Quality in Primary Care 2012;20:149–64

Quality improvement in action

Recommended care adherence: improved by patient reminder letters but with potential attenuation by the healthcare process complexity

Zhou Zhang MD
Resident Physician in Department of Family Medicine, Kaiser Permanente Woodland Hills Medical Center, Woodland Hills, USA

Jason Fish MD MSHS
Assistant Professor of Internal Medicine and Director of Ambulatory Quality and Safety, Division of General Internal Medicine, University of Texas Southwestern Medical Center, Dallas, USA

ABSTRACT

Background American adults receive the recommended care just over half of the time for all recommended services. Many patient reminder strategies have attempted to increase the adherence rates for preventative and chronic disease management. However, there is a lack of data available in relation to adherence rates for symptom-specific recommended services and a lack of data identifying any contributions from the organisational structures to these adherence rates.

Purpose To identify the efficacy and differences in patient reminder letter strategies on various categories of recommended services, as well as to analyse the relationship between a novel quantification of a healthcare system's process complexity with adherence rates.

Design Retrospective cohort study analysing pilot data collected from an urban, academic healthcare provider utilising patient reminder letters.

Participants Adults attending one academic medical centre's outpatient practice from 2008 to 2009.

Intervention Two reminder letters sent chronologically if the recommended care was not completed in the appropriate time frame.

Main measures Adherence rates of each recommended service at baseline, after first and second reminder letters, and non-adherence rates despite the reminder letter intervention. Process flow complexity was calculated as a composite score combining elements of fastest time to complete routine order, number of different steps in routine order, number of departments involved, and number of sites patients visit.

Results Patient adherence rates increased for all the recommended services after the first reminder letter. Preventative and Chronic Disease Management recommendations demonstrated additional moderate increases after the second reminder letter. Referrals and Radiologogy and Diagnostic Testing (acute, symptom specific) and Labs (acute and non-acute) demonstrated additional minimal adherence rate increases after the second reminder letter. Comparison of the process flow complexity demonstrated an inverse relationship between process complexity and adherence rates, particularly for non-acute orders.

Conclusions One reminder letter seemed to be sufficient for most recommended care. The complexity of the healthcare process may be an important predictive factor for patient adherence.

Keywords: chronic disease, patient adherence, reminder letters

How this fits in with quality in primary care

What do we know?
Patient reminder strategies have been shown to increase adherence rates for preventative and chronic disease management. However, little is known about differences in the effect of reminders on preventative, chronic disease and symptom-specific patient adherence rates or the effect of complexity of healthcare organisational processes with adherence rates.

What does this paper add?
Patient adherence rates increased for all the recommended services after the first reminder letter. Although there were moderate increases in Preventative and Chronic Disease Management recommendations after the second reminder letter there was little change in adherence to Referrals and Radiology and Diagnostic Testing (acute, symptom specific) or Labs (acute and non-acute). The complexity of the healthcare process may be an important predictive factor for patient adherence.

Introduction

Research has showed that American adult patients receive the appropriate clinical care just over half of the time for a wide variety of recommended services.[1] With so many Americans not receiving these recommended services, there has been much effort to identify the factors contributing to the low adherence rates, as well as an increased interest in finding ways to improve upon current adherence rates.[2] Both patient and healthcare system-level factors have been suggested as important components. For example, patient-level factors include: a lack of patient awareness of the need for the recommended services; embarrassment involved in completing the services; fear of pain or other side-effects from the recommended services; patients feeling asymptomatic or less susceptible to diseases; and a lack of insurance coverage.[3–9] For the healthcare system factors, the Institute of Medicine's (IOM's) landmark publication *Crossing the Quality Chasm* suggests that the American system is overly complex and uncoordinated, requiring multiple steps and patient 'hand-offs' that decrease patient care efficiency and compromise patient safety.[10] Patients additionally identify healthcare system barriers as 'poor access to services and unaffordable costs'.[9]

There are several reported interventions that have aimed to improve patients' adherence to their recommended care. Current research has focused on three dominant patient reminder strategies: letters, phone calls and text messaging – with the letter reminder strategy being the most commonly studied intervention. The letter reminder strategy has been shown to be cost-effective, widely accepted and welcomed by patients.[11–13] Yet, although there have been many strategies studied to improve adherence rates, most have focused on preventative services and chronic disease management, with significant variability reported. Furthermore, research has not yet focused on symptom-specific recommendations, such as referrals for acute complaints (i.e. eye pain or abdominal pain). There is also a paucity of literature delineating any organisational or system-level characteristics or strategies aimed at improving adherence to the recommended care.

This study analysed pilot data from one physician's office at one academic, urban healthcare organisation that utilised the letter reminder strategy. The goal of this study was to determine whether there were differences between preventative and chronic disease adherence rates and symptom-specific patient adherence rates, as well as to explore the extent to which there was a relationship between the complexity of that healthcare organisation's processes with adherence rates. We hypothesised that adherence rates for preventative and chronic disease management would be similar to rates found in prior research, and that symptom-specific recommendations would show an improvement from the letter reminder strategy. We further hypothesised that the complexity of the healthcare system processes would generally be inversely related to the adherence rates.

Method

Data source

Data were obtained from August 2008 to May 2009 from one primary care physician's records at an academic, urban healthcare centre. All patients were provided with appropriate counselling for risks and benefits of the ordered test or referrals. All recommended tests or referrals agreed upon by the patient and ordered by the physician were entered into a database and reconciled monthly for completion. The patients of this practice were all adults older than 18 years and had a variety of health insurances including

Health Maintenance Organization (HMO), Preferred Provider Organization (PPO) and Medicare.

Reminder protocol

The physician's office followed a standard protocol for reconciling the completion of recommended services as well as for mailing reminder letters. Initial reconciliation and mailing of a first reminder letter occurred after one month for urgent recommendations and two months for non-urgent recommendations. A second reminder letter was mailed one month after the first reminder letter if the ordered service was not completed at each monthly reconciliation process following the mailing of the first reminder letter.

Recommended services categories

Upon reviewing the dataset, ordered services were divided into several categories: (1) Prevention and Chronic Disease Management; (2) Referrals (acute, symptom-specific management); (3) Radiology and Diagnostic Testing (acute, symptom-specific management); and (4) Labs (acute and non-acute). Prevention and Chronic Disease Management included tests for colon cancer screening (colonoscopy), breast cancer screening (mammogram), cervical cancer screening (smear test), osteoporosis screening (DEXA), vaccinations and diabetes examinations, such as annual foot and eye examination. Referrals (acute, symptom-specific management) included referrals to specialists. Radiology and Diagnostic Testing (acute, symptom-specific management) included all studies ordered for purposes of investigation of an acute complaint. The final category, Labs (acute and non-acute) included all laboratory testing ordered.

Process mapping

Using Microsoft Visio, process flow maps of several organisational processes required to complete the recommended care were generated after both direct observation of the processes and discussion with multiple staff members from the organisation.

Given the paucity of the healthcare literature found around rating process complexity, literature from the manufacturing industry provided some guidance on quantifying process complexity management. Frizelle and Woodcock[14] stated that quantification of the system can provide 'a tool that can assist in a strategy development exercise by quantifying the problem areas on a common basis'. In 1996, Frizelle also wrote that by measuring complexity, the measurement could give 'insight that might otherwise be missed, and allows for comparisons to be drawn'.[15] Further, Frizelle identified that there are two types of complexity: static and dynamic. Static complexity relates to the structure of the system and dynamic complexity relates to how the parts interact with each other.[15] In this study, based on suggestions for measuring complexity from the manufacturing literature[14–17] and *a priori* knowledge of the healthcare structure, the complexity of completing the recommended services was measured in a novel way with the following components: (1) fastest time to complete routine order (measured in weeks); (2) number of different steps leading to completion of routine order (measured by counting steps starting at order given, ending at patient arriving at specific site to complete order); (3) number of different departments involved; and (4) convenience as measured by number of sites visited by patient in order to complete a routine order. The first measurement was thought to be a marker of the dynamic complexity, with the remaining three measurements markers of static complexity. The sum of these four categories was then added and a composite score was calculated.

Results

During the 10-month study period, a total of 1630 recommended services and completion rates were recorded. After excluding four samples from Referrals (acute, symptom-specific services) because the documentation listed only 'referral', and 20 samples from Prevention and Chronic Disease Management services listed as 'follow-up appointment', total sample size was 1606 recommended services. This included 413 Prevention and Chronic Disease Management services, 330 Referrals (acute, symptom-specific, non-radiological, services), 180 Radiologic and Diagnostic Testing (acute, symptom-specific) and 683 Labs (acute and non-acute).

For all categories, 1111 [69% (95% adjusted Wald CI 67–71)] of the ordered services were completed without any reminder letters, 221 [14% (95% CI 12–16)] additional ordered services were completed after one or two reminder letters and 274 (17% [95% CI 15–19)] of the ordered services were not completed even after two reminder letters. The adherence rates were then reviewed by specific category of service by examining the effect of one reminder letter or two reminder letters (Table 1 and Figure 1). For Preventative and Chronic Disease Management services, 187 [45% (95% CI 41–50)] of the ordered services were completed without any reminder letters, 56 [14% (95% CI 11–17)] and 28 [7% (95% CI 5–10)] were added after the first and second reminder letters, respectively, and 142 [34% (95% CI 30–39)] of the ordered services were not completed even after two reminder letters. For Referrals (acute, symptom-specific services), 219

Table 1 Adherence rates for each category of services, by category of completion (baseline completion, numbers of reminder letters, and non-adherence)

	Baseline completion with no reminder letters	One reminder letter	Two reminder letters	Non-adherence
Preventative and Chronic Disease Management services $n = 413$	187 (45%) (95% CI: 41–50)	56 (14%) (95% CI: 11–17)	28 (7%) (95% CI: 5–10)	142 (34%) (95% CI: 30–39)
Referrals (acute, symptom-specific services) $n = 330$	223 (67%) (95% CI: 62–72)	36 (11%) (95% CI: 8–15)	7 (2%) (95% CI: 1–4)	68 (20%) (95% CI: 17–25)
Radiology and Diagnostic (acute, symptom-specific services) $n = 180$	142 (79%) (95% CI: 72–85)	17 (9%) (95% CI: 6–15)	2 (1%) (95% CI: 0.04–4)	19 (11%) (95% CI: 7–16)
Labs (acute and non-acute) $n = 683$	563 (82%) (95% CI: 79–85)	52 (8%) (95% CI: 6–10)	23 (3%) (95% CI: 2–5)	45 (7%) (95% CI: 5–9)

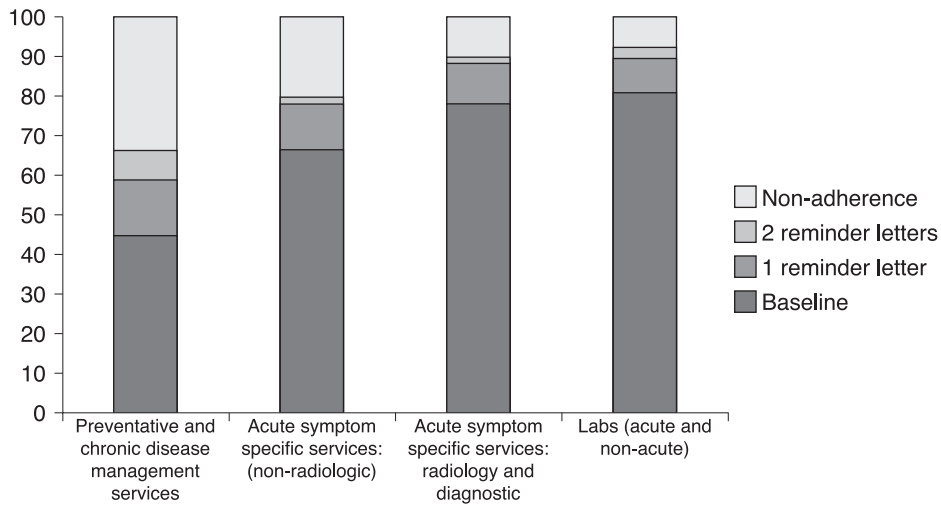

Figure 1 Adherence rates for each category of services, by category of completion (baseline completion, numbers of reminder letters and non-adherence)

