Measuring prevalence, reliability and variation in high-risk prescribing in general practice using multilevel modelling of observational data in a population database

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Scientific summary

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Background

Prescribed drugs have large potential benefit but also cause considerable harm. Potentially inappropriate or high-risk prescribing is common in primary medical care. However, there are fewer published data on how high-risk prescribing varies between practices or between individual physicians, and how it has changed over time. Previous research has shown that there is moderate to large variation in quality of care between physicians and between institutions. Studies that have examined both typically found that between-physician variation is larger for care processes which physicians directly control (such as blood pressure measurement) whereas between-institution variation is often larger for processes organised on a wider scale (such as eye screening in diabetes). We have previously shown that high-risk prescribing measured by a basket of 15 indicators is common in UK primary care, and that there is statistically and clinically significant variation between practices after adjustment for patient characteristics. However, to our knowledge there is no published research systematically examining variation in high-risk prescribing between practices and between physicians.

Objectives

The aims of this study are to define a set of prescribing safety indicators that can be operationalised in existing electronic clinical data and to examine how high-risk prescribing varies between patients, general practitioners (GPs) and practices in order to determine the validity of these indicators for safety improvement, clinical governance and appraisal/revalidation purposes.

Objective 1: to define and operationalise prescribing safety indicators that can be applied at individual prescriber level and practice level.

Objective 2: to examine the prevalence of individual indicators and appropriate composites, associations with patient, prescriber and practice variables, and the relative importance of variation at prescriber level and practice level before and after adjustment for patient-level variables.

Objective 3: to measure the reliability of individual and composite indicators at prescriber level and practice level.

Objective 4 (additional in revised protocol): to examine changes in rates of high-risk prescribing over time (2004–9) and variation between practices, using a basket of indicators validated in previous consensus studies.

Data sources and methods

Data sources

Anonymised data were extracted from GP electronic medical records and provided to us by the University of Aberdeen Primary Care Clinical Informatics Unit (PCCIU). The NHS Grampian Research Ethics Committee has reviewed the process by which PCCIU extracts and manages this data set and does not require individual study approval. For objectives 1–3, data for calendar year 2006 were extracted for 398 GPs and 26,539 patients from 38 Scottish practices. Extracted data included patient demography, morbidity recorded using Read Codes and prescribing plus information on the practice the patient was registered with and the GPs they had encounters with. For objective 4, data for 2004–9 for ≈ 300,000 patients

particularly vulnerable to adverse drug effects were extracted from 190 Scottish practices, comprising the same patient data plus information on the practice but without GP identifiers (IDs).

Objective 1 methods

The feasibility of implementing high-risk prescribing indicators using data from GP electronic medical records was examined, as well as the feasibility of measuring high-risk prescribing at GP level.

Objectives 2 and 3 methods

Five indicators of high-risk non-steroidal inflammatory drug (NSAID) prescribing were defined, as well as a single overall high-risk NSAID composite measure. Multilevel logistic regression modelling was used to examine variation between practices and/or between GPs, and to examine associations between high-risk prescribing and patient, GP and practice characteristics. A two-level model of patients clustered within practices using 'any high-risk prescribing' as the outcome was initially fitted and variation between practices estimated using the intraclass correlation coefficient (ICC) and median odds ratios. A three-level model of encounters clustered within GPs within practices was then fitted using 'new NSAID prescribing' as the outcome and variation between practices and between GPs estimated using ICCs and median odds ratios. The reliability of measurement (in the sense of the ability of the indicator to distinguish between practices' and/or GPs' high-risk prescribing rates) was estimated using the Spearman–Brown prophecy formula in the two-level model and generalizability theory in the three-level models.

Objective 4 methods

Nineteen indicators of high-risk prescribing proposed in one or more previous consensus studies were defined and implemented to measure changes in high-risk prescribing between Q2 2004 and Q1 2009. For each indicator and for a set of predefined composite indicators, the prevalence of high-risk prescribing was measured in each quarter and change over time examined by fitting a linear or quadratic trend line to the data. Change in variation between practices over time was examined by estimating the ICC in each quarter in a two-level multilevel model with patients clustered within practices.

