RAND EUROPE

THIS.Institute The Healthcare Improvement Studies Institute

Acute Respiratory Infection Hub process evaluation

Technical annex

Callum Gunn,[1] Manon Richard-Sheridan,[1] Michelle Sokol,[1] Jon Sussex,[1]
Kiri Dargaville,[2] Graham Martin,[2] Robert J. Romanelli[1]

[1] RAND Europe [2] THIS Institute, University of Cambridge

This research was made possible by the National Institute for Health and Care Research



CARE-NET

The Cambridge and RAND Europe National Evaluation Team

CARE-NET (the Cambridge and RAND Europe National Evaluation Team) is a collaboration between THIS Institute (The Healthcare Improvement Studies Institute) at the University of Cambridge and RAND Europe. CARE-NET is one of three teams in England selected to generate long term, robust and broad national evaluations of health and social care innovations.

Funded by
NIHR | National Institute for Health and Care Research

CARE-NET is funded by the National Institute for Health and Care Research (NIHR). This publication does not necessarily reflect the opinions of the funder.

RAND Europe is a not-for-profit research organisation that helps improve policy and decision making through research and analysis. To learn more about RAND Europe, visit www.randeurope.org

THIS Institute (The Healthcare Improvement Studies Institute) at the University of Cambridge strengthens the evidence needed to improve healthcare. We study what works, what doesn't, and why, combining academic rigour with the realities of care. THIS Institute is made possible by the Health Foundation. Find out more at www.thisinstitute.cam.ac.uk

The Health Foundation

UNIVERSITY OF CAMBRIDGE

For more information on this publication, visit www.rand.org/t/RRA5157-1

Published by the RAND Corporation, Santa Monica, Calif., and Cambridge, UK

Research Integrity
Our mission to help improve policy and decision making through research and analysis is enabled through our core values of quality and objectivity and our unwavering commitment to the highest level of integrity and ethical behaviour. To help ensure our research and analysis are rigorous, objective, and nonpartisan, we subject our research publications to a robust and exacting quality-assurance process; avoid both the appearance and reality of financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursue transparency in our research engagements through our commitment to the open publication of our research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. For more information, visit www.rand.org/about/research-integrity

RAND® is a registered trademark.

Cover: Adobe Stock

© 2026 University of Cambridge

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the University of Cambridge.

Annex A: Methodology

Evaluation design

This was a mixed-methods evaluation, conducted between May 2025 and June 2026, employing quantitative and qualitative approaches to address the evaluation questions. Data-collection activities included desk research; a survey of ARI Hubs; interviews with national, regional and local NHS stakeholders; focus groups with public participants; and a workshop with NHS stakeholders and people with recent lived experience of ARIs. A detailed protocol for the evaluation was developed and was registered with Research Registry (ref: 11470).

Research governance and ethics

The UK's Health Research Authority provided governance review and approval of this evaluation (IRAS Project ID: 357921). The RAND Europe Research Ethics Committee reviewed and provided a favourable opinion on the ethical conduct of this evaluation (RECFO: 24285.003).

Additional oversight for this study was provided by a project-level Expert Collaborative Group (ECG), which was composed of three professional members – one with expertise in ARI Hubs, one in medicine and one in evaluation – and three members of the public with experience of chronic health conditions and/or caring for a family member with chronic health conditions. ECG members were selected by the evaluation team for their professional or personal expertise/experiences. The evaluation team met quarterly with the ECG (total of four meetings) to discuss the set-up of the study and its progress and to interpret findings. Public members of the ECG were reimbursed for their time based on National Institute for Health and Care Research (NIHR) guidance.

