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ORIGINAL ARTICLE

Implementing prescribing safety indicators in prisons: A mixed methods study

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Aims: To examine the prevalence of potentially hazardous prescribing in the prison setting using prescribing safety indicators (PSIs) and explore their implementation and use in practice.

Methods: PSIs were identified and reviewed by the project team following a literature review and a nominal group discussion. Pharmacists at 2 prison sites deployed the PSIs using search protocols within their electronic health record. Prevalence rates and 95% confidence intervals (CIs) were generated for each indicator. Semi-structured interviews with 20 prison healthcare staff across England and Wales were conducted to explore the feasibility of deploying and using PSIs in prison settings.

Results: Thirteen PSIs were successfully deployed mostly comprising drug–drug interactions ($n = 9$). Five yielded elevated prevalence rates: use of anticholinergics if aged ≥65 years (Site B: 25.8% [95%CI: 10.4–41.2%]), lack of antipsychotic monitoring for >12 months (Site A: 39.1% [95%CI: 27.1–52.1%]; Site B: 28.6% [95%CI: 17.9–41.4%]), prolonged use of hypnotics (Site B: 46.3% [95%CI: 35.6–57.1%]), antiplatelets prescribed with nonsteroidal anti-inflammatory drugs without gastrointestinal protection (Site A: 12.5% [95%CI: 0.0–35.4%]; Site B: 16.7% [95%CI: 0.4–64.1%]), and selective serotonin/norepinephrine reuptake inhibitors prescribed with nonsteroidal anti-inflammatory drugs/antiplatelets without gastrointestinal protection (Site A: 39.6% [95%CI: 31.2–48.4%]; Site B: 33.3% [95%CI: 20.8–47.9%]). Prison healthcare staff supported the use of PSIs and identified key considerations to guide its successful implementation, including staff engagement and PSI 'champions'. To respond to PSI searches, stakeholders suggested contextualised patient support through intraprofessional collaboration.

Conclusion: We successfully implemented a suite of PSIs into 2 prisons, identifying those with higher prevalence values as intervention targets. When appropriately

resourced and integrated into staff workflow, PSI searches may support prescribing safety in prisons.

KEYWORDS
electronic health records, medication safety, patient safety, prescribing, prescribing safety indicators, prison health

1 | INTRODUCTION

Adults in contact with the criminal justice system or residing in prisons have greater mental and physical health needs compared to the general population.[1,2] It is acknowledged that patients make extensive use of healthcare services during imprisonment,[3,4] which presents an opportunity to improve prisoner health. However, there is evidence of varied practice in health-care delivery between prisons[5,6] and the need to focus on the quality and safety standards of prisoner care has been emphasised in the UK.[7,8]

Prescribing practice is an important factor influencing the quality and safety of prison healthcare alongside others such as staffing and complications arising from an ageing prisoner population.[8,9] For example, there is evidence of potentially inappropriate prescribing in prisons,[9] and the chronic health needs of incarcerated patients may also be overshadowed by issues related to the frequent misuse and diversion of prescribed medication,[10] with vigilance and risk management processes important facets of prison prescribing.[5]

Prescribing safety indicators (PSIs) have been developed to enhance the safety of prescribing.[11–14] PSIs are statements describing "a pattern of prescribing that could be hazardous and may put patients at risk of harm".[11] Clinical trials and an interrupted time–series evaluation have demonstrated that a pharmacist-led intervention using PSIs to measure improvements in prescribing and medication monitoring safety in primary care significantly reduced the rates of potentially hazardous prescribing.[12,15]

In contrast with their more extensive use and impact across primary and secondary care, there is limited evidence to date exploring the development and application of PSIs to prison settings.[16] Exploring the prevalence of potentially hazardous prescribing, implementation and practical use of PSIs into prison electronic health records (EHRs) can provide insight into ways to improve prescribing and monitoring practices at a national scale, as all 142 prisons in England and Wales use the same EHR.[17] This study, therefore, aimed to develop and deploy a suite of PSIs into the EHRs of 2 UK prisons to determine their prevalence, and to qualitatively explore their potential practical use to improve medication safety.

What is already known about this subject

- Complex medication regimens are commonly prescribed in prison settings, and therefore require careful management to minimise the risk of adverse events.
- Prescribing safety indicators (PSIs) have been used to enhance the safety of prescribing and monitoring, but evidence for use in prisons is limited.
- Evaluating the implementation and practical use of PSIs in prisons can provide insights to improve prescribing and monitoring practices in this setting.

What this study adds

- We successfully deployed a tailored suite of 13 PSIs across 2 prisons to help identify patients at risk of potentially hazardous medication prescribing. Five out of 13 PSIs were associated with high prevalence between 12.5 and 46.3%.
- Unique contextual factors such as clinical coding and patient issues were identified by stakeholders as key factors that would influence the successful implementation and clinical response to PSI data.
- Our findings provide a framework for use of PSIs by other secure environments as a platform for improvement efforts, with the multidisciplinary team at its heart.

2 | METHODS

Three study phases took place to examine the prevalence of PSIs in 2 large prisons and to explore their practical implementation and use with stakeholders from England and Wales. The first phase involved the identification and development of potential PSIs. The second was the deployment of PSIs into 2 prison electronic health records to evaluate their frequency, and the third involved interviewing prison healthcare staff to explore their views on accessing, using and responding to PSI data, including any past experience of using PSI data to improve prescribing and medication monitoring practices in prisons.

Ethics approval for this study was granted by the National Research Committee on 27 July 2018 (Reference 2018–211) for Phase 1; the Health Regulatory Authority on 26 July 2019 (REC Reference 19/NW/0265) and National Research Committee on 22 May 2019 (Reference 2019–146) for Phases 2 and 3. Approvals were obtained from prison Governors for PSI development and deployment in the 2 study prisons.

2.1 | Phase 1: Identification and development of candidate prescribing safety indicators

The identification and development of PSIs involved a 2-stage process: (i) identification and development of PSIs by scoping relevant published literature and using a nominal group discussion); and (ii) reviewing/refining PSIs identified in stage 1 by the research team.

Existing PSIs developed for primary, secondary and mental health-care settings were extracted from key PSI papers in the existing literature.[14,18,19] In addition, a nominal group discussion was held with prison healthcare and senior level professionals with at least 3 years' experience in UK prison settings, along with an interest in medicines management/safety and/or experience in prescribing safety and quality in prisons. The nominal question asked was, "what medication-related errors/harms or examples of hazardous prescribing are most likely to occur in the prison setting and what is their potential severity?" Panellists generated their contributions to the nominal question and shared their responses in a *round-robin* format before being discussed by the whole group.[20,21] Pre-reading material containing potential indicators from earlier studies identified from the literature search above were raised and discussed with the panel.[14,18] Ideas generated during the discussion were prioritised by the group resulting in a list of potential harms/errors associated with prescribing and monitoring of medication (potential PSIs) alongside wider prescribing safety challenges in prisons. A total of 11 generated ideas with the potential to be PSIs were taken forward (Appendix 1). When combined with the literature search findings, a total of 100 potential PSIs were taken forward to the review stage by the research team (Appendix 2).

Members of the research team (R.N.K., E.M.-M., P.B. and J.D.) then independently reviewed the generated list of 100 potential PSIs based on: (i) their clinical importance; and (ii) feasibility for deployment within UK prison settings (Table 1). The team included 1 prison pharmacist member (J.D.) and 1 Chief Pharmacist (P.B.) involved in prisons medicines management. R.N.K. and E.M.-M. are both practising clinical pharmacists in other sectors, and R.N.K. has expertise in medicines safety and use of prescribing safety indicators.