Results

Objective 1 (feasibility)

It is feasible to implement indicators of high-risk prescribing in primary care electronic medical record data, but measurement at GP level is very challenging for two reasons. First, it is not possible in current data to identify who actually makes the decision to initiate many drugs, with GPs not infrequently prescribing on the recommendation or instruction of a hospital specialist. Second, it is common for GP electronic data not to have a clinician ID attached. After exploration of the data, we considered that new acute NSAID prescribing (the issue of an acute NSAID prescription when there had been no NSAID prescribing in the previous year) could be attributed to individual GPs because initiation is usually by the GP and such prescriptions almost all have clinician ID. This could be replicated for some other high-risk prescribing but is neither generally applicable to all new prescriptions nor straightforward to implement. We concluded that it was only narrowly feasible to create prescribing safety indicators that could be applied at individual prescriber level, and that new acute NSAID prescribing was one such indicator that was feasible to measure at GP level.

Objectives 2 and 3 (variation between practices in total high-risk non-steroidal anti-inflammatory drug prescribing)

This initial analysis examined between-practice variation in total high-risk NSAID prescribing. It found that 9.5% of patients particularly vulnerable to NSAID adverse drug events (ADEs) received a NSAID in Q4 2006. High-risk NSAID use was lower in people with multiple reasons to be vulnerable to ADEs and in the oldest patients. At practice level, total high-risk NSAID use was associated with prior practice rates of new acute NSAID prescribing, consistent with the latter being an important transition associated with total prescribing and a reasonable outcome to model in the three-level analysis. There was statistically significant

moderate variation between practices [empty model ICC 0.034, 95% confidence interval (CI) 0.020 to 0.056; median odds ratio 1.38] which persisted after adjustment for patient characteristics (ICC 0.026, 95% CI 0.015 to 0.044; median odds ratio 1.23). The observed ICC is in the range typically seen in this kind of analysis and is typically interpreted as showing fairly small variation between practices, but the large numbers of patients vulnerable to NSAID ADEs meant that the composite indicator was highly reliable in distinguishing practices as having higher or lower high-risk NSAID prescribing.

Objectives 2 and 3 (variation between practices and between general practitioners in new high-risk non-steroidal anti-inflammatory drug prescribing)

New acute NSAID prescribing occurred in 1.1% of encounters in 2006 with people particularly vulnerable to NSAID ADEs. Male GPs were more likely than female GPs to issue a high-risk new acute NSAID [adjusted odds ratio (OR) 1.73, 95% CI 1.39 to 2.16], but none of the practice characteristics examined was associated with high-risk new acute NSAID prescribing. There was moderate variation in outcome between practices (empty model ICC 0.055, 95% CI 0.029 to 0.102) and large variation between GPs (empty model ICC 0.166, 95% CI 0.135 to 1.197) respectively. In other words, 5.5% of variation in outcome was attributable to variation between practices and 16.6% to variation between GPs. There was relatively little change after accounting for encounter characteristics [adjusted model ICC 0.042 (95% CI 0.027 to 0.083) at practice level and 0.142 (95% CI 0.114 to 0.173) at GP level]. The median odds ratio at GP level can be interpreted as the median difference in the odds of receiving a new acute NSAID if a patient were to randomly encounter two different GPs from the same practice, and it was 2.22 (95% CI 1.00 to 1.50) in the empty model and 2.06 (95% CI 1.87 to 2.30) in the model adjusted for encounter characteristics. The median odds ratio at practice level can be interpreted as the median difference in the odds of receiving a new acute NSAID if the patient were to randomly encounter two different GPs from different practices (but should be interpreted in terms of how different it is from the median odds ratio at GP level, as it includes variation between GPs as well as between practices), and was 2.52 (95% CI 2.15 to 3.09) in the empty model and 2.28 (95% CI 1.98 to 2.76) in the model adjusted for encounter characteristics. Variation between GPs is, therefore, of a similar magnitude as all but one of the associations with encounter and GP characteristics included as fixed effects.

Three out of 38 practices and 51 out of 398 GPs had statistically significantly above average high-risk new acute NSAID prescribing after accounting for encounter characteristics. However, most GPs in practices with above average high-risk NSAID prescribing were not themselves significantly above average, and 43 GPs with above average prescribing were in practices which were average or significantly below average. It was not possible to discriminate reliably between practices in terms of their high-risk new acute NSAID prescribing (reliability ≥ 0.7 in only a minority of larger practices). Measurement was more reliable at GP level, although only 62% of GPs in this study could be measured with reliability ≥ 0.7, which is adequate for comparative feedback for improvement purposes, and only 45% with reliability ≥ 0.8, which is required for high-stakes evaluation.

