records for a total of 2.3 million currently registered patients, or 95% of the NW London population, with historical data going back 10 years (https://discover-now.co.uk/). Comparisons with the UK population and the Clinical Practice Research Datalink (CPRD) showed that the Discover population matches the overall age/sex distribution of the UK and CPRD, but is more ethnically diverse. The prevalence of most chronic diseases are comparable to national rates. Additional advantages of Discover are the identifiable care organisations and postcodes, allowing mapping and linkage to healthcare provider variables such as staffing, and includes contacts with social, community and mental health care. Although being representative of a single geographical area, the breadth of data available is key to being able to answer the questions posed in the proposed work, which cannot be met by any other existing UK databank to our knowledge. The databank has been used by clinicians, academics and medical industries to inform and assess care and for research.

5.4.2 Data Collection

Patient-level data will be used to determine community and social care use by age and frailty category. Following confirmation of approval from the North West London Data Access Committee, the data specification will be developed by the research team with support from with a Discover-NOW analyst and clinician familiar with the dataset. SQL queries will be used to extract data on primary, secondary, mental health, community health and social care service use for adults aged ≥50 present in the dataset between 2015 to 2019 inclusive, an estimated 620,000 individuals as of December 2019. The dataset also includes the staff role for the workforce providing services. Data will be accessible to the Southampton team via the Trusted Research Environment (TRE).

5.4.3 Data Analysis

The frequency of community, adult mental health and social care use by age group (50-64, 65-74, 75-84, 85+) and electronic frailty index (eFI) frailty category by calendar year from 2015 to 2019 will be described and the proportion of each age group/frailty category using services each year will be calculated. Sub-group analysis by key covariates including ethnicity and Indices of Multiple Deprivation will be performed. Where staffing data are available (for example staff role in social care data), an overall description of staff providing services by frailty category will be produced. Service use for specific population subgroups will be further stratified by staff role.

5.4.4 Contextualisation with Discover PPI representatives

We will recruit 15-20 people whose data is contributing to the Discover-NOW dataset (aged ≥50). We will discuss the different health and care services (both formal and informal sectors) they/people they care for come into contact, with regard to managing frailty, the type of people (i.e. workforce) that provide services for them, what they feel they need more / less of and results from the Discover data analysis. Discussions will be summarised using plain language and infographics and circulated to the participants for comment. Participants who would like to be involved in the wider aspects of the project will be invited to participate in stakeholder engagement meetings (WP2) so that they can inform how the WP3 results feed into the simulation model.

5.5 Work package 4 - Simulation modelling

5.5.1 Modelling approach

We will use a System Dynamics modelling approach as described in Section 6.1, using AnyLogic software. This work package will build on the existing Frailty Dynamics simulation model, expanding the model from service use in primary and secondary care to projections of health and social care workforce requirements to manage current and future demand. The Frailty Dynamics population simulation model provides information on health care demand for primary and secondary care services for adults aged ≥50, including GP consultations, prescriptions, hospital admissions and outpatients and urgent care. Whilst being able to provide estimates of service use to healthcare planners and commissioners, the model would be even more useful if it could provide estimates of the workforce needed to fulfil these demands in the ageing population. Adapting the Frailty Dynamics model to include workforce data will enable both demand and supply to be considered and will allow development of a tool for those planning future health and social care services for this substantial group within the population. The existing Frailty Dynamics model will be adapted to include estimates of demand for community health and social care to enable modelling of the workforce across all sectors identified in the other work packages.

Model development will be informed by the scoping review, stakeholder engagement events and survey. Information on how the workforce in both primary and secondary care looks after the population of older people living with frailty will be essential in adapting the Frailty Dynamics model to consider supply as well as demand. Some evidence on utilisation of generic services, including GP consultations, ED attendances, hospital admissions and prescriptions has been established through the Frailty Dynamics study. This study will build on this, adding further information on frailty-specific services and integrated and social care service utilisation.

