



Utilising practice management system data for quality improvement in use of blood pressure lowering medications in general practice

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Abstract

Aim To assess use of Electronic Medical Records (EMRs) to identify patient cases for potential quality improvement in use of blood pressure-lowering medications in general practice.

Setting One metropolitan general practice in Auckland with a high proportion of Pacific patients.

Participants Patients registered as regular patients with the practice; classified within the previous 5 years as having hypertension; with at least one prescription for antihypertensive medication in the year prior to the evaluation period of 9 May to 8 November 2007.

Intervention Iterative discussion of quality improvement opportunities and review of EMRs with a panel of practice clinicians to identify agreed quality indicators based on EMR data. This resulted in a set of eight evidence-based criteria for patients classified with hypertension, implemented as database queries, which identify cases for potential quality improvement. The panel conducted blind assessment of antihypertensive therapy on a sample of 20 cases matching at least one criterion and 20 cases that met no criterion; the case classifications based on the database queries were then revealed for direct comment and consideration by the panel.

Results Of 517 eligible patients, 209 (40.4%) met one or more of the eight criteria. Of these 209, 110 (21.3%) met only criteria related to persistence of medication possession and/or blood pressure recording. After assessment of the 40-patient sample by the practice GPs, the eight criteria taken as a whole had a Positive Predictive Value of 70% (95% CI 46-88%) and Negative Predictive Value of 70% for clinician assessment of suboptimal therapy and/or process.

Conclusion EMRs can provide moderately reliable identification of patients with suboptimal management of blood pressure in general practice. It should be noted, however, that the complexity of required query formulation is substantial with current tools. Identification of patients with poor persistence of antihypertensive therapy is the most promising outcome for follow-up investigation. The study needs to be replicated in a range of different practice settings.

Clinical audit is a process for quality improvement that seeks to improve patient care and outcomes through systematic review of care against explicit criteria and the implementation of change.¹ In 2004, 99.0% of New Zealand general practices (920 out of 929 respondent practices) used specifically designed patient management

system software to assist with recording of patient and clinical consultation details and to help with the daily running of their business.² This routine use of patient management systems motivates further exploration of the potential of general practice EMRs to provide the data for quality audit reports that can support clinical audit both to provide objective measurement of a practice's attainment of evidence-based quality of practice, and to identify specific cases that merit follow-up.

Hypertension is a major risk factor both in cardiovascular disease (CVD; New Zealand's number one killer³) and in chronic kidney disease (CKD).⁴ Broadly accepted hypertension treatment guidelines exist; notably, JNC7.⁵ These guidelines identify compelling indications for individual drug classes, such as ACEi (angiotensin-converting enzyme inhibitor) or ARB (angiotensin receptor blocker) with diabetes and CKD.⁵

Although no specific guideline should be expected to apply to 100% of individuals in a general practice setting, by the nature of evidence based guidelines, we expect that high rates of adherence to these compelling indications will yield the best health outcomes. Thus, the use of blood pressure lowering medications is a particularly worthwhile area of investigation with respect to quality audit research.

It has been shown that EMRs can be used to produce high-specificity alerts with respect to antihypertensive prescribing quality.⁶ In this paper we assess use of EMR data to identify specific cases for quality improvement in use of blood pressure lowering medications in general practice.

Method

This research was conducted under University of Auckland Human Participants Research Ethics Committee approval Reference no 2007/078. The method, rationale and surrounding technical issues have been reported previously.^{7,8} Test statistics were calculated with the *diag* routine in Stata 9 software.

The setting was a West Auckland general practice with a predominance of Pacific patients. Quality improvement criteria were developed via an iterative process working with a panel consisting of the practice manager, two GPs of the practice, and two of the practice's nurses.

Three 1-hour meetings with the panel were conducted on the premises of the practice between May 2007 and July 2007 to develop a quality audit report based on EMR data from the practice. The information needs for audit were determined by the investigators external to the practice and the practice's panel. (Note—among the authors, JK is a GP of the practice, TK is a GP external to the practice, and RG has practiced medicine outside NZ.)

The quality audit report was designed to document:

- Descriptive data about the practice (e.g., prevalence of hypertension);
- Positive attributes (numbers that the panel would like to raise—e.g., percent of patients diagnosed with hypertension with blood pressure now controlled) and
- Quality improvement opportunities.

After each of the three meetings, queries were implemented to populate the quality audit report from practice data, including prescribing and relevant laboratory data and observations for the 18-month period preceding the first meeting, and also all problem classifications (Read Codes) for the preceding 5-year period. Use of unique practice identification codes (not NHI numbers) for each patient allowed the practice to identify patients while maintaining patient anonymity in data used by the external investigators.

