

<b>Institution:</b> University of Nottingham		
<b>Unit of Assessment:</b> UOA2 – Public Health, Health Services and Primary Care		
<b>Title of case study:</b> Implementing PINCER to reduce medication errors in general practices		
<b>Period when the underpinning research was undertaken:</b> 2003-2018		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Professor Tony Avery (TA)	TA: Professor of Primary Health Care	TA: February 1992 to date
Dr Sarah Rodgers (SR)	SR: Principal Research Fellow/PINCER National Programme Manager	SR: September 1996 to June 2009/December 2010 to date
<b>Period when the claimed impact occurred:</b> From August 2013 to December 2020		
<b>Is this case study continued from a case study submitted in 2014?</b> No		
<p><b>1. Summary of the impact</b></p> <p>University of Nottingham researchers developed PINCER, a pharmacist-led IT-based intervention to reduce clinically important medication errors in primary care, which has been proven to substantially reduce hazardous prescribing in its widespread implementation in general practices across England. PINCER is recommended in NICE guidance (2015) and included in 5 National Health Service (NHS) guidance documents. PINCER has extensive reach, having been rolled out to 39% of English general practices, covering 40% of England's population. By December 2020: 2,032 health care professionals had been trained to deliver PINCER; 2,688 general practices in 104 Clinical Commissioning Groups (77% of CCGs) had implemented PINCER and 25,545,538 patient records had been searched for prescribing errors. Analysis of follow-up data from 1,060 practices that implemented the PINCER intervention (between December 2018 and March 2020) shows a decrease of 14% in the number of patients at risk of at least one medication error and a decrease of 26% in errors associated with gastrointestinal bleeding, a common cause of medication-related hospital admissions.</p>		
<p><b>2. Underpinning research</b></p> <p>Prescribing errors in general practice are an important and expensive preventable cause of safety incidents, illness, hospitalisations and deaths. This is a significant quality and safety issue that is widely relevant to all health care systems. To address this, we conducted a study to determine the prevalence and nature of prescribing and monitoring errors in general practices in England and found that prescribing errors were identified in 5% of prescription items, with 1 in 550 items containing a severe (potentially life threatening) error; this equates to approximately 2,000,000 serious prescribing errors in English general practices each year.<sup>1</sup> A further study showed hazardous prescribing in general practices to be a contributory cause of around 1 in 25 hospital admissions,<sup>2</sup> and a recent Department of Health and Social Care (DHSC) commissioned report into the prevalence and cost of medication errors estimated the annual hospital admission costs for primary care avoidable adverse drug events to be GBP83,700,000 resulting in 627 deaths in England each year (<a href="http://www.eepru.org.uk/article/prevalence-and-economic-burden-of-medication-errors-in-the-nhs-in-england/">http://www.eepru.org.uk/article/prevalence-and-economic-burden-of-medication-errors-in-the-nhs-in-england/</a>).</p> <p>In a systematic review, we identified 12 drug groups which account for 80% of hospital admissions that are medication-related and preventable.<sup>2</sup> We showed that three groups of drugs are responsible for over a third of these admissions; anticoagulants, antiplatelets and non-steroidal anti-inflammatory drugs (which all cause gastrointestinal (GI) bleeding). An important implication from this study is that reducing hazardous prescribing (medication errors) in general practice associated with specific groups of drugs could prevent most medication-related hospital admissions. Therefore, we developed a set of 'prescribing safety indicators'<sup>3</sup> to identify patients exposed to medication errors in general practice, and the PINCER intervention is designed to ameliorate risk from these errors.</p> <p>Informed by the Medical Research Council's framework for complex interventions, we developed and tested a pharmacist-led, IT-based intervention to reduce medication error in</p>		

