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PROTOCOL

# Emergency admission Predictive RIsk Stratification Models: Assessment of Implementation Consequences (PRISMATIC 2): a protocol for a mixed-methods study

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## Abstract

**Background:** Emergency admissions are costly, increasingly numerous, and associated with adverse patient outcomes. Policy responses have included the widespread introduction of emergency admission risk stratification (EARS) tools in primary care. These tools generate scores that predict patients' risk of emergency hospital admission and can be used to support targeted approaches to improve care and reduce admissions. However, the impact of EARS is poorly understood and there may be unintended consequences.

**Aim:** To assess effects, mechanisms, costs, and patient and healthcare professionals' views related to the introduction of EARS tools in England.

**Design & setting:** Quasi-experimental mixed-methods design using anonymised routine data and qualitative methods.

**Method:** We will apply multiple interrupted time-series analysis to data, aggregated at former clinical commissioning group (CCG) level, to look at changes in emergency admission and other healthcare use following EARS introduction across England. We will investigate GP decision making at practice level using linked general practice and secondary care data to compare case-mix, demographics, indicators of condition severity, and frailty associated with emergency admissions before and after EARS introduction. We will undertake interviews (approximately 48) with GPs and healthcare staff to understand how patient care may have changed. We will conduct focus groups ($n$ = 2) and interviews (approximately 16) with patients to explore how they perceive that communication of individual risk scores might affect their experiences and health-seeking behaviours.

**Conclusion:** Findings will provide policymakers, healthcare professionals, and patients, with a better understanding of the effects, costs, and stakeholder perspectives related to the introduction of EARS tools.

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## How this fits in

The consequences of using emergency admission risk stratification (EARS) tools in primary care remain unclear. Our previous study found unexpected effects associated with the introduction of EARS tools in South Wales, including increases in emergency admissions to hospital. We will determine if those effects extended across England and investigate how GPs changed practice following introduction of EARS tools. We will also explore patient perspectives, which have been largely overlooked.

## Introduction

Worldwide, discussions on primary healthcare efficiency focus on reorienting systems towards proactive, anticipatory, and integrated care.[1] This shift responds to rising life expectancy, multimorbidity, and health complexity. Emergency hospital admissions continue to rise despite policy efforts to reduce them.[2] While potentially lifesaving and preventing long-term morbidity, emergency admissions are generally unwelcome to patients. They are linked to adverse outcomes such as functional decline and hospital-acquired infections. From a provider perspective, these admissions are expensive and constrain planned care.[3]

In the UK, a significant policy response involves the introduction of emergency admission risk stratification (EARS) tools. These tools use routine patient data to generate scores reflecting the risk of emergency hospital admission. Widely implemented in UK general practices[4] and internationally,[5,6] EARS tools support targeted approaches to improve care and reduce emergency admissions. The intention, with primary care targeted at those at higher risk, is to prevent many hospitalisations,[2] notably for ambulatory care sensitive (ACS) conditions such as diabetes, epilepsy, and high blood pressure.[7] A large variation in ACS admission rates across general practices in England has previously been observed,[8] driven by factors such as deprivation, multimorbidity, and primary care quality.[9,10] The introduction of EARS has also been aligned to integrated care approaches and a focus on personalised and holistic care.[11,12] The UK allocated substantial budgets to EARS initiatives, including more than £480 million for the English Avoiding Unplanned Admissions Enhanced Service (2014–2017).[13] This service encouraged general practice teams to proactively support patients at high risk of emergency admission following identification using EARS. Further initiatives using EARS have followed across the UK, including the recent roll-out of a new AI tool across South-West England.[14]

Despite such commitments, the impact and worth of EARS as a policy option remains unclear.[12] It is important to understand the costs and consequences of using risk stratification tools, both beneficial and adverse, to inform future care delivery.[15]

Our previous randomised trial (PRISMATIC) found unexpected effects following EARS introduction to 32 general practices in South Wales, with associated increases in emergency hospital admissions, emergency department (ED) attendances, and days spent in hospital.[16] Costs to the NHS increased substantially, by an average of £72 per GP-registered patient per year. As a result of PRISMATIC, the planned roll-out of EARS was halted in Wales, saving an estimated £220 million per year, largely through avoided days spent in hospital.[16]