Desk research

Data collection

An informal search of the grey literature, primarily via access to NHS Futures,[1] was conducted to identify ARI Hub models across England. A total of 61 documents was collected between September 2025 and January 2026. The evaluation team also requested relevant internal publications from ARI Hub professional stakeholders, including ICB commissioners and ARI Hub service providers, following identification through NHS England national and regional contacts. These included operating procedures and internal policies, surveillance dashboards, local evaluations and associated presentations, infographics and reports. Additional documents were collected from Google Scholar searches, white papers, regional and local health system publications (e.g. ICB winter plan documents), healthcare provider publications and public media publications (e.g. BBC news articles). All documents were stored in Zotero, a reference management software package, and categorised by whether each document was publicly

1 An online platform supported by NHS England that enables knowledge- and document-sharing among health and social care workers.

available. The documents were further tagged by their NHS region, if applicable. Information from the grey literature was used to develop a preliminary theory of change for the ARI Hub model.

Analysis

An extraction template was developed for content analysis. The template was developed to answer: (a) how ARI Hubs were expected to work, including their indicators (e.g. value for money, enhanced access); (b) whether the document described an evaluation of the ARI Hub model; and (c) whether there was an evaluation described, what were the methods for finding the reported outcomes, as well as making explicit both the methods and the outcomes (e.g. reduced pressures across primary care, patient satisfaction).

Survey

Recruitment

Regional and local stakeholders from across England were recruited to participate in a survey about ARI Hub models to understand where and how hubs operated. National stakeholders from NHS England provided names and email addresses for relevant regional stakeholders and they, in turn, provided names and email addresses for relevant local stakeholders. Local stakeholders were ICB and Sub-ICB Location (SICBL) representatives or operational or clinical staff within ARI Hubs. An email invitation was distributed to local stakeholders to inform them about the evaluation and the purpose of the survey. National, regional and local stakeholders were also asked if they would be interested in participating in a one-hour, semi-structured interview. Participants were not reimbursed for completing the survey or the interview.

Data collection

Representatives from 35 of the 42 ICBs responded to the survey. Survey responses were collected using an Excel spreadsheet. Participants were asked to add information about the ARI Hub(s) in their area in the spreadsheet or, if preferred, we met with the individual to discuss the information, and a member of the evaluation team added it to the spreadsheet on the stakeholder's behalf.

Operational information on active ARI Hubs as of winter 2025/2026 was collated by the evaluation team and input into a single database. Data were organised into spreadsheets describing active ARI Hubs, model types and features of active ARI Hub systems. We defined an 'ARI Hub system' as an operating model whereby the provision of ARI Hub services is organised, managed and funded separately from other ARI Hubs in the local area, including the provision of care services and business operations.

We opted to count the number of hub systems rather than the number of individual hub sites to facilitate comparison of different ARI Hub models across SICBLs. For example, some ARI Hub systems had one centralised site, and others had multiple distributed sites; however, site numbers did not necessarily reflect overall activity or total appointment capacity.

Descriptive statistics were used to analyse the distribution of ARI Hub systems across England by underlying SICBL characteristics, including deprivation, respiratory disease burden and population density.

- Deprivation was measured using the **English Indices of Multiple Deprivation (IMDs) 2025** at Lower Layer Super Output Area (LSOA) level, obtained from the Ministry of Housing, Communities and Local Government.[2]
- Respiratory disease burden was measured by **rates of emergency hospital admission for respiratory disease**, obtained from the Office for Health Improvement and Disparities using data originally sourced from NHS Digital from 2021/2022 and 2024/2025 (Indicator ID: 93575).[3]
- Population density was measured as **population per square mile** by using the total estimated population in 2024 for each LSOA[4] and the standard area measurements for each LSOA[5] from the Office of National Statistics.

Geographic boundaries for SICBLs were obtained from the Open Geography Portal to facilitate the aggregation of LSOAs to SICBLs.[6] To quantify deprivation at the SICBL level, IMD deciles for all LSOAs within each SICBL were aggregated by calculating a median IMD decile per SICBL.

Respiratory disease emergency department (ED) admissions were calculated as the sum of emergency admissions for patients with any respiratory disease as a primary diagnosis (ICD10 codes J00 to J99). The dataset featured respiratory disease ED admission rates aggregated to SICBL level by the following method: SICBL populations were aggregated from GP practice population snapshots, from NHS Digital's 'Patients Registered at a GP Practice' publication.[7]

To quantify population per square mile at the SICBL level, LSOA total population and land area were each summed across SICBLs, using the abovementioned data sources.