primary care (PINCER). It involves searching GP clinical systems using computerised prescribing safety indicators to identify patients at risk from their prescriptions, and then acting to correct the problems with pharmacist support. Findings from our cluster-randomised controlled trial of 72 general practices,<sup>4,5</sup> demonstrated that PINCER is an effective and cost-effective method for reducing a range of clinically important and commonly made medication errors in primary care. For example, at 6 months' follow-up, patients in the PINCER group were significantly less likely to have been prescribed an oral non-steroidal anti-inflammatory drug (NSAID) if they had a history of peptic ulcer without gastroprotection (Odds Ratio (OR): 0.58; 95% Confidence Interval (CI): 0.38–0.89), thereby reducing their risk of hospital admission with GI bleeding. Economic analysis suggested that PINCER had a 95% probability of being cost effective if the decision-maker's ceiling willingness to pay reached GBP75 per error avoided (at 6 months) or GBP85 per error avoided (at 12 months).

With funding obtained from The Health Foundation (through their *Scaling Up Improvement* Programme) and East Midlands Academic Health Science Network (AHSN), PINCER was “scaled up” to 370 (94%) general practices across 12 East Midlands CCGs between September 2015 and April 2017 using an updated set of 11 prescribing safety indicators.<sup>6</sup> Findings from the evaluation of this rollout identified 22,105 instances of potentially hazardous prescribing in a patient population of 2,970,000 and demonstrated statistically significant reductions in the number of patients at risk of at least one medication error at six-months follow-up (OR: 0.83; CI: 0.81-0.86), particularly in relation to prescribing safety indicators associated with risk of GI bleeding (OR: 0.76; 95%CI: 0.73-0.79).<sup>7</sup>

### 3. References to the research (University of Nottingham UoA2 researchers in bold)

1. **Avery AJ**, Ghaleb M, Barber N et al (including **Armstrong SJ** and **Serumaga B**). The prevalence and nature of prescribing and monitoring errors in English general practice: a retrospective case note review. *BJGP* 2013;63(11):543-553. <https://doi.org/10.3399/bjgp13X670679>
2. **Howard RL**, **Avery AJ**, Slavenburg S et al (including **Royal S**). Which drugs cause preventable admissions to hospital? A systematic review. *Br J Clin Pharmacol* 2007;63(2):136-147. <https://doi.org/10.1111/j.1365-2125.2006.02698.x>
3. **Spencer R**, **Bell B**, **Avery AJ** et al. Identification of an updated set of prescribing-safety indicators for GPs. *BJGP* 2014; 64(621):e181-e190. <https://doi.org/10.3399/bjgp14X677806>
4. **Avery AJ**, **Rodgers S**, Cantrill JA et al (including **Armstrong S**). A pharmacist-led information technology intervention for medication errors (PINCER): A multicentre, cluster randomised, controlled trial and cost-effectiveness analysis. *Lancet* 2012;379(9823): 1310-1319. [https://doi.org/10.1016/S0140-6736\(11\)61817-5](https://doi.org/10.1016/S0140-6736(11)61817-5)
5. Elliott RA, Putman KD, Franklin M et al (including **Rodgers S** and **Avery AJ**). Cost effectiveness of a pharmacist-led information technology intervention for reducing rates of clinically important errors in medicines management in general practices (PINCER). *PharmacoEconomics* 2014; 32(6):1-18. <https://doi.org/10.1007/s40273-014-0148-8>
6. Stocks SJ, Kontopantelis E, Akbarov A et al (including **Rodgers S** and **Avery AJ**). Examining variations in prescribing safety in UK general practice: a cross-sectional study using the Clinical Practice Research Datalink. *BMJ* 2015;351:h5501. <https://doi.org/10.1136/bmj.h5501>
7. **Rodgers S**, Salema N, Waring J et al (including **Armstrong S**, **Mehta R**, **Bell B** and **Avery T**). Improving medication safety in general practices in the East Midlands through the PINCER intervention: *Scaling Up PINCER*. Report to the Health Foundation, August 2018. Available on request

### Key Research Grants

1. Oliver K, **Rodgers S**, Panayiotidis T, Fensome L, Johnson J, Barrett J, Evans D. Scale up, replication and licensing of the PINCER intervention. Health Foundation Exploring Social Franchising and Licensing Programme. Amount awarded GBP145,000 (with additional funding of GBP120,000 awarded May 2019). Award period: February 2018 to January 2021.
2. **Avery AJ**, Elliott RA, **Rodgers S** et al. Avoiding patient harm through the application of prescribing safety indicators in English general practices (acronym: PRoTeCT). NIHR

Programme Grant for Applied Research. Amount awarded GBP2,430,144. Award period: March 2017 to August 2021.

