Diabetes, kidney disease and cardiovascular disease patients. Assessing care of complex patients using outpatient testing and visits: additional metrics by which to evaluate health care system functioning

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Abstract

Background. The triad of cardiovascular disease (CVD), chronic kidney disease (CKD) and diabetes mellitus (DM) share many fundamental disease pathways. Patients with these conditions contribute excessively to health care costs. Opportunities for system redesign require metrics by which to evaluate the impact.

Methods. Using a provincial comprehensive set of administrative billing databases (outpatient visits, laboratory tests, pharmacy and hospital inpatient services), we itemized the prevalence of each and combination of conditions, resource utilization associated with each condition and combinations, using ICD 9-10 billing codes and standard definitions. Three consecutive years (2003–2005) were used to establish stability of findings.

Results. CKD, CVD and DM diagnoses are found in 422,124 persons within a province of 4.3 million individuals (10%); 1.7% had all three conditions. The median age of each cohort varied significantly between those with multiple conditions (67–79 years) versus those with single condition (56–72 years). The median number of physician visits was 26 per patient year. Duplicate testing accounted for expenditures of $3 million/annum; 7.55% of patients accounted for 34.4% of duplicate tests. Those with DM or CKD had similar use of medications, physician visits and hospital days. Those with all conditions (CVD–CKD–DM) had a median of 6 in-hospital days/year. A significant proportion were not on ACE/ARB or statin medications (30 and 45%, respectively).

Conclusion. Patients with chronic, complex conditions consume a large number of outpatient and inpatient resources. Documenting these allows identification of a set of metrics by which to design and measure health care system redesign initiatives. Potential targets to benchmark in designing more effective systems have been identified.

Introduction

There is increasing recognition that patients with chronic kidney disease (CKD) have multiple comorbidities. In particular, over 90% of patients with CKD receiving Medicare in the United States also have diagnosis of hypertension or diabetes (DM) or both [1]. There are well-established links between CKD and cardiovascular disease (CVD), and diabetes, and that any combination of these diseases leads to less favourable health outcomes [2,3].

Patients with more than three chronic conditions have higher health care resource utilization, and consistently it has been shown that while those with CKD make up <10% of the population, resource utilization in this complex group is often >20% of total health care expenditures [1]. The usual resource utilization metric is inpatient hospital days and acute care admissions. However, the extent of outpatient and monitoring resources consumed by those patients, with any combination of DM, CVD and CKD, remains poorly described. Previously the poor outcomes of these patients have been attributed to the high comorbidity alone. It is possible, however, that the co-existence of multiple conditions leads to fragmented care that may contribute to less favourable outcomes in this patient group.

Data related to processes of care in this complex group are not well documented in the literature. Thus, by describing a set of process measures as surrogates for care practices, we may identify information useful in system redesign, supporting integration of care and reducing unnecessary redundancies. This information would inform clinicians, and policy makers would have a reproducible set
of metrics by which to evaluate current health care system functioning, and by which to evaluate changes in health care system delivery models.

The purpose of this study is to describe a series of resource utilization parameters of a set of complex patients in the province of British Columbia, defined as having any combination of CVD, CKD and/or DM. Using administrative databases, including billing data, hospital discharge data and comprehensive pharmacy data, we describe the number and type of physician visits, the number of duplicate laboratory tests, as well as acute care-related hospitalizations, so as to begin quantify the burden of resource utilization, including redundancies, and thus the potential for health care system redesign and metrics by which to measure success.

Methods

Creation of patient registry/cohorts

Data were gathered from the British Columbia Ministry of Health databases in an aggregate, anonymized fashion for the calendar years of 2003, 2004 and 2005. The use of 3 years’ worth of data was to evaluate the consistency of the data over a recent time period, to increase the confidence in the findings.

Physicians bill the Medical Service Plan (MSP) in British Columbia for each patient encounter using a billing code and an ICD-9 diagnosis code. Hospital discharge data are coded using either ICD-9 or ICD-10 codes and procedures codes. These diagnostic codes were used to identify patients who had CKD, CVD or diabetes mellitus (DM) as per specific case definitions as described below.

