The Role of Electronic Medical Records in the Identification of Suboptimal Prescribing for Hypertension Management: An Opportunity in Unchanged Therapy

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Abstract

A Participatory Action Research (PAR) approach was taken to identify electronic medical record (EMR) queries for hypertension management quality review in the context of a Pacific-led New Zealand general practice. In each PAR cycle, queries to identify patients with prescribing at variance from evidence-based practice were formulated and run, relevant patient notes were retrieved, and a quality audit of the medication decisions was carried out by a medical practitioner working in the practice. 764 enrolled and funded patients with current antihypertensive prescriptions were queried regarding adherence to national treatment guidelines. Queries based on drug classes indicated by specific comorbidities (e.g. hypertension complicated by diabetes) retrieved few cases, and with almost none having a compelling case for change in therapy upon review. A query on unchanged therapy while cardiovascular risk (CVR) and systolic blood pressure remained high, however, yielded 30 cases for review, and 10 of these were deemed as warranting further investigation. We conclude that a promising area for the use of EMR queries to improve long-term condition management is in identification of patients with persistently high risk of adverse outcomes and concurrent unchanged therapy during successive general practice visits.

Keywords: clinical quality improvement; computer-based patient records; electronic prescribing; hypertension management.

1 Introduction

Hypertension is a significant health burden due to its strong association with CVR and chronic renal disease (Kearney et al., 2005). Hypertension has a high prevalence, with 73 million (34%) individuals over 20 diagnosed with the condition in the US in 2005

(Rosamond et al., 2008). In terms of cardiovascular disease (CVD), an individual's risk doubles for each rise of 20/10mmHg, beginning at 115/75mmHg (Chobanian et al., 2003b).

Research has shown impressive efficacy rates of blood pressure (BP) lowering medications for reduction in cardiovascular risk and renal disease (Strippoli et al., 2005, Law et al., 2009). Although these drugs are effective when taken as directed, even when diagnosed and treated, patients frequently fail to achieve BP control to recommended levels (Chobanian et al., 2003a, National Committee for Quality Assurance, 2009). Part of the problem is certainly poor adherence; in fact, it is thought that poor adherence to antihypertensive medication contributes to inadequate BP control in more than two-thirds of hypertensive patients (Miller et al., 1997). Beyond adherence per se, however, are there other similarly large opportunities for improved BP control in better alignment of treatment decisions to evidence based best practice?

New Zealand is recognised in the top tier of nations with respect to information technology use in General Practice medicine (Schoen et al., 2009). Our research indicates that the electronic medical records (EMRs) held in General Practice systems are reasonably sensitive and specific for detecting patients whose hypertension management is suboptimal (Warren et al., 2008). We find that there is a large cohort of high-needs patients in New Zealand with poor adherence identifiable through General Practice EMRs (Mabotuwana et al., 2009a), and that poor adherence observable through these EMRs is associated with significantly reduced odds of BP control (Mabotuwana et al., 2009b).

The present study focuses on identifying queries to the General Practice EMR that, rather than being related to adherence issues, can function to identify other substantial case cohorts with specific opportunities to improve their hypertension management. We take a particular interest in management of hypertension for the Pacific population. The Pacific population in New Zealand (NZ) has grown dramatically since World War II, from 2,200 people in 1945 to 266,000 in 2006, with 66% living in the Auckland metropolitan area and Samoan being the largest Pacific ethnic group (Statistics New Zealand and Ministry for

Pacific Island Affairs, 2010). This Pacific population has a greater cardiovascular disease (CVD) risk than European New Zealanders (Sundborn et al., 2008).