Relevant laboratory tests were identified in advance of the first meeting by analysis of guidelines (notably, JNC7⁵), but extended based on meeting results (in particular, to include estimated Glomerular

Filtration Rate, eGFR). Heuristics text processing to detect blood pressure (BP) readings in EMR notes was also extended between meetings based on feedback from the practice.

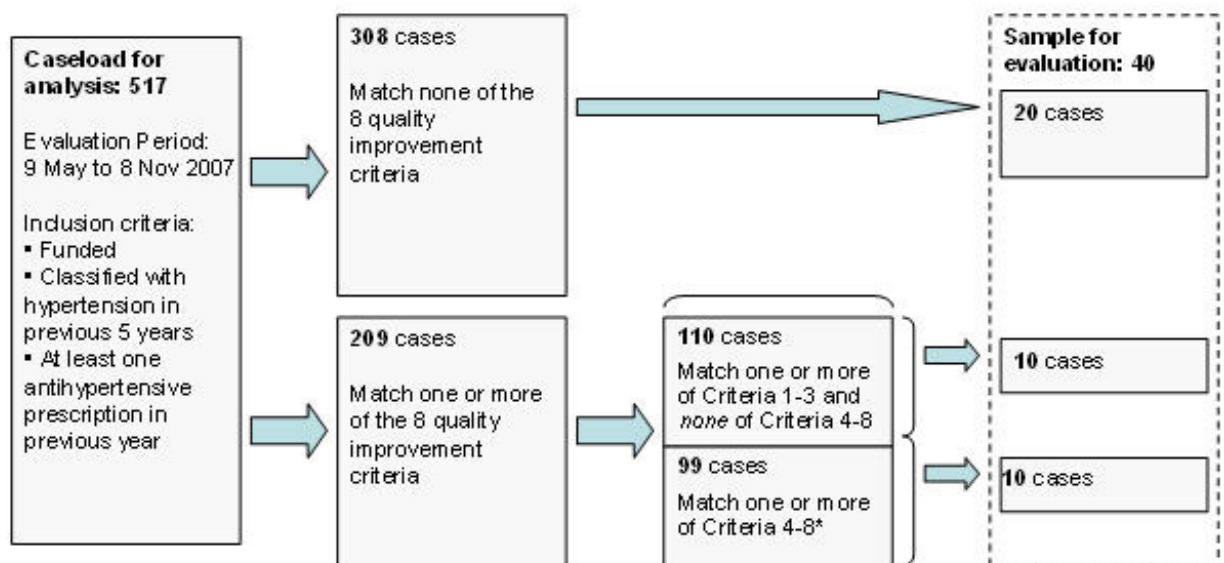
The queries required pre-processing to compute the duration of medication supply for each prescription as indicated by dose, frequency, pack size and repeats (generally 90 days). *Lapses* were identified where a medication, if first dispensed on the day of prescribing and subsequently taken as directed, would have run out. Periods of lapse were computed both for total antihypertensive therapy (AHT) and for several AHT drug groupings of interest to the panel, including ACEi and ARB (collectively), beta-blockers, and thiazide diuretics. Computational methods have been previously described by Warren et al.⁹

Table 1 shows the eight quality improvement criteria arrived at upon conclusion of the third meeting with the expert panel. A recent evaluation period not previously reviewed by the panel was used as the basis for a sample to validate the criteria. The criteria were assessed by database queries for the period of 9 May to 8 November 2007 for all funded patients enrolled with the practice who had been classified with hypertension in the previous five years and had at least one antihypertensive prescription in the previous year. A random sample of 40 cases total was drawn where:

- 20 cases were drawn from among those patients satisfying none of the eight criteria;
- 10 cases were drawn from those patients satisfying one or more of Criteria 1–3, but none of Criteria 4–8; and
- 10 cases were drawn from those satisfying one or more of Criteria 4–8 (irrespective of whether they also satisfied one or more of Criteria 1–3).

This process is illustrated in Figure 1.

Figure 1. Criteria and sampling for evaluation



* 27 cases that match one or more of Criteria 4-8 also match one or more of Criteria 1-3

The practice panel, independent of the external investigators and blind from the data query results, assessed each of the 40 sample cases by review of records at the practice. For each sample case, the panel's GPs completed a three-question assessment instrument (Appendix 1) which queried:

1. Freedom from significant contraindications or interactions;
2. Therapy optimized, or satisfactory process of seeking optimal treatment;
3. Adequacy of EMR data to support assessment of AHT.