Case definitions for establishing the cohort

Chronic kidney disease. Patients were included as having CKD, diabetes or CVD if they had one hospitalization or two medical visits in a 365-day period with diagnosis codes specific to each disease from 1 April 1992 to 31 March 2006. The CKD data were censored for patients who were on a renal replacement modality (i.e. dialysis) or had a functioning renal transplant; thus, only those not on renal replacement therapy were included in this cohort.

Diabetes. Patients were included as having DM if they had billing code data for DM by physicians specifically, but also if they had filled two or more prescriptions for insulin, oral hypoglycaemics or blood glucose testing strips. Gestational diabetes was excluded from the dataset by excluding all records 6 months prior to and 3 months after a gestational event.

Cardiovascular disease. Patients were originally included in the CVD group if they met the case definitions for hypertension, congestive heart failure, acute myocardial infarction or angina. A more restricted CVD cohort definition was created excluding hypertension so as to exclude that group of patients with hypertension alone who may be at risk for CVD but may not be considered by all to have CVD. We report here only the results of the more restricted definition.

Calendar year cohorts were created for 2003–2005 by including any patient who met the case definition for any of the diseases prior to the end of each year and who were alive and present in the province at the start of the calendar year. Analyses were restricted to patients aged 20–94 years.

Key variables of interest

The key variables of interest included number of patient visits to general practitioners (GPs) and specialists; the number of duplicate laboratory tests (defined below); the medication usage as prescribed by best current practice and published guidelines; and the number of acute care hospitalizations and rehabilitation days.

Outpatient physician visits

For each disease group, MSP billing data were analysed to generate the mean number of both specialist and general practitioner visits per patient in each of the years 2003–2005. Hospital discharge abstract data were used to generate the mean number of hospital days per patient year over the same time period. Costs for these hospitalizations were calculated using Resource Intensity Weighting Methods [5] available from the Canadian Institute for Health Information.

Laboratory tests

Of these patients with the above three diseases or combinations of them, MSP billing data were obtained from the total number of selected laboratory tests billed for during each of the calendar years 2003–2005. A selected group of tests pertaining to the conditions were selected a priori (lipid profile, haemoglobin A1C, creatinine, urea, urine albumin:creatinine ratio, CBC, iron profiles, fasting glucose and electrolytes) and were evaluated. The criteria for selection included those commonly advocated for monitoring in the BC-published guidelines and those pertaining to any or all of the three conditions. Using dates of test billing, duplicate tests were defined as those tests performed/billed in the same patient within 30 days. Costs for duplicate tests were obtained using MSP billing codes from 2005, and were then summed. The data are presented in aggregate in all cases. No specific laboratory values were available.

Medication data

Using anonymized data, individual patient records within each of the cohort groups were linked with the British Columbia PharmaNet data, which contain prescription data for the entire population. Medications of interest were those considered the standard of care according to best practices and published guidelines for many of these patients. The medications of interest for the purposes of this analysis were angiotensin-converting enzyme inhibitors (ACE-i) or angiotensin receptor blockers (ARBs), HMG-CoA reductase inhibitors (statins) or beta-blockers. We determined the percentage of these patients on selected medications by cohort grouping.

Acute hospital days

A count and cost of acute hospital days were obtained from hospital discharge data accrued at the Ministry of Health and include all acute and rehabilitation days accrued to the individuals identified in the sample. Note that emergency room visits are not included in this analysis.

A sample of 3 years was selected from 2003 to 2005 to ensure consistency of results over time and to reflect a period during which GPs had access to a set of guidelines pertaining to these three conditions, as well as increasing awareness of the need for integrated care.