2 Methodology

Data and Algorithms – EMRs of 5454 enrolled and funded patients of a Pacific-led New Zealand metropolitan general practice, having largely Pacific caseload, were extracted under protocol NTX/09/100/EXP of the Northern X Regional Ethics Committee. Data extraction included prescriptions, diagnosis codes, laboratory test results, BPs and CVRs (the practice made extensive use of PREDICT (Riddell et al.), which provides this value into the EMR) up to 15 May 2009. 764 patients had at least one antihypertensive prescription since January 1 2008. Medication Possession Ratio (MPR, percent of days covered by a prescription – a supply-based measure of adherence) was computed from the prescriptions in the EMRs through methods we have previously documented (Mabotuwana et al., 2009b, Mabotuwana and Warren, 2010). In brief, MPR and other EMR statistics were computed on data extracted from Medtech32 using its interactive reporting function and then imported into a Microsoft SQL Server database for further processing with a system of stored procedures and supporting data files (including lists of drug names and diagnosis codes) called the ChronoMedIt framework (Mabotuwana and Warren, 2010). Additional processing was conducted using study-specific SQL (structured query language) queries formulated as part of the procedure.

Procedure – Participatory Action Research (PAR) methodology has been endorsed and promoted internationally as a format for primary health care research, particularly in communities with high needs (Macaulay et al., 1999). Key elements of PAR were considered: (a) the use of an iterative plan, act, observe, reflect cycle; and (b) collaborative, collective and self-reflective enquiry (Baum et al., 2006, Kemmis and McTaggart, 1988). These elements were adapted for the development of evidence-based EMR queries, yielding a three-stage cycle (Figure 1). Firstly (A, Figure 1), hypertension prescribing quality improvement opportunities were considered in light of relevant guidelines and research literature, with reflection on what is known about the local cases (especially after the first cycle) and consideration of what criteria are amenable to automated assessment from the EMR. This led to an hypothesized opportunity to identify discrepancies between actual and evidence-based best practice in terms of specific criteria. Secondly (B, Figure 1), one or more EMR queries were formulated and run to identify cases at variance to the criteria. Finally (C, Figure 1), patient notes were retrieved, and a quality audit of the medication decisions in the patient notes carried out by a medical staff member working in the practice. The findings of this audit were considered in depth to assess the relevance of the query to actual practice and to inform the next PAR cycle. We executed PAR cycles over the period November 2008 to February 2009.
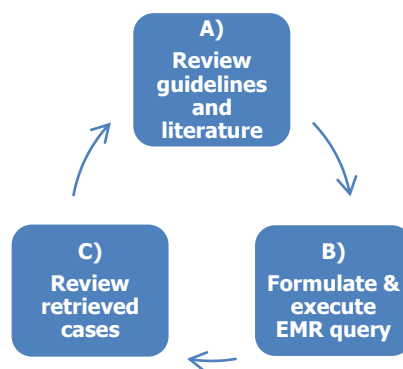

Figure 1: PAR cycle for EMR query development

Due to the iterative nature of the PAR cycles, we report the details of our specific queries, along with the results of those queries, in the Results section below.

3 Results

A total of four queries were formulated, taking the NZ Guidelines Group *Cardiovascular Guidelines Handbook* (New Zealand Guidelines Group, 2009) as our primary guide, but supplementing with research literature around specific known deficiencies in hypertension management. Key concepts from the guidelines concern the indications for prescribing specific antihypertensive agents including angiotensin converting enzyme inhibitors (ACEi), angiotensin II receptor blockers (ARBs), beta-blockers and thiazide diuretics, as well as key comorbidities (other conditions that complicate treatment) of diabetes, previous myocardial infarction (MI, i.e. heart attack) and microalbuminuria (small amounts of protein in the urine).

Query 1. ACEi/ARB in diabetes – Our first query was founded on the recommendation of ACEi (or ARB if ACEi not tolerated) as preferred therapy in diabetes, and aggressive BP control if microalbuminuria is also present. Our query identified patients whose EMR data indicated:

- Diagnosis with diabetes with neither ACEi nor ARB (MPR=0, i.e. no ACEi or ARB prescription records from 1 January 2008 to 15 May 2009)
  and
- Diagnosis with hypertension or either:
  - A diagnosis of microalbuminuria and at least three systolic BPs ≥ 135mmHg, or
  - At least three systolic BPs ≥ 140mmHg
  and
- CVR≥15% recorded or diagnosis with microalbuminurea.

Figure 2 provides a breakdown of the results from this query; of the six cases retrieved, none presented a compelling case for change of therapy at the time of review.

Query 2. Beta-blocker and ACEi post-MI – Our second query was based on the recommendation to treat all people post-MI with beta-blocker and to consider adding an ACEi regardless of BP, especially if there is any significant left ventricular impairment. Lack of adherence to this recommendation had been observed for a US cohort, where only 64% had any beta-blocker and 52% any ACEi/ARB in the first three months after hospital

discharge for acute coronary syndrome (Lee et al., 2008). Our EMR query required:

- Patients with recorded MI who have not received both a beta-blocker and an ACEi/ARB (i.e., MPR=0 for one, the other or both).
- Exclusion of patients with recorded diagnoses of asthma, heart block, peripheral vascular disease, sinus bradycardia, acute decompensated heart failure, hypotension, end stage renal failure or primary renal artery stenosis.

This query retrieved only two cases (see figure 3); clinicians characterised these as logistical issues in GP / cardiologist communications, rather than suboptimal prescribing patterns by the GPs per se.

The modest yield from the first two queries suggested that there were few identifiable opportunities for improvement where patients were indicated towards certain therapies due to comorbidities, such as diabetes and post-MI. This motivated a third query to investigate prescribing of first-line antihypertensives in patients not otherwise indicated towards therapies due to comorbidities.

Query 3. Thiazides as first-line antihypertensive – This query looked for those who, in the absence of other indicators, did not have a thiazide or thiazide-like diuretic as a first line antihypertensive agent at the time of a hypertension diagnosis. This query was motivated by calls internationally (Sweileh, 2009) and locally (van der Merwe, 2008) to keep thiazides in the therapeutic mix when treating hypertension. The query retrieved patients whose EMR data indicated:

- A hypertension diagnosis since 1 Jan 2007 (and none earlier than that).
- No prescription of a thiazide/thiazide-like diuretic prior to or 90 days following their hypertension diagnosis
- A CVR≥15% recorded or a diagnosis of microalbuminurea
- Never diagnosed with diabetes
- Never diagnosed with gout

Figure 4 shows the breakdown of the results of this query; two of the 13 cases retrieved were deemed in need of follow-up action upon clinical review.

The results of the first three queries led us to consider backing off to a more fundamental concept: 'clinical inertia' (Phillips et al., 2001). Rather than looking for the absence of a particular therapeutic agent, we would look for cases of poor control where nothing further had been tried.

Query 4. Non-intensification of antihypertensive therapy – Our fourth and final query identified patients who were receiving the same set of antihypertensive medications and at the same dose in the face of consistently high BP readings and high CVR. The criteria were:

- Risk: recorded CVR ≥15%
- Identical antihypertensive prescription: same set and dose(s) of antihypertensives prescribed on two occasions, with the second coinciding to end of supply from the first (90 days ± 2 weeks)

- Sustained high BP: identical antihypertensive prescription subsequent to the recording of 3 high BP readings (above 'target' – see point below) and no BP not-high in the prior 200 days
- Target: for diabetic patients a systolic BP of ≥130mmHg was considered above target; for non-diabetics ≥140mmHg was considered above target
- No obvious adherence problem: have MPR ≥80% (for at least some antihypertensive) in the 6 month period prior to their second visit with identical antihypertensive prescription.

This query retrieved 30 cases, 10 of which were deemed in need of follow-up upon clinical review (see figure 5).

4 Discussion

We undertook an iterative programme of EMR query development with a Pacific-led general practice to find ways to identify automatically patients whose antihypertensive prescribing was at variance with evidence-based guidelines. Our initial two queries focused on drug/co-morbidity combinations (ACEi/ARB in diabetes; beta-blocker and ACEi/ARB post-MI), and a third on greater use of a drug (thiazide diuretic). These queries yielded few cases: 21 retrieved in total, with two warranting further investigation, from 764 patients with active antihypertensive therapy. A fourth query targeting unchanged therapy in light of established risk and sustained high BP had a much better yield: 30 retrieved with 10 warranting further investigation.

The low yield from our first three queries should not be taken as indicating that there is a lack of opportunity for better use of ACEi/ARB, beta-blocker and thiazide diuretics in management of hypertension and co-morbidities. It does, however, indicate two barriers to better use. First, review of Figures 2-4 reveals factors inhibiting a simple progression to the maximal guideline-indicated therapy, including patients who are stable on therapy they have had for some time, concern that the polypharmacy effect of adding another agent may outweigh the benefits, and logistic issues of a patient seeing different doctors. Second, there is the challenge of case identification. To identify patients via the EMR, the appropriate data must be present, such as BPs, diagnoses (and/or in some cases laboratory test results) and, ideally, CVRs. The practice we worked with has a dedication to CVD management for its largely Pacific Island community of patients, and with this a dedication to use of PREDICT, which provides CVRs, and may account for the low number of cases at variance from guidelines. Nonetheless, we have probably erred on the conservative side in query formulation and thus have missed cases because the data for inclusion is not encoded in the EMR.
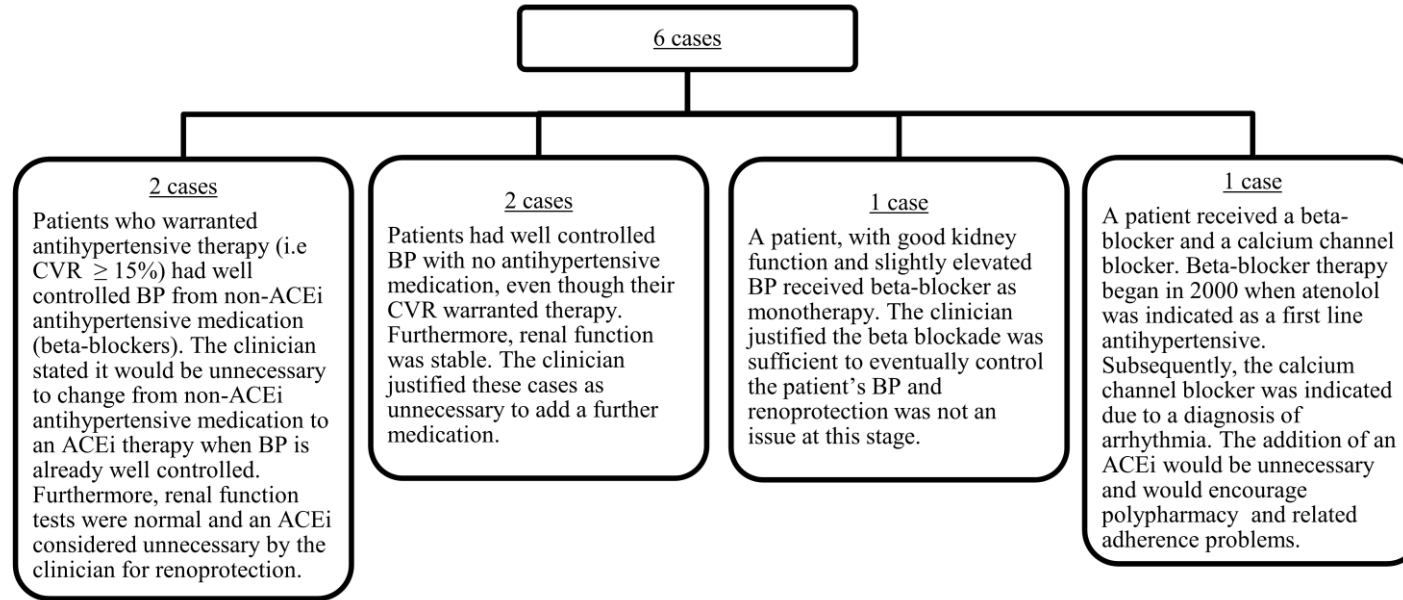
6 cases

2 cases

Patients who warranted antihypertensive therapy (i.e CVR ≥ 15%) had well controlled BP from non-ACEi antihypertensive medication (beta-blockers). The clinician stated it would be unnecessary to change from non-ACEi antihypertensive medication to an ACEi therapy when BP is already well controlled. Furthermore, renal function tests were normal and an ACEi considered unnecessary by the clinician for renoprotection.

