A Case Study of Visit-Driven Preventive Care Screening Using Clinical Decision Support: The Need to Redesign Preventive Care Screening

Gregory M. Garrison, MD, MS¹, Chelsea R. Traverse, MD¹, and Robert G. Fish, MD¹

Abstract
Introduction: In the traditional model of care, an annual visit was dedicated to the task of assessing and delivering preventive care. With the move away from annual physicals, primary care physicians are addressing preventive services at every clinic visit often aided by electronic clinical decision support (CDS) systems.

Methods: We conducted a case study of a visit-driven CDS system in use at a primary care clinic. Steady-state performance was assessed via control charts of quality metrics, data regarding completion of recommendations, and an analysis of screening intervals achieved with patient visits.

Results: Under this visit-driven CDS system, quality metric performance was poor and declining. Almost half of the patients were not screened (46.5%), and the other half were overscreened the majority of the time (83.3%). Recommended preventive services were ordered less than half the time (42.6%), despite CDS reminders.

Discussion: Various barriers and systematic inefficiencies combined to produce ineffective screening in this visit-driven CDS preventive service delivery system. As a result, we conclude a visit-driven system cannot produce optimal results. In order to improve performance, preventive services should be delivered separately from clinical visits, perhaps by a “preventive service ranger” (PSR) utilizing the CDS system to review each patient once annually. Under such a system, patients would receive preventive services in an organized and efficient fashion, potentially leading to better continuity, higher quality metrics that are mathematically predictable, and improved satisfaction.

Keywords
primary care, program evaluation, medical informatics, health outcomes, efficiency

Introduction
Preventive care screening is an essential part of family medicine and the patient-centered medical home.¹ It was recently estimated that 7.4 hours of physician time per working day would be required to deliver all United States Preventive Services Task Force (USPSTF)-recommended services to a typical panel of patients.² Currently, the best predictor of up-to-date preventive screening is the presence of an annual health maintenance visit.³ However, with demands on access and efficiency as well as changes in reimbursement, there has been a move away from the traditional annual health maintenance visit during which preventive care needs were assessed and delivered.⁴ Instead, patients come in for acute care visits and for scheduled chronic disease management visits that deal with an increasing number of problems.⁵ While the list of evidence-based guidelines for interval-driven preventive care services has expanded dramatically, the traditional method of preventive care delivery has faded.⁶

New models, relying on electronic clinical decision support (CDS) systems, have been proposed to deliver recommended

¹ Department of Family Medicine, Mayo Clinic, Rochester, MN, USA

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Corresponding Author:
Gregory M. Garrison, Department of Family Medicine, 200 First Street SW, Rochester, MN 55905, USA.
Email: garrison.gregory@mayo.edu
preventive services at visits.\textsuperscript{7,8} Such CDS systems have been shown to improve the delivery of preventive services and reduce physician workload.\textsuperscript{9,10} In this organizational case study, we use quantitative methods to evaluate the steady-state performance of a visit-driven CDS system for delivering recommended preventive care. We also examine potential external, environmental, and inertial barriers to delivering preventive care by analyzing visits and the ordering process.\textsuperscript{11}

### Methods

#### Environment

We conducted our case study at a single outpatient family medicine residency clinic, consisting of 9 faculty family physicians and 24 family medicine residents who care for 15 584 patients with approximately 22 000 visits annually. Since 2008, our clinic employs a standardized rooming process utilizing a CDS system consisting of logic rules for various diagnoses, medications, and preventive services as detailed by Chaudhry et al.\textsuperscript{12} At every patient visit, nursing staff rooms the patient, obtains vital signs, reconciles medications, and utilizes the CDS system to determine preventive health needs. When needs are identified, the rooming nurse “tees up” electronic orders for the required services to the treating physician. The physician has the option of issuing or canceling the order following discussion with the patient.

#### Quantitative Analysis

**Quality Metrics.** Electronically abstracted quality data on an array of preventive service and chronic disease metrics became available in 2013, therefore we chose July 2013 as a start date. We focused on 4 metrics shown in Table 1, representing a mix of services derived from the Minnesota Community Measures project.\textsuperscript{13} Control charts with three sigma control limits were constructed from the monthly quality data. Shewart rules defined special cause variation for (a) any point outside the 3 sigma control limits, (b) a run of 9 points on the same side of the center line, or (c) 6 points steadily increasing or decreasing.

**Clinical Decision Support Ordering.** One of the three care teams at the clinic manually tracked the number of CDS recommendations and whether or not they were actually ordered during September 2015.

**Visit Analysis.** An analysis of all paneled patients and their visits over one year from July 1, 2014, to June 30, 2015, was

| Measure | Definition |
|---------|------------|
| Cervical cancer screening | Female patients aged 24 to 64 who have a cervical cytology performed every 3 years or female patients aged 30 to 64 who have cervical cytology/human papillomavirus (HPV) cotesting performed every 5 years |
| Colon cancer screening | Completed flexible sigmoidoscopy within last 5 years, completed colonoscopy within last 10 years, or an annual colorectal FIT or FOBT; ages 51 to 75 years |
| Cardiovascular care (V4) | Patients aged 18 to 75 years with diagnosis of coronary artery disease, stroke, or peripheral vascular disease meeting all 4 criteria: |
| | - BP: <140/90 documented within 12 months |
| | - Aspirin: Patient has documented daily aspirin or contraindication any date (on anticoagulation medications, history of gastrointestinal or intracranial bleed, allergy, and GERD if specifically documented as a contraindication by the physician) |
| | - Tobacco: Currently a nontobacco user |
| | - Lipids: LDL in the last 5 years and |
| | - LDL <40 or on a statin or contraindication to statin or attempt to use a statin in the last 5 years with documentation of contraindication or negative impact |
| Diabetes care (D5) | Aged 18 to 75 years with diagnosis of diabetes mellitus meeting all 5 criteria: |
| | - Hemoglobin Alc: HbA1c < 8 within 6 months |
| | - BP: <140/90 documented within 12 months |
| | - Tobacco: Currently a nontobacco user |
| | - Aspirin: For patients with a comorbidity of ischemic vascular/cardiovascular disease patient has documented daily aspirin or an accepted contraindication (on anticoagulation medications, history of gastrointestinal or intracranial bleed, allergy, or GERD if specifically documented as a contraindication by the physician) |
| | - Lipids: LDL in the last 5 years and |
| | - LDL age 18-20—no LDL/statin requirement |
| | - LDL age 21-39—LDL <190 or on a statin or contraindication to statin or attempt to use a statin in the last 5 years with documentation of contraindication or negative impact |
| | - LDL age 40-75—LDL < 70 or on a statin or contraindication to statin or attempt to use a statin in the last 5 years with documentation of contraindication or negative impact |
| | - LDL with vascular disease—LDL <40 or on a statin or contraindication to statin or attempt to use a statin in the last 5 years with documentation of contraindication or negative impact |

Abbreviations: BP, blood pressure; FIT, fecal occult blood test; FOBT, Fecal Immunochemical Test; GERD, gastroesophageal reflux disease; LDL, low-density lipoprotein.
conducted to determine whether the visit-driven CDS system produced appropriate screening intervals. The number of times each paneled patient was seen at the clinic was counted. In addition, the number of days between their current visit and their most recent previous visit was computed.

Results

Quality Metrics

Figure 1 shows the control charts for data on the percentage of eligible patients up to date on each metric. Both cervical and colon cancer screening show steadily decreasing screening rates (rules a and c). The discontinuity in cervical cancer screening rates between April 2015 and May 2015 reflects the metric’s adoption of new guidelines for 5-year screening intervals instead of the previous 3-year interval. Both cardiovascular and diabetes care show decreased results in May 2015 (rule a).

Clinical Decision Support Ordering

In 487 consecutive patients on a single care team during September 2015, the CDS system recommended services on 202 (41.5%) patients. Overall, orders were issued only 42.6% of the time for recommended services. Significant differences ($P < .001$) were found in the ordering rate for mammograms (66.7%), laboratory tests (48.2%), diabetic eye examinations (28.6%), immunizations/PPD/lead/vision/hearing screening (18.5%), and osteoporosis screening (0%