Results

British Columbia is a province with a total population of about 4.3 million [6]. In the calendar year of 2005, British Columbia had a total of 844 842 patients identified as having one or a combination of diagnoses including CKD, DM or CVD according to our most liberal case definitions of CVD (which included hypertension alone as a diagnostic criteria for CVD). For the purposes of this analysis, however, we used the more restricted CVD definition (excluding those with hypertension alone), thus creating an analytic cohort of 422 214 persons in 2005 (Figure 1).

Note that the proportion of patients with all three conditions is 1.7%, and those with CKD and DM or CVD is 2.7%; half of the cohort has either CVD or DM: two conditions that place people at risk for CKD. Table 1 describes the demographics of the various cohorts by disease category. Note that those with CKD alone tend to be female and that those with multiple conditions tend to be older.

GP and specialist visits (per year)

Figure 2 demonstrates the mean and median number of General Practitioner’s visits that patients in these groups
Table 1. Cohort demographics by category (source: MSP Billing Data)

<table>
<thead>
<tr>
<th>Year</th>
<th>CKD</th>
<th>CAD</th>
<th>DM</th>
<th>CAD + CKD</th>
<th>DM + CKD</th>
<th>DM + CAD</th>
<th>CKD + CAD + DM</th>
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<td>2003</td>
<td>12 117</td>
<td>137 686</td>
<td>170 037</td>
<td>4609</td>
<td>3237</td>
<td>44 333</td>
<td>3417</td>
</tr>
<tr>
<td>2004</td>
<td>13 966</td>
<td>140 671</td>
<td>182 691</td>
<td>5443</td>
<td>3946</td>
<td>48 243</td>
<td>4183</td>
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<tr>
<td>2005</td>
<td>15 748</td>
<td>143 176</td>
<td>195 216</td>
<td>6151</td>
<td>4862</td>
<td>51 997</td>
<td>5064</td>
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</table>

Proportion female

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<th>2004</th>
<th>2005</th>
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<tbody>
<tr>
<td>2003</td>
<td>52.9%</td>
<td>53.3%</td>
<td>53.5%</td>
</tr>
<tr>
<td>2004</td>
<td>45.6%</td>
<td>45.6%</td>
<td>45.4%</td>
</tr>
<tr>
<td>2005</td>
<td>49.2%</td>
<td>49.4%</td>
<td>49.6%</td>
</tr>
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</table>

Mean age

<table>
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</tr>
<tr>
<td>2005</td>
<td>70</td>
<td>70</td>
<td>71</td>
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</table>

Median age

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<th>2004</th>
<th>2005</th>
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<tbody>
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</tr>
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<td>2004</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>2005</td>
<td>73</td>
<td>72</td>
<td>74</td>
</tr>
</tbody>
</table>

Fig. 1. CKD, CVD and DM patients in British Columbia, 2005 (source: MSP Billing Data).

Fig. 2. Mean GP visits per patient year by group, 2003–2005 (source: MSP Billing Data).

had over the calendar years 2003–2005. Patients with the triad of CKD–CVD–DM had a median of 18 GP visits per year.

Specialist’s visits for this group are described in Figure 3; note that the median visits per patient to any specialist group is eight times per year.

Cumulatively, the median MD visit per year for this cohort is 26 visits. These results were consistent over each of the calendar years sampled and differed by number of conditions present.

Duplicate lab testing

Table 2 shows the proportion of patients in each disease group and the percentage of duplicate tests in each group for 2005. Note that patients with CKD (either in isolation or in combination with one or more of CVD and DM) comprised only 7.5% of these patients, but 34.4% of the duplicate tests ordered. Table 3 shows these data broken down by individual-specific duplicate laboratory test selected for this analysis and their attendant costs. In 2005, there were a total of over 747 000 duplicate laboratory tests done costing almost three million dollars. Haematology profiles alone accounted for about 1.6 million of these dollars. Of note, two tests for which no clinical justification
Table 3. Duplicate laboratory test by type and attendant costs (within 30-day period) (source: MSP Billing Data)