2 cases

Patients had well controlled BP with no antihypertensive medication, even though their CVR warranted therapy. Furthermore, renal function was stable. The clinician justified these cases as unnecessary to add a further medication.

1 case

A patient, with good kidney function and slightly elevated BP received beta-blocker as monotherapy. The clinician justified the beta blockade was sufficient to eventually control the patient's BP and renoprotection was not an issue at this stage.

1 case

A patient received a beta-blocker and a calcium channel blocker. Beta-blocker therapy began in 2000 when atenolol was indicated as a first line antihypertensive. Subsequently, the calcium channel blocker was indicated due to a diagnosis of arrhythmia. The addition of an ACEi would be unnecessary and would encourage polypharmacy and related adherence problems.

Figure 2: Results of ACEi/ARB in diabetes query

2 cases

1 case

Cardiologist report had no mention of an ACEi.

1 case

Cardiologist prescribed an ACEi, however, this was not followed through in the GP's antihypertensive therapy.
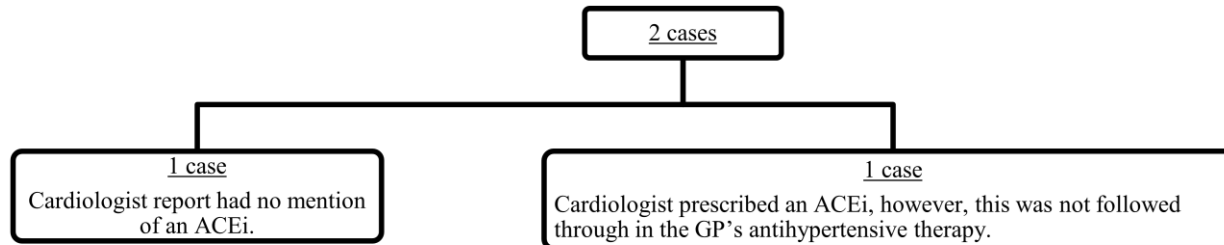
Figure 3: Result of beta-blocker and ACEi post-MI query

13 cases

9 cases

Patients received antihypertensive therapy in the form of non-thiazide/thiazide-like diuretic medication. All these patients had well controlled blood pressure and the clinician felt it would be unnecessary to add a thiazide/thiazide-like diuretic to the treatment regime. When questioned why there was no initial prescription at the time of a hypertension diagnosis, the main theme presented by the clinicians was which first-line antihypertensive class was indicated at the time of diagnosis or which antihypertensive the clinician felt most comfortable with.

1 case

Patient initially received a non-thiazide/thiazide-like diuretic, however is now on combined antihypertensive therapy with a thiazide/thiazide-like diuretic. Query picked up patient during the initial interval.

2 cases

Clinician accepted that in these cases further investigation regarding the potential addition of thiazide/thiazide-like diuretics was warranted These patients had BP readings above target and potentially required intensification.

1 case

Patient is currently awaiting review from a cardiologist.

