Patient Reported Outcome MeasureS using Electronic informed consent and data capture (PROMiSe): developing methods and infrastructure

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Abstract

Background

There is strong motivation to improve the rigour of non-randomised research designs in healthcare contexts where randomised controlled trials are difficult or impossible. We investigated an individual-level interrupted time series approach to the evaluation of interventions, using a database of patient reported outcomes linked to electronic health records on the timing and nature of interventions.

Methods

We developed a platform for collecting electronic informed consent and patient reported outcomes, and conducted user testing. We investigated the challenges of linking this data to clinical data, demonstrating proof-of-concept using local systems. We reviewed and appraised statistical methods for the analysis of individual-level interrupted time series data obtained in this way.

Results

Online consent and data collection were acceptable to users, who were, on the whole, happy to receive regular prompts to enter data during the course of a longitudinal study. Response rates to invitations to provide data were low, but helped identify practical steps that could be taken to improve response. Linkage required between research and clinical databases was straightforward. There are currently few examples of studies which have adopted this kind of approach to quantify or compare the effectiveness of treatments. Existing methods of data analysis – mixed regression and interrupted time series – provide the necessary tools for quantifying intervention effects.

Conclusions

We have demonstrated proof-of-concept for a scalable framework for the collection and analysis of patient-reported outcomes as time series. Such a platform provides a foundation to conduct large-scale, non-randomised healthcare evaluations with improved rigour and efficiency.

Introduction

Background

Continued efforts should be made to deliver high-quality clinical trials wherever possible, but the increasing availability of routine data and the challenges of conducting randomised controlled trials also motivate us to improve the quality and rigour of non-randomised research designs.[1,2] Observational data could contribute to the evidence base for some interventions.

One area where there is a pressing need to explore non-randomised research designs is in relation to surgical innovations. Here the current evidence base is dominated by individual case series and registry studies with poor external validity. Though increasing slowly, the number of randomised controlled trials and systematic reviews in surgical innovations remains small compared with the number of studies evaluating pharmacological treatments.[3] A review of surgical trials in 2012 also found significant weaknesses in reporting: more than a third did not identify a trial sponsor, only two thirds reported a sample size calculation, and one in six failed to specify a primary endpoint.[4] There are well-rehearsed challenges to overcome when running trials in surgery.[5] The intervention may be widely available outside of the trial, and patients and surgeons may not be happy with the idea of randomisation. Placebo (sham) surgery is controversial, and masking or blinding is otherwise difficult.

Ergina and colleagues called in 2009 for a more comprehensive approach to evaluating surgical innovation that made use of "patient reported outcomes, recorded in real time, and whenever possible by an independent observer who is masked to treatment assignment".[5] This was to become the basis for the IDEAL framework for surgical evaluations, which also recommended that studies should allow for practice-level and patient-level covariates, and should collect data from consecutive patients and from multiple surgeons.[6]

The challenges outlined above are by no means unique to surgical settings.[5] They span the spectrum of delivery of care, including the evaluation of therapies in primary care – for example the introduction of novel digital adherence support interventions, or the withdrawal of pharmacological agents in the treatment of asthma and chronic obstructive pulmonary disease (COPD). In this report we emphasise a surgical example, but the applications of the work will be much more general. Whatever the setting the following words from the IDEAL framework are pertinent: "any observational study conducted as an alternative to a high quality, randomised controlled trial should have as many positive design features of such a trial as possible".[6]

Interrupted time series approaches

One approach to non-randomised evaluation which is endorsed by the Cochrane Collaboration's Effective Practice and Organisation of Care Group (EPOC) and the IDEAL framework is an interrupted time series (ITS).[6,7] ITS studies have tended to focus on population-level time-series. A study published in the BMJ in 2013 showed, for example, how numbers of suicides involving paracetamol in England and Wales had fallen following legislation to control pack size.[8] This aggregate approach to ITS fails, however, to accommodate the IDEAL principles of adjustment for patient- and service-level factors, use of patient reported outcomes, and masking of treatment assignment.