It is worth emphasising that model development is an iterative process, initially informed by the scoping review, stakeholder engagement workshops, survey of provider organisations and health and social care data analysis, followed by internal validation using data from Discover-NOW London. Baseline projections from the model will be run for 25 years (where possible), followed by scenario modelling of different service configurations determined through the stakeholder consultation events. Data on primary, secondary, and urgent care service use by frailty category has already been established for the Frailty Dynamics study. Gaps in evidence on demand for community and social care use will be addressed through patient-level analysis of community and mental health and social care service use in frail older people from the Discover-NOW London databank in Work Package 3. In addition, these data sources will be supplemented with information on social care use, including privately funded care, from the English Longitudinal Study of Ageing (ELSA) data downloads (https://www.elsa-project.ac.uk/accessing-elsa-data). Workforce information will be supplied by Skills for Care – Adult Social Care Workforce dataset, NHS Digital – aggregate social care use data and Health Education England Data Service - workforce and trainee data and NHS Benchmarking (https://www.nhsbenchmarking.nhs.uk/all-sectors#integratedcare) and other relevant data sources identified in the scoping review (WP 1). As in the development of the Frailty Dynamics model, we will again use best available evidence to quantify workforce requirements for different frailty severity groups, but we will also work closely with our core collaborators and stakeholders in work package 2 to identify which parameters in the simulation model will need to be adjustable in the user interface to reflect local contexts or changed circumstances. For example, variation in workforce configurations and supply will be explored through the stakeholder meetings and can be addressed via what-if scenario modelling. In this case, constraints in workforce supply in one sector can be reflected through what-if scenarios that explore the impact of reduced access to some services.

The simulation model will require the analysis of social care service use requirements per patient in each age/frailty subgroup of the population from Work Package 3. For example, the number of intervention packages, visits by carers, length of stay in a care home etc. would be analysed from the scoping review, stakeholder consultations and analysis of the available datasets and fed into the model. The workforce parameters would also be added into the model following analysis of the available data and stakeholder consultation.

5.5.3 Model validation

The model outputs (underlying population, primary, secondary, and social care service use and associated workforce requirements) will be internally validated against datasets from the Frailty Dynamics study and Discover-Now. Model outputs will be discussed in stakeholder engagement workshops to assess the accuracy of the model in estimating the workforce needed to provide the required level of care for patients aged 50 and over in the population.

5.5.4 Scenario modelling

Following the model validation, the baseline model will be used to provide an estimate of both demand and the required workforce for a large population. The Frailty Dynamics model includes cost information for service use, so FLOWS will have capacity to determine the relative impact of different health outcome and service use scenarios. The scoping review and survey of frailty services will provide information on types of frailty intervention, service configurations, staffing needs of different frailty service types and potential service substitutions/trade-offs. Alongside our existing cost analysis, we can therefore estimate workforce and other costs associated with different types of service configurations. With our stakeholders, we will review this evidence and prioritise what-if scenarios that can explore the consequences of different workforce scenarios for health outcomes and workforce requirements and the effect of 'second best solutions' and service substitutions. 'What-if' scenarios, e.g., service or workforce substitution, will then be considered to see how different situations affect the level of care provision and workforce needed to provide that care. Being able to evaluate these 'what-if' scenarios is one of the largest benefits of simulation modelling to health and social care planners. For example, being able to see the effect of delaying the onset of frailty for health and social care provision would be extremely beneficial to those planning primary, secondary, and social care for those that need it. The scenarios investigated will be derived from the stakeholder engagement events and survey in work package 2.

6. Dissemination & Projected Outputs

6.1 Intended Outputs

In the proposed study, the long-term impact of frailty on health and social care service demand and workforce requirements will be modelled. This study will provide new, direct evidence about the impact of frailty on health and social care workforce requirements within an ageing population. Outputs of the study will include information about community health and social care service use and the associated workforce delivering care to adults living with frailty; workforce planning guidance for service providers and commissioners; a simulation model to predict workforce requirements associated with frailty. We will collate the outputs of the study into a workforce planning toolkit. Study outputs will have an impact on workforce planning and commissioning by providing new guidance on the impact of frailty, specifically in relation to trends in service use and associated workforce requirements as the population ages. The simulation model will allow local and regional service planners and commissioners to explore a range of scenarios with relevance to their specific contexts. The simulation model will be capable of adaptation for exploration of different service and demographic contexts. The simulation model algorithms will be transferable to modelling of workforce requirements associated with other chronic conditions that are common within the ageing population. This study, through use of simulation modelling building on prior research, represents a cost-effective approach to exploration of frailty-associated demand health and social care demand and workforce needs. The simulation model architecture, and the know-how relating to populating and operationalising the model, will be transferable to prediction of demand for other populations and conditions with a high population prevalence (e.g. dementia, obesity, mental health problems).