<table>
<thead>
<tr>
<th>Lab text</th>
<th>Number</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematology profile</td>
<td>126,436</td>
<td>$1,588,392</td>
</tr>
<tr>
<td>Haemoglobin (A1C)</td>
<td>10,208</td>
<td>$145,070</td>
</tr>
<tr>
<td>Ferritin (serum)</td>
<td>4,670</td>
<td>$116,423</td>
</tr>
<tr>
<td>Creatinine (serum/plasma)</td>
<td>107,993</td>
<td>$112,502</td>
</tr>
<tr>
<td>Potassium (serum/plasma)</td>
<td>93,177</td>
<td>$86,562</td>
</tr>
<tr>
<td>Urinalysis (macroscopic)</td>
<td>24,808</td>
<td>$94,938</td>
</tr>
<tr>
<td>Sodium (serum/plasma)</td>
<td>83,177</td>
<td>$86,562</td>
</tr>
<tr>
<td>Microalbumin</td>
<td>4,322</td>
<td>$85,098</td>
</tr>
<tr>
<td>Glucose semiquantitative</td>
<td>22,466</td>
<td>$74,816</td>
</tr>
<tr>
<td>Urea (serum/plasma)</td>
<td>61,055</td>
<td>$63,837</td>
</tr>
<tr>
<td>Total duplicate tests</td>
<td>747,286</td>
<td>$2,969,085</td>
</tr>
</tbody>
</table>

Use of CVD protective medications

Figures 4–6 show these groups of patients that are prescribed ACE inhibitors/ARB, HMG CoA reductase inhibitors (statins) or beta blockers by the patient group in 2005. As depicted, the X axis from right to left describes the cohorts with a progressively increasing cardiovascular risk profile (defined as higher number of comorbidities for repetition within 30 days exists, haemoglobin A1Cs and ferritin were performed over 10,000 times and 4000 times, respectively, for an annual cost approximating $250,000.

CVD, CKD and DM): note that in the highest risk groups, <70% are on ACEi/ARB medications.

Hospitalization days

Figure 7 shows the cohort by disease category groupings with respect to median and mean hospital days. Those with CKD and any combination of DM or CVD spent a median 6 days in acute or rehab inpatient units per year. Table 4 describes the total costs of hospital days for this cohort, using resource intensity weights, individuals with any CKD, who comprise 7.5% of this cohort, accounted for a disproportionate 18% of the total costs of hospital days or $189 million of hospital costs in 1 year.
Discussion

We report here a comprehensive, quantitative description of both outpatient and inpatient resource utilization in all patients who have been billed by a physician for diagnoses of CVD, CKD and/or DM in the province of British Columbia, Canada. We have specifically excluded dialysis and transplant patients in the CKD group. This is the first time to our knowledge that an administrative dataset has been used to identify this specific group of patients with respect to targeted questions related to comprehensive resource utilization, which includes both outpatient and inpatient data. These data collected within a universal health care system, with a sole payer (government), assure a complete data capture of all resources used by these individuals. The government system captures all billed tests, irrespective of source of funding (provincial, federal government). Thus, this does represent a robust analysis of a complete population.

Of note over the 3-year period examined, there has been substantial increase in the populations of interest. This is in keeping with epidemiological data describing the increased incidence of diabetes, CVD and CKD. Note that the numbers of CKD patients are large and represent those identified by their primary care physicians as having CKD. Moreover, there is a disproportional increase in CKD over the 3-year time period (30% increase in CKD diagnoses versus 15% increase in DM and 4% increase in CVD). This is likely attributable to the introduction of eGFR reporting in October 2003, with dissemination of provincial guidelines at the same time. Thus, with increasing awareness and education, the diagnosis of CKD was more likely over time. We would contend that this is likely an ‘increased recognition’ bias driving the disproportionate rise in CKD rather than a true increase in incidence.