This study builds on the findings of the PRISMATIC trial and responds to the wider EARS literature, including a systematic review.[17,18] EARS tools have typically been used to identify patients for further intervention (case-finding), often alongside other identification approaches.[19–27] Overall, there are no high quality studies demonstrating effectiveness, with a limitation being that most comparative studies had used EARS to identify eligible patients in both control and intervention arms, making it challenging to isolate effects. Most studies of EARS have had short follow-up periods (<12 months), although longer-term effects of use are theorised.[28,29] One US study showed gradual positive effects on admissions, notably for ACS conditions.[30] Other studies revealed unintended consequences, potentially owing to unmet need,[31] or lowered hospital admission risk for prioritised patients but not others.[32]

Studies, including qualitative approaches, identify support for tools in principle alongside concerns about model accuracy, data access, and clinical capacity to support patients.[33–35] Patient perspectives are lacking in the literature.

With ever-increasing demand for emergency and acute care, this research is crucial to determine: (a) if effects found in PRISMATIC extend across England and over a longer period; (b) to understand

the mechanisms by which EARS has an effect (intended or unintended); and (c) patient and stakeholder views. PRISMATIC2 employs a 'natural experiment' approach to address these aspects.[36]

## Aim

To assess effects, mechanisms, costs, and patient and healthcare professionals' views related to the introduction of EARS tools in England.

## Objectives

1. Determine the effects of the introduction of EARS tools across all patients and in sub-groups, including those with ACS conditions on emergency admissions, ED attendances, admissions to intensive care units (ICU), time spent (bed days) in hospital and ICU, deaths, and NHS costs.
2. Assess effects of the introduction of EARS tools on clinician behaviour related to admission decisions, including how the threshold for admission and case-mix characteristics change.
3. Describe perspectives of GPs and other practitioners in primary care, ED and working on admission avoidance about use of EARS tools on their management and communication of risk.
4. Capture the views of patients on risk management and how communication of admission risk (scores) may affect their own behaviours, including self-care.

# Method

We will employ a quasi-experimental mixed-methods design to investigate EARS introduction effects, mechanisms, and patient perspectives. Following Medical Research Council (MRC) guidance for development and evaluation of complex interventions,[37] we will develop a logic model detailing the programme theory with inputs, mechanisms, and intended or unintended effects.[38] This model will guide four work packages (***Figure 1***). We will examine processes of EARS adoption using Normalisation Process Theory.[39]

## Quantitative work packages

### Work package 1 (WP1): Trends in general practice-initiated emergency hospital admissions

We will use multiple interrupted time-series (MITS) analysis[40] to examine trends in data relating to general practice-initiated emergency hospital admissions in England's population, aggregated at the former clinical commissioning group (CCG) level, with reference to published dates of EARS approval for use at each CCG (interruption or introduction dates).[41] With approximately 205 CCGs (study sites) and varying EARS introduction dates, we will analyse routine data from Hospital Episode Statistics (HES), Office for National Statistics (ONS), and Emergency Care Data Set (ECDS) via NHS England. This includes anonymised data on emergency admissions, ED attendances, and hospital and intensive care days at CCG level from 2010–2021, linked to EARS introduction dates.

We will request comprehensive data items, including admission details, demographics, health event specifics, and treatment information. We will aggregate data at study-site level across defined short periods to form time series of our primary outcome (emergency admissions) and secondary outcomes. We will assess data quality across study sites, checking for completeness, unexpected features, or trends. Any anomalies will be explored in the context of site history over the study window, seeking reasons for data 'spikes', omissions, or unexpected variations over time, which may reasonably be attributed to local circumstances or complexities.

We will assess changes associated with EARS introduction, adjusting for demographic and case-mix differences. We will also explore profiles at CCG level, including patient sub-groups of those at highest risk (using frailty risk scores)[42] and those with ASC conditions; and estimate healthcare resource use costs before and after EARS introduction.