We will produce a final research synopsis report for NIHR detailing a high-level summary of the research, summarising all the data and evidence to support its conclusions against the overarching research questions and objectives, plus an abstract and plain language summary. The abstract of the research synopsis will be suitable for use as a briefing paper for NHS managers and commissioners. In addition, we will prepare a short PowerPoint presentation to present the main findings to NHS

organisations. The slides will be made available, alongside the full report, on the HS&DR programme web pages and, where possible, as additional linked material with other publications. We will work closely with the University communications team and ensure that members of the study team are given appropriate support and training in handling enquiries from the media. In addition, the core study team will lead on other study outputs, including academic journal papers. We will submit abstracts for oral and poster presentations at a minimum of two national and one international conference focusing on care of older people and health care workforce, aiming for the widest possible audience. We will submit at least two academic papers to high impact open access journals. These will be focused on the health, integrated and social care use by older people living with frailty and the workforce requirements to meet frailty-associated demand.

6.2 Impact and Implementation of Study Outputs

We will be guided by the initial stages of the benefits realisation approach as a framework to support dissemination and implementation of study outputs (Badewi, 2016; Serra et al. 2015). This approach consists of five key steps:

1. Benefits Identification
2. Benefits Prioritisation
3. Benefits Realisation Planning
4. Benefits measurement
5. Benefits reviews

Working with our stakeholders, benefits will continually (throughout the whole project) be identified and recorded. Second, we will consider benefits prioritisation, recognising that not all benefits have equal priority or relevance for individual stakeholders. We will therefore incorporate stakeholders' perspectives in any prioritisation of effort to inform, the third step, benefits realisation planning that aims to understand how benefits can be delivered and critically, identifying where implementation responsibility lies. After each phase of the study, a joint benefits review process will be conducted to evaluate any impact and inform future benefits realisation. In this study, we will be able to commence the first two steps and work with our stakeholders to support them in planning the remaining activities. In line with the HS&DR remit, the audience for this research is the public, service users, clinicians, service providers and commissioners. We will use the established networks of our team to share our findings with leaders in implementation and commissioning of frailty services. In WP 2, we will run three benefits realisation workshops to which we will invite NHS commissioners and frailty service leaders from health, integrated and social care organisations to review our findings, consider their implications and implementation and explore key messages and strategies for dissemination and implementation. We will also share the final results of the study with the public and staff in the relevant health, local and third sectors a public/patient friendly way by use of infographics, using plain English, and via use of local and national media and social media. We will summarise the findings of our work via professional journals (e.g. HSJ) and health service networks and professional organisations (e.g. Academic Health Sciences Network, British Geriatrics Society).

6.3 Impact of the proposed research

Operations Research approaches, such as that proposed for this study, have demonstrated impact, for example, in both the Wessex and Peninsula ARCs, where projects have contributed to service re-

design, effective resource allocation and demand management whilst maintaining or improving quality, through informing service re-design to improve bed management, optimising the resources required for a clinical decision unit and reducing waiting time in emergency departments. We anticipate that realisable benefits from the proposed work will include guidance for commissioners and service providers on workforce requirements and the development of a workforce planning toolkit for local exploration of service demand and workforce configurations. We aim to ensure that guidance, resources, and tools emerging from this study are widely disseminated to health and social care organisations, e.g. via the HEE Star Framework portal, HEE Wessex, NIHR ARC and across AHSNs via Wessex AHSN. Our core collaborator group links to these and other relevant organisations will facilitate dissemination and implementation of study outputs.

The study outputs will have direct benefit for commissioners; commissioning is a complex cycle involving assessment and understanding of population health needs, planning services to meet those needs, procuring appropriate and cost-effective services and monitoring their delivery and impact. The outputs of this study will have the potential to contribute at each of these stages but will have most impact in relation to assessment of health and social care workforce requirements. The planning stage of the commissioning cycle is often limited by a lack of reliable data on demand, particularly data which allows for forward projections; this study will address this need in relation to the workforce required to provide services to older people with frailty. The simulation modelling approach proposed in this study is particularly well-positioned to support commissioning, with its recent shifts towards more local commissioning, joint working and context specific (or 'place-based') commissioning and a focus on integrated systems of care Integrated Care Boards (ICBs) (NHSE 2021b) In planning this proposal, we have been aware of the need to collaborate with commissioners and organisations involved in service planning and delivery in order to fully realise the potential benefits for commissioning.

7. Plan of Investigation & Timetable

Month	**Pre-Project**	**Year 1 – Nov 2022-October 2023**	**Year 2 – November 23-October 24**	**Year 3 – November 24 – October 25**
1) November		Full team start-up meeting Finalise Protocol Ethics application Study Registrations Confirm SSC membership Recruit to PPI Panel (WP 2 & 3)	Study Steering Committee Full Research Team meeting Model building (WP4) Discover-NOW data cleaning and database preparation (WP3)	Study Steering Committee Full Research Team meeting Commence simulation scenario development (WP4)
2) December		Data Sharing Agreement – Discover-NOW /Imperial (WP3) Engagement event 1: review data sources (WP2) Commence Scoping review (WP1)	Model building (WP4)	Scenario development (WP4)
3) January		Full team meeting Study Steering Committee	Full Research Team meeting Commence Discover-NOW data analysis (WP3)	Full Research Team meeting Report simulation development (WP4)
4) February			Model building Engagement event 3: model structure (WP 2 and 4)	Engagement event 5: simulation scenarios (WP2 and 4)
5) March		Full team meeting	Full Research Team meeting Complete Survey data collection (WP2)	Full Research Team meeting Simulation scenario testing (WP4)
6) April		Engagement event 2: service mapping/classification/survey development (WP2)	Survey data analysis (WP2)	
7) May		Full Research Team meeting Data specification for Discover-NOW(WP3) Commence simulation model building (WP4)	Full Research Team meeting Identify supplementary data sources for simulation (WP4)	Full Research Team meeting Workforce planning guidance and toolkit development (WP2) Engagement event 6: recommendations & guidance/benefits realisation (WP2)
8) June		Service mapping and classification (WP2) Survey sampling strategy (WP2)	Simulation model parameterisation (WP4)	
9) July		Full Research Team meeting Survey development (WP2)	Full Research Team meeting	Full Research Team meeting
10) August		Commence Discover-NOW data extraction (WP3)	Model validation (WP4)	Report on simulation findings (WP4)

			Simulation sensitivity testing (WP4)	Prepare final report
11) September		Full Research Team meeting Report scoping review (WP1)	Full Research Team meeting Report on survey (WP2) Report on Discover-NOW analyses (WP3)	Full Research Team meeting Prepare final report Finalise workforce planning guidance and toolkit (WP2)
12) October 2022	Staff appointments Scientific Summary Management Plan Commence ethics & approvals	Submit paper – scoping review (WP1) Commence stakeholder survey data collection (WP2)	Report model validity (WP4) Engagement event 4: feedback analyses (WP2 and 3) Submit papers – service provider survey (WP2) and Discover-NOW analyses (WP3)	Final report to NIHR Paper – simulation model and scenarios (WP4) Dissemination and implementation event

8. Project Management

The project will be overseen and managed by Bronagh Walsh (BW) with oversight by the Study Steering Committee (SSC) for purposes of overall project supervision on behalf of the sponsor and funder. The SSC will focus on progress of the study, adherence to the protocol, oversight of governance and ethics processes and consideration of any new information relevant to the study. Carole Fogg (CF) will deputise and attend the SSC in case of unforeseen absence.

Day to day project delivery will be co-ordinated by CF and the project coordinator (Francesca Lambert - FL). The core management team (BW, CF, FL and Senior Research Fellow Tracey England - TE) will meet weekly to review and coordinate progress on each work stream, monitoring progress against the key project milestones. Full research team meetings, chaired by BW and including all co-applicants and relevant members of the core collaborator group, are scheduled at key points in data collection and analysis and members of the research team will be invited to core management team meetings as required.

Prof. Martin Pitt, Professor of Applied Healthcare Modelling and Data Science at Exeter University, has agreed to act as independent chair of the Study Steering Committee (SSC). We will include at least one PPI representative on the SSC and 75% of the members will be independent of the study.

The Stakeholder Engagement Events and Core Collaborator Group will be co-ordinated by FL and CF with support from Abigail Barkham (AB), and with input from the PPI representative Vivienne Windle (VW). The study will be organised into work packages with co-applicants leading in their areas of expertise and reporting to the core management group:

- Work Package 1: Scoping Review (BW)

- Work Package 2: Stakeholder Perspectives (CF/FL/AB)
- Work Package 3: Health and Social Care Data Analysis (CF)
- Work Package 4: Simulation Modelling (SB)

9. Ethics & Governance

This study will utilise routinely collected NHS patient data and social care data where explicit consent has not been gained from participants. Discover-NOW has an established governance structure in place for research applications. The research proposal will be submitted to the North West London Data Access Committee (NWL DAC) for approval (https://imperialcollegehealthpartners.com/discover-now/). The research team with work with Discover-NOW to prepare the project application and supporting material required to submit to the NWL DAC. The allocated Discover-NOW Clinical Investigator will present the research proposal to the NWL DAC and demonstrate compliance to the NWL DAC eligibility criteria.