A tabular summary of relative frequency distribution of deprivation, respiratory disease burden and population density by SICBLs with and without ARI Hubs was created, with these variables expressed as tertiles to express the distribution of each by SIBCL.

Interviews

Recruitment

National, regional and local NHS stakeholders (hereafter referred to as 'professional stakeholders') were recruited for interviews to better understand the set-up and delivery of ARI Hubs across England. Potential stakeholders for interviews were recruited from initial survey outreach (as described above). Additionally, a snowball approach to recruitment was used, whereby identified stakeholders recommended other individuals within the NHS who could

---

2 As of 29 July 2026: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2025

3 As of 29 July 2026: https://fingertips.phe.org.uk/respiratory-disease#gid/8000003/ati/15

4 As of 29 July 2026: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareamidyearpopulationestimates

5 As of 29 July 2026: https://geoportal.statistics.gov.uk/datasets/ba0873184e6349bebb63b5da6dd050b5/about

6 As of 29 July 2026: https://geoportal.statistics.gov.uk/datasets/ons::lsoa-2021-to-sicbl-to-icb-to-lad-april-2023-lookup-in-en/about

7 As of 29 July 2026: https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice

speak about ARI Hubs. Email invitations were sent to potential participants. We sought to recruit individuals holding a range of roles across NHS regions.

Data collection

We conducted 23 online interviews with 38 professional stakeholders. Some participants requested to be interviewed with colleagues, such as a clinical ARI Hub leader and an operational (non-clinical) ARI Hub leader from the same system. The stakeholders were from various regions in England, covering six of seven NHS regions (North East and Yorkshire, North West, South West, Midlands, East of England and London), corresponding to regions with active ARI Hubs. Participants held different roles within their regions, including ICB commissioning leads, clinical directors, primary-care transformation managers and other programme directors/managers. We also interviewed healthcare professionals, including respiratory consultants. Tables A1 and A2 summarise interview participants by role and region, respectively.

Table A1. Interview participants by role

Role	Count
ICB Stakeholder	12
SICBL Stakeholder	7
ARI Hub Operational Leader	8
ARI Hub Clinical Leader	5
Clinician (non-ARI Hub provider)	1
NHS England Stakeholder	5
Total	**38**

Table A2. Interview participants by region

NHS region	Count
East of England	1
Midlands	8
North East and Yorkshire	13
North West	2
London	1
South West	8
N/A (NHS England Stakeholder)	5
Total	**38**

An initial interview topic guide was developed by the evaluation team and further tailored for different interviews depending on what type of stakeholder was being interviewed. The topic guides were also tailored based on what was already known of the area, as determined by desk

research (i.e. hub model, local population characteristics). Each interview lasted approximately 60 minutes and was conducted on Microsoft Teams. Professional stakeholders were not reimbursed for their participation in interviews.

Analysis

Interviews were recorded by the evaluation team and transcribed by an external organisation (Language Insight) to generate an accurate written record of the discussion. After quality-checking transcripts against the recordings for accuracy, transcripts were imported into NVivo, a qualitative analysis software package.

A thematic analysis approach was adopted, guided by a codebook developed by the evaluation team. The initial codebook was informed by the programme theory framework (i.e. theory of change) underpinning the evaluation, with initial codes focused on:

- The **inputs and resources** required to establish ARI Hubs;
- The **activities and processes** involved in implementation;
- The **expected outputs, outcomes and impacts;** and
- **Influences on successful delivery.**

Drawing on an inductive approach, the initial codebook was adapted after a sample of transcripts was coded to allow for unanticipated concepts to emerge from the data. To support coding reliability and consistency, the first two transcripts were independently coded by three members of the evaluation team, with coding decisions discussed and reconciled. After this, each interview was coded by a single member of the team using the established codebook. This formal analysis was supplemented by informal notes taken during each interview, which helped inform codebook development.