Figure 4: Results of query for lack of thiazide/thiazide-like diuretic as first-line therapy in absence of diabetes or gout.
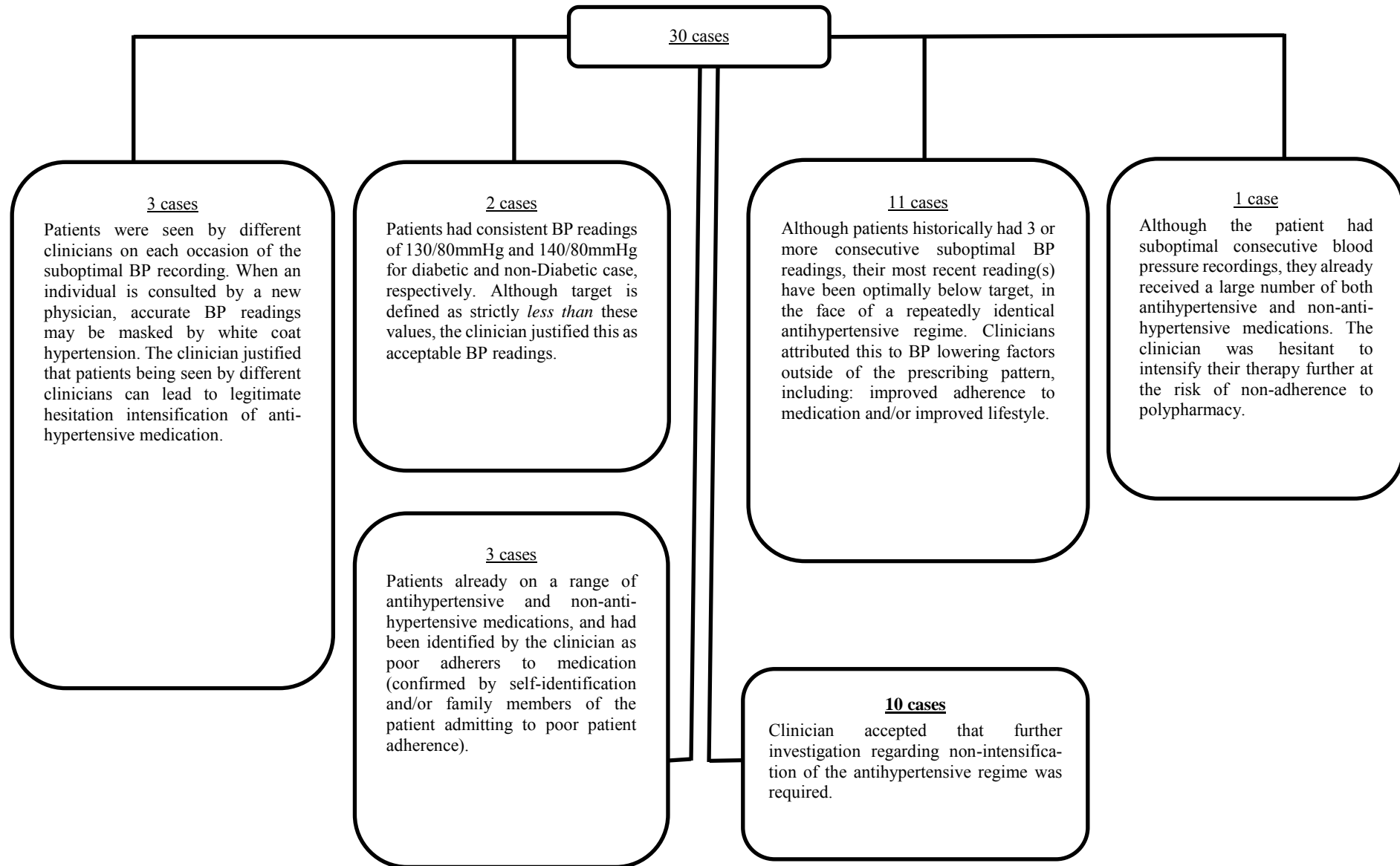
Figure 5: Results of query for unchanged therapy in light of persistently high BP.