[67% (95% CI 61–71)] of the ordered services were completed without any reminder letters, 36 [11% (95% CI 8–15)] and seven [2% (95% CI 1–4)] were added after the first and second reminder letters, respectively, and 68 [20% (95% CI 17–25)] of the ordered services were not completed even after two reminder letters. For Radiology and Diagnostic Testing (acute, symptom-specific services), 142 [79% (95% CI 72–84)] of the ordered services were completed without any reminder letters, 17 [9% (95% CI 6–15)] and two [1% (95% CI 0.04–4)] additional services were completed after one or two reminder letters, respectively, and 19 [11% (95% CI 7–16)] of the ordered services were not completed even after two reminder letters. For the Labs category, 563 [82% (95% CI 79–85)] of the ordered services were completed without any reminder letters, 52 [8% (95% CI 6–10)] and 23 [3% (95% CI 2–5)] additional services were completed after one or two reminder letters, respectively, and 45 [7% (95% CI 5–9)] of the ordered services were not completed even after two reminder letters.

To understand the results further, flow maps were generated for some of the processes to delineate the patient- and system-level steps required to complete the recommended service. Figure 2a–d presents process flow maps for colonoscopies from the Preventative and Chronic Disease Management category, the

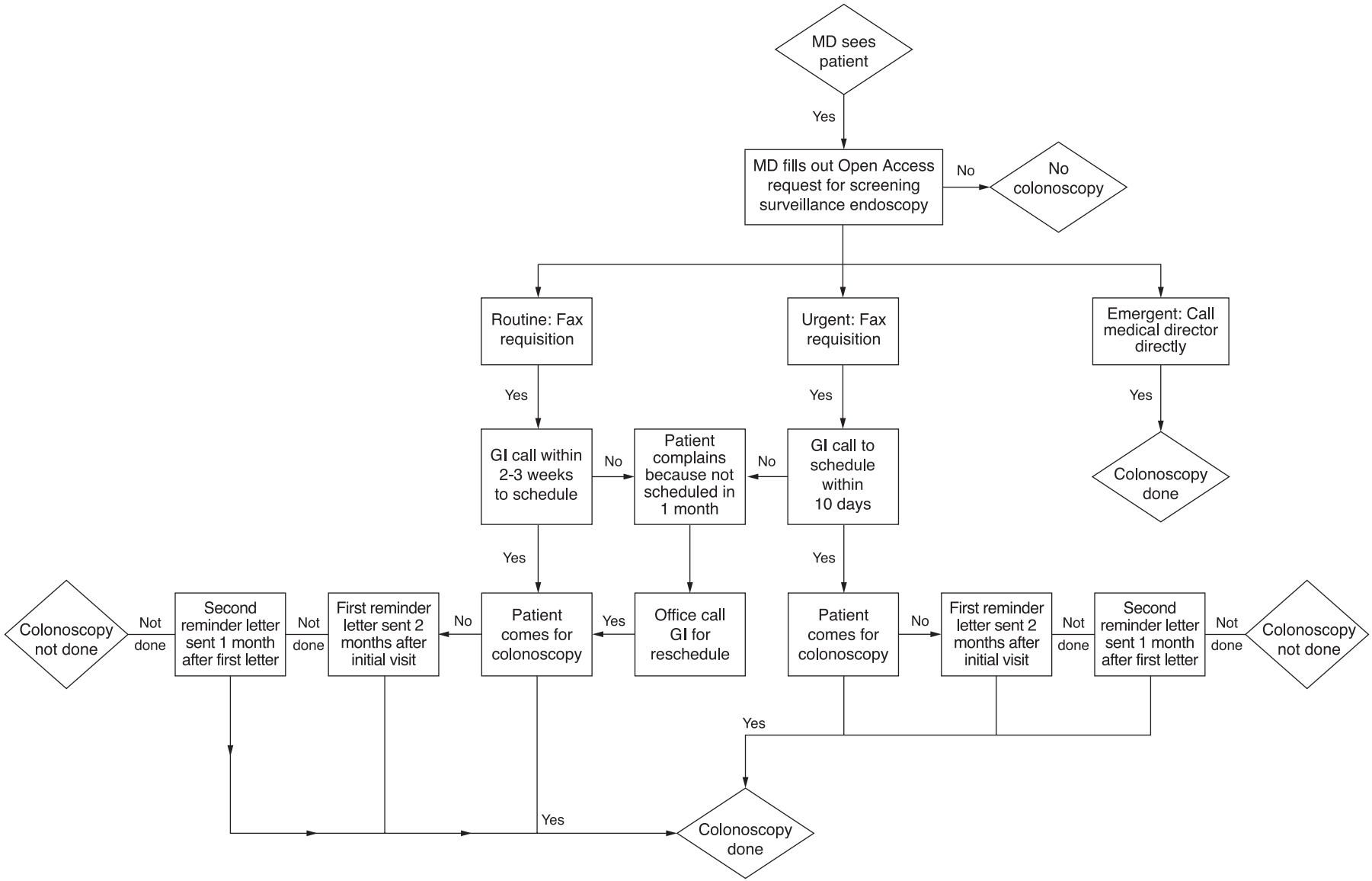

Figure 2a Colon cancer screening (colonoscopy) process flow mapping

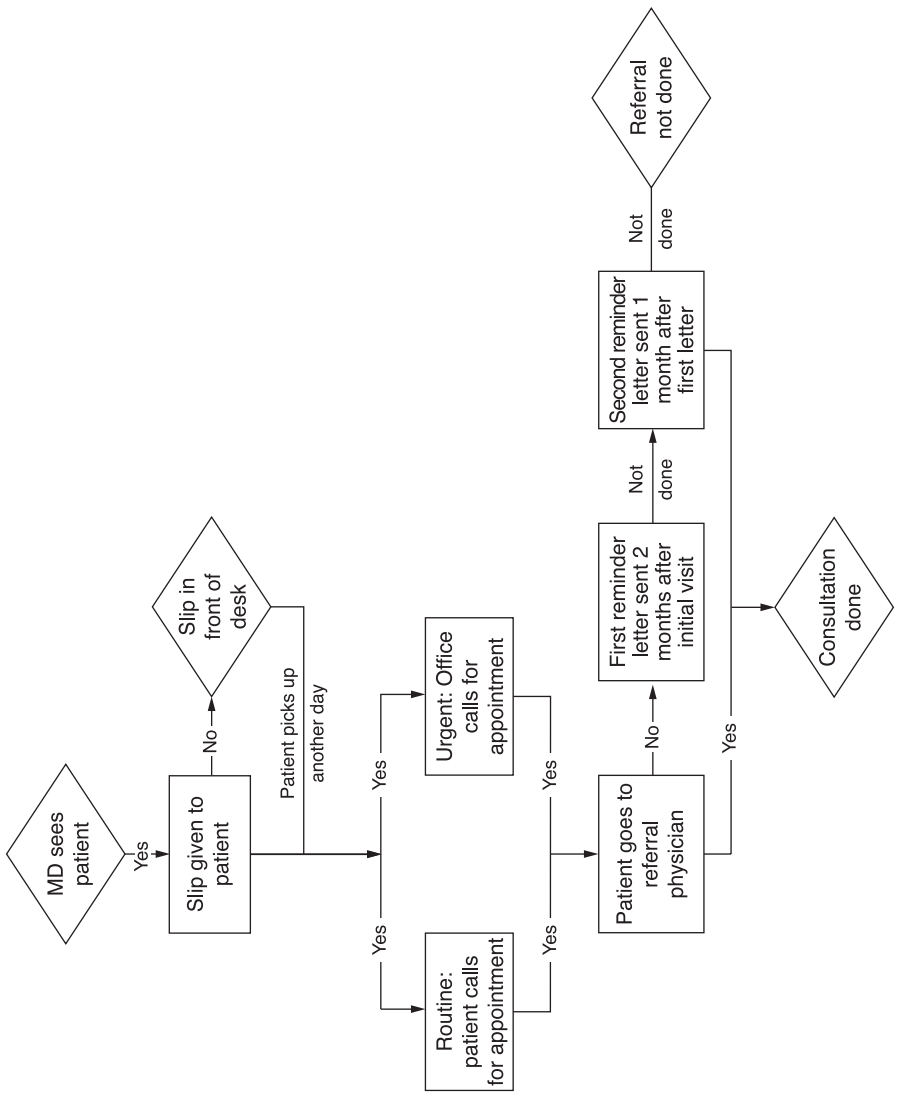

Figure 2b Referral to specialists process flow mapping

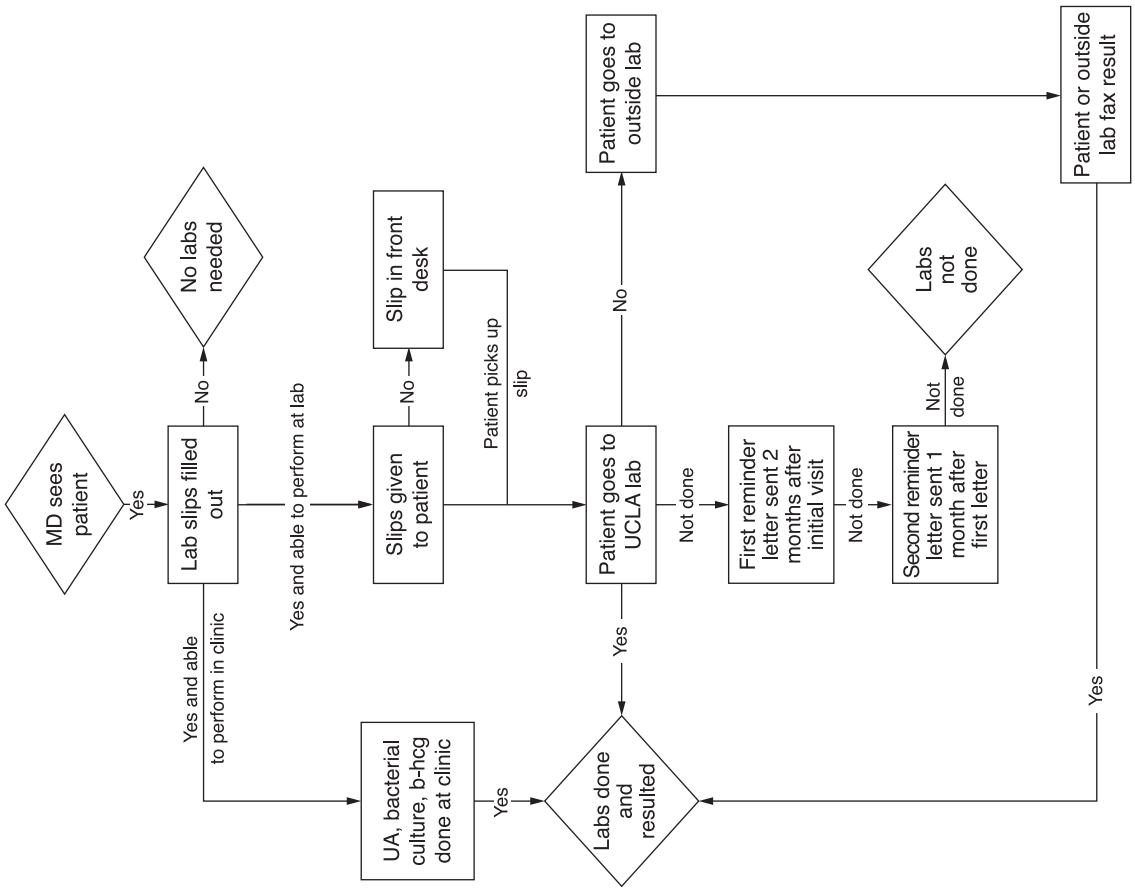

Figure 2c Laboratory process flow mapping

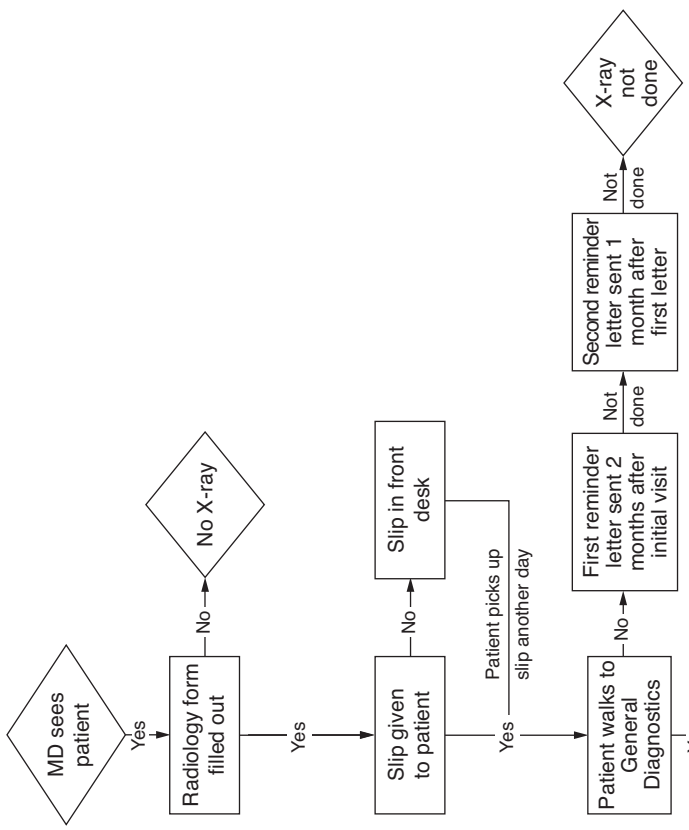

Figure 2d Radiographic Study (X-ray) process flow mapping

general referral process to specialists from the Referrals category, the general diagnostic X-rays process from the Radiology and Diagnostic Testing category and laboratory tests from the Labs category. The process map for colonoscopy demonstrated three possible paths to completion depending on the urgency of the clinical situation, with the fastest completion for an emergency or urgent colonoscopy. The fastest routine colonoscopy completion was two weeks. The colonoscopy service also involved multiple departments including the ordering physician's office, the gastroenterologist's office and the medical director's office (if deemed emergent). Process mapping for