The initial programme theory framework facilitated the development of initial codes, focused on the inputs and resources, activities and processes of implementing ARI Hubs, influences on successful delivery and expected impacts of service delivery.

Following the initial round of coding, the evaluation team met to review the codes and explore their hierarchical relationships, leading to the construction of overarching themes. These themes then informed a second round of coding in which raw data were more explicitly mapped to the identified themes and the relationships between themes were refined and examined in greater depth.

Focus groups

Recruitment

Members of the public were recruited from across England to participate in one of three online focus groups through The Healthcare Improvement Studies (THIS) Institute's mailing lists and social media networks. Interested individuals were asked to complete an online registration questionnaire. This questionnaire enabled the evaluation team to screen potential participants for eligibility criteria and, from the demographics provided, to select for a diverse group of individuals based on age, gender, ethnicity, whether they had long-term conditions or a disability and the region in which they lived. Individuals were eligible to participate in a focus group if they were at least 18 years of age and had used NHS services for an ARI (such as visiting a GP or pharmacy,

calling NHS 111 or visiting an ED or urgent treatment centre) in the past 12 months. Participants were not required to have used an ARI Hub.

Data collection

We conducted three online focus groups with a total of 28 public participants. Across focus groups, 21 participants were women and 7 were men. The age of participants ranged from 25 to 76 years old (median 58), and 18 participants were white British while 10 were from another ethnic group (British Indian, South Asian, Black/African/Caribbean, other). Participants were representative of all NHS England regions.

The focus-group topic guide was developed by the evaluation team. Focus groups were led by a member of the evaluation team with assistance from one of the public contributors of the ECG. Focus-group participants were reimbursed for their time based on NIHR guidance. Each focus group lasted approximately 90 minutes and was conducted on Microsoft Teams. Table A3 below summaries focus-group participant characteristics.

Table C3. Summary of focus-group participant characteristics

Demographics	Category	FG 1	FG 2	FG 3	Total
Gender	Female/woman	7	6	8	21
	Male/man	3	2	2	7
Age	Age range, years	25–76	25–75	28–72	25–76
	Median age, years	58	70	48	
Ethnicity	White British/Irish	7	4	7	18
	Other ethnicity	0	1	2	3
	British Indian	1	1	0	2
	South Asian	1	2	0	3
	Black/African/Caribbean	1	0	1	2
Region	East of England	1	0	1	2
	London	0	1	3	4
	Midlands	3	0	2	5
	North East and Yorkshire	2	3	1	6
	North West	0	1	1	2
	South East	1	1	0	2
	South West	3	2	2	7
Total		**10**	**8**	**10**	**28**

Analysis

Focus groups were recorded by the team and transcribed by an external organisation (Language Insight) for an accurate written record of the discussion. Transcripts were imported into NVivo and analysed thematically using a codebook developed by the team. This codebook was adapted after a sample of transcript was coded to allow for unanticipated concepts to emerge from the data. Each focus group was coded by one member of the team after discussion of the accuracy of the codebook among the team. Observational notes taken by the evaluation team during interviews were also used to inform codebook development and initial analysis.

After the initial round of coding in NVivo, the evaluation team undertook an internal analysis workshop to establish the main themes that had emerged from the focus-group and interview data. As for the interview analysis, focus-group data were revisited to further explore themes and their relationships.

Workshop

Recruitment

Workshop participants were recruited from amongst a list of professional stakeholders from the survey and interviews, who were initially introduced to us by NHS England staff, but did not necessarily take part in these data-collection activities.

Data collection

The 90-minute online workshop was conducted on 21 May 2026. Of the 80 stakeholders invited, 22 attended. Additional attendees included six members of the evaluation team and three public-contributor members of the ECG. The workshop was recorded, with permission from attendees, to create an accurate written record of the discussion for analysis.