After assessing all 40 cases, the criteria met by each case were revealed to the panel. The panel's GPs then gave feedback and had the option to revise their assessment. Subsequently, there was a joint meeting of the panel GPs and external investigators to further consider the assessments and feedback on the sample.

Table 1. Eight quality improvement criteria agreed with practice panel

Lack of persistence of medication; and/or lapsed BP recording

1. A lapse in AHT of >30 days and the lapse extends into the Evaluation Period (EP)
2. A period of >180 days with no BP measurements extending into the EP
3. A BP measurement of $\geq 160/100$ mmHg followed by a gap of >120 days in BP measurements extending into the EP

Persistently high BP; lacking indicated therapy; and/or lab test contraindicating treatment

4. Three or more consistently high BP measurements ($\geq 160/100$ mmHg) over 120 days or more where either
 - i) the last of these high BPs was within the EP or
 - ii) with no subsequent "controlled" BP ($< 160/100$ mmHg) measurements after the consistently high BPs
5. Classified with diabetes mellitus and not on ACEi/ARB at any time during EP*
6. Classified with myocardial infarction and not on beta-blocker at any time during EP*
7. Classified with renal impairment and on ACEi/ARB and with eGFR < 60 mL/min at any time during EP
8. On thiazide(s) and with serum uric acid > 0.42 mmol/L at any time during EP and not on Allopurinol or Colchicine

EP—Evaluation period (9 May to 8 Nov 2007); * i.e., a lapse of the indicated drug at some time during the EP and after the indicating diagnosis.

Results

There were 517 patients in the caseload for analysis. Of these cases, 209 (40.4%) met one or more of the 8 criteria during the 6-month evaluation period; 110 of the 209 (21.3% of total) met only Criteria 1-3—i.e. medication lapse or blood pressure measurement lapse. Figure 1 shows frequencies with which the criteria groupings 1-3 and 4-8 were met.

Assessment of the 40 sampled cases by the practice panel yields six false-positives and six false-negatives (see Table 2) thus giving the observed validity for the sample as: sensitivity 70%; specificity 70%; positive predicative value (PPV) 70%; and negative predictive value (NPV) 70%; by chance, the 95% confidence intervals are the same for each statistic (46-88%).

Table 3 shows the frequencies of individual criteria in the caseload and for the sample, and whether the panel concurred with the automated assessment. Tables 4 and 5 report the specific panel feedback for false-positive and false-negative cases, respectively, with Table 4 including those true-positive cases where the blind assessment was positive for Question 2 ("The therapy is optimised, or the process of seeking optimised treatment is satisfactory").

Table 2. Accuracy of automated queries as assessed against final review by the practice panel

		Final classification by panel	
		Quality suboptimal (+)	Quality optimal (-)
Classification by automated queries	Met one or more criteria (+)	14*	6
	Met none of the criteria (-)	6	14

*Including three cases described as optimal on blind assessment but where practice GPs concurred to criteria on final review; all others initially negative on Question 2 (refer to Appendix)

Table 3. Criteria and practice panel assessments for six-month evaluation period

Criterion	Number (as % of cases) in caseload	Number in sample	Number in sample where panel agreed with automated classification during blind assessment (after final assessment)
1	69 (13.3%)	7	4 (5)
2	79 (15.3%)	6	5 (5) *
3	21 (4.1%)	0	--
4	16 (3.1%)	1	1 (1)
5	39 (7.5%)	6	2 (2)
6	5 (1.0%)	0	--
7	25 (4.8%)	3	1 (3)
8	20 (3.9%)	0	--

*Criteria 1 and 2 co-occurred in two sample cases, one a true-positive and one a false-positive; Criterion 2 also co-occurred with Criterion 5 in a true-positive.

Table 4. Cases where panel initially disagreed with classification by automated queries (false-positives); and final classification after review

Case	Criteria satisfied	Panel comments on Question 2	GP Comments upon viewing criteria satisfied	Final class
1	5: Classified with diabetes mellitus and not on ACEi/ARB at any time during EP	CVR 9%	On dietary management	False-positive
2	5: Classified with diabetes mellitus and not on ACEi/ARB at any time during EP	BP for diabetes CVR 10%; ACEi last prescribed Feb 2007, seems to have "slipped off", list of regular medications	ACEi prescribed in Feb but not on list of medications (ACEi first prescribed in 2005)	False-positive*
3	1: A lapse in AHT of >30 days during the EP or the lapse extends into the EP	CVR 3%	Patient has low CVR and may not need Rx	False-positive
4	1: A lapse in AHT of >30 days during the EP or the lapse extends into the EP	CVR 6%	? Needs BP treatments. CVR 6%	False-positive