referrals to specialists demonstrated two possible paths to completion depending on the urgency of the clinical situation, and involved the ordering physician's office as well as the possible requirement of the patient's participation to call for an appointment. Process mapping for general X-rays demonstrated one path to completing the X-ray (patient goes to the medical centre's X-ray department) immediately following the ordering physician's visit in the same building with no appointment needed. Process mapping for laboratory work demonstrated two possible paths to completion depending on the urgency (may complete some studies such as urinalysis in office) and patient's preference to complete the laboratory tests at the medical centre or outside laboratory, with fastest completion immediately after the ordering physician's visit at the office centre's laboratory within the same building on the same floor.

Based on process flow mapping and knowledge from the manufacturing industry literature, a novel quantitative measurement of process completion complexity was calculated. To measure the dynamic complexity, time-to-completion was examined; and, to measure static complexity, the number of departments involved, the number of locations the patient would have to visit and the number of different steps required for completing the outcome were identified. The composite scores of laboratory tests and X-rays were both calculated to be 6; referrals were calculated to have a complexity of 8; and the colonoscopy process was calculated to have the highest complexity composite score of 11–12 (Table 2).

Table 3 shows individual recommendations and completion rates, along with complexity scores for each recommendation. Some highlights of the completion rates are that, within the Preventative and Chronic Disease Management services, colon cancer screening (colonoscopy) and osteoporosis screening (DEXA) had adherence rates of 33% without any reminder letters and increased to 56% after two reminder letters. In the Referral (acute, symptom specific) category, significant variation was seen among adherence rates across the different subspecialty referrals. In the Radiology and Diagnostic Testing (acute, symptom specific) category, several adherence rates were 100% at baseline, and many had very low non-adherence rates.

Discussion

Data from this study showed similar trends with national data for patients receiving recommended services.[1,18] This study further indicated, as in other published data, that patients have difficulty completing certain preventative services.[1] Although the reminder letter intervention is an effective method to increase the completion rate for preventative services, 35% of patients still did not complete preventative services even after two patient reminder letters were mailed. Further research should focus on how to most effectively improve upon the reminder letter strategy or to delineate the reasons that the 35% of patients are declining even after multiple provider attempts to assist.

Comparison of the process flow complexity with adherence rates demonstrated a general trend that the more complex a process was found to be, the lower the adherence rates. For example, colonoscopy for screening purposes received a complexity score of 11–12 and was found to have one of the lowest adherence rates, even after two reminder letters; whereas, laboratory tests and general X-rays had low complexity scores with very high adherence rates. However, this inverse relationship mainly held true for non-acute categories. This suggests that healthcare complexity could be overcome in acute, symptom-specific situations. For example, completion of Referrals (acute symptom specific) had much higher adherence rates even with a moderately elevated complexity score of around 8 at this academic institution. Magnetic resonance imaging (MRI) or computed tomography (CT) scans from the acute category, estimated to have complexity scores of 8, also had very high adherence rates. Yet, mammography and DEXA scanning, with similar estimated complexity scores of 8, but from the non-acute categories, had low adherence rates. These examples suggest that acute patient needs may increase the likelihood of adherence even when complexity is high. Because the complexity composite score approach is novel, further research would need to be done in order to validate these findings and to determine complexity score thresholds, and how patient-level factors may interact with organisational complexity. Nevertheless, in the non-acute setting, it is very interesting to note that the complexity of the processes was generally found to be inversely related to the adherence rates. In future studies, process complexity may be an important system-level factor predicting adherence, which may be more important for certain patients than others.