An alternative is to consider time series data for patient reported outcomes at an individual patient level, where the introduction of the experimental intervention may be staggered across individuals. This offers a natural experiment where each individual acts as his/her own control. It also allows us to compare individuals' outcomes following the intervention with concurrent outcomes for

individuals who have not yet had the intervention. This is the observational equivalent of a stepped wedge design for a randomised trial.[9] A data structure like this can be used to look for a consistent step-change in outcome associated with the introduction of the intervention at any point in time, enhancing causal inference.[10]

The individual-level ITS approach outline above is sometimes referred to as a single-subject multiple baseline design.[11] In behavioural research the analysis of single-subject or *n*-of-1 studies has tended to rely on visual inspection of graphs, though it is recognised that there may be inconsistencies in the way different raters interpret the same plot.[12] For a study that is to be conducted as a high quality alternative to a clinical trial we want a more objective and scalable approach to data analysis which can provide a quantitative estimate of the treatment effect in the target population, and adjust for possible confounders.

Data requirements

To implement an individual-level ITS approach we need two types of information:

(1) **Clinical data** – data on the timing and nature of interventions and other key predictors of outcome and confounders. This data could be obtained from routine clinical data such as hospital episode statistics (HES), or could be derived from a simple case report form completed locally.

(2) **Research data** – a time series of outcome measurements (ideally patient-reported outcomes). These typically cannot be obtained robustly from patient records, and must be independently collected at an individual level, with individual consent.

Even if research data are routinely collected there is a risk of bias if patients report outcomes to staff who are directly involved in their care. A more robust approach is to separate the clinical and research data with a "firewall". If the research database is managed separately by a Clinical Trials Unit (CTU) or independent data hub, then data analysts can remain masked to the clinical data (including intervention status) until the databases are locked and ready for analysis.

Data collection may need to be spread over a long duration (to allow for variation in intervention timing) and over a wide geographical area. Furthermore, if a balance of pre- and post-intervention assessment is desired participants should be approached as soon as they are on the relevant treatment pathway – often in a general practice setting. Consent for research data collection (and linkage with HES or other routine data using NHS number) could be done electronically. Electronic informed consent (e-ICF) is valid for all types of research so long as regulatory requirements are met.[13] The FDA and HRA have recently released guidelines in support of both electronic and proportionate consent respectively.[14,15]

PROMiSe Study Aims

The overall aim of our project was to deliver a proof-of-concept, scalable framework for the collection and analysis of patient-reported outcomes as time series, using electronic data capture and incorporating a robust and compliant electronic informed consent form (e-ICF) mechanism.

The project was divided into four Work Packages (WP) with the following specific aims:

WP1. Develop and pilot a robust, compliant patient electronic informed consent form (e-ICF) and patient reported outcome measures (PROMs) platform (the "PROMiSe platform");

WP2. Assess user acceptability of the PROMiSe platform in a range of user-groups;

WP3. Investigate and review the challenges of linking PROMiSe data to clinical data from a variety of sources, and demonstrate proof-of-concept using the EMIS Web general practice database;

WP4. Review and (if necessary) develop statistical methods for the analysis of individual-level interrupted time-series data from PROMiSe.

A PROMiSe workshop was scheduled towards the end of the study to disseminate findings to representatives of UKCRC-registered Clinical Trials Units and other stakeholders.

Methods

WP1: Research database set-up

User data for this pilot study were collected and managed using REDCap electronic data capture tools hosted at Queen Mary University of London.[16] REDCap is a secure data collection system that allows patients to log in and enter their data directly. It is free to use for academic studies and thus cost-effective. The system is compliant with research information governance requirements, is secure and encrypted, has real time data entry validation, a full audit trail as well as an electronic signatures module and linkage with several common statistical packages for data analysis.

The PROMiSe platform included four modules:

1. Online participant information sheets and consent forms;

2. Identifiable data (email address and NHS number required for future data linkage);

3. EQ-5D-5L questionnaire (as an exemplar of a PROM);

4. User acceptability questionnaire.

The electronic participant information sheet and consent form (e-ICF) and questionnaires underwent patient and public involvement (PPI) review prior to being set up on the PROMiSe system. End-to-end testing of the system was completed using the test server to ensure it was fit for purpose. We also tested the system to ensure that surveys were sent at the correct time intervals in the test server before the system went live. We built in report functions for the end of each survey period. The testing was completed in December 2017 and the system went live in January 2018.

WP2: User testing

Participating CTUs contacted coordinators of local PPI groups with information about the PROMiSe study to be distributed to members of the group. The information contained the details and purpose of the study and contact details for the trial manager at each unit. Each participant was offered a £10 voucher (Amazon or similar) on completion of the study, which they could opt instead to donate to their PPI charity. Details of participating CTUs and PPI groups are given in Table 1. Once expressions of interest were received by trial managers, email invitations were sent to participants to join the study from the REDCap system. In total 86 invitations were sent in January 2018.

CTU	PPI groups
Birmingham Clinical Trials Unit	Birmingham 1000 Elders (adults aged 65 and over, in good health)
Edinburgh Clinical Trials Unit	Asthma UK Centre for Applied Research Patient Advisory Group, and other PPI networks
Pragmatic Clinical Trials Unit	Bowel & Cancer Research Charity PPI group, and CTU researchers

Table 1. Clinical Trials Units (CTUs) and patient and public involvement (PPI) groups who participated in the user testing

Invitations contained a link to the e-ICF. An EQ-5D-5L questionnaire was sent to volunteers automatically (via email) from the PROMiSe platform and collected every 4 weeks for 6 months, in order to accumulate an extended time series of outcomes for each individual within the short duration of this study. An acceptability questionnaire to assess user satisfaction and to explore reasons for any non-compliance and possible improvements was sent in the first month, and again after 3 and 6 months. Table 2 summarises the data collection.

	Jan '18 ('PROM1')	Feb '18 ('PROM2')	Mar '18 ('PROM3')	Apr '18 ('PROM4')	May '18 ('PROM5')	Jun '18 ('PROM6')	Jul '18 ('PROM7')
e-ICF	X						
EQ-5D-5L	X	X	X	X	X	X	X
Acceptability	X			X			X

Table 2. PROMiSe data collection

WP3: Data linkage

We aimed to: (a) investigate and review the challenges of linking PROMiSe data to electronic patient records and other routine data sources (e.g. HES and EMIS Web data) at different sites and using different systems; (b) determine identifiers required to successfully link with routine data sets; (c) simulate linkage of PROMiSe data to real, non-identifiable data from the EMIS Web general practice database indexed with a pseudonymised ID, in order to demonstrate proof of concept for linking clinical and research data; and (d) consider the quality of routine data extracts and quality control methods (if any) required for future studies.

To address these aims, we developed a pilot scenario in which a cohort of real patients (at Barts Health NHS Trust) would be used. A readily-available source of such patients (and their data) were patients undergoing common general and colorectal surgical (elective and emergency) procedures under the care of Prof Knowles (CK). A sample size of 50 patients was considered sufficient to pilot the aims. These were identified consecutively from CK's 2017 surgical logbook. They included operations such as abscess drainage, appendectomy, haemorrhoids and hernia (note that the exclusion of complex elective colorectal procedures was deliberate to enrich the population for local referrals and thus EMIS Web coverage).

Using these data as a starting point it was easy to ascertain that the Barts Health NHS Trust electronic record system (Cerner Millenium SurgiNet, Cerner Corporation, Kansas City) could deliver phenotypic 'state' information, *i.e.* at the time of surgery. These data are extractable (albeit manually) from the 'documentation' function of PowerChart (Cerner). Data are available on admission, discharge and surgery dates, operating surgeons, duration of operation, ASA grade. The anaesthetic chart lists main comorbidities, vital signs *etc*. Subsequent 'clinical documentation' covers perioperative complications.

However, it is well known that hospital data in general are poor at recording many phenotypic 'trait' characteristics that may influence short and long-term surgical outcomes. It was thus necessary to simulate linkage to primary care records using EMIS Web. To achieve this, we developed a strategy for linkage that could pilot the system while conforming to information governance requirements. We used the patient's NHS number (derived from Cerner) to create a pseudonymised ID using open

source desktop software OpenPseudonymiser, V:2.0b (University of Nottingham). This was performed for all 50 patients and the pseudonymised ID then used to extract EMIS Web data (this never being linked back to the original records).