The workshop was divided into three sections, one for each evaluation question. Within each section, a member of the evaluation team provided a brief overview of findings, followed by insights from one of the public-contributor ECG members and, finally, a discussion among all attendees.

Analysis

A transcript of the workshop was generated using the automated function in Microsoft Teams. This transcript was analysed alongside written notes from one of the evaluation team members. The analysis was not intended to bring new information to the evaluation questions but rather to contextualise the findings of the prior data-collection activities.

Cross-analysis and synthesis

We analysed data across data-collection activities to address each of the evaluation questions. This included the development of a theory of change for the ARI Hub model and a feasibility assessment for the conduct of a future outcomes and economic evaluation.

For the theory of change, expected impacts and the potential mechanisms of impact of the ARI Hub delivery model were mapped to a theory-of-change framework, based on the grey literature

search. We then interrogated and refined this preliminary theory of change against data collected through other aspects of the evaluation (i.e. surveys, interviews, focus groups and the workshop).

A theory of change provides a model for how an intervention leads to intended impact through specific inputs, activities, outputs and outcomes. In the case of ARI Hubs, inputs represent the features or characteristics of the ARI Hub delivery model; activities represent the actions or processes that result from these features; outputs represent the proximal or immediate/short-term changes that bridge activities to more distal changes; outcomes represent the medium-term changes that are a direct result of outputs; and finally, impacts represent the longer-term changes that are a direct result of outcomes.

The feasibility assessment for a future outcomes and economic evaluation was conducted using data from desk research and interviews. The feasibility assessment considered the theory of change and mechanisms of impact, as well as detailed data from a prior impact analysis conducted by NHS England (aggregated data were provided by NHS England for this purpose). This prior ICB-level analysis focused on the association between ARI Hub activity, measured by appointments delivered, and rates of ARI-related ED walk-in attendances for each of the 41 ICBs with an ARI Hub between December 2023 and March 2024. We used this prior analysis to estimate the potential magnitude of the impact of ARI Hubs on ED attendances and the required sample size for a future evaluation.

Strengths and limitations

Strengths

This evaluation has several strengths. First, the methodology for this evaluation was reviewed by multiple stakeholders, including public contributors, which strengthened the approach and its credibility. Secondly, this evaluation benefited from a mixed-methods design, drawing on a diverse range of data sources and participants, including representatives from national and regional organisations, local commissioning bodies and care providers as well as patients and carers. In total, we interviewed or conducted focus groups with 66 individuals and engaged with numerous other individuals through desk research, the survey of ICBs and the workshop. This breadth of perspectives enabled us to capture the experiences and views of diverse stakeholders. The triangulation of qualitative and quantitative data sources further supported a robust and in-depth understanding of the design, implementation and delivery of ARI Hubs. Thirdly, the evaluation achieved broad geographic coverage, with primary data on ARI Hubs implementation collected from across the seven NHS England regions, with the exception of the South East region, where available secondary evidence was sourced. Finally, we utilised a theory-informed approach, drawing on a programme theory to structure data collection and analysis, which supports the evaluation of complex interventions (Skivington et al. 2021). This provided transparency to the underpinning logic of evaluation, allowing stakeholders to better understand the assumptions underlying the intervention's expected impact, while facilitating the triangulation of mixed-method data and overall synthesis.

Limitations

Despite its strengths, this evaluation has limitations that should be considered when interpreting the findings. These are presented below for the quantitative and qualitative elements of the evaluation, separately.

Quantitative data limitations

The quantitative analysis relied on data aggregated at the SICBL level, including IMD and rates of ED admission for respiratory disease. Aggregated deprivation information at the SICBL level lacks sensitivity to the variance of deprivation between LSOAs within SICBLs. SICBL rather than LSOA level was chosen as the unit of analysis because the ARI Hub footprint was generally spread across an SICBL. The descriptive summary of SIBCL characteristics by those with and without ARI Hubs are intended to be illustrative rather than causal. Furthermore, while we collected quantitative data on ARI Hub systems active in winter 2025/2026, we were only able to collect data from those systems still in operation..