Table 2 Process mapping complexity scores

	Fastest time for completion of routine order	Number of steps to complete routine order	Number of different departments involved	Convenience as measured by number of sites visited by patient in order to complete routine order	Complexity composite score
Colonoscopy (Prevention and Chronic Disease Management)	2 weeks	4	2 (or 3) (ordering physician, gastrointestinal department, +/– medical director)	3 (ordering physician's office, pharmacy and gastrointestinal colonoscopy centre)	11 (or 12)
Referral (acute, symptom specific)	1 week	3	2 (ordering physician and referral physician's office)	2 (ordering physician's office and referral physician's office)	8
General X-rays (acute, symptom specific: radiology/diagnostic)	Same day (0)	2	2 (ordering physician and radiology)	2 (ordering physician's office and radiology)	6
Labs (acute and non-acute)	Same day (0)	2	2 (ordering physician and laboratory)	2 (ordering physician's office and laboratory)	6

Table 3 Adherence rates of individual recommended services, by category of completion (baseline completion, numbers of reminder letters and non-adherence), with complexity scores

	Baseline completion with no reminder letters	One reminder letter	Two reminder letters	Non-adherence	Complexity score
Preventative and Chronic Disease Management services					
Colon cancer screening (colonoscopy) $n = 105$	35 (33%) (95% CI: 25–43)	11 (11%) (95% CI: 6–18)	14 (13%) (95% CI: 8–21)	45 (43%) (95% CI: 34–52)	11 (or 12)
Breast cancer screening (mammography) $n = 112$	57 (51%) (95% CI: 42–60)	16 (14%) (95% CI: 9–22)	5 (6%) (95% CI: 2–10)	34 (30%) (95% CI: 79–85)	8
Cervical cancer screening (smear) $n = 95$	51 (54%) (95% CI: 44–63)	10 (11%) (95% CI: 6–18)	6 (6%) (95% CI: 3–13)	28 (30%) (95% CI: 21–39)	2 (if done by PCP) 8 (if referred)
Vaccines $n = 9$	5 (55.6%) (95% CI: 27–81)	1 (11.1%) (95% CI: 0.01–46)	1 (11.1%) (95% CI: 0.01–46)	2 (22.2%) (95% CI: 5–56)	2
Osteoporosis screening (bone mineral density) $n = 30$	10 (33.3%) (95% CI: 19–51)	6 (20%) (95% CI: 9–38)	1 (3.3%) (95% CI: 0.01–18)	13 (43.3%) (95% CI: 27–61)	8
Annual foot exam for patients with diabetes $n = 27$	15 (55.6%) (95% CI: 37–72)	5 (18.5%) (95% CI: 8–37)	0 (0%) (95% CI: 0–11)	7 (25.9%) (95% CI: 13–45)	2
Annual eye exam for patients with diabetes $n = 35$	14 (40%) (95% CI: 26–56)	7 (20%) (95% CI: 10–36)	1 (2.9%) (95% CI: 0.01–16)	13 (37.1%) (95% CI: 23–54)	8–10 (insurance factors add complexity)

Table 3 Continued

	Baseline completion with no reminder letters	One reminder letter	Two reminder letters	Non-adherence	Complexity score
Referrals (acute, symptom-specific management)					
Referral to allergy and immunology $n = 8$	7 (87.5%) (95% CI: 51–100)	0 (0%) (95% CI: 0–29)	0 (0%) (95% CI: 0–29)	1 (12.5%) (95% CI: 0.1–50)	8
Referral to cardiology $n = 11$	9 (81.8%) (95% CI: 51–96)	0 (0%) (95% CI: 0–23)	0 (0%) (95% CI: 0–23)	2 (18.2%) (95% CI: 4–49)	8
Referral to dermatology $n = 66$	57 (86.4%) (95% CI: 76–93)	0 (0%) (95% CI: 0–5)	1 (1.5%) (95% CI: 0.01–9)	8 (12.1%) (95% CI: 6–22)	8
Referral east–west medicine $n = 3$	1 (33.3%) (95% CI: 6–80)	1 (33.3%) (95% CI: 6–80)	0 (0%) (95% CI: 0–53)	1 (33.3%) (95% CI: 6–80)	8
Referral to endocrinology $n = 15$	9 (60%) (95% CI: 36–80)	1 (6.7%) (95% CI: 0.01–32)	0 (0%) (95% CI: 0–18)	5 (33.3%) (95% CI: 15–59)	8
Referral to ENT $n = 25$	12 (48%) (95% CI: 30–67)	4 (16%) (95% CI: 6–35)	1 (4%) (95% CI: 0.01–21)	8 (32%) (95% CI: 17–52)	8
Referral to general surgery $n = 14$	10 (71.4%) (95% CI: 42–92)	1 (7.1%) (95% CI: 0.2–34)	0 (0%) (95% CI: 0–19)	3 (21.4%) (95% CI: 7–48)	8
Referral to geriatrics $n = 1$	1 (100%) (95% CI: 22–100)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	8
Referral to GI $n = 27$	17 (62.9%) (95% CI: 44–79)	1 (3.7%) (95% CI: 0.01–20)	1 (3.7%) (95% CI: 0.01–20)	8 (29.6%) (95% CI: 16–49)	8
Referral to obstetrics/ gynaecology $n = 27$	14 (51.9%) (95% CI: 34–69)	7 (25.9%) (95% CI: 13–45)	1 (3.7%) (95% CI: 0.01–20)	5 (18.5%) (95% CI: 8–37)	8
Referral to haematology/ oncology $n = 6$	2 (33.3%) (95% CI: 10–70)	0 (0%) (95% CI: 0–36)	0 (0%) (95% CI: 0–36)	4 (66.7%) (95% CI: 30–91)	8