We tested the hypothesis that EMIS Web could provide suitable data pertinent to a 'generic' high-quality surgical cohort study such as trait phenotypic characteristics influencing surgical outcomes. We developed a data specification document listing approximately 100 selected fields of data covering demographics, comorbidities (by system), exposures, frailty scores, drug prescriptions, and clinical measurements e.g. BP, BMI, routine blood tests. We then linked these data to the 50 pseudonymised IDs. It was determined in advance that results would be presented descriptively on the basis of data available or unavailable per individual (without interest in the actual results).

WP4: Statistical methods

We conducted a systematic review of applied research studies (or reviews of applied research studies) with an observational stepped wedge or multiple baseline design, and methods papers describing approaches to the analysis of such studies. A list of databases and search terms is given in Appendix 1. Reference lists of identified papers were hand-searched against the eligibility criteria to assess whether any papers had been missed. In the case of methods papers we also searched for papers which cited these. Full details of the protocol for the review are available at the PROSPERO website.[17]

We did not include "interrupted time series" as a search term because this was considered likely to identify studies where there was either a single, aggregated time-series of outcomes assessed under control and then intervention conditions, or else two time series, with the second being in the control condition throughout. Papers which refer explicitly to an interrupted time series approach will be captured in other reviews, for example the review currently being conducted by Ewusie and colleagues.[18]

We screened abstracts and (if necessary) full texts against the following criteria for research design:

- Non-randomised evaluations of interventions in humans.

- Repeated assessments of the same individuals or clusters of individuals, including repeated assessments under both the control and intervention conditions (or before and after the intervention).

- More than one 'baseline' (which could be at individual or cluster level) – that is, the intervention is not switched on in all the individuals/clusters at the same time. Specifically there should be individuals or clusters who are assessed over the same period of time, but with different sequences of control and intervention conditions.

- 'Multiple' baselines: primary research studies should only be included if they have more than 5 distinct sequences of control/intervention, and methods papers should only be included if the method can be generalised to any number of baselines – not just one, two, or a 'few'.

- The target of estimation is an effect of the intervention which is common to all individuals/clusters.

Results and Conclusions

WP1: Research database set-up

Through setting up, testing and user testing the database, we learnt some valuable lessons. Firstly, we noticed that some of the emails sent from the REDCap system went to participants' junk mail boxes. We advised our participants to check their junk email and be sure to mark the email as safe to prevent the problem recurring. A solution for future studies could be to send the email from a personal nhs.net email account rather than a generic REDCap account. Secondly, the signature function for the consent form only worked on a PC. Anyone trying to sign the consent form using a smart-phone or tablet was not able to sign the form. For future studies we will include a consent statement with a tick-box for patients to confirm their agreement to take part in the study. Thirdly, we found that many participants preferred to have a person available to contact, in order to help them with any technical issues, and to reassure them regarding the integrity of the emails and online database.

WP2: User testing

Detailed findings are summarised in slides from the PROMiSe Workshop – see Dissemination, below.

50/86 (58%) participants responded to the first round of invitations in January 2018 (PROM1), 25/50 (50%) participants responded to the surveys at the end of April (PROM4) and 23/25 (92%) participants responded to the last round of surveys at the end of July (PROM7). More effort would be needed in future studies to increase response rates – for example using text or email reminders.

51% of participants were aged 66-80 years and 74% were female. Of those participants who responded to the January 2018 (PROM1) acceptability questionnaire, 92% found the method of online consent acceptable and 94% said that if they were receiving treatment in hospital or from a GP they would agree to take part in a study that used online consent and surveys to help doctors assess their response to treatment, although 22% were concerned about data security and sharing their personal information online. When asked how frequently they would prefer to receive questionnaires in a 1-year study, 68% were happy to receive questionnaires monthly, and 92% were happy to receive questionnaires at least every 3 months. For a 3-year study, 78% were happy to receive questionnaires at least every 3 months, and 98% at least every 6 months. For a 5-year study, 63% were happy to receive questionnaires at least every 3 months, and 98% at least every 6 months.