Qualitative data limitations

The qualitative element of the evaluation generated rich and diverse data. However, participants were recruited through a convenience sampling approach, which limits the extent to which findings can be generalised to the wider population of ICBs, providers or public participants.

Furthermore, the public participants included individuals with higher acuity of respiratory diseases, often with pre-existing conditions that are exacerbated by ARIs. Clinical pathways for these individuals are often already established and in the case of more serious exacerbations, ARI Hub services may not be the most optimal treatment option.

National and regional stakeholders that participated in this study are employed through NHS England, the organisation that set up the ARI Hub model. Thus, selection bias among these groups is possible for individuals with favourable views of ARI Hubs. Similarly, local stakeholders who are still operating ARI Hubs in winter 2025/2026 may represent individuals with more favourable views on ARI Hubs as compared to those who decided to decommission ARI Hubs. To mitigate the issue of selection bias, in all interviews, we attempted to draw out both positive and negative features of ARI Hubs to obtain more balanced perspectives. We also included in our interview sample a small number of representatives of ICBs/SICBLs that no longer operate ARI Hubs, who offered valuable perspectives on decision making on decommissioning.

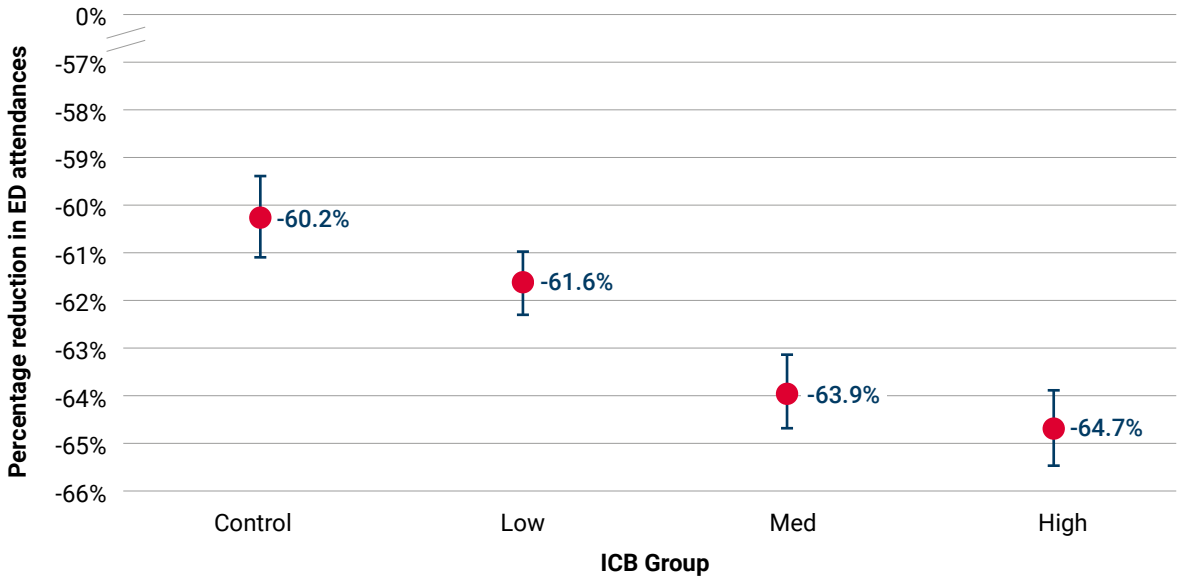
Furthermore, the cross-sectional nature of our data collection limited insight into changes in ARI Hub provision and decision making over time; however, we have included insights into changes in commissioning and service delivery approaches over time where possible.

Annex B: Assessment of prior national-level impact analysis

NHS England conducted a national-level impact analysis of ARI Hubs that were active during winter 2022/2023. The analysis was conducted at the ICB level and included 41 ICBs that originally commissioned ARI Hub services. ICBs were categorised into quartiles of ARI Hub appointments per 1,000 population, labelled control, low-, medium- and high-activity groups. The analysis focused on the four months between December 2022 and March 2023, a period when most ARI Hubs were active. Because this period showed an overall downward trend in ARI-related ED walk-in attendances per 1,000 population (in line with the transition from winter to spring), the analysis examined differences in the percentage change in this outcome between the four ARI Hub activity groups (a difference-in-difference analytic approach).