The analysis describes extensive resource utilization ascribed to this cohort. While previous data on dialysis or transplant patients have reported similar disproportional use of resources by those populations, most reports on CVD and DM cohorts describe excess inpatient hospital utilization. Uniquely, we describe an intensive outpatient resource utilization of these complex patient groups. There are a large number of both specialist and primary care visits (26 per year). However, more importantly, these patients undergo a large number of duplicate laboratory testing. While there are various justifiable reasons for duplicate testing within a 30 day period, we did identify two tests with no physiological justification (HbA1C and ferritin) summing more than $250 000 per annum. Irrespective of this apparent intensive monitoring, a substantial portion of patients at high risk for cardiovascular events are not being prescribed cardioprotective medications that may be considered the standard of care for that high-risk group. In addition to the outpatient resources, the cohort consumes a significant number of hospital days per year (median 6, mean 12). Concomitant with the increase in number of patients, the total costs of care rose. This again underscores the importance of attention to this cohort of complex patients: in the presence of increasing growth, it is invaluable to understand the drivers of increasing costs.

Duplicate laboratory testing

We chose to evaluate only those tests that are part of usual monitoring of these cohorts to examine the frequency of duplicate testing. We describe that $3 million dollars is attributed to duplicate testing of a small number of common tests in this selected, though substantive, cohort. Thus, this likely represents a conservative estimate of the costs of duplicate testing and underestimates the total laboratory testing costs. While there may be clinically justifiable reasons for repeat testing (such as potassium and creatinine after changes in medications, or haemoglobin changes during a suspected bleed or initiation of therapies), it is possible that at least some of the repeat testing may be due to unavailability of results to the various, numerous physicians seen by these patients and dis-coordination of test ordering between different physicians. We hypothesize that tests are re-ordered due to lack of availability to different physicians, all caring for the same patient. This hypothesis is supported in part by the large number of visits of each patient to different physicians over the year, which we have tabulated. Unfortunately, due to privacy issues, we were not able to determine which specific lab results were available to which physicians, so we were unable to test that hypothesis. However, we were able to discern that at least 25% of the duplicate tests were ordered by different MDs. Furthermore, given that two specific tests (HBA1C and ferritin) have no physiological basis for repetition within a 30-day period, we would submit that the lack of availability at point of care is the most likely explanation, and thus a critical driving factor in duplication of laboratory tests. The advantage of our analysis is that we can have defined duplicated tests, and not judge them to be necessary or not, although we have pointed out which tests could be construed as truly unnecessarily duplicative.

There are several published studies that have attempted to address the problem of repeat laboratory testing and the use of various strategies to ameliorate this problem [7–9]. There is limited published research into the magnitude of unnecessary duplicate laboratory testing, although some does exist. Bates et al. [10] reported that in patients discharged from one tertiary care centre, 8.6% of a selection of 10 commonly ordered tests were redundant, resulting in substantial unnecessary costs. When these were modelled by the RAND Corporation, they extrapolated that an estimated 2.2 billion dollars a year were spent in the United States on unnecessary duplicate laboratory testing. It is beyond the purview of this paper to describe solutions to these problems, but their identification is a first step in developing a comprehensive strategy.

Complex patients and systems

This complex group of patients is being seen by a myriad of physicians and clinical teams of health professionals, which may indicate a problem with integration of information and organized care plans. Like many health care systems at the current time, BC does not have one integrated medical record accessible to all care providers. Complex patients with multiple physicians are a group of patients in whom this integrated information may be of most value.
A single provincial integrated electronic health record would potentially alleviate some of the redundancy due to lack of information at point of care. There is some evidence that electronic health records can be used as tools to improve clinical decision making [11], facilitate better medication management [12,13] and increase the adoption of screening programmes and preventative health measures [14]. However, the current analysis simply identifies a problem of substantial resource use in complex patients, and we hypothesize that one of the reasons is the lack of integrated information, which may be helped by adoption of single health records. Further, in-depth analysis of root causes and testing of various solutions should be undertaken.