### Work package 2 (WP2): Changes in thresholds for general practice-initiated emergency hospital admissions

Using individual-level general practice data held within the Clinical Practice Research Datalink (CPRD) repository,[43] we will explore effects of EARS on thresholds for general practice-initiated emergency hospital admission decisions and the associated case-mix.

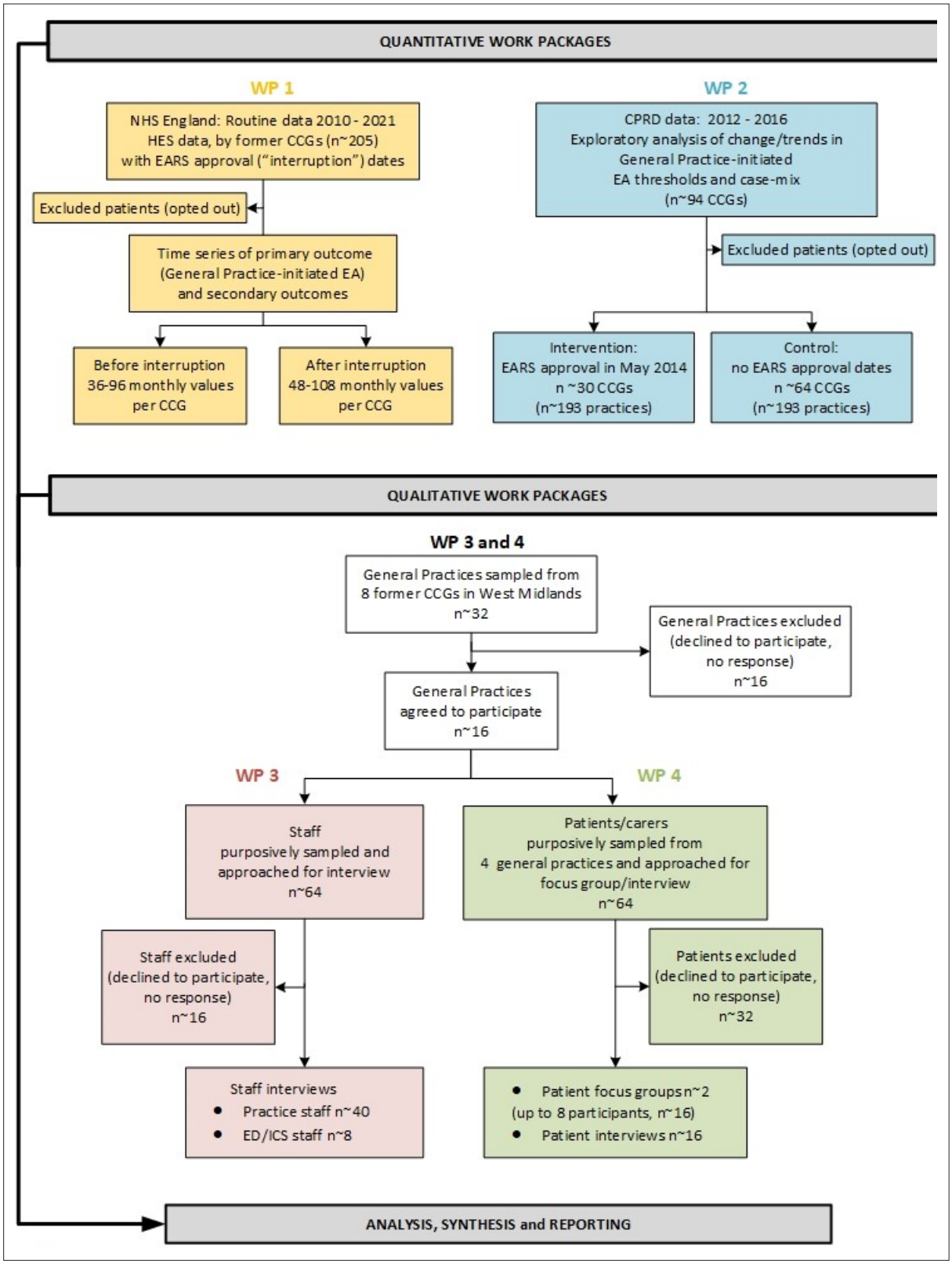


**Figure 1** Overview of study design and participant identification.
CPRD = Clinical Practice Research Datalink. EA = emergency admission. EARS = emergency admission risk stratification. ED = emergency department. HES = Hospital Episode Statistics. ICS = integrated care system

We will focus on practices in approximately 30 English CCGs where EARS was approved in May–June 2014, comparing demographic and clinical data for 2 years before and after (at practice and CCG level). We will also link CPRD and HES data, to obtain a more in-depth picture of the effect of the introduction of EARS. We will request equivalent data for a control group of practices within former CCGs (approximately 10) where EARS was approved after June 2016 or not at all.

## Qualitative work packages

We will undertake qualitative work in one English region, recruiting 16 practices across eight CCGs. We will recruit practices using purposive sampling to address diversity in practice size, location, and patient demographics. Experienced qualitative researchers will conduct the interviews and focus groups, which will be recorded and transcribed. We will use Normalisation Process Theory to examine processes of adoption by clinicians.

### Work package 3 (WP3): Semi-structured interviews with general practice clinical staff

We will interview GPs and other primary care staff involved in emergency admission decision making (approximately 40, ≤3 per practice) to capture views about how introduction and use of the software may have changed perceptions of risk and accountability and emergency admission decision making. We will ask about key inputs, mechanisms, and effects, both intended and unintended. We will also interview ED clinicians and integrated care system (ICS) or former CCG staff with responsibility for admission avoidance (approximately 8) to understand their perspectives on the effect and role of EARS.

### Work package 4 (WP4): Focus groups and interviews with patients

We will recruit patient participants (approximately 32) from four WP3 practices, selected to account for local demographic diversity. We will explore through focus groups ($n = 2$) and interviews (approximately 16) how patients perceive individual emergency admission risk score communication and its potential impact on experiences and behaviours, including self-care. We will recruit two focus groups, each with up to eight patients, through existing patient networks within the study area. Additionally, we will conduct approximately 16 interviews in person, by phone, or online, with patients recruited via participating practices using letters and telephone follow-up. We will target participants with varied emergency admission experiences, risk profiles, ages, ethnic groups, and long-term conditions. Translation and interpretation will be offered, and participants will receive a £25 incentive gift voucher.

## Data analysis

### Quantitative

We will calculate site-level measures from patient-level data to summarise and compare sites, with monthly aggregation for primary analysis, and fortnightly aggregation in sensitivity analyses. Outcome measures include rates or number of ED attendances, general practice-initiated emergency admissions, and proportions of re-attendances and inpatient admissions. We will profile patient demographics and use International Classification of Diseases, Tenth Revision (ICD10) codes for diagnoses to explore modal causes of attendance and identify sub-groups (for example, patients identified with ACS conditions). Exploratory time-series methods will evaluate trends pre- and post-EARS introduction, considering seasonal patterns and outliers. Two time periods starting in 2010 will be analysed: one including the COVID-19 pandemic period to 2021; and a pre-pandemic one ending on 1 March 2020.

Analysis of MITS models will test the null hypothesis that the introduction of EARS has no effect on the trend in outcome measures. We will have at least 120 monthly values for any outcome. Based on assessment of HES accident and emergency data within this period, we expect moderate autocorrelation, in the range of 0.2–0.5, for a lag of 1 month. Interpolating from available data, we should, using 90% power and 5% significance, be able to detect an effect of size in the range of 0.5–0.8 for a single series; with concomitantly greater power in analysing panel data.

Planned sensitivity analyses will assess: the robustness of findings for different aggregation periods and frailty risk thresholds; and consistency of findings across pre-specified patient sub-groups.

We will undertake a cost consequences analysis (CCA) alongside the clinical effectiveness analysis. We will estimate healthcare resource use and use weighted standard unit costs applied to resource

use data based on Healthcare Resource Group (HRG) codes, to calculate the cost associated with healthcare use before and after introduction of EARS. We will explore costs for the total study population and sub-groups and present disaggregated resources, their unit costs, and a range of outcomes together with estimates of mean costs with appropriate measures of variation. Our primary CCA will be supplemented by sensitivity analyses, to account for uncertainty in parameter estimates. Discounting will be applied at the standard rate where follow-up periods exceed 1 year. Implementation costs per patient will be based on extrapolation from PRISMATIC.[17]

For WP2, we will analyse linked demographic, case-mix and clinical data from CPRD and HES to explore thresholds for emergency admission decisions before and after EARS introduction and compare with the control group data.

### Qualitative

We will follow a framework approach for qualitative data analysis,[44,45] informed by the logic model and Normalisation Process Theory. We will convene a qualitative sub-group of researchers, clinicians, and patient and public contributors. The sub-group will review transcripts and develop codes, and an initial analytical framework for testing and revision with both patient and health professional datasets. Each transcript will be reviewed by a minimum of two members. The sub-group will discuss interpretation and emerging themes and consider any contradictions or inconsistencies. Analysis will take place first within and then across groups (health professionals; patients). Findings will be structured around themes with verbatim quotations. Findings will be grounded in first-hand accounts of technology introduction and impact and have transferability to other settings and healthcare technologies. The sub-group will use the findings to refine the logic model.

## Public and patient involvement (PPI)

We are strongly committed to the involvement of patients and the public, and the UK Standards for Public Involvement will be followed.[46] Two patient/public contributors are co-applicants and sit on the research management group and a further two on an independent steering committee. Patient/public contributors were involved in research development.

In developing this study we held a focus group with a patient involvement group,[47] and found support for using EARS tools to frame discussion of risk based on shared decision-making principles.[48]

## Synthesis and dissemination

We will formally synthesise qualitative and quantitative data, sequentially, using a triangulation protocol described by O'Cathain *et al* and the analytical approach outlined by Östlund *et al*.[49,50] We will develop communication, publication, and dissemination plans to inform our wider engagement activities. We will share findings widely in partnership with policymakers, health service providers, and patient and public contributors and participants.

# Discussion

## Summary

PRISMATIC2 builds on our previous evaluation of a tool in one Health Board area (PRISMATIC), by evaluating the implementation of EARS software across England.

## Strengths and limitations

Our main study strength is in the use of mixed methods that address national- and site-level data and perspectives. The MITS approach is particularly suited to evaluating interventions introduced at a population level over a defined period that target population level health outcomes, while site-based qualitative data will provide important insights from practitioners and patients. A potential limitation lies with undertaking qualitative work in one geographic region. However, we will recruit across multiple former CCGs and practices with varying sociodemographic patient profiles, and our analytic approach is designed to produce generalisable findings.

## Implications for research and practice

This study will provide policymakers, practitioners, and the research community with a better understanding of the effects of predictive risk software on costs, processes, and outcomes of care across a range of settings.

### Funding

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### Ethical approval

This study is observational, with minimal risk to patients, staff or researchers. Quantitative data analyses will be undertaken on routine data without identifying information and will be subject to strict rules about presentation of outputs, to protect privacy. If patients become distressed in qualitative interviews or focus groups, we will stop data collection and implement appropriate support processes. We will seek information governance permissions from NHS England and CPRD.

The study and protocol has approval from Harrow NHS Research Ethics Committee (reference 23/LO/0036). The authors confirm that we have provided an honest, accurate and transparent account of the revision with no important omissions.

### Research Registration

Research Registry Unique Identifying Number: researchregistry8491

https://www.researchregistry.com/browse-the-registry#home/registrationdetails/63738f3f6c6999002195f8c9/

### Provenance

Freely submitted; externally peer reviewed. This protocol has not been peer reviewed by BJGP Open. The authors confirm that it has undergone external peer review.

### Data

NHS England and CPRD data is available with appropriate research governance approvals. Qualitative data is not available due to study specific consent arrangements.

### Acknowledgements

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### Competing interests

Helen Snooks is a Health Technology Assessment journal editor for the NIHR. Alan Watkinsis a member of the NIHR Health Services and Delivery Research (HSDR) FundingCommittee.

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