The fourth query reveals an opportunity in unchanged therapy. 'Clinical inertia' has been examined in some depth in the context of diabetes, with indications that it is a major problem (Ziemer et al., 2005) but may be reduced with appropriate computerized alerts (Ziemer et al., 2006). Schmittdiel et al. (2008) found that lack of therapy intensification was a more common problem than lack of adherence for reaching risk targets in diabetes patients. This is at variance with our findings where adherence problems to long-term medications appear to be present in 50% of cases (Mabotuwana et al., 2009a). That said, our query was highly conservative in that it required multiple BPs and a CVR to be present in the EMR; many cases of unchanged therapy would be missed by this query due to absence of these data. Moreover, we only looked at exactly identical drugs and doses on two visits spaced close to 90 days apart; there are many more prescribing patterns that could be classed as inertia or lack of intensification.

Caution is warranted around the interaction of adherence and unchanged therapy. Heisler et al. (2008) note a lack of influence of adherence on dose intensification which they point out as worrying – a patient suddenly moving into compliance could suffer hypotension. Particularly with the elderly, falls risk must also be considered as a reason for moderation in antihypertensive treatment. Review of Figure 5 shows known poor adherence as one of the reasons for unchanged therapy in our cohort – there would be further cases of unknown poor adherence. Nonetheless, the unchanged therapy cohort represents an area of opportunity to manage down patient CVR within the scope of normal general practice activities.

General practice EMRs provide a rich resource to target quality improvement in treatment of long-term conditions, including hypertension. Automatic case identification from the EMR, however, is an area still in need of further study to assess its sensitivity, specificity and overall value to effectiveness of healthcare delivery. Searching out patients with unchanged antihypertensive therapy in the face of significant risk and sustained high blood pressure is one promising direction for further development and evaluation. Such queries are different in technical form in terms of looking for absence of change as compared to simply looking for the co-occurrence of the presence of conditions or actions as is done for a drug-drug or drug-problem interaction. We are some way from having a visual query builder or other easy tool for end users to explore unchanged therapy scenarios on their caseloads.

Decision support of the type illustrated herein is dependent on EMR data that is structured for automated interpretation. In environments such as New Zealand (or Australian) general practice medicine, electronic prescribing is virtually universal and forms the foundation to identify unchanged therapy and medication possession ratios consistent with medication adherence. The other requirement is an outcome measure. In the case of blood pressures their recording into the EMR is potentially ad hoc – the software supports their entry as structured observations, but they may also simply be entered as text in the practice notes. Fortunately, blood pressures are relatively easy to detect in an automated scan of the notes. Increasing use of devices that interoperate with the EMR to log blood pressures automatically (as home monitoring devices, or in the practice), have the potential to make the tracking of outcome more reliable. Our case was further facilitated by the use of CVR computations that interoperate with the EMR system, providing additional support that these high blood pressures were indeed important to manage down.

We restricted our analysis to blood pressure management (which is, in and of itself, a huge area of opportunity). The work should extend readily for related cardiovascular risk factors around management of cholesterol and blood sugar, where outcome measures are typically tracked routinely and would be expected to be recorded as structured observations (the relevant laboratory tests for these conditions are automatically transmitted to the general practice system in New Zealand). In theory, the approach may extend to other long-term conditions such as in the mental health domain, but would be dependent on regular tracking of outcomes (e.g. as a PHQ-9 depression score (Spitzer et al., 1999)). It is worth noting that a further and related decision support opportunity is for systems to prompt for the requisite outcome measures when they are absent.

5 Conclusions

A query on unchanged therapy while cardiovascular risk (CVR) and systolic blood pressure remained high yielded 30 cases for review, 10 of which were deemed as warranting further investigation. In contrast, EMR queries based narrowly on drug class or comorbidity criteria yielded small numbers of cases and mostly patients with reasons for maintaining present therapy that are at least as compelling as the reasons for change. On this basis we see queries for unchanged therapy in the presence of concurrent high risk of adverse event (such as the CVD events like heart attacks, as well as kidney damage, in the case of hypertension) as a promising direction for use of the EMR to guide quality improvement efforts with respect to prescribing to manage long-term conditions.

6 Acknowledgments

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