This analysis showed that higher levels of ARI Hub activity were associated with larger percentage decreases in ARI-related ED walk-in attendances between December and March (see Figure 1). The analysis did not adjust for other potential differences between ARI Hub activity groups that could explain this rate change, such as other interventions, ICB-level characteristics or population demographics. While the findings imply statistically significant associations between levels of ARI Hub activity and changes in ARI-related ED walk-in attendances (based on non-overlapping 95% confidence intervals), the difference-in-difference effect size is small. The control group had a relative decrease in ARI-related ED walk-in attendances of -60.2% from December to March. By comparison, the highest ARI Hub activity group had a relative decrease in ARI-related ED walk-in attendances of -64.7% from December to March, representing a percentage-point difference of 4.5% compared to the control group.

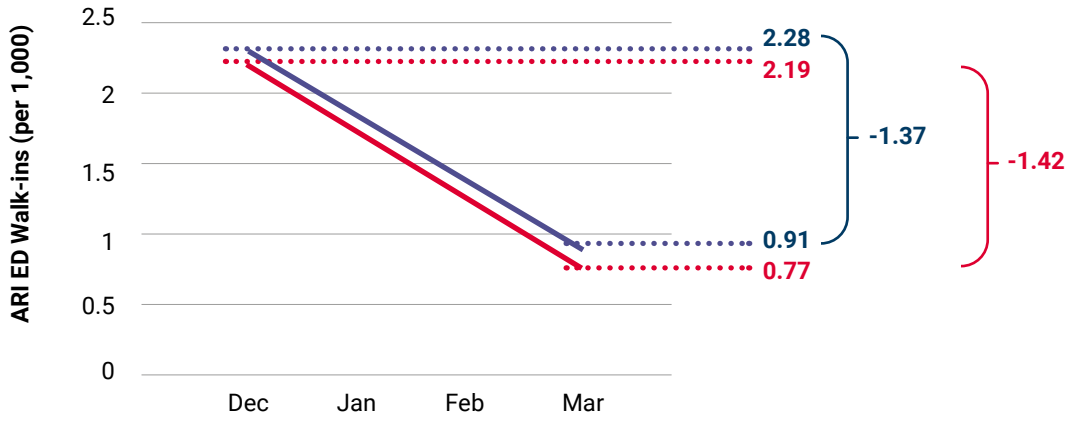
Figure 1. Percentage change in ARI-related ED walk-in attendances by ICB ARI Hub activity group



Source: NHS England.

While the prior analysis focused on the relationship between ARI Hub activity and the percentage rate change of ARI-related ED walk-in attendances, we explored these data focusing on absolute changes in both the rate change (i.e. slope) and shift change (i.e. level) of impact, comparing the groups with the lowest level of ARI Hub activity (control) and the highest level of ARI Hub activity. The absolute difference-in-difference (i.e. difference in rate change or slope) in ARI-related ED walk-in attendances from December through March between the highest-activity group (-1.42 ED walk-in attendances per 1,000 population) and the control group (-1.37 ED attendances per 1,000 population) was 0.05 attendances per 1,000 population (Figure 2). While this difference may be real, we do not know if it represents a meaningful or important change in clinical or economic terms.

Figure 6. Absolute change in ARI-related ED walk-ins by highest and lowest (control) ICB ARI Hub activity group.



Source: RAND Europe.

We also quantified the level differences in ARI-related ED walk-in attendances between the highest-activity ARI Hub group and the control group per month, using data provided by NHS England. Cumulatively, between December and March, ICBs in the highest-activity ARI Hub group had 4.76 ARI-related ED walk-in attendances per 1,000 population compared to 5.30 per 1,000 population in the control group, representing an absolute difference of -0.54 per 1,000 (or a relative cumulative level difference of 10%) (see Table B1 below).