WP3: Data linkage

A total of 50 patients undergoing common procedures were selected as planned and pseudonymised IDs generated. The results of data linkage to EMIS Web are shown in Appendix 2. The tables show that 37/50 patients had data retrievable by EMIS Web. The remaining 13 patients were either from out of area or had not been registered with a GP (both of these scenarios are common and expected at a large urban hospital with a mobile population). For the 37 patients with a local EMIS Web record, data extraction was in general superb. All had data for demographic fields including ethnicity and index of deprivation. Comorbidities were as expected for this population. All patients had complete data for exposures and for Charlson comorbidity score. Similarly, measurements such as BMI and BP were available in the majority (>34/37).

Taken together with Cerner hospital data, it would thus be possible to construct a very accurate picture of an individual patient's state and trait phenotypic characteristics such as might be required

for a surgical cohort study, leaving little to be recorded by research teams on bespoke CRFs. The timetable for such a project would need to allow appropriate time for data linkage and extraction.

WP4: Statistical methods

Data extraction from applied research papers and the narrative review of methodological papers are ongoing (see the PROSPERO website for the current status).[17] Here we provide a brief summary of preliminary findings. The final methodological review will be written up as a separate, peer-reviewed publication.

As noted in the Introduction, the analysis of single-subject or *n*-of-1 studies often relies on visual inspection of graphs. Where quantitative analysis is attempted it rarely involves statistical modelling. Some authors have noted two contrasting rationales for single-subject designs: firstly to establish what works best for each participant, using only results for that individual; secondly to estimate a treatment effect which can be generalised to future patients drawn from the same population (analogous to a clinical trial).[19,20] The latter could be achieved by meta-analysing treatment effects derived for different individuals, or using a mixed regression analysis with random effects to model individual variation, and segmented regression approaches to model discontinuities associated with the introduction of the intervention in each individual time series.[21] In particular, Araujo, Julious & Senn recommend including a random treatment-by-patient interaction in the mixed regression model – that is, to allow for variation in the effect of treatment between individuals – even if the intention is solely to estimate an "average" treatment effect for a new patient.[19]

Though there are currently few examples of applied health research studies using this approach to quantify or compare the effectiveness of treatments, the tools for this kind of analysis are readily available.

Overall conclusion

We have demonstrated proof-of-concept for a scalable framework for the collection and analysis of patient-reported outcomes as time series. Such a platform provides a foundation for piloting and conducting large-scale, non-randomised healthcare evaluations with greatly improved rigour and efficiency. The methodology could also significantly reduce NHS and other study support costs through its use of electronic informed consent and PROM data capture, as well as exploitation of NHS digital routine data.

Dissemination

A workshop to disseminate findings from the project was held on Friday 6th July 2018, at Queen Mary University of London. The workshop was advertised through Patient and Public Involvement representatives at collaborating Clinical Trials Units, the Information Systems and Statistics Operations Groups of the CRCUK's network of registered Clinical Trials Units, the CRCUK newsletter, NIHR funding programme managers, the NIHR Statistics Group, NIHR Research Design Services, the NIHR Clinical Research Network Coordinating Centre, the CHAIN (Contact, Help, Advice & Information) Network, and Management Group members' own networks.

Slide presentations from the workshop can be found here:

https://www.qmul.ac.uk/pctu/courses-and-events/past-events/patient-reported-outcomes-as-individual-level-interrupted-time-series-in-observational-studies/

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Contribution of authors

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Appendix 1: Methodological review: databases and search terms

Medline + EMBASE + PsycINFO (via Ovid)
1. ((multi or multiple or (set adj1 of) or (series adj1 of)) adj1 ((single adj1 case) or (single adj1 subject) or (n adj1 of adj1 "1") or (n adj1 of adj1 one))).mp. 2. ((observational or (non adj1 randomi?ed) or nonrandomi?ed) and ((stepped adj1 wedge) or (multi adj1 baseline) or (multiple adj1 baseline))).mp 3. 1 or 2

CINAHL

Un-tick suggest subject terms:
  1. ((multi or multiple or "set of" or "series of") N0 ("single case" or "single subject" or "n-of-1" or "n-of-one"))
  2. ((observational or "non-randomi?ed" or nonrandomi?ed) and ("stepped wedge" or "multi baseline" or "multiple baseline"))
  3. 1 or 2

Cochrane Library

Using search manager:
  1. Multi
  2. Multiple
  3. Set next of
  4. Series next of
  5. #1 or #2 or #3 or #4
  6. single next case
  7. single next subject
  8. n next of next "1"
  9. n next of next one
  10. #6 or #7 or #8 or #9
  11. #5 next #10
  12. Observational
  13. non next randomi?ed
  14. nonrandomi?ed
  15. #12 or #13
  16. stepped next wedge
  17. multi next baseline
  18. multiple next baseline
  19. #15 or #16 or #17
  20. #14 and #18
  21. #19 or #11

Web of Science
1. ((multi or multiple or (set near/0 of) or (series near/0 of)) near/0 ((single near/0 case) or (single near/0 subject) or (n near/0 of near/0 "1") or (n near/0 of near/0 one))) 2. ((observational or (non near/0 randomi?ed) or nonrandomi?ed) and ((stepped near/0 wedge) or (multi near/0 baseline) or (multiple near/0 baseline))) 3. 1 or 2

Appendix 2: Data linkage

N = 50 patient NHS numbers provided

N = 37 had retrievable data from EMIS Web

Variable	Number with linkage	Notes
Demographic		
Age	37/37	Latest recording. Age at search date calculated from year of birth.
Sex	37/37	Latest recording.
Ethnic group	35/37	Latest recording. Columns: code, date, term.
Index of m. deprivation	37/37	Latest recording. LSOA (lower super output area) mapped to IMD quintile.
Comorbidities		
Cardiovascular		
Myocardial Infarction	1/37	Earliest recording and latest recording. Columns: code, term, date.
Ischaemic heart disease	1/37	Earliest recording and latest recording. Columns: code, term, date.
Stroke/TIA	0/37	Earliest recording and latest recording. Columns: code, term, date.
Heart failure	1/37	Earliest recording and latest recording. Columns: code, term, date.
Atrial fibrillation	2/37	Earliest recording and latest recording. Columns: code, term, date.
Peripheral arterial disease	0/37	Earliest recording and latest recording. Columns: code, term, date.
Hypertension (and BP >140/90)	4/37	Earliest recording and latest recording. Columns: code, term, date.
Venous or arterial leg ulcer	1/37	Earliest recording and latest recording. Columns: code, term, date.
Use of anticoagulant	0/37	Information collected in prescribing.
Respiratory disease		
Asthma	6/37	Earliest recording and latest recording. Columns: code, term, date.
COPD	1/37	Earliest recording and latest recording. Columns: code, term, date.
GI disease	2/37	Gastroenteritis. Earliest recording and latest recording. Columns: code, term, date.
Liver disease	1/37	Fatty liver. Earliest recording and latest recording. Columns: code, term, date.
Hep B, C	0/37	Earliest recording and latest recording. Columns: code, term, date.

Cirrhosis	0/37	Earliest recording and latest recording. Columns: code, term, date.
Portal hypertension	0/37	Earliest recording and latest recording. Columns: code, term, date.
Bleeding varices	Not included in data collection	
IBD: Crohn's disease	6/37	Earliest recording and latest recording. Columns: code, term, date.
IBD: ulcerative colitis	1/37	Earliest recording and latest recording. Columns: code, term, date.
Gastric or duodenal ulceration	2/37	Earliest recording and latest recording. Columns: code, term, date.
Metabolism / Endocrine		
Diabetes T1/2	4/37	Earliest recording and latest recording. Columns: code, term, date.
Chronic renal impairment eGFR <60	2/37	Earliest recording and latest recording. Columns: code, term, date.
Chronic renal impairment eGFR <30	0/37	Earliest recording and latest recording. Columns: code, term, date.
Autoimmune		
Rheumatoid	0/37	Earliest recording and latest recording. Columns: code, term, date.
SLE	0/37	Earliest recording and latest recording. Columns: code, term, date.
Sjorgrens	0/37	Earliest recording and latest recording. Columns: code, term, date.
Sarcoid	0/37	Earliest recording and latest recording. Columns: code, term, date.
Polymyalgia	0/37	Earliest recording and latest recording. Columns: code, term, date.
Vasculitis	0/37	Earliest recording and latest recording. Columns: code, term, date.
Neurological		
Dementia	0/37	Earliest recording and latest recording. Columns: code, term, date.
Parkinson's disease	0/37	Earliest recording and latest recording. Columns: code, term, date.
Multiple sclerosis	0/37	Earliest recording and latest recording. Columns: code, term, date.
Serious mental illness	7/37	Earliest recording and latest recording. Columns: code, term, date.
Depression	12/37	Earliest recording and latest recording. Columns: code, term, date.
Epilepsy	0/37	Earliest recording and latest recording. Columns: code, term, date.