Overall suitability for each indicator was then discussed face-to-face amongst the research team using these 2 assessments together, and indicators with higher clinical importance and feasibility were selected by consensus to take forward to the deployment phase. Reasons for exclusion included a lack of reliable clinical coding (e.g. medical condition-related PSIs), rare prescribing events in prison and PSIs specific to females (see below, PSI deployment sites were male prisons). This process resulted in a total of 21 PSIs taken forward to potential deployment (Appendix 3).

TABLE 1 Criteria used to review potential prescribing safety indicators based on their clinical importance (clinical impact and frequency of prescribing in prisons) and feasibility (whether relevant data needed for the indicator was routinely collected)

Clinical importance	Feasibility score
1 Low	High feasibility
2 Moderate	Medium feasibility
3 High	Low feasibility
4 Extreme	

2.2 | Phase 2: Deployment of prescribing safety indicators

Prison pharmacists (J.D. and A.O.) working in 2 male prison sites in England and Wales collaborated with the research team to operationalise and deploy 21 PSIs from Phase 1 by developing and applying search protocols within the prison EHR (Table 2 shows characteristics of the prison testing sites). These prisons were selected based on convenience sampling and prior working relationships, and the operationalisation process was supported by the EHR developer who provided training in conducting the computer searches.

Prison pharmacists used an iterative test and feedback model to validate the electronic PSI data. This involved optimising the search for PSIs using EHRs and manually checking patient records to ensure the results of the search were sensitive and specific in capturing data of the PSIs. Clinical codes were utilised for laboratory value searches, which are a thesaurus of clinical terms to record patient findings and procedures in EHR.[22] The team preferentially selected *fully automated* PSIs for inclusion in the final list, due to resource constraints associated with manual screening of large numbers of patient records. The *test and feedback* approach resulted in the exclusion of 8 further indicators, due to: (i) the need for a combination of electronic and manual searches (5 indicators); (ii) insufficient search capacity with the EHR search tool (2 indicators); and (iii) insufficient use of the indicator medication(s) in prisons (1 indicator).

Once the indicator search protocols were finalised and agreed, final searches involving 13 PSIs were conducted in July 2020. Individual reports were generated before joining them together in a Venn diagram fashion to establish all possible logical relations between the reports.

Anonymised audit data extracted from prisoner health records (for each PSI) included the number of patients affected by potential PSIs (numerator), the number of patients in the *at risk* group (denominator) and the proportion (prevalence) affected (numerator/denominator $\times$ 100) which was expressed as a percentage with corresponding 95% confidence intervals.

2.3 | Phase 3: Semi-structured interviews to explore practical implementation of prescribing safety indicators

Semistructured telephone interviews were conducted with prison healthcare staff to explore the feasibility of deploying and using PSIs in prisons. This included barriers and enablers to accessing, viewing and responding to PSI data in prisons. The goal was to generate recommendations for the deployment and application of PSIs to prison

TABLE 2 Prison prescribing safety indicator testing site characteristics

Prison characteristics	Site A	Site B
Category	C (with remand and men convicted of sexual offences [MCOSO] function)	B (training prison with category A unit)
Sex	Male	Male
Age range	General & MCOSO = 21+ y Remand = youth offenders (18–21 y) and adults	21+ y
Healthcare wings	One assisted mental health community	Inpatient unit

Category B are prisons that are either local or training prisons. Training prisons hold long-term and high-security prisoners who are convicted of serious offences such as murder or rape, but are considered to be of lower risk. Category C are prisons that are training and resettlement prisons, which provide prisoners with the opportunity to develop their own skills in order to resettle back into the community on release. Prisoners in Category C are usually convicted with minor offences and shorter lengths of stay. Most prisoners are in Category C.[42]

settings. These topics were covered as part of a wider agenda to explore the processes and factors influencing safe prescribing and medication monitoring in prisons.[5]

Briefly, a flyer to publicise the study was emailed and circulated via social media and shared professional networks across England and Wales. Prison healthcare staff such as general practitioners (GPs), psychiatrists, pharmacists, nurse prescribers and other clinicians/managers with a minimum of 3 years prison-based experience and an interest in medicines management/safety were invited to participate. Those who expressed interest in participating were sent pre-reading material containing background information about PSIs and their use. Written/verbal consent was obtained from participants prior to conducting interview. The interview schedule included questions related to challenges to medication and prescribing safety and potential improvement strategies.[5] Topics covered relating to PSIs and medication safety, and participants' experience of their deployment/impact in prisons are included in Appendix 4 and are the focus of this paper.

Interviews took place from October 2019–July 2020, were digitally audio-recorded and anonymised transcripts imported into NVivo 12 (QSR) for coding using inductive thematic analysis.[23] Interviews were independently coded by E.M.-M. and A.A., with a third author (R.N.K.) reading 50% of transcripts and contributing to the development of the final analytical framework that was agreed by these 3 authors.

3 | RESULTS

Thirteen *fully automated* PSIs were successfully deployed that consisted of 9 drug–drug interaction, 2 drug monitoring, 1 drug-duration and 1 drug–age indicators. Medications featuring in the PSIs included 3 mood stabilisers, 2 opioids, 2 antipsychotics, 2 antidepressants, 2 cardiovascular system agents, 1 anxiolytic, and 1 anticholinergic.

Table 3 shows the proportion of patients in both prisons triggered by these 13 PSIs, including the number affected and the number of patients in the *at risk* group. The prevalence of patients affected by a PSI in Site A ranged between 0–39.6%, and in site B this ranged between 0–46.3%. Five PSIs had 0% prevalence in both sites, 4 of which were related to lithium.

Data across sites A and B revealed elevated prevalence values for prescribing selective serotonin reuptake inhibitors (SSRI)/selective norepinephrine reuptake inhibitors (SNRI) with nonsteroidal anti-inflammatory drugs (NSAIDs) or antiplatelets with no gastrointestinal (GI) protection (A: 39.6% (95%CI: 31.2–48.4); B: 33.3% (95% CI:20.8–47.9)), prescribing antiplatelets with NSAIDs without GI protection (12.5% (95%CI: 0.0–28.7); 16.7% (95%CI:0.4–64.1)), and prescribing antipsychotics for at least 12 months without monitoring blood glucose, weight or lipid profile within the previous year (39.1% (95%CI:27.1–52.1); 28.6% (95%CI:17.9–41.4)). Site B also had high prevalence values for patients who were prescribed benzodiazepines, Z-drugs or sedating antihistamines for >1 month (46.3% [95%CI:35.6–57.1]) and prescribing a medication with medium/high anticholinergic activity to a patient aged ≥65 years (25.8% [95%CI:10.4–41.2]). Zero prevalence values were reported for 5 indicators from both sites, of which 4 were related to lithium.

3.1 | Practical implementation and utility of prescribing safety indicators in prisons (interviews)

A total of 20 prison healthcare staff were interviewed to explore the practical use of PSI data in prisons. This included 10 pharmacists, 6 GPs, 3 psychiatrists and 1 nurse. Of these, 9 participants (5 pharmacists, 3 GPs and 1 psychiatrist) reported to have some existing experience with PSIs, which involved prescribing quality/safety audits and clinical reports.

Four key themes emerged from the data: (i) accessing PSIs; (ii) usability of PSIs; (iii) reviewing and reporting PSIs; and (iv) responding to PSIs.