In the absence of an integrated health record, we might suggest other strategies to reduce resource utilization. A policy or laboratory strategy that attempts to ensure that all physicians caring for a patient are copied on all/any laboratory results may appear prudent from a health care payer’s perspective, as this would alleviate the need to order additional tests due to non-availability of results. Such a strategy is being formally tested at the current time, along with a recommended predetermined laboratory requisition for these complex patients (Provincial Health Services Authority/Ministry of Health, personal communication). The development of these kinds of tools, in combination with a framework that includes laboratory physicians to take a more active role in test ordering and cancelling, may support the meaningful integration of complex care procedures into practical clinical care pathways. Such a system would require input from both primary and specialist physicians as well as support systems such as laboratory and medical services plans.

As in all studies, this analysis has several limitations. Our case definitions of diseases rely on physicians reliably entering the correct diagnosis codes on the billing data, in a system where only one diagnosis per visit can be coded. It is possible that some patients with mild CKD were excluded, as that condition may not have formed the basis of any one visit. This would serve to conservatively bias our conclusions, and is therefore not seen as a major limitation. Our case definitions for DM and CVD, however, were robust and unlikely to have missed any individuals with those conditions. This missing data, however, would likely not significantly alter the observations given the objective nature of the results (billed tests/visits and hospitalizations).

We are unable to determine the true appropriateness of these tests or the multiplicity of visits in aggregate. It is possible that these cohorts require intensive, frequent follow-up in order to maintain health, and that less intensive follow-up would result in poorer outcomes (more hospitalizations/death, etc.). However, the converse is also possible: that the excessive visits and multiplicity of persons involved in the care of the individuals have led to under-treatment, over-testing and potentially contributed to the hospitalizations. This would need to be tested using other complimentary evaluative techniques. Qualitative data about MD visits would allow determination of visit reasons/outputs and consequences, and prospective evaluation in a more clinical trial setting would allow determination of sequencing of visits, testing and hospitalizations.

These data serve to describe current practices and care patterns, so that strategies to address questions raised can be subsequently evaluated against current state. Using metrics of health care system integration, and other indicators of health system ‘health’ (such as outpatient visits, testing and medication use), may be important in future assessments of chronic disease management. This may be especially true as this high-risk group of patients may always consume a fixed set of hospital resources due to their underlying illness/comorbidity. It is thus of ultimate importance for health care providers and policy makers to understand how to best manage outpatient care and implementation of prevention in this group more effectively. This analysis serves to provide a set of easily obtained metrics in a high-risk group of patients. These metrics may serve the basis of evaluation strategies for health care system redesign initiatives.

The responsibility for health care system resource utilization is shared between payers and users. In the Canadian health care system, the costs and consequences of monitoring of outpatients have not been well recognized by physicians. With increasing emphasis on chronic disease management and outpatient-based care, it will be of importance to ensure that some cohesive approach to integration is supported by infrastructure such as laboratory and information systems.

Many innovative strategies could help address the gaps and redundancies in the system. Laboratory prompts, patient self-management and awareness of tests and results may be implemented to reduce unnecessary testing. Multidisciplinary chronic disease clinics have demonstrated benefits in many diseases such as CVD [15], CKD [16,17] and DM [18]; however, integrating care for the patients visiting one or more of these types of clinics in addition to their general practitioner remains a challenge. Our group is currently studying the feasibility and outcomes of a combined DM, CVD and CKD clinic, which will attempt to address the redundancies currently identified, by developing a single laboratory requisition and regular communication to the GP regarding the combination of conditions in one letter. Formalizing shared care between GP and specialists may be another approach by which to facilitate communication and reduce unnecessary redundancies in the current system. This too is being developed and evaluated in British Columbia under the primary health care initiative activities.

We present this model of enquiry whereby administrative datasets are developed and analysed with input from clinician researchers and clinical methodologists as an invaluable first step towards innovative health care system redesign. These types of analyses may strengthen policy initiatives to improving care quality by focusing on true cost savings that can be reinvested into the system. Effective and efficient health care delivery systems dealing with ever increasing numbers of complex patients require this integration.

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