3. Siriwardena N, **Avery AJ, Rodgers S** et al. Improving prescribing safety in general practices in the East Midlands through the PINCER intervention. Health Foundation Scaling Up Improvement. Amount awarded GBP500,000 (with a further GBP250,000 awarded by East Midlands AHSN). Award period: March 2015 to August 2017.
4. **Rodgers S, Avery AJ**, Silcock N et al. (including **Bell B, and Salema N**). Preparing for a Phase IV implementation trial using PINCER methodology aimed at reducing the incidence of serious hospital admissions. NIHR Research Capability Funding to develop an NIHR Programme Grant for Applied Research, January 2014. Amount awarded GBP49,878. Award period: March 2014 to February 2015.
5. **Rodgers S, Avery AJ**, Elliott R et al (including **Bell B**). Modelling the cost effectiveness of prescribing safety indicators to identify those that are likely to be most cost-effective for inclusion in a rollout of the PINCER trial intervention. NIHR SPCR Round 7. Amount awarded GBP29,973. Award period: June 2013 to May 2014.
6. **Rodgers S**. Development of prescribing safety indicators and data extraction methods in UK general practice. NIHR SPCR Fellowship, June 2012. Amount awarded GBP243,600. Award period: October 2012 to September 2015.

#### 4. Details of the impact (E = evidence source)

**Summary:** We have developed and tested a pharmacist-led IT-based intervention to reduce clinically important medication errors in primary care (PINCER). PINCER has been widely implemented in general practices across England with reductions in hazardous prescribing, particularly prescribing associated with increased risk of gastrointestinal bleeding. PINCER's impact in making primary care prescribing safer for patients has been demonstrated in its rollout to 39% of general practices in England. Its expansion continues, maintaining comparable reductions in medication errors to the original research study,<sup>4</sup> which we have managed to replicate at scale and pace.

**a. Development of a PINCER replication model (E1):** Since 2017, PRIMIS at the University of Nottingham (<https://www.nottingham.ac.uk/primis/>) has been funded by the Health Foundation to work with Spring Impact (<https://www.springimpact.org/>), a non-profit global leader in social replication, to implement their systematic five-stage process to design a replication model for the scale and spread of PINCER using a social franchising approach (<https://www.health.org.uk/funding-and-partnerships/programmes/exploring-social-franchising>) (E1). Social franchising involves enabling another team or organisation to deliver a proven intervention to agreed standards under a franchise agreement, with the primary aim of maximising social benefit. As a result of this work, in 2018 PINCER was selected by the AHSN Network for national adoption and spread (<https://www.ahsnnetwork.com/about-academic-health-science-networks/national-programmes-priorities>) whereby PRIMIS acts as "Franchisor" and the 15 AHSNs in England act as "Franchisees".

**b. Organisational and clinical impact of PINCER (E2-E7):** As of 7 December 2020, the scale and scope of the national rollout of PINCER was as follows:

- 104 (77%) CCGs in England had participated (E2).
- 25,545,538 individual patient records had been searched to identify those at risk of medication error using 13 prescribing safety indicators (E3).
- 2,688 (39%) general practices had implemented PINCER and had uploaded anonymised aggregate baseline data to the PINCER CHART Online comparative analysis service (E3).
- 206,109 patients had been identified as being at risk of at least one medication error prior to PINCER implementation (baseline) giving an overall prevalence of 8.07 patients at risk of medication error per 1,000 registered patients (E3).