Table 3 Continued

Referral to hepatology $n = 1$	1 (100%) (95% CI: 22–100)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	8
Referral to neurology $n = 18$	12(66.7%) (95% CI: 44–84)	4 (22.2%) (95% CI: 8–46)	0 (0%) (95% CI: 0–15)	2 (11.1%) (95% CI: 2–34)	8
Referral to nutrition $n = 14$	12 (85.7%) (95% CI: 59–97)	2 (14.3%) (95% CI: 3–41)	0 (0%) (95% CI: 0–19)	0 (0%) (95% CI: 0–19)	8
Referral to orthopaedics $n = 47$	30 (63.8%) (95% CI: 50–76	7 (14.9%) (95% CI: 7–28)	2 (4.3%) (95% CI: 0.3–15)	8 (17%) (95% CI: 9–30)	8
Referral to physical med and rehab/pain management $n = 2$	2 (100%) (95% CI: 37–100)	0 (0%) (95% CI: 0–63)	0 (0%) (95% CI: 0–63)	0 (0%) (95% CI: 0–63)	8
Referral to psychiatry $n = 5$	0 (0%) (95% CI: 0–40)	2 (40%) (95% CI: 12–77)	0 (0%) (95% CI: 0–40)	3 (60%) (95% CI: 23–88)	8
Referral to pulmonology $n = 11$	5 (45.5%) (95% CI: 21–72)	2 (18.2%) (95% CI: 4–49)	1 (9.1%) (95% CI: 0–23)	3 (27.3%) (95% CI: 9–57)	8
Referral to physical therapy $n = 9$	6 (66.7%) (95% CI: 35–88)	1 (11.1%) (95% CI: 0.01–46)	0 (0%) (95% CI: 0–27)	2 (22.2%) (95% CI: 5–56)	8
Referral to rheumatology $n = 6$	4 (66.7%) (95% CI: 30–91)	1 (16.7%) (95% CI: 1–58)	0 (0%) (95% CI: 0–36)	1 (16.7%) (95% CI: 1–58)	8
Referral to specialty surgery $n = 1$	1 (100%) (95% CI: 22–100)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	0 (0%) (95% CI: 0–78)	8
Referral to urology $n = 13$	7 (53.8%) (95% CI: 29–77)	2 (15.4%) (95% CI: 3–43)	0 (0%) (95% CI: 0–20)	4 (30.8%) (95% CI: 12–58)	8

Table 3 Continued

	Baseline completion with no reminder letters	One reminder letter	Two reminder letters	Non-adherence	Complexity score
Radiology and Diagnostic Testing (acute, symptom-specific services)					
Ankle brachial index $n = 2$	2 (100%) (95% CI: 37–100)	0 (0%) (95% CI: 0–63)	0 (0%) (95% CI: 0–63)	0 (0%) (95% CI: 0–63)	8
Surgical biopsy $n = 4$	4 (100%) (95% CI: 54–100)	0 (0%) (95% CI: 0–46)	0 (0%) (95% CI: 0–46)	0 (0%) (95% CI: 0–46)	8
24-hour ambulatory blood pressure monitoring $n = 5$	3 (60%) (95% CI: 23–88)	1 (20%) (95% CI: 2–64)	0 (0%) (95% CI: 0–40)	1 (20%) (95% CI: 2–64)	8
CT scan $n = 15$	13 (86.7%) (95% CI: 61–98)	2 (13.3%) (95% CI: 2–39)	0 (0%) (95% CI: 0–18)	0 (0%) (95% CI: 0–18)	8
Cardiac echocardiogram $n = 20$	11 (55%) (95% CI: 34–74)	5 (25%) (95% CI: 11–47)	0 (0%) (95% CI: 0–14)	4 (20%) (95% CI: 7–42)	8
Cardiac event recorder $n = 13$	5 (38.5%) (95% CI: 18–65)	1 (7.7%) (95% CI: 0.01–35)	1 (7.7%) (95% CI: 0.01–35)	6 (46.2%) (95% CI: 23–71)	10
MRI $n = 12$	12 (100%) (95% CI: 78–100)	0 (0%) (95% CI: 0–22)	0 (0%) (95% CI: 0–22)	0 (0%) (95% CI: 0–22)	8
Pulmonary function tests $n = 3$	2 (66.7%) (95% CI: 20–94)	0 (0%) (95% CI: 0–53)	0 (0%) (95% CI: 0–53)	1 (33.3%) (95% CI: 6–80)	8
Cardiac stress test $n = 9$	6 (66.7%) (95% CI: 35–88)	1 (11.1%) (95% CI: 0.01–46)	0 (0%) (95% CI: 0–27)	2 (22.2%) (95% CI: 5–56)	8
Ultrasound $n = 68$	55 (80.9%) (95% CI: 70–89)	7 (10.3%) (95% CI: 5–20)	1 (1.4%) (95% CI: 0.01–9)	5 (7.4%) (95% CI: 3–16)	8
General X-ray $n = 29$	29 (100%) (95% CI: 90–100)	0 (0%) (95% CI: 0–10)	0 (0%) (95% CI: 0–10)	0 (0%) (95% CI: 0–10)	6
Labs: Acute and Non-Acute					
Labs: acute and non-acute $n = 683$	563 (82.4%) (95% CI: 79–85)	52 (7.6%) (95% CI: 6–10)	23 (3.4%) (95% CI: 2–5)	45 (6.6%) (95% CI: 5–9)	6

While there was a tremendous benefit for the two reminder letters strategy, data from this study suggested that for acute, symptom-specific management (Referrals and Radiology and Diagnostic Testing) and for Labs, the reminder strategy was important but may need to be modified for these services. One reminder letter seemed to be sufficient because the second reminder letter only resulted in an additional 1–3% of recommended services completed. This echoed other published research which demonstrated the small marginal benefit from multiple reminder letters for diabetic retinopathy screening, with second reminder letters offering only increasing completions by 2%.[18] For many of the recommended services in these categories, high adherence rates may be due to patients' desire to resolve their symptoms which lead to the ordering of these recommended services initially. However, further research is needed to fully understand the differences observed and to understand if this desire for adherence may be overcome by more complex processes.