Objective 4 (change over time)

Nineteen indicators that were previously validated in UK consensus studies were implemented, although two indicators could not be implemented across the whole period because of changes in coding. Changes in the prevalence of and variation between practices in each of these indicators were estimated. For the 17 indicators included in the overall composite, the percentage of patients receiving any high-risk prescription fell from 8.5% in Q2 2004 to 5.2% in Q1 2009, which was largely driven by reductions in high-risk NSAID and to a lesser extent antiplatelet prescribing. Only one type of high-risk prescribing significantly increased in prevalence: high-risk coprescribing to people prescribed coumarin anticoagulants. Change in variation between practices could be assessed for only 15 indicators, and it increased for five indicators, did not change for five and decreased for five, with no clear relationship between change in prevalence and change in variation between practices.

Limitations

The data used are collected for routine clinical care and are, therefore, not explicitly designed for research. Although prescribing data are near complete, practices will vary in how accurately they record the conditions which some indicators are based on, although recording of common conditions in UK general practice is reasonably good. Electronic recording of a GP ID for prescriptions issued was not good, although adequate for new acute NSAID prescriptions, but it was not possible to independently assess the accuracy of GP IDs. Although the analysis uses data from only Scottish general practices, we believe that the findings are likely to be relevant across the UK, as most divergence in health-care systems across the UK countries applies to other aspects of care such as commissioning.

Conclusions

Implications for practice

Measurement at general practitioner level is not routinely feasible for either governance or improvement activity

Although variation between GPs was estimated to be approximately three times greater than variation between practices, routinely measuring high-risk prescribing at GP level is not feasible with current data because of attribution problems. High-risk prescribing indicators at GP level are, therefore, unlikely to be usable for governance or wide-scale improvement purposes in the near future.

Measurement at practice level for governance purposes

It is feasible to measure total high-risk prescribing at practice level using the NSAID indicators examined in this study and these indicators distinguish between practices with high reliability, making them suitable for high-stakes evaluation as part of governance activity. However, focusing on practices with above average rates would not identify the majority of GPs with high-risk prescribing (as most work in practices that would not be targeted) or the majority of patients exposed to high-risk prescribing (as such prescribing is relatively common in most practices).

Measurement at practice level for improvement purposes

Practice-level measurement of total high-risk prescribing is feasible and easily reliable enough to support interventions in all practices on its own (e.g. for feedback of practice performance including comparison against other practices or a benchmark) or as part of a broader intervention. The findings indicate that intervention targets could include review of existing prescribing (as repeat prescribing is the bulk of prevalent high-risk NSAID use), and understanding and intervention to influence the initiation of new prescribing, which varies considerably between GPs. In addition, improvement outcomes could usefully combine measures of overall quality and safety and measures of variation between practices, as overall improvement may be associated with increasing inequalities between practices.

Implications for research

Causes of variation between practices and between general practitioners

There is relatively little known about why practices and GPs vary in their high-risk prescribing, with only a limited range of practice structural characteristics examined in this and previous analyses of variation and no systematic examination of GP characteristics associated with high-risk prescribing. There is a need for research to better understand how the organisation of safety critical processes such as repeat prescribing systems influences safety and patient outcomes, how this organisation reflects wider practice culture, and if and how GP characteristics such as knowledge and risk tolerance are associated with high-risk prescribing.

Quantifying the risk of commonly used drugs

One potential cause of variation in high-risk prescribing is that the risk of many of the drugs believed to be harmful is relatively poorly quantified. Although the indicators used in this study had all been validated in consensus studies based on existing evidence, there is a need to more systematically quantify the risk of commonly used drugs using robust pharmacoepidemiological methods in order to target prescribing most commonly associated with harm.

Interventions to manage and reduce high-risk prescribing

The PINCER study in the UK has shown that a pharmacist-led intervention can improve prescribing safety, but it is unclear how pharmacist-led interventions compare in effectiveness with simpler interventions using regular feedback alone or with other complex interventions prompting and facilitating GP review of high-risk prescribing, and interventions that target patients with polypharmacy rather than focusing on particular indicators. Most critically, research is needed to examine the extent to which these interventions improve patient outcomes as well as prescribing safety indicators.

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