In terms of clinical impact (as documented in our PINCER progress report: E4), analysis of follow-up data over a 15-month period (between December 2018 and March 2020) relative to baseline from 1,060 practices showed (pp 4-5, 59-65; E4):

- A decrease of 13,387 (14%) in the number of patients at risk of at least one medication error (92,762 patients at baseline; 79,375 patients at follow-up).

- Greatest reductions for errors associated with GI bleeding, which showed a decrease of 10,559 (26%) patients (40,720 patients at baseline; 30,161 patients at follow-up).

Given that PINCER focuses on ameliorating some of the most important prescribing errors, it is likely (based on the evidence presented in section 2) that the intervention will have reduced medication-related hospital admissions and patient harm. Indeed, the Deputy Chief Pharmaceutical Officer for NHS England states: “I am in no doubt that PINCER will have prevented hospital admissions and patient harm in England” (E5).

One of the key strengths of the national rollout of PINCER has been the ability for general practices, pharmacists and named individuals at CCGs to access comparative views of numbers of at-risk patients using the PRIMIS CHART Online comparative analysis service, including time-trended analyses (E6). Over time, as more and more practices have been participating in the national rollout of PINCER and uploading their summative data to CHART Online, the facility has been providing a national picture of medication safety thus enabling localities to prioritise areas for their own improvement as well as evaluating the impact of the PINCER implementation. For example, in Wessex AHSN, PINCER was implemented in 236 (94%) general practices. The Clinical Lead Medicines Optimisation (MO) with Wessex AHSN and Clinical Lead for National MO Programme says: “This has given us a robust baseline measure of medication safety but more importantly, when practices implemented the PINCER intervention, we had 3,441 fewer patients at risk from clinically significant medication errors compared to baseline” (E7).

**c. Upskilling the primary care pharmacy workforce (E8):** As part of the national rollout, PRIMIS has been providing a comprehensive training package to support pharmacists to deliver the PINCER intervention, based on the training materials developed as part of the PINCER trial.<sup>4</sup> To date, a total of 2,032 health care professionals (1,505 primary care pharmacists, 153 primary care pharmacy technicians, 176 GPs, 48 practice managers and 150 CCG/other primary care staff) have been trained to deliver the PINCER intervention through a combination of eLearning tools, online resources, live webinars and face-to-face action learning set sessions (E8). To meet demand for training, we have developed a Train-the-Trainer model to enable 8 AHSN Training Partners and 5 University of Nottingham contracted Training Associates to deliver training on our behalf.

**d. Integration of PINCER indicators into third party software solutions (E9):** In response to findings from the evaluation of the Health Foundation *Scaling Up PINCER* project in the East Midlands,<sup>7</sup> PRIMIS has produced system searches that are embedded within the major GP clinical systems used in England such as EMIS WEB and The Phoenix Partnership (TPP) SystemOne. PRIMIS has developed a process for other IT system providers to embed the national PINCER indicators in their computer software. As a result, the University of Nottingham has licensed the national PINCER prescribing safety indicators to 4 major third-party suppliers for the purposes of implementing the PINCER indicators via their own software (E9). For example, the PINCER prescribing indicators are now embedded in First Databank’s clinical decision support software ‘Optimise Rx’ to improve patient safety by alerting clinicians to potential medication error at the point of prescribing

(<https://www.fdbhealth.co.uk/company/press-releases/2020-02-11-fdb-partner-with-primis>).

Optimise Rx software has been rolled out to over 4,000 general practices in England covering more than 38,000,000 patients (<https://www.fdbhealth.co.uk/solutions/optimiserx>).

**e. Incorporation of PINCER into national Medicines Optimisation policy and guidance (E10-E16):** Since 2015, PINCER has been incorporated into the NICE ‘Medicines Optimisation Clinical Guideline’ published 04 March 2015 (pp13,15; E10). This means that general practices throughout the country are encouraged to use the intervention. In 2017, the World Health Organisation identified ‘Medication Without Harm’ as the theme for their third Global Patient Safety Challenge which aims to reduce severe avoidable medication-related harm by 50% globally in the next 5 years. In response to this challenge, the NHS Business Services Authority produced a Medication Safety Dashboard incorporating the PINCER

indicators for GI bleed (p44; **E11**). The Dashboard links prescribing data in primary care to hospital admissions to help the NHS monitor and prevent errors.

In January 2019, NHS England published “Investment and evolution: A five-year framework for GP Contract Reform to implement the NHS Long Term Plan”. Prescribing safety was a new quality improvement (QI) domain in the contract, with practices incentivised to demonstrate continuous quality improvement in relation to prescribing safety. The Framework stated (pp22, 103, 106; **E12**) “the nationally-backed rollout of the pharmacist-led information technology intervention for medical errors (PINCER or equivalent) by the AHSNs” as 1 of 4 key areas for Quality Improvement. As highlighted in the 2019/20 GMC Contract Quality and Outcomes Framework (QOF) Guidance (p101; **E13**) practices were encouraged to engage AHSN support for PINCER implementation to improve prescribing safety and achieve the QOF points for this domain.

PINCER has also been identified as an evidence-based approach to reducing a range of medication errors as part of the mandatory quality improvement project in the new General Medical Services (GMS) Contract Wales: QI Framework 2019-20 (pp22-23; **E14**). In July 2019, the NHS Patient Safety Strategy (pp17, 51; **E15**) highlighted PINCER as one of its Medicines Safety Improvement Programmes to “support work to reduce prescribing error rates by 50%, improving safety and reducing costs” and stated that “AHSN-supported national roll-out will reach at least 40% of GP practices [in England] by 2020.” In September 2020, the Network Contract Directed Enhanced Service Structured Medication Reviews and Medicines Optimisation Guidance cited PINCER as “an evidence-based intervention that reduces the risk of harm from clinically significant medication errors” and highlighted PINCER as a tool to help clinicians to identify patients who would benefit most from receiving a Structured Medication Review (pp5,17; **E16**).

**f. National awards (E17):** In recognition of our work, the team was shortlisted from 800 teams across the NHS Midlands and East and selected as regional winner in “The Excellence in Primary Care Award” category of the 2018 NHS70 Parliamentary Awards (**E17.1**). The team was also shortlisted for the HSJ Patient Safety Awards 2020 in the category of Patient Safety Team of the Year, recognising our “outstanding contribution to healthcare through the national rollout of PINCER” (**E17.2**; p61; **E17.3**).

##### **5. Sources to corroborate the impact**

- E1. PINCER Replication Model Design Report (July 2018)
- E2. PRIMIS CHART Online Comparative Analysis Service (8 December 2020)
- E3. PINCER Baseline Summary Datasheet (7 December 2020)
- E4. PINCER Progress Report (July 2020) [Weblink](#)
- E5. Letter of support from Deputy Chief Pharmaceutical Officer for NHS England
- E6. PRIMIS CHART Online Time Trend Data
- E7. Letter of support from Clinical Lead Medicines Optimisation with Wessex AHSN
- E8. PINCER Training Delegates Summary Datasheet (8 December 2020)
- E9. PINCER Delivery Partners (7 December 2020)
- E10. NICE Medicines Optimisation Guidance (March 2015) [Weblink](#)
- E11. NHS Medication Safety Dashboard Indicators Specification (August 2019)
- E12. NHS England. Investment and evolution: A five-year framework for GP Contract Reform to implement the NHS Long Term Plan (January 2019) [Weblink](#)
- E13. NHS England. 2019/20 General Medical Services (GMS) contract Quality and Outcomes Framework (QOF) (April 2019) [Weblink](#)
- E14. Welsh Government. Quality Assurance and Improvement Framework Guidance for the GMS Contract Wales 2019/20 (September 2019) [Weblink](#)
- E15. The NHS Patient Safety Strategy (July 2019) [Weblink](#)
- E16. NHS England. Network Contract DES Structured Medication Reviews and Medicines Optimisation: Guidance (September 2020) [Weblink](#)
- E17. Evidence for PINCER National Awards