Limitations

This study has several limitations. First, patients were not surveyed to enquire reasons for declining the recommended services; future studies could be done to survey patients in order to clarify patient motivations and potential facilitators and barriers to receiving the recommended care. Second, patients with HMO insurance may have received additional reminder letters directly from the insurance carriers, which may have influenced adherence rates. Further research is needed to clarify whether the effect of managed care organisation reminders and physician–patient communication strategies work synergistically, or, possibly antagonistically, with one another. Finally, the patients in this study were from only one primary care practitioner's outpatient office at one urban academic centre. The results from this study may not be applicable to other practices or other patient populations. However, the study did include a mix of insurance carriers and had a significant number of recommended services that may increase the generalisability of the results.

Even with the aforementioned limitations, this study did demonstrate the efficacy of the patient reminder letter strategy across multiple categories of services, and it primarily indicates the importance of using measured process flow complexity as a tool to predict adherence rates, particularly in the non-acute setting. As this finding is still in the preliminary phase, future research can more clearly investigate how measured process flow complexity can be more accurately used as a tool to predict patient health outcomes.

ACKNOWLEDGEMENT

Presented at Society of General Internal Medicine 34th Annual Meeting May 4th, 2011 at Sheraton Phoenix Downtown Hotel in Phoenix, Arizona.

REFERENCES

1 McGlynn EA, Asch SM, Adams J *et al.* The quality of health care delivered to adults in the United States. *New England Journal of Medicine* 2003;348(26):2635–45.
2 Jencks SF, Huff ED and Cuerdon T. Change in the quality of care delivered to Medicare beneficiaries. 1998–1999 to 2000–2001. *Journal of the American Medical Association* 2003;289:305–12.
3 Klabunde CN, Vernon SW, Nadel MR, Breen N, Seeff LC and Brown ML. Barriers to colorectal cancer screening: a comparison of reports from primary care physicians and average-risk adults. *Medical Care* 2005 Sep;43(9):939–44.
4 Hoffman RM, Rhyne RL, Helitzer DL *et al.* Barriers to colorectal cancer screening: physician and general population perspectives, New Mexico, 2006. *Preventing Chronic Disease* 2011 Mar;8(2):A35.
5 Murakami Y, Lee BW, Duncan M *et al.* Racial and ethnic disparities in adherence to glaucoma follow-up visits in a county hospital population. *Archives of Ophthalmology* 2011 Jul;129(7):872–8.
6 Bastani R, Marcus AC, Maxwell AE, Das IP and Yan KX. Evaluation of an intervention to increase mammography screening in Los Angeles. *Preventive Medicine* 1994 Jan;23(1):83–90.
7 Richardson JL, Mondrus GT, Danley K, Deapen D and Mack T. Impact of a mailed intervention on annual mammography and physician breast examination among women at high risk of breast cancer. *Cancer Epidemiology Biomarkers and Prevention* 1996 Jan;5(1):71–6.
8 Wall KM, Rocha GM, Salinas-Martinez AM, Baraniuk S and Day RS. Modifiable barriers to cervical cancer screening adherence among working women in Mexico. *Journal of Women's Health* (Larchmt) 2010 Jul;19(7):1263–70.
9 DeVoe JE, Baez A, Angier H, Krois L, Edlund C and Carney PA. Insurance+access≠health care: typology of barriers to health care access for low-income families. *Annals of Family Medicine* 2007;5:511–18.
10 Committee on Quality of Health Care in America, Institute of Medicine. *Crossing the Quality Chasm: a new health system for the 21st century.* National Academies Press: Washington DC, 2001.
11 Rosser WW, Hutchinson BG, McDowell I and Newell C. Use of reminder to increase compliance with tetanus booster vaccination. *Canadian Medical Association Journal* 1992;164(6):911–17.
12 Winston CA, Mims AD and Leatherwood KA. Increasing pneumococcal vaccination in managed care through telephone outreach. *American Journal of Managed Care* 2007;13:581–8.

13 Kaczorowski J, Karwalajtys T, Lohfeld L *et al.* Women's views on reminder letters for screening mammography. *Canadian Family Physician* 2009;55:622–3. e1–4.
14 Frizelle G and Woodcock E. Measuring complexity as an aid to developing operational strategy. *International Journal of Operations & Production Management* 1995; 15(5)5:26–39.
15 Frizelle G. Getting the measure of complexity. *Manufacturing Engineer* 1996;75(6):268–70.
16 Pippenger N. Complexity theory. *Scientific American* 1978 Jun;238(6): 114–25.
17 Klir G. Complexity: some general observations. *Systems Research* 1985;2:131–40.
18 Halbert RJ, Leung KM, Nichol JM and Legorreta AP. Effect of multiple patient reminders in improving diabetic retinopathy screening. A randomized trial. *Diabetes Care* 1999 May;22(5):752–5.

FUNDING

None.

ETHICAL APPROVAL

Independent Review Board approval was obtained for this study.

PEER REVIEW

Not commissioned; externally peer reviewed.

CONFLICTS OF INTEREST

None.

ADDRESS FOR CORRESPONDENCE

Zhou Zhang, Kaiser Permanente Woodland Hills Medical Center, 5601 De Soto Avenue, Woodland Hills, CA 91367, USA. Email: zzhan001@ucla.edu

Received 30 October 2011
Accepted 21 February 2012