Table B1. Differences in ARI-related ED walk-in attendances and ARI Hub appointments

	ARI Hub appointments per 1,000 (Dec. to Mar.)	ARI-related ED walk-in attendances per 1,000 (per month and cumulatively)				
		Dec.	Jan.	Feb.	Mar.	Cum.
Highest-activity group	21.5	2.19	1.05	0.74	0.77	4.76
Control group	3.3	2.28	1.20	0.91	0.91	5.30
Absolute difference	18.2	-0.09	-0.15	-0.17	-0.14	-0.54
Percentage difference	--	4%	12%	19%	15%	10%

Given the between-group difference in ARI Hub activity during this period, we estimated that 18.2 ARI Hub appointments per 1,000 population were associated with a cumulative decrease in ARI-related ED walk-in attendances of 0.54 per 1,000 population. This suggests that every 34 ARI Hub appointments avoided one ARI-related ED walk-in attendance and that ARI Hub services induce demand for services rather than divert demand away from the ED. These differences in ARI-related ED walk-in attendances translate to a standardised mean difference (or Cohen's *d*) of 0.39 – a small effect size.[8] For reference, tangible impacts of an intervention are typically observed with at least a moderate effect size (≥0.5). However, in the absence of adjustment for confounding, including baseline levels of ARI-related ED walk-in attendances, we cannot know in which direction and to what magnitude the effect size is biased.

If ARI Hub appointments on average cost £40 each to deliver (an estimate based on our evaluation, in which stakeholders reported that an ARI Hub appointment cost between £30 and £50) and ARI-related ED walk-in attendances on average cost £250 each to deliver (an estimate based on publicly available information), for the ARI Hub model to be good value for money, approximately every six ARI Hub appointments must be associated with a reduction of at least one ARI-related ED walk-in attendance.[9] This estimate assumes patients have similar outcomes regardless of whether they attended the ED or had an ARI Hub appointment.

Expressed in another way, for ARI Hubs to save the NHS money, assuming an ARI Hub appointment rate of 18.2 per 1,000 population between December and March, the cumulative-level decrease in ARI-related ED walk-in attendances would need to reach -3.0 per 1,000 population during this period,[10] or an average of 0.75 per 1,000 population per month – a cumulative percentage difference of 57% (see Table B2 below). This 'required' effect size is about six-fold higher than the observed absolute effect (34:1 vs. 6:1 ratio of ARI Hub appointments to ARI-related ED walk-in attendances). Again, this is only an estimate, as we cannot know if and to what extent the effect sizes from the NHS England analysis or our exploration of the data are biased. Moreover, changes in the estimated costs of ARI Hub appointments and ARI-related ED walk-in attendances could, of course, change the threshold ratio for value for money in either direction.

Table B2. Hypothetical differences in ARI-related ED walk-in attendances required for 'good value for money'

	ARI Hub appointments per 1,000 (Dec. to Mar.)	ARI-related ED walk-in attendances per 1,000 (per month and cumulatively)				
		Dec.	Jan.	Feb.	Mar.	Cum.
Highest-activity group	21.5	1.53	0.45	0.16	0.16	2.30
Control group	3.3	2.28	1.20	0.91	0.91	5.30
Absolute difference	18.2	-0.75	-0.75	-0.75	-0.75	-3.00
Percentage difference	--	33%	62%	82%	82%	57%

8 Cohen's *d* = mean difference/pooled standard deviation (0.39=0.54/1.39). Small effect size <0.50, moderate effect size 0.50–0.80, large effect size >0.80.

9 6 ARI Hub appointments x £40 = £240, whereas 1 ARI-related ED walk-in attendance = £250.

10 Each 18.2 ARI Hub appointments/6 ARI Hub appointments per 1 reduction in ARI-related ED walk-in attendance = 3 ARI-related ED walk-in attendances.