Case	Criteria satisfied	Panel comments on Question 2	GP Comments upon viewing criteria satisfied	Final class
	2: A period of >180 days with no BP measurements extending into the EP			
5	1: A lapse in AHT of >30 days during the EP or the lapse extends into the EP	CVR 13%	Not detected. CVR 13%	True-positive
6	5: Classified with diabetes mellitus and not on ACEi/ARB at any time during EP	CVR 15% microalbuminuria; No uric acid recorded; BP not satisfactory	Given ACEi in 2003; only has IGT – misclassified	False-positive
7	7: Classified with renal impairment and on ACEi/ARB and with eGFR < 60mL/min at any time during EP	CVR 8%; Chronic renal failure; No lipids or glucose measurements for four yrs	Agree	True-positive
8	5: Classified with diabetes mellitus and not on ACEi/ARB at any time during EP	CVR 19%; BP too high; Microalbuminuria	On accupril since Dec 2002	False-positive
9	7: Classified with renal impairment and on ACEi/ARB and with eGFR < 60mL/min at any time during EP	CVR 20%; eGFR low; Cr high; BP too high	Agree	True-positive

EP—Evaluation Period; CVR—estimated 5-year cardiovascular risk as assessed by PREDICT,¹⁰⁻¹¹ based on the Framingham risk equations with some adjustments specific to New Zealand; *Negative for Question 3 (refer Appendix); IGT – Impaired glucose tolerance.

Table 5. False-negatives

Case	Panel comments on Question 2	GP comments upon viewing criteria satisfied
1	Microalbuminuria reducing CVR 9%, but needs better BP control	BP too high; On thiazide + gout + uric acid 0.46
2	CVR 7%; Microalbuminuria improving. Poor diabetes control	Poor diabetes control*
3	CVR 15%; BP too high; Medication insufficient; Poor attendance	Poor attendance (late)
4	CVR 22%; BP Rx	Thiazide + history of gout + high uric acid; BP too high; CVR 22%
5	CVR 15%, poor attendance ACEi-cough; Statin – constipation	Poor attender; ACE-cough; statin not taken
6	BP could be lower; ACEi therapy not maximised	ACEi could increase

*On further consideration, practice ambivalent on False Negative / True Negative status of this case

Discussion

This study assessed the use of EMRs to identify cases of relevance for quality improvement efforts in the context of antihypertensive prescribing in general practice. A three-session process of liaison between a clinical panel of a general practice and a group of analysts was able to derive a set of eight explicit criteria and associated database queries to the practice EMRs that were agreed to be indicative of cases that would warrant follow-up for quality improvement. When tested by clinical review on a sample of 40 cases, the criteria were observed to be moderately accurate indicators of cases relevant for follow-up.

Two main uses for this form of reporting for improvement of chronic disease management are evident. The first application is for near-term follow-up on specific patients. This could take a form similar to our study protocol, wherein a practice panel reviews a sample of cases satisfying one or more of the automated criteria based on queries processed on their practice EMRs and there takes a decision to recall the patient, enter a note for next visit, or to accept the status quo.

The second application is to use the audit report (e.g. on a quarterly basis) as a baseline measure against which the effectiveness of any other quality improvement efforts may be tracked. The observed accuracy of the criteria as an indicator of clinical concurrence to suboptimal therapy or process (PPV, NPV, sensitivity and specificity) is only moderate; however, for the review application as per above the accuracy could be acceptable in terms of bringing a rich pool of cases to the attention of the panel for a low cost. That said, false-positives waste time for a review panel, providing impetus to improve reporting methods and/or the quality of the underlying EMRs.

Review of the cases from Tables 4 and 5 reveals that the use of CVR within quality audit criteria may improve accuracy. The practice with which we were working was in the process of running PREDICT CVD/Diabetes over all indicated patients, and thus had CVRs available to provide a convenient input to the criteria assessment process. Several observed False Positives (for cases 1, 3 and 4 in Table 4) had <10% CVR and several False Negatives had $\geq 15\%$ CVR (for cases 3-5 in Table 5).

In an ideal world we could also query the PREDICT CVD/Diabetes management recommendations as part of queries, and also would have access to more coded information on non-prescribing actions (e.g. the 'on dietary management' of Table 4, case 1). One could even envision running the PREDICT CVD/Diabetes algorithms in 'batch' mode to dynamically generate recommendations as part of the quality audit process, however this would only be effective if all required data were already in the EMR.