Learning disability	0/37	Earliest recording and latest recording. Columns: code, term, date.
Cancer-related		
Colorectal	0/37	Earliest recording and latest recording. Columns: code, term, date.
Anal	0/37	Earliest recording and latest recording. Columns: code, term, date.
Uterine	0/37	Earliest recording and latest recording. Columns: code, term, date.
Cervical	0/37	Earliest recording and latest recording. Columns: code, term, date.
Prostate	0/37	Earliest recording and latest recording. Columns: code, term, date.
Bladder	0/37	Earliest recording and latest recording. Columns: code, term, date.
Lung	1/37	Earliest recording and latest recording. Columns: code, term, date.
HIV positive	0/37	Earliest recording and latest recording. Columns: code, term, date.
Palliative care	0/37	Earliest recording and latest recording. Columns: code, term, date.
Exposures		
Smoking status	37/37	Earliest recording and latest recording. Columns: category, code, term, date.
Alcohol intake	33/37	Earliest recording and latest recording. Columns: code, date, value, units.
Major Substance misuse	0/37	Earliest recording and latest recording. Columns: code, term, date.
Scores		
Charlson comorbidity score	37/37	Earliest recording and latest recording for 21 conditions. Each condition is assigned a weight. Sum of weights = Charlson comorbidity score.
Frailty score	1/37	Earliest recording and latest recording. Columns: code, date, value.
Measurement		
Systolic/diastolic BP last recorded	34/37	Earliest recording and latest recording. Columns: code, date, value, units.
Weight	35/37	Earliest recording and latest recording. Columns: code, date, value, units, age at event.
Height	34/37	Earliest recording and latest recording. Columns: code, date, value, units, age at event.

BMI	31/37	Earliest recording and latest recording. Columns: code, date, value, units, age at event.
eGFR	28/37	Earliest recording and latest recording. Columns: code, date, value, units.
Hb	30/37	Earliest recording and latest recording. Columns: code, date, value, units.
HbA1c	24/37	Earliest recording and latest recording. Columns: code, date, value, units.
ALT	29/37	Earliest recording and latest recording. Columns: code, date, value, units.
Prescribing		
Anticholinergics	0/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Acetylcholinesterase inhibitors	Not included in data collection	
Hypnotics	1/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Axiolytics	0/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Antipsychotics	0/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Tricyclic antidepressants	2/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
MAOIs	0/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
SSRIs	3/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Calcium channel blockers	1/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Anticoagulants	0/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
NSAIDs	2/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.
Opioid containing analgesics [weak, strong – some basic classification]	7/37	Latest recording within 6 months. Columns: BNF chapter, BNF chapter heading, term, issue date, quantity, units.

Stoma appliances	Not included in data collection	
Previous surgery		
Hysterectomy +/- oophorectomy	Not included in data collection	
Colorectal surgery	Not included in data collection	
Other abdominal surgery	12/37	Endoscopy. Earliest recording and latest recording. Columns: code, date, term.
Primary HC utilisation		
Total GP attendances	Not included in data collection	
Total home visits	Not included in data collection	
GP attendances: abdominal / pelvic pain	Not included in data collection	
GP attendances: constipation	Not included in data collection	
GP attendances: rectal or uterine prolapse	Not included in data collection	
GP attendances: faecal or urinary incontinence	Not included in data collection	
GP attendances: rectal bleeding	Not included in data collection	

Conflict of interest declaration

No conflicts of interest were declared.