3.1.1 | Accessing PSIs

To optimise searching for PSIs using the EHR, respondents with direct experience working on PSIs recognised the need for accurate coding of patient data related to diagnoses, prescribing and monitoring. Participants reported a number of barriers related to inconsistencies in data-entry using clinical codes into the her, which made conducting PSI searches complex. Some reported that clinical codes were at times

TABLE 3 Number and prevalence values of patients affected by prescribing safety indicators at each prison site

Prescribing safety indicator and source	Type	Associated risk	Number of patients affected by PSI in site A	Number of patients affected by PSI in site B	Number of patients in the *at risk* group of site A	Number of patients in the *at risk* group of site B	Prevalence in site A (%, 95% CI)	Prevalence in site B (%, 95% CI)
Coprescribed opioid with methadone/ buprenorphine.[14] [Identified from NGD]	Drug–drug interaction	Risk of sedation, respiratory depression	6	13	349	174	1.7 (0.4–3.1)	7.5 (4.0–12.4)
Coprescribed opioid and gabapentin/ pregabalin. [Identified from NGD]	Drug–drug interaction	Risk of sedation, respiratory depression	6	7	342	138	1.8 (0.7–3.8)	5.1 (2.1–10.2)
Lithium prescribed in conjunction with NSAID.[14]	Drug–drug interaction	Increased risk of toxicity	0	0	1	0	0.0	0.0
Prescribed benzodiazepine, Z-drug or sedating antihistamine for >1 mo.[19]	Drug duration	Risk of prolonged sedation, confusion, impaired balance, falls	1	38	21	82	4.8 (0.0–13.9)	46.3 (35.6–57.1)
Prescribed SSRI/SNRIs with NSAID or antiplatelet with no GI protection.[14,19]	Drug–drug interaction	Increased risk of GI bleeding	53	17	134	51	39.6 (31.2–48.4)	33.3 (20.8–47.9)
Coprescribed SSRI/ SNRIs with NOACs or warfarin.[19]	Drug–drug interaction	Increased risk of bleeding	15	1	451	140	3.3 (1.9–5.4)	0.7 (0.0–2.1)
Coprescribed lithium with ACEi or ARB.[19]	Drug–drug interaction	Risk of lithium toxicity, which can cause tremor, dysarthria, ataxia and confusion	0	0	52	45	0.0	0.0
Coprescribed lithium with a diuretic (loop/ thiazide).[14]	Drug–drug interaction	Risk of lithium toxicity, which can cause tremor, dysarthria, ataxia and confusion, and risk of hypokalaemia which increase the risk of torsade de pointes	0	0	20	20	0.0	0.0
Lithium prescribed for at least 6 mo without monitoring U&E or thyroid function during the 6-mo period.[19]	Drug monitoring	Risk of lithium toxicity and renal impairment; risk of thyroid disorder	0	0	1	0	0.0	0.0

(Continues)

TABLE 3 (Continued)

Prescribing safety indicator and source	Type	Associated risk	Number of patients affected by PSI in site A	Number of patients affected by PSI in site B	Number of patients in the *at risk* group of site A	Number of patients in the *at risk* group of site B	Prevalence in site A (%, 95% CI)	Prevalence in site B (%, 95% CI)
A medication with medium/high anticholinergic activity prescribed to a patient aged ≥65 y.[19]	Drug–age	Risk of falling and fracture, risk of acute confusion, urinary retention	1	8	17	31	5.9 (0.2–28.7)	25.8 (10.4–41.2)
Warfarin prescribed concomitantly with a NSAID.[14]	Drug–drug interaction	Increased risk of bleeding	0	0	376	209	0.0	0.0
Antiplatelet prescribed to a patient concomitantly with a NSAID without GI protection.[14,43]	Drug–drug interaction	Increased risk of bleeding	1	1	8	6	12.5 (0.0–35.4)	16.7 (0.4–64.1)
Antipsychotic prescribed for at least 12 mo without monitoring blood glucose, weight or lipid profile within the previous year.[19]	Drug monitoring	Risk of metabolic adverse effects	25	18	64	63	39.1 (27.1–52.1)	28.6 (17.9–41.4)

ACEi/ARB: angiotensin-converting enzyme inhibitor/angiotensin-receptor blocker; CI: confidence interval; GI: gastrointestinal; NGD: nominal group discussion; NOAC: novel oral anticoagulant; NSAID: nonsteroidal anti-inflammatory drug; SSRI/SNRI: selective serotonin/norepinephrine reuptake inhibitor; U&E: urea and electrolytes).

entered either incorrectly, were not documented, or were not used in certain specialties such as psychiatry. In some cases, the variation in clinical coding was as a result of different professions coding differently. Participants recognised that more training is needed to use the EHR to its full potential.

> *"They're (GPs) generally very good at [clinical] codes because it's a system they use in primary care. The psychiatrists use ICD-10, we use completely different systems to code what we diagnose. We don't really use the [clinical] code system or in psychiatry in the community here."* (Interview 7, Psychiatrist).

Variation in the use of the EHR between prisons affected the perceived feasibility of implementing PSI searches into practice. If clinical codes were not entered correctly, searching for specific patients proved to be difficult and time-consuming.

Participants felt that the EHR could be better utilised to support PSI searches if an interface/data sharing between GP and prison settings occurred to ensure continuity in patient care when prisoners were released.

> *"So [EHR], it has no interface with GPs and the outside … I think the drug-seeking behaviour would be curbed and I think the documentation and continuity would be so much more accurate and easier. And it would also sort the problem out of, if this audit was run, it pointed out that this PSI has not been met, that information would transfer to wherever the prisoner is going."* (Interview 2, Pharmacist).

3.1.2 | Usability of PSIs

A number of factors influenced the applicability and usability of PSIs in practice. This included staff motivation and engagement to use PSIs, their time and capacity, the type of prison and service offered and who would have responsibility for generating this data. Recognising the potential for increased workload associated with conducting a PSI search, the majority of participants who were mainly pharmacists or GPs emphasised the need to delegate a member of staff to generate PSI reports. However, not all prisons were reported to have regular staff or an on-site pharmacy service and some mentioned relying on locum GPs to provide routine clinical services. The majority of participants stated that employed pharmacists or nurses would be ideal to conduct regular PSI searches and to also support continuity of patient care. Those with prior experience of using prescribing safety/quality indicators reported devising methods to overcome staffing issues such as using central reporting teams and EHR data analysts to search and submit PSI reports.

> *"Because we're doing this centrally, and sending back something that looks quite pretty to the teams, then I think it's used more because we send something out as an end product, in terms of graphs, and something with dashboards, something looking nice."* (Interview 12, Pharmacist).

Many participants described the importance of engaging healthcare staff to use PSIs by explaining their rationale for use and how the reports may be used to their advantage. This included the benefits at an organisational level, such as using PSI reports to conduct audits, monitor the implementation of new guidance, and improve prescribing and monitoring practices. One participant commented that staff may be more inclined to adopt PSIs if the benefits outweighed the workload burden.

> *"As long as they believe this is a real risk and by doing the thing that they need to do reduces that risk, that provides benefit then I think they would take it on."* (Interview 3, Pharmacist).

A couple of participants stated that prison management considered nonpatient facing work to be unproductive and therefore PSI activity would probably be deemed as noncommissioned "*clinical governance work*" (Interview 17, GP). One participant commented that embedding this task into service specifications and job roles could help resolve this issue.

3.1.3 | Reviewing and reporting PSIs

Participants with experience of PSIs described the need to check the validity of the search and have the ability to interpret them accurately. This was the case when administrative staff were tasked to conduct a patient search and were unable to clinically interpret the results.

> *"So I think our [EHR] sort of user experts have looked at it, but they don't have the clinical knowledge to interpret … so they don't know what they can and can't tweak within the kind of the clinical aspects of the report; so there's not been that joint bit of work which would be useful I think."* (Interview 4, Pharmacist).

Participants also reported the need to manually check that there is indeed a real risk to the patient identified as being affected by a PSI—filtering patients with a theoretical risk that is acceptable in clinical practice was 1 example discussed by this participant.

> *"So say we had 19 patients who are on Bisoprolol for asthma or COPD [chronic obstructive pulmonary disease] but it's all cool, it's all fine, the benefits outweigh the risks, it's okay. They'll always remain on those indicators at the moment"* (Interview 14, Pharmacist).

In addition to engaging healthcare staff to use PSIs, 1 pharmacist stated that GPs were more likely to initiate action plans if reports were presented in an accurate and understandable format, which would help them save time. Many participants also mentioned the importance of engaging healthcare staff to utilise PSIs by delegating a PSI-champion to drive it forward.

> *"You do generally need somebody who's interested in it [PSI reports]. If it was a huge safety concern … I think they [GPs] would generally do it. But if it was something like, let's look at all patients on something, they all need reviewing, then that might take a bit of … getting somebody engaged to do it. And you find different sites react in different ways."* (Interview 14, Pharmacist).

3.1.4 | Responding to PSIs

A common theme to addressing PSI reports was intraprofessional collaboration. Many healthcare staff reported having regular medication management meetings to promote a safer prescribing culture and address challenges to prescribing in prisons. This included difficulties in approaching aggressive or verbally abusive patients and the need to devise a consistent intraprofessional approach to communicating with patients if the prescriber changes or discontinues certain medications. A few participants commented that the unique nature of a prison settings resulted in prescribers having more responsibility and accountability for patients. Assessing patients in a holistic manner based on their clinical profile and context was reported to influence how healthcare staff may choose to respond to PSIs, such as the patient's willingness to change medication, risk of suicide/self-harm/medication diversion and any potential drug–drug interaction of prescribed medicines with illicit drugs.

> *"We provide the teams, on a monthly basis, with a medicines optimisation dashboard, and the patient safety indicators only form one strand of that dashboard … we also track prescribing trends of abusable medicines, formulary compliance, numbers of medicines, reconciliations, that have completed, there's a few substance misuse measures in there, a few antibiotic stewardship measures"* (Interview 12, Pharmacist).

By devising methods through intraprofessional collaboration to improve prescribing and monitoring, participants commented that PSI reports could also be used in patient consultations to make patients aware of the rationale for medication changes.

> *"It's useful to show patients, isn't it? To say actually look, this has flagged up. I'm not making it up. I'm not having a bad day."* (Interview 1, General Practitioner).

Ultimately, the implementation of PSIs in prison settings was perceived by stakeholders to rely on a series of stages that supported the development of a report with action plans to address the results from the PSI search. This has been summarised in Figure 1.

4 | DISCUSSION

We have successfully deployed a suite of PSIs in prisons to examine their prevalence whilst also exploring their practical utilisation in order to understand their optimal deployment and use. Our findings highlight that particular PSIs may be common and pose an important threat to patient safety in this setting, making them a potential improvement target. Alongside this we identify key considerations and strategies supporting successful implementation of PSIs, many of which reflect characteristics unique to the prison environment and its patient population. We envisage that use of these PSIs and our

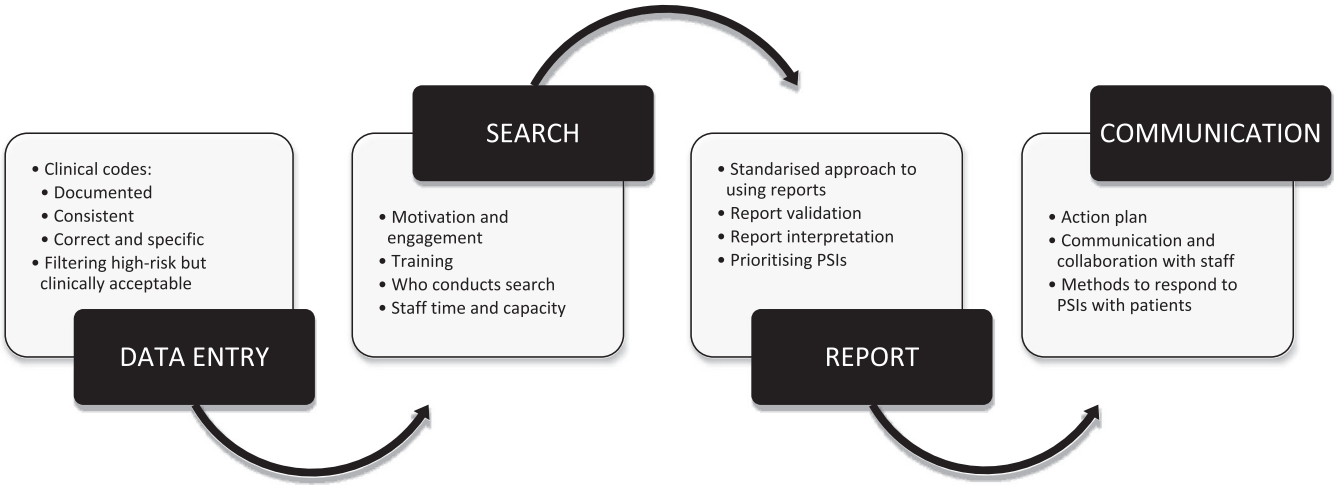

FIGURE 1 Processes involved for the implementation of prescribing safety indicators in prison settings

interview findings will support prison health-care staff to understand and take mitigating action against potentially hazardous prescribing in their care settings, whilst also providing opportunities for the development or adoption of new medication safety improvement interventions. By focusing on high risk prescribing and harnessing the potential of EHRs, our work supports national and international health-care strategy goals to improve medication safety across care settings.[24,25]

Our findings reveal that the indicators SSRI/SNRIs with NSAIDs/antiplatelets without GI protection, antipsychotics prescribed for at least 1 year without monitoring blood glucose, weight or lipid profile within the previous year, and antiplatelets prescribed with NSAIDs without GI protection were commonly reported across both study sites. Studies show that patients in prisons have a raised prevalence of mental disorders[1,26] and psychotropic medication prescribing with 47.9% of women and 16.9% of men prescribed at least 1 psychotropic medicine in English prisons.[9] This may later result in further health complications due to the increased risk of cardiovascular disease and cardiovascular-related mortality in patients with severe mental illness.[27] In addition, the prescribing of hypnotics for >1 month, and anticholinergics with medium or high activity to patients older than 65 years were also found to be common in Site B. With the number of older incarcerated patients increasing[28] the numbers potentially exposed to anticholinergic medications and heightened bleeding risk may also rise. For example, recent studies reveal that strong anticholinergic medicines are associated with an increased risk of developing dementia[29] and that advancing age is an established risk factor for GI bleed when prescribed other medications such as SSRIs/SNRIs, which are known to increase this risk.[30,31] The variation in the prevalence of some indicators between our study sites reveals that prescribing patterns and hence the level of risk from PSIs in prisons may vary, as it does in general practice. Indeed, studies from primary care also reveal variability in high-risk prescribing between practices.[32] There may be opportunities to standardise prescribing practice in prisons, whilst also taking into consideration local issues for targeted practice interventions. Whilst prisoner turnover can be high,[33] it is important that adequate medication monitoring is carried out. The opportunity to treat patients in prison settings and continue to care for their health outside can be obstructed due to the lack of system interoperability with GP practices. Moreover, prisons that rely heavily on locum staff may result in additional medication monitoring barriers due to the lack of prescriber continuity.[5]

Conversely, the prescribing of SSRI/SNRIs with novel oral anticoagulants or warfarin, and the coprescribing of opioids with either methadone/buprenorphine or gabapentin/pregabalin was less commonly observed across both study sites. The apparent low prevalence of coprescribing gabapentinoids in both sites may reflect increased awareness nationally among prescribers of the risk of diversion of these medicines as currency to obtain illicit drugs in prison[30] as well as elevated reports of drug-related deaths among prisoners from opioids and gabapentinoids.[34]

Our study revealed key practical considerations associated with running and responding to PSI searches in prison settings. Whilst we were able to operationalise and deploy 13 *fully automated* searches, which may reduce workload associated with creating indicators locally, our findings highlight that these PSI searches depend upon accurate data entry into the EHR and interoperability with primary and secondary care settings. Other key considerations included staff time, capacity and engagement to search PSIs, the ability to validate and interpret results from a PSI search and supporting methods of responding to PSI searches through intraprofessional collaboration. As with our study, others have identified the need for a designated staff member to act as the *change agent* when responding to errors through intraprofessional collaboration.[35,36] Within the PINCER trial, the pharmacist took a lead with this role, and received training and spent time establishing working relationships with general practice staff, which helped them become familiar with contextual information to provide implementation support.[12] Moreover, conducting a PSI search would need to be viewed as an important task that would also need to be sustained as part of normal work practices. Healthcare staff in our study emphasised the need to engage staff to use PSIs by rationalising the benefit of using PSIs in their practice, which has been reported elsewhere.[12,35,37] Whilst our findings reveal apparent similarities between prison health care and other settings in the important facets supporting successful PSI delivery processes, they also identify challenges more unique to the secure environment and its patients. These include issues relating to limitation in which PSIs may be possible to search due to incomplete clinical coding in records; consistent availability of clinical staff to lead PSI searches and respond to PSI data; and taking action to address PSI data in a way that holistically reflects patient-prisoner characteristics.

Our study supports wider evidence[5,38,39] that medication management in prisons may be fragmented. Continuity of care is affected both during incarceration (e.g. varying staff, turnover) and the transfer of patients into/from prisons. We have provided suggestions for how improvement may be realised using PSIs, with key considerations that reflect the unique prison setting. Utilising the prison EHR as the host of PSI searches may also enable rapid and consistent PSI searches at scale. There is therefore now the opportunity for health-care leaders and researchers to conduct further work to upscale this project and widen automated access to this data (for example, as part of a national medication safety dashboard)[40] alongside using it as a basis for remedial intervention development, which will address key medicines safety improvement goals (for example concerning safety measurement).[24,25,40]

4.1 | Study strengths and limitations

Our study has the following limitations. It was restricted to adult male prisons, which meant we that were unable to explore indicators and risk profiles specific to women's prisons and young offender institutions. We chose to exclude women's prisons to be broadly generalisable, as female prisoners make up <5% of the overall prison population.[41] Nonetheless, our indicators could potentially be applied to women prisons. We were unable to deploy

PSIs that required manual searching due to resource constraints (although we do present these in the Appendix). In addition, it was not possible to interview prisoners or prison IT staff, which may have been useful when exploring how to optimise and address PSI search results.

A key strength of our study is that we explored in-depth the practicality of PSI implementation and use in clinical practice with a range of stakeholders that included those with prior experience of PSI implementation in this setting. Despite restricting deployment of the PSIs to 2 large prisons, we are confident that our pragmatic design can be replicated to measure the prevalence of PSIs in other secure environments.

5 | CONCLUSION

Prescribing safety indicators were successfully implemented into the EHR of 2 large prisons, with a subgroup of indicators associated with elevated prevalence targeted for intervention. We also identified important factors underpinning the key steps to successfully implementing and using PSI data in prisons, some of which reflected this unique environment and its patient population. These findings form a foundation from which others may deploy their own PSI suites to facilitate prescribing safety improvement and address international safety priorities.

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COMPETING INTERESTS

The authors have no conflicts of interest to declare that are relevant to the content of this article.

CONTRIBUTORS

R.N.K., P.B., J.D., E.M.-M. and D.M.A. originated the concept and contributed to the design of the study. E.M.-M. led recruitment, data collection and analysis for the nominal group discussion supported by R.N.K. R.N.K., E.M.-M., P.B. and J.D. reviewed and refined potential prescribing safety indicators, supported by W.K. J.D. and A.O. operationalised and deployed prescribing safety indicators into electronic health records to generate prevalence data, supported by R.N.K, A.A. and D.M.A. E.M.-M. led on recruitment and data collection for the staff interviews, supported by R.N.K. E.M.-M. and A.A. analysed staff interview data, supported by R.N.K. A.A. prepared the study manuscript. All authors critically evaluated and approved the final manuscript.

DATA AVAILABILITY STATEMENT

Due to reasons of patient confidentiality, the raw prescribing safety indicator data searches pertaining to this project cannot be made available. This is a qualitative study and was confined to specific health professional staff roles working in prisons in 2 UK regions. Making the full data set publicly available could therefore potentially lead to the identification of participants. Our ethics approval was granted based on the anonymity of the individuals consenting to participate. Furthermore, our ethics approvals were based upon statements in the participant information sheets and consent forms that specifically referred to anonymised quotations from transcripts being used. As such, the participants did not consent to their full transcript being made publicly available.

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APPENDIX A

TABLE A1 Ideas with the potential to be prescribing safety indicators generated from the nominal group discussion (NGD)

Grouped themes	Ideas generated
Specific central nervous system groups	Methadone prescribed with QT-prolonging drugs without electrocardiogram
	Coprescribed opioid with methadone
	Methadone prescribed with gabapentin/pregabalin
	Prescribing opioid drugs with high dose of buprenorphine
	No methadone dose reduction after stopping tuberculosis medicines
	Gabapentinoids prescribed in substance misusers
Medicines use	Prescribing sodium valproate in women without contraception/consent issues
	Antipsychotic load British National Formulary percentage maximum dose exceeded
	Nicotine replacement therapy patches and concurrent use of vaping, and over 12 wk of nicotine replacement therapy prescribed
	Clozapine prescribed with nicotine replacement therapy
Practitioner behaviour	Dual antiplatelet therapy that is not stopped when appropriate

APPENDIX B

TABLE A2 Prescribing safety indicators generated from nominal group discussion and literature review which were reviewed by members of the research team

	GROUP	INDICATOR	ASSOCIATED RISK
1	OPIOID	Methadone prescribed with QT-prolonging drugs without electrocardiogram	Risk of QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia
2	OPIOID	Coprescribed opioid with methadone	Risk of sedation, respiratory depression
3	OPIOID	Coprescribed methadone with gabapentin/pregabalin	Risk of sedation, respiratory depression
4	OPIOID	Prescribing opioid based analgesia with high dose buprenorphine	Risk of sedation, respiratory depression
5	OPIOID	No methadone dose reduction after stopping tuberculosis medicines	Increased risk of methadone overdose
6	OPIOID	Opioid patch prescription	Increased risk of abuse/diversion
7	OPIOID	Tramadol prescribed with opioids in wrong preparation (24 h/12 h)	Toxicity or subtherapeutic dose
8	OPIOID	Tramadol prescribed concomitantly with a monoamine oxidase inhibitor	Increased risk of serotonin syndrome
9	OPIOID	Tramadol prescribed concomitantly with antiepileptics	Increased risk of seizures in patients with uncontrolled epilepsy
10	ANTI-EPILEPTICS	Gabapentinoids prescribed in substance misusers	Increased risk of sedation, respiratory depression
11	ANTI-EPILEPTICS	Prescribing sodium valproate in women of child-bearing potential without contraception/consent issues	Increases the risk of birth defects
12	Nicotine replacement therapy (NRT)	NRT—patches and concurrent use of vaping + over 12 wk of NRT	Risk of nicotine overdose
13	ANTIPSYCHOTICS	Clozapine with NRT	Dose adjustment may be required if smoking stopped/started during treatment
14	ANTIPSYCHOTICS	Clozapine dose not adjusted or omitted in a patient with a clozapine concentration above therapeutic range 600 μg/L	Increased risk of adverse effects

(Continues)

TABLE A2 (Continued)

	GROUP	INDICATOR	ASSOCIATED RISK
15	ANTIPSYCHOTICS	Clozapine prescribed without monitoring lipid profile and weight every 3 mo for the first year, then yearly.	Increased risk of adverse effects—cardiovascular disease
16	ANTIPSYCHOTICS	Clozapine prescribed without monitoring fasting blood glucose tested at baseline, after 1 mo treatment, then every 6 mo	Increased risk of adverse effects—elevated blood sugar
17	ANTIPSYCHOTICS	Clozapine prescribed without monitoring blood pressure (sitting and standing) at baseline, after 1, 2, 3 and 6 mo and annually	Increased risk of adverse effects—cardiovascular disease, tachycardia
18	ANTIPSYCHOTICS	Clozapine prescribed without monitoring leucocyte and differential blood counts weekly for 18 wk then fortnightly for up to 1 y, and then monthly	Risk of potentially fatal agranulocytosis, contraindicated with past medical history of agranulocytosis and neutropenia
19	ANTIPSYCHOTICS	Clozapine prescribed to a patient with leukocyte count <3000/μL or if absolute neutrophil count <1500/μL	Increased risk of neutropenia Risk of agranulocytosis
20	ANTIPSYCHOTICS	Prescribing clozapine with anticholinergic medicine	Risk of constipation and potentially fatal risk of intestinal obstruction, faecal impactioncand paralytic ileus
21	ANTIPSYCHOTICS	Prescribing antipsychotics for patients with prolonged QTc interval	Risk of potentially fatal torsade de pointes arrhythmia
22	ANTIPSYCHOTICS	Prescribing antipsychotics without monitoring full blood count (FBC), urea and electrolytes (U&Es), prolactin, liver function tests (LFTs), glucose, weight, or lipid profile annually	FBC: risk of blood dyscrasias U&Es: to avoid overdose and electrolyte abnormalities than can increase the risk of QTc prolongation Prolactin: risk of hyperprolactinaemia LFTs: risk of increasing liver enzymes and hepatic disorders glucose, weight, or lipid profile: risk of metabolic adverse effects
23	ANTIPSYCHOTICS	Prescribing antipsychotics without monitoring prolactin at baseline and 6 mo after starting therapy	Risk of hyperprolactinaemia
24	ANTIPSYCHOTICS	Prescribing antipsychotics without monitoring glucose, weight, lipid profile at baseline and 3 mo after starting therapy	Risk of metabolic adverse effects
25	ANTIPSYCHOTICS	Antipsychotic load British National Formulary (BNF) percentage max dose exceeded	Risk of toxicity
26	ANTIPSYCHOTICS	Prescribing antipsychotic with QT prolonging drugs (antiarrhythmic with QT interval-prolonging properties [e.g. amiodarone, disopyramide, flecainide, and sotalol], macrolides, azole antifungal, moxifloxacin, citalopram and escitalopram)	Risk of QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia)
27	ANTIPSYCHOTICS	Zuclopenthixol acetate prescribed in combination with regular antipsychotics	Risk of QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia
28	ANTIPSYCHOTICS	Prescribing high dose antipsychotics (above BNF 100% maximum)	Risk of anticholinergic and extrapyramidal effects
29	ANTIPSYCHOTICS	Lithium dose not adjusted or omitted in a patient with a lithium concentration above the therapeutic range (>1.0 mmol/L)	Risk of lithium toxicity
30	ANTIPSYCHOTICS	Lithium prescribed in conjunction with newly prescribed nonsteroidal anti-inflammatory drugs (NSAIDs) without dose adjustment or increased monitoring	Increased risk of toxicity
31	ANXIOLYTICS	Prescribing benzodiazepines or Z-drugs for patients aged ≥ 65 y	Increased risk of falling and fracture
32	ANXIOLYTICS	Benzodiazepine or benzodiazepine-like drug prescribed to a patient with chronic obstructive pulmonary disease	Risk of respiratory depression
33	ANXIOLYTICS	Benzodiazepines prescribed long term (i.e. >2–4 wk) Benzodiazepine-like drugs (e.g. zopiclone) prescribed long term (i.e. >2–4 wk)	Risk of dependence and withdrawal reactions

TABLE A2 (Continued)

	GROUP	INDICATOR	ASSOCIATED RISK
34			
35	ANXIOLYTICS	Prescribing benzodiazepine, Z-drugs or sedating antihistamine for >1 mo	Risk of prolonged sedation, confusion, impaired balance, falls
36	ANXIOLYTICS	Benzodiazepine or benzodiazepine-like drug prescribed during pregnancy	Risk of neonatal withdrawal symptoms
37	ANXIOLYTICS	Prescribing 2 benzodiazepines or Z-drugs concurrently	Increased risk of falling and fracture
38	ANXIOLYTICS	Coprescribing benzodiazepines or Z-drugs with strong CYP3A4 inhibitor	Increases exposure, which results in reduced psychomotor functioning and prolonged sedation
39	ANTIDEPRESSANTS	Prescribing tricyclic antidepressants for patients aged ≥65 y except in low dose for neuropathic pain	Highly anticholinergic, sedating, and cause orthostatic hypotension Age
40	ANTIDEPRESSANTS	Prescribing bupropion for patients aged ≥65 y	May lower seizure threshold
41	ANTIDEPRESSANTS	Tricyclic antidepressant prescribed at the same time as a monoamine oxidase inhibitor (MAOi)	Increased risk of serotonin syndrome
42	ANTIDEPRESSANTS	Selective serotonin reuptake inhibitor (SSRI) prescribed concomitantly with tramadol	Increased risk of serotonin syndrome
43	ANTIDEPRESSANTS	SSRI prescribed concomitantly with/without appropriate prophylaxis with antisecretory drugs or mucosal aspirin protectant	Increased risk of gastrointestinal bleeding
44	ANTIDEPRESSANTS	Citalopram prescribed concomitantly with other QT-prolonging drugs	Increased risk of arrhythmias
45	ANTIDEPRESSANTS	Prescribing SSRI/selective norepinephrine reuptake inhibitors (SNRIs) with NSAID or aspirin with no gastrointestinal protection	Increased risk of gastrointestinal bleeding
46	ANTIDEPRESSANTS	Prescribing SSRI/SNRIs with novel anticoagulants or warfarin	Increased risk of bleeding
47	ANTIDEPRESSANTS	Coprescribing SSRI/SNRIs with linezolid	Increased risk of serotonin syndrome
48	ANTIDEPRESSANTS	Coprescribing SSRI with tramadol	Increased risk of serotonin syndrome
49	ANTIDEPRESSANTS	Coprescribing MAOi with amphetamine and its derivatives	Risk of potentially fatal hypertensive crisis and/or serotonin syndrome
50	ANTIDEPRESSANTS	Coprescribing MAOi with opioids	Increased risk of serotonin syndrome, and opioids toxicity
51	ANTIDEPRESSANTS	Coprescribing MAOi with levodopa	Risk of serious and potentially life-threatening hypertensive reaction
52	ANTIDEPRESSANTS	Coprescribing MAOi with carbamazepine	Increased risk of serotonin syndrome
53	ANTIDEPRESSANTS	Coprescribing MAOi with sumatriptan	Risk of serotonin syndrome, MAOIs increases the exposure to sumatriptan
54	ANTIDEPRESSANTS	Coprescribing MAOi for pregnant women	Increased risk of neonatal malformations
55	ANTIDEPRESSANTS	Coprescribing citalopram, escitalopram, clomipramine or venlafaxine with QT-prolonging drugs	Increased risk of arrhythmias
56	ANTIDEPRESSANTS	Coprescribing fluvoxamine with theophylline	Risk of theophylline toxicity
57	ANTIDEPRESSANTS	Coprescribing trazodone with hepatitis C virus antiviral	Cause QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia
58	ANTIDEPRESSANTS	Coprescribing antidepressants with selegiline	Increased risk of serotonin syndrome
59	MOOD STABILISERS	Coprescribing carbamazepine with strong CYP3A4 inhibitor	Risk of carbamazepine toxicity which can cause dizziness, diplopia, ataxia and mental confusion
60	MOOD STABILISERS	Coprescribing carbamazepine with oral or intravaginal contraceptives, patches or pure progestogen pills	Risk of failure of contraception and risk of foetal malformation
61	MOOD STABILISERS	Coprescribing carbamazepine with warfarin/direct oral anticoagulants	Risk of reducing anticoagulation effect which can cause blood clots
62	MOOD STABILISERS	Coprescribing carbamazepine with clozapine	

(Continues)

TABLE A2 (Continued)

	GROUP	INDICATOR	ASSOCIATED RISK
			Risk of reducing clozapine concentration, risk of blood dyscrasias and risk of fatal pancytopenia or neuroleptic malignant syndrome
63	MOOD STABILISERS	Coprescribing carbamazepine for pregnant women	Increases the risk of neural tube defects
64	MOOD STABILISERS	Coprescribing lithium with angiotensin converting enzyme inhibitor/angiotensin receptor blocker	Risk of lithium toxicity which can cause tremor, dysarthria, ataxia and confusion
65	MOOD STABILISERS	Coprescribing lithium with diuretics	Risk of lithium toxicity which can cause tremor, dysarthria, ataxia and confusion, and risk of hypokalaemia which increase the risk of torsade de pointes
66	MOOD STABILISERS	Coprescribing lithium with NSAID	Risk of lithium toxicity which can cause tremor, dysarthria, ataxia and confusion
67	MOOD STABILISERS	Coprescribing valproic acid with lamotrigine	Risk of increasing lamotrigine concentrations and cause sedation, tremor, ataxia, fatigue and rash
68	MOOD STABILISERS	Coprescribing valproic acid with carbapenems	Dramatically decreases the serum concentration of valproate—reduced concentration of valproic acid may lead to increased risk of clinical deterioration, e.g. seizures, mental illness)
69	MOOD STABILISERS	Women of childbearing potential prescribed valproate	Risk of congenital malformations
70	MOOD STABILISERS	Prescribing lamotrigine with hormonal contraceptive or combination pills	Risk of failure of contraception
71	MOOD STABILISERS	Prescribing carbamazepine without monitoring U&E and plasma levels of carbamazepine every 6 mo	Risk of carbamazepine toxicity which can cause dizziness, diplopia, ataxia and mental confusion
72	MOOD STABILISERS	Lithium preparation not prescribed by brand	Increased risk of toxicity or therapeutic failure
73	MOOD STABILISERS	Lithium prescribed in the first trimester of pregnancy	Risk of teratogenicity, including cardiac abnormalities
74	Attention deficit hyperactivity disorder (ADHD)	Prescribing clonidine with propranolol	Risk of bradycardia and hypotension
75	ADHD	Methylphenidate modified-release not prescribed by brand	Increased risk of toxicity or therapeutic failure
76	ADHD	Prescribing any ADHD medication without monitoring heart rate, blood pressure, height and weight at baseline	Risk of raised heart rate and blood pressure, and risk of growth suppression
77	ADHD	Prescribing any ADHD medication without monitoring heart rate and blood pressure every 6 mo	Risk of raised heart rate and blood pressure
78	ANTIDEMENTIA	Prescribing 2 anticholinesterase inhibitors	Risk of accumulation of side effects
79	ANTICHOLINERGICS	Prescribing 2 anticholinergics with at least 1 of them strong or moderate	Increased risk of cognitive impairment, falls and all-cause mortality in older people
80	Cardiovascular system (CVS)	Dual antiplatelet therapy that is then not stopped	Increased risk of bleeding
81	CVS	Continuing of deep vein thrombosis treatment because no plan in place	Increased risk of bleeding
82	CVS	Digoxin prescribed at a dose >125 mg daily to a patient with renal impairment	Increased risk of digoxin toxicity
83	CVS	Warfarin prescribed with any antibiotic without international normalised ratio monitoring within 5 d	Increased risk of bleeding
84	CVS	Warfarin prescribed concomitantly with a NSAID	Increased risk of bleeding
85	CVS	Clopidogrel prescribed to a patient concomitantly with a NSAID	Increased risk of bleeding
86	CVS	Verapamil prescribed with β- blocker	Increased risk of heart block, bradycardia
87	CVS	Low-molecular-weight heparin omitted to be prescribed for prophylaxis	Increased risk of thrombosis
88	ENDOCRINE		Increased risk of lactic acidosis

TABLE A2 (Continued)

	GROUP	INDICATOR	ASSOCIATED RISK
		Metformin prescribed to a patient with estimated glomerular filtration rate <30 mL min^{-1} (1.73 $m)^{-2}$	
89	ENDOCRINE	Weekly dose of an oral bisphosphonate prescribed daily	Risk of hypocalcaemia
90	INFECTION	Penicillin prescribed to a patient with a history of penicillin allergy	Risk of hypersensitivity reactions
91	INFECTION	Penicillin-containing compound prescribed to a penicillin-allergic patient without reasoning (e.g. a mild or nonallergy such as diarrhoea or vomiting entered as an allergy where the indication for penicillin is compelling)	Risk of hypersensitivity reactions
92	INFECTION	Gentamicin prescribed to a patient with renal impairment without dose adjustment	Increased risk of toxicity
93	INFECTION	Vancomycin prescribed intravenously to a patient with renal impairment without dose adjustment	Increased risk of toxicity
94	INFECTION	Quinolone prescribed to a patient who is also receiving theophylline	Possible increased risk of convulsions
95	IMMUNOSPRESSION	Oral methotrexate prescribed to a patient with an inappropriate frequency	Increased risk of toxicity
96	IMMUNOSPRESSION	Methotrexate prescribed without folic acid	Increased risk of mucosal and gastrointestinal side-effects and hepatotoxicity
97	IMMUNOSPRESSION	Coprescribing of methotrexate 2.5 and 10 mg	Increased risk of dosing error and toxicity
98	IMMUNOSPRESSION	Prescription of methotrexate without record of LFT in previous 3 mo	Risk of hepatic dysfunction undetected
99	IMMUNOSPRESSION	Prescription of methotrexate without record of FBC in previous 3 mo	Blood dyscrasias reported, including fatalities and risk of going undetected
100	ANALGESIA	More than 1 paracetamol-containing product prescribed to a patient at a time	Maximal dose exceeded, risk of liver toxicity

APPENDIX C

TABLE A3 Final list of prescribing safety indicators taken forward to deploy into prison electronic health records

INDICATOR	Duration	Patients at risk of prescribing safety indicator (denominator)	Patients receiving prescribing safety indicator (numerator)	ASSOCIATED RISK
Coprescribed opioid with methadone/buprenorphine	6 mo	Prescribed any opioid or methadone during the 6-month period	Prescribed any opioid and concurrently prescribed methadone during the 6-mo period	Risk of sedation, respiratory depression
Coprescribed opioid with gabapentin/pregabalin	6 mo	Prescribed opioid or gabapentin/pregabalin during the 6-month period	Concurrently prescribed gabapentin/pregabalin and opioid during the 6-mo period	Risk of sedation, respiratory depression, mortality
Antipsychotic prescribed for at least 12 months without monitoring glucose, weight or lipid profile within the previous year	13 mo	Prescribed any antipsychotic in month 1 and again in month 13	Have not had glucose, weight and/or lipid profile test within the screening 13-mo period	Risk of metabolic adverse effects
Prescribing antipsychotic with QT-prolonging drugs	6 mo	Prescribed any antipsychotic during the 6-month period	Prescribed any QT-prolonging drug during the 6-mo period	Risk of QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia
Prescribing >1 regular antipsychotic for >2 months	6 mo	Prescribed >1 regular antipsychotic other than clozapine during the 6-month period	Prescribed >1 regular antipsychotics other than clozapine for >2 mo during the 6-mo period (any 3 mo during 6-mo window)	Increased risk of adverse effects
Lithium prescribed in conjunction with nonsteroidal anti-inflammatory drugs	6 mo	Prescribed lithium during the 6-month period	Prescribed NSAID during the 6-mo period, and not in the previous 3-mo period	Increased risk of toxicity
Prescribing benzodiazepine, Z-drugs or sedating antihistamine for >1 month	3 mo	Prescribed benzodiazepine, Z-drug or sedating antihistamine during the 3-month period	Prescribed benzodiazepine, Z-drug or sedating antihistamine for >1 mo during the 3-mo period (any 2 mo during 3-mo period)	Risk of prolonged sedation, confusion, impaired balance, falls
Prescribing 2 benzodiazepines or Z-drugs	6 mo	Prescribed benzodiazepines or Z-drug during the quarter	Prescribed benzodiazepines and concurrently prescribed Z-drug during the quarter	Increased risk of falling and fracture
Prescribing citalopram, escitalopram, tricyclic antidepressant, venlafaxine or trazadone with QT-prolonging drugs	6 mo	Prescribed citalopram, escitalopram, tricyclic antidepressant, trazadone or any QT-prolonging drug during the 6-month period	Prescribed any QT-prolonging drug and concurrently prescribed citalopram, escitalopram, tricyclic antidepressant or trazadone during the 6-mo period	Risk of QT prolongation that can lead to potentially fatal torsade de pointes arrhythmia
Prescribing SSRI/SNRIs with NSAID or antiplatelet with no gastrointestinal protection	6 mo	Prescribed SSRI/SNRI and concurrently prescribed an NSAID or antiplatelet during the 6-month period	Not prescribed gastroprotection during the 6-mo period	Increased risk of gastrointestinal bleeding
Prescribing SSRI/SNRIs with NOACs or warfarin	6 mo	Prescribed SSRI, SNRI, warfarin or DOAC during the 6-month period	Prescribed SSRI or SNRI and concurrently prescribed warfarin or DOAC during the 6-mo period	Increased risk of bleeding
Prescribing lithium with ACEi/ARB	6 mo	Prescribed lithium or ACEi/ARB during the 6-month period	Prescribed lithium and concurrently prescribed ACEi/ARB during the 6-	Risk of lithium toxicity which can cause tremor, dysarthria, ataxia and confusion

TABLE A3 (Continued)

INDICATOR	Duration	Patients at risk of prescribing safety indicator (denominator)	Patients receiving prescribing safety indicator (numerator)	ASSOCIATED RISK
Prescribing lithium with diuretics	6 mo	Prescribed lithium or a diuretic during the 6-month period	Prescribed lithium and concurrently prescribed diuretic during the 6-mo period	Risk of lithium toxicity, which can cause tremor, dysarthria, ataxia and confusion, and risk of hypokalaemia, which increase the risk of torsade de pointes
Lithium prescribed for at least 6 months without monitoring U&E or thyroid function within the last 6 months	6 mo	Lithium prescribed in period 6 months before screening period and in 6 month screening period	Have not had U&E and/or thyroid function testing during the 6 mo screening period	U&E: risk of lithium toxicity and renal impairment Thyroid: risk of thyroid disorder
Prescribing 2 anticholinergics with both of them strong or moderate	6 mo	Prescribed any medication with anticholinergic activity during the 6-month period	Prescribed concurrently a second anticholinergic medication that has moderate/high anticholinergic activity during the 6-mo period	Increased risk of adverse effects
A medication with medium/high anticholinergic activity prescribed to a patient aged ≥65 years	6 mo	Patients aged ≥65 years before the start of the 6-month period	Prescribed any medication with medium/high anticholinergic activity during the 6-mo period	Risk of falling and fracture, risk of acute confusion, urinary retention
Warfarin prescribed with any antibiotic without INR monitoring within 5 days	6 mo	Prescribing warfarin and a concomitant antibiotic during the 6-month period	No record of INR monitoring test within 5 d of combination being prescribed during the 6-mo period	Increased risk of bleeding Potential risk of INR dropping–occlusion event
Warfarin prescribed concomitantly with an NSAID	6 mo	Prescribed warfarin or NSAID during the 6-month period	Prescribed warfarin and concurrently prescribed NSAID during the 6-mo period	Increased risk of bleeding
Antiplatelet prescribed to a patient concomitantly with a NSAID without gastrointestinal protection	6 mo	Prescribed antiplatelet and NSAID during the 6-month period	Not prescribed gastrointestinal protection during the 6-mo period	Increased risk of bleeding
Four or more psychotropics prescribed to a patient for >3 months	6 mo	Prescribed 3 psychotropics concurrently during the 6-month period	Prescribed 4 or more psychotropics concurrently for 3 mo during the 6-mo period (any 3 mo, does not have to be sequential)	Increased risk of adverse effects
Three or more psychotropic drugs prescribed on a PRN basis	6 mo	Prescribed 2 psychotropics as PRN during the 6-month period	Prescribed 3 or more psychotropics as PRN during the 6-mo period	Increased risk of adverse effects

NSAID: nonsteroidal anti-inflammatory drugs; SSRI/SNRI: selective serotonin reuptake inhibitor/selective norepinephrine reuptake inhibitor; ACEi/ARB: angiotensin converting enzyme inhibitor/angiotensin receptor blocker; NOAC/DOAC: novel oral anticoagulants/direct oral anticoagulants; U&E: urea and electrolytes; INR, international normalised ratio; PRN, pro re nata (as required).

APPENDIX D

Interview Schedule

Prescribing Safety Indicators and medication safety.

Have a look at the prescribing safety indicators (PSIs) examples we sent to you, to help you understand the purpose and use of patient safety indicators for safer prescribing, which is to help identify patients who are at risk of harm. We would like you to think about those statements, and using them in practice.

For the following PSIs:

1. Would you want to access PSI data like this? How would you want to access it?
2. How would you go about reviewing it/responding to the data?
3. What kind of impact do you think this would have—on staff, on prescribing, on workload on patient safety?
4. What would prevent you from using PSIs like this in your prison?
5. What would help/support you to use PSI like this in your prison?