Other areas for improvement of the criteria performance related to more accurate interpretation of the prescribing record (noting cases 2 and 8 in Table 4, where re-prescription was done, but was missed by the database queries), less porous clinical criteria in specific areas (e.g. cases 1 and 4 in Table 5 around gout, uric acid and thiazides), and consideration of dose maximisation (case 6 in Table 5).

The diabetes/ACEi criterion (Criterion 5) seemed to be particularly vulnerable to the above problems and appears to be the most fruitful for refinement. It should be noted that the entire effort is underpinned by the high quality use of the Practice Management System being exercised by the general practice, where the 40 cases reviewed indicated the records to be almost perfectly fit to purpose (with the Diabetes/IGT confusion in case 6 in Table 4 as the sole exception beyond the prescribing issues noted above).

This study has a number of limitations. First is the use of a single practice, where the coding practices, interests, and biases of a few staff will have influenced the quality of the EMRs and the quality improvement criteria of interest. While the scale is of course small, EMR data in New Zealand general practice is held, in the first instance, at the practice level. Thus, we believe it is useful to investigate how the Practice

Management System can extend the power of those specific clinicians to measure quality and pursue change in the areas that they consider to be of the highest priority. In this regard, we do not see the localised development of the criteria as a limitation, but there is the obvious need to examine the transferability of the process across practices.

A further and significant limitation is the size of the sample drawn. The confidence intervals are large for the aggregate of the criteria and the sample far too small to test individual criteria (indeed, not all criteria were observed in the sample).

The practice population studied has a high average level of cardiovascular risk and renal disease. Renal impairment is a component of CVR but there are separate drivers (i.e. prevention or delay of renal failure) for a practice to look for improvements in blood pressure control and manage co-morbidities such as gout. At the simplest level, however, the problem in persistence of antihypertensives (assessed by Criterion 1) shows a promising pathway for intervention. Quality improvement strategies that improve medication persistence are recognised as a priority area for research by Cochrane Collaboration Reviews on this topic.¹²

The immediate future work programme is to investigate the issues and motivations associated with those patients whose prescribing patterns indicate a low medication possession ratio (MPR)¹³ and from the results of this to design a targeted intervention based on telephone and/or home visit. A serious concern is that, with 40% of caseload observed to be implicated in one or more quality improvement criteria, it is unclear how practices can raise sufficient resources to implement the indicated scale of evidence-based quality improvement programmes.

A further outstanding challenge lies with the technology of querying EMR data. At this stage there are some significant intermediate data structures that need to be built to answer questions as posed by our quality improvement criteria. These include:

- Identification of observations, both local observations such as BP and lab test results, which appear embedded in textual data fields, and which in the former case are sometimes, but not reliably, picked up by the practice management software for coded representation in the EMR.
- Grouping of medications into meaningful therapeutic groups (with consideration of issues such as combination drugs).
- Grouping of problem classification codes into meaningful groups.
- The complexity of temporal queries considering the boundaries of an evaluation period and the order of events (e.g. continuity of ACEi *after* a diabetes diagnosis *during* a specific 6-month period).
- Identification of the duration of a prescription (which is not always aligned to the period as stored in the practice EMR, depending on instructions given by the prescriber).

As such, at present the development of queries by practice managers is impractical and one would need to compromise to ask the questions that are easily formulated rather than exploiting the true potential of the practice EMRs. Improvement of

Practice Management System query tools is required to suit the needs of quality improvement efforts.

Conclusion

EMR data has been shown to provide a basis for moderately reliable automated identification of cases with suboptimal management of blood pressure in the general practice setting as per criteria developed by a clinical panel of the practice. The criteria are suitable either for direct use in quality improvement efforts or for tracking of quality improvement outcomes over time. Further work is needed both to identify the transferability of this finding and to improve tools and methods for EMR querying. The practice involved in the study reported herein is, in the first instance, pursuing a follow-up of the cases where the EMRs indicate gaps in persistence of antihypertensive therapy.

Competing interests: None known.

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Appendix 1

Questionnaire for Practice Panel Case Assessment

Answer the following questions with respect to antihypertensive therapy for this patient for the period from 9 May 2007 to 8 Nov 2007. Tick either Yes or No for the questions.

1. The therapy is free of clinically significant contraindications and interactions. Yes No

If not, describe problem:

2. The therapy is optimized, or the process of seeking optimized treatment is satisfactory. Yes No

If not, describe your concern:

3. The data from the PMS satisfactorily explains the therapy. Yes No

If not, suggest facts missing:
