



RESEARCH

INFORMATION

Chronic Pain Identification Through Electronic Records (C-PICTURE): Development and Validation of an Algorithm to Identify People with Chronic Pain Using Primary Care

Chronic pain (pain that persists or recurs for more than 3 months) affects up to 2 in 5 people in the UK, yet there is no validated method to identify people living with chronic pain using routine primary care data.



AIMS

The C-PICTURE study was designed to address the absence of a reliable, population-based method for identifying chronic pain within primary care electronic health records. By combining quantitative validation with qualitative insights, the purpose of the project was to establish a clinically meaningful and scalable approach to case identification that reflects both recorded healthcare activity and lived experience. The C-PICTURE aimed to:

- Construct an electronic case-finding algorithm using routinely coded diagnostic, prescribing, and clinical activity data within Scottish primary care systems.
- Evaluate its accuracy against detailed medical record review, treating clinician-adjudicated notes as the reference standard.





- Assess concordance with patient-reported pain severity, functional impact, and expressed need, using large-scale survey data.
- Explore how chronic pain is recognised and documented in practice, through interviews with patients and healthcare professionals.
- Establish a scalable tool capable of supporting surveillance, research recruitment, and informed service planning across Scotland.



KEY FINDINGS

1. The algorithm performed strongly against medical notes review.

The SPIRE algorithm was tested against detailed medical record reviews and correctly identified most people with chronic pain, while rarely missing cases. It also performed consistently when tested in larger primary care datasets, suggesting it could be used reliably to identify chronic pain in routine healthcare data.

2. The algorithm preferentially identifies clinically meaningful pain.

The algorithm aligned more closely with high pain interference and high expressed treatment need than with broad “any pain” self-report. SPIRE classifications increased with pain severity, functional limitation, and unmet need, indicating that the algorithm captured more severe and impactful pain rather than mild or occasional symptoms.

3. Differences between data sources reflect documentation practices.

Chronic pain is often not explicitly coded in clinical records. Clinicians frequently record underlying conditions or manage pain through prescribing rather than using a specific chronic pain diagnosis. Differences between algorithm, notes, and survey classifications therefore likely reflect real-world recording practices. The lower specificity observed in the PCIS implementation using the original prescribing rule likely reflects broader capture of prescribing through newer (dm+d) drug codes.





4. False positives were more common in older and multimorbid patients.

SPIRE-positive individuals without chronic pain documented in the notes were more likely to be older and to have multiple pain-related indicators recorded, including diagnoses such as migraine, neuropathy, or arthritis. This suggests the algorithm captures broader pain-related healthcare burden.

5. The algorithm does not require refinement at present.

Given its strong and stable performance, further modification would likely provide only marginal improvement. The current version therefore represents a robust and scalable case-finding tool.



WHAT DID THE STUDY INVOLVE?

A four-phase, mixed-methods validation study across six diverse Scottish GP practices:

Phase A — Medical Notes Review (n=1,200)

- Detailed review of electronic records
- Gold-standard classification of chronic pain

Phase B — Patient Survey (~6,200 invited, n=889 completed)

- Pain severity
- Pain interference
- Level of Expressed Need (LEN)

Phase C — Qualitative Interviews (16 HCPs, 31 patients) & Focus Groups (n=17)

- Patients (lived experience)
- Clinicians (coding & prescribing practice)

- Exploration of discrepancies and invisibility

Phase D — Algorithm Testing

- Applied across full practice lists
- Compared against notes and survey
- Logistic modelling and ROC analysis

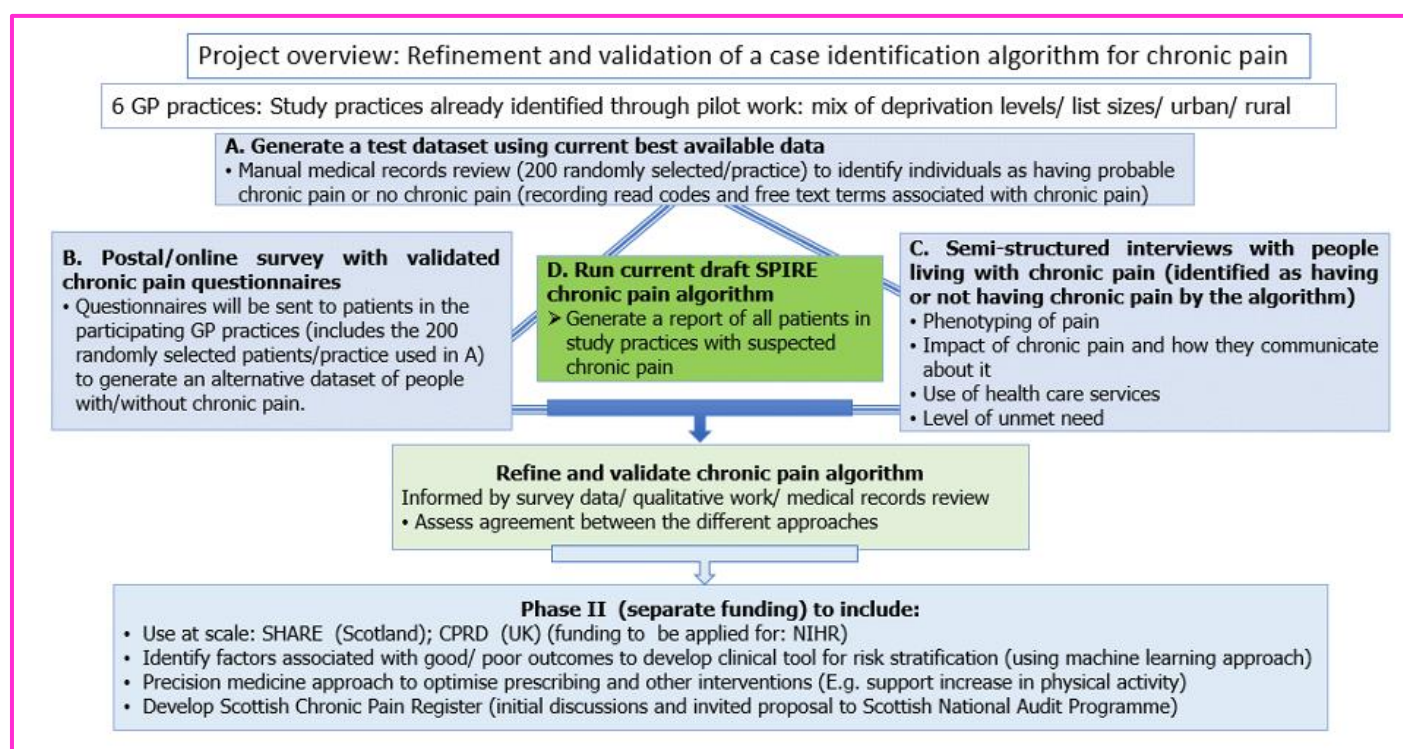


Figure 1. C-PICTURE project overview



WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

Quantitative Findings

Validation Against Medical Notes (Gold Standard)

The SPIRE algorithm performed well when compared with detailed medical record reviews and accurately identified most people with clinically documented chronic pain. Very few cases were



missed, and the algorithm showed consistent performance across analyses, suggesting the indicator structure was robust and reliable.

Primary Care Intelligence Service (PCIS) Implementation

The PCIS implementation showed similarly strong performance in identifying chronic pain cases within primary care datasets. Using the original prescribing rule, the algorithm maintained high case detection and strong overall performance. Increasing the prescribing threshold modestly improved the accuracy of identifying non-cases while maintaining stable identification of chronic pain cases. Overall performance remained consistent across both SPIRE and PCIS datasets.

What this means

Both SPIRE and PCIS reliably identify clinically documented chronic pain using routinely collected healthcare records. The findings suggest the algorithm performs consistently across different healthcare datasets and may provide a practical tool for identifying chronic pain populations in research and healthcare settings.

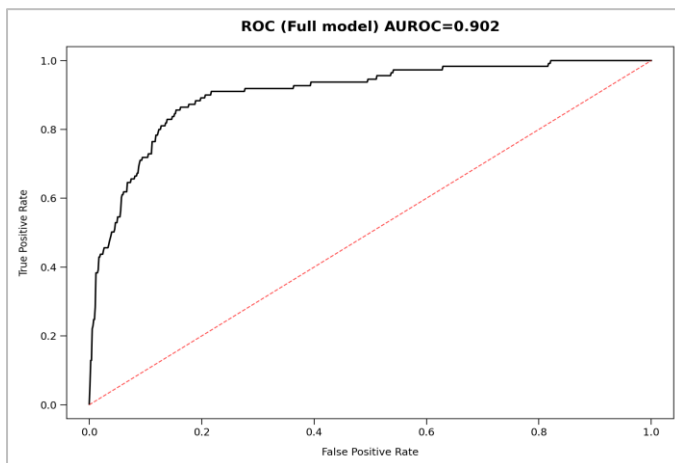


Figure 2. Receiver operating characteristic (ROC) curve for SPIRE logistic regression model

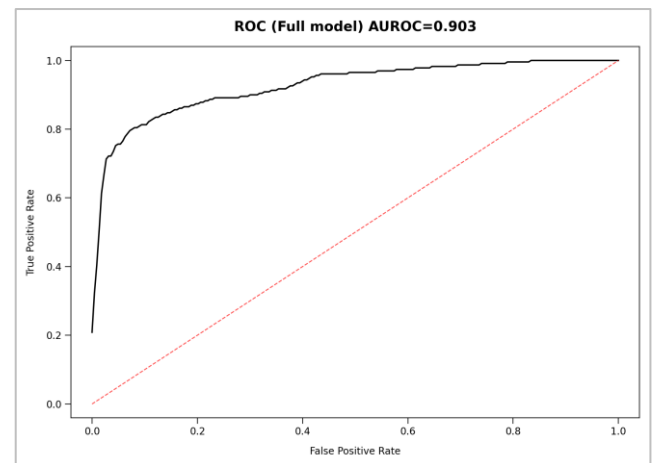


Figure 3. Receiver operating characteristic (ROC) curve for PCIS ≥8 prescriptions logistic regression model

Alignment with Patient-Reported Outcomes

Agreement between SPIRE and self-reported chronic pain was more moderate, likely reflecting differences between patient experiences and clinician-recorded diagnoses. However, SPIRE aligned more closely with severe and functionally limiting pain than with broader self-reported pain alone. Individuals identified by SPIRE reported greater pain severity, greater interference with daily activities, and stronger unmet treatment needs. Higher SPIRE scores were consistently associated with worse pain and functional outcomes.

What this means

The algorithm preferentially identifies persistent and clinically meaningful chronic pain rather than mild or occasional symptoms. This may help identify individuals with greater healthcare needs and support future healthcare planning and service delivery.

Analysis	Test	Statistic	p-value
LEN level vs pain mean	Spearman correlation	$\rho = 0.85$	<0.001
LEN level vs SPIRE	Spearman correlation	$\rho = 0.43$	<0.001
Pain mean vs SPIRE	Spearman correlation	$\rho = 0.425$	<0.001
Interference mean vs SPIRE	Spearman correlation	$\rho = 0.418$	<0.001
Pain mean vs interference mean	Spearman correlation	$\rho = 0.94$	<0.001
Interference mean vs LEN level	Spearman correlation	$\rho = 0.856$	<0.001
LEN level by SPIRE_any	Wilcoxon rank-sum	$W = 61010$	<0.001



Pain mean by SPIRE_any	Wilcoxon rank-sum	W = 59561	<0.001
Interference mean by SPIRE_any	Wilcoxon rank-sum	W = 60128	<0.001
LEN_high vs SPIRE_any	Chi-square	$\chi^2 = 74.315$ (df = 1)	<0.001
LEN_level ~ pain_mean	Linear regression	$\beta = 0.219$ (SE = 0.022)	<0.001
LEN_level ~ interference_mean	Linear regression	$\beta = 0.178$ (SE = 0.021)	<0.001

Table 1. Associations Between SPIRE Classification, Pain Severity, Interference, and Treatment Need

Qualitative Findings

Patients

Patients described chronic pain as gradual, fluctuating, and often normalised over time. Many did not initially identify themselves as having “chronic pain,” instead framing symptoms as part of ageing, comorbidity, or daily life. Help-seeking was often delayed, and pain was frequently self-managed.

Meaning:

Chronic pain may not always be actively presented in consultations, contributing to under-recording in clinical systems.



Clinicians

Clinicians reported that chronic pain is rarely coded explicitly as “chronic pain.” Instead, underlying diagnoses (e.g., osteoarthritis, back pain) are recorded, and ongoing pain management is often reviewed through prescribing activity rather than structured pain assessment. Coding practices varied and were shaped by time pressures and system routines.

Meaning:

Pain often becomes visible in electronic records indirectly, through medication patterns and repeated encounters rather than diagnostic labelling.

Focus Groups

Focus group discussions reinforced the theme of invisibility. Participants highlighted emotional burden, fluctuating severity, and the effort required to articulate pain in brief consultations. Across groups, chronic pain was described as persistent yet partially hidden within healthcare systems.

Meaning:

Discrepancies between documentation, self-report, and algorithm classification reflect structural features of healthcare recording rather than absence of clinically meaningful pain.

Overall Interpretation

The mixed-methods findings indicate that SPIRE captures clinically meaningful and burdensome pain within the realities of everyday primary care practice. Where disagreement occurs, it largely reflects how chronic pain is understood, articulated, and recorded rather than weakness in the algorithm itself.

Given its strong performance and stability, refinement is not currently required, as additional modification would likely produce only marginal gains.



WHAT IMPACT COULD THE FINDINGS HAVE?

The C-PICTURE study provides the first validated, population-based method for identifying clinically meaningful chronic pain using routinely collected Scottish primary care data. This represents an important advance in chronic pain surveillance, as current prevalence estimates rely largely on surveys and do not allow routine monitoring of healthcare needs or service demand. By enabling systematic identification of individuals with persistent and high-impact pain, the algorithm supports more accurate prevalence estimation, improved understanding of geographic and socioeconomic variation, and clearer identification of populations with greater healthcare needs. The findings have important implications for both healthcare services and patients. Health boards and policymakers could use this approach to better understand demand for pain services, evaluate prescribing patterns and care pathways, and identify areas of unmet need. For patients, improved identification of chronic pain within healthcare records may help support earlier recognition of persistent pain problems, more targeted referral pathways, and better access to appropriate support and interventions. The algorithm also provides a scalable framework for future epidemiological studies and clinical research, including more efficient and representative recruitment into clinical trials. The mixed-methods findings additionally highlight structural invisibility in chronic pain coding and documentation practices. This creates opportunities to strengthen how chronic pain is recognised and recorded within primary care systems, potentially improving communication, continuity of care, and long-term management for people living with chronic pain.



HOW WILL THE OUTCOMES BE DISSEMINATED?

The primary findings will be submitted for peer-reviewed publication and presented at national and international conferences in pain research, primary care, and health services research over the next 12 months. We will engage directly with NHS Scotland and Public Health Scotland to support implementation of Scotland's Pain Management Framework and ongoing service planning initiatives. Participating GP practices will receive tailored feedback reports summarising findings relevant to their populations. Patient and public involvement contributors informed the development and interpretation of this work and will continue to contribute to dissemination activities. We also plan to



share findings through patient engagement events, workshops, and online dissemination activities. The methodological framework will also be shared with researchers and data platform leads to explore adaptation in other UK primary care systems and international contexts.



CONCLUSION

C-PICTURE delivers the first validated, robust, and scalable algorithm for identifying clinically meaningful chronic pain using Scottish primary care data. The algorithm demonstrates strong performance, aligns with high-impact pain and unmet need, and reflects the realities of clinical documentation and lived experience. By enabling the use of routinely collected data as a sampling frame for both population-level surveillance and clinical trial recruitment, this work establishes an essential foundation for improved chronic pain surveillance, research, and equitable service planning in Scotland.



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Additional Information

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