Retrospective analysis using Discover data has standing ethics approval for all studies approved by Northwest London Data Access Committee (NWL DAC), and hence no other ethics is required for the proposed data extraction and analysis. The NWL DAC has responsibility for evaluating whether completed applications to access Discover are consistent with the Discover Principles Charter criteria and that the requests do not pose undue risk to the individuals, communities, or organisations to which they relate. This includes evaluation of risk to loss of privacy and assurance that appropriate protections of confidentiality and ethics review are in place. Access to the Discover dataset for the proposed project will be decided by the NWL DAC.

In addition, we will seek approvals from the Faculty of Environmental & Life Sciences Ethics Committee at the University of Southampton. We will use approved Information Governance procedures for database access at the database organisation, including use of secure servers, analysis at secure sites and independent data analysts for data extraction and linkage. Only anonymised, aggregate data extracts will be exported from database secure servers.

Procedures for maintaining confidentiality will be as per usual standard for data of this type; all databank organisations collate pseudonymised data with direct patient identifiers removed; data extracts and aggregate analyses will be pseudonymised/anonymised as described; the research team will not seek individual patient identifiers; and, when using these data, we will suppress small numbers in reporting and avoid the presentation of data that can potentially be used to reveal identities. The proposed study is focused on modelling of population flows and service use, so a high level of data aggregation is used in the analysis; we do not therefore anticipate significant issues in relation to confidentiality

The study will be registered with an appropriate register for observational studies (https://clinicaltrials.gov/).

10. Patient & Public Involvement

The research team is experienced in project delivery and brings expertise in a range of relevant settings and research methods. In line with the Programme remit, the audience for this research is the public, service users, clinicians, and managers. The research team has the networks and expertise to disseminate and implement across a range of NHS settings and services. We will use a range of dissemination approaches to reach the various target audiences for this research. We will

work with our PPI lead and PPI contributors to plan dissemination via the benefits realisation workshops, with a focus on making the results 'accessible' to the wider public, both in writing and verbally, through presentations at workshops/team meetings/to patient groups. Our dissemination strategy will be guided by our PPI representatives and study collaborator group and the feedback from the stakeholder engagement events. Our study team and collaborators include senior stakeholders relevant to development of frailty services . Patient and Public Involvement (PPI) is embedded in all work packages. We used extensive PPI and stakeholder engagement in the Frailty Dynamics study and will build on this approach for the proposed work . We will involve the School of Health Sciences' Older People & Dementia PPI Panel to enhance patient and carer input to the stakeholder workshops and dissemination. This group has clearly identified the importance of a diverse workforce in meeting needs associated with frailty, with an emphasis on different staff skills, for example occupational therapists, physiotherapists, and counsellors, to enable them to manage changes in their health and prevent further decline. We will also benefit from expanding PPI participation to a more diverse population through the Discover-NOW database PPI panel, allowing us to carry out additional engagement and recruitment activities with under-served communities. Throughout the study, our PPI lead representative and 2 core panel members will be engaged in study management and delivery, attending full project team meetings, and working with PPI lead (FL) to inform the format and content of stakeholder engagement sessions and accessibility considerations for PPI contributors.

In WP2, the focus is on stakeholder perspectives and the PPI lead representative, core collaborator group and additional participants from the PPI panel will be invited to participate in engagement events where they will be asked to contribute perspectives on frailty services and workforce information collected in the scoping review (WP1), identifying key points to include in the simulation model and gaps for iterative review or for inclusion in the survey of service providers. PPI contributors in Southampton and London will also reflect on results of WP3 data analysis, reviewing and contextualising service use data, and considering how they inform the simulation model (WP4). They will contribute lived experiences regarding workforce availability and types of health and social care staff for managing frailty for consideration in the simulation model (WP4). Finally, we will involve PPI contributors in co-producing dissemination summaries of the simulation model and the main results.

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12. APPENDICES

APPENDIX 1: FLOWS Ethical Approvals

Southampton University Research Ethics Committee (FELS) 71937.P - NIHR134305 – Approval in principle granted 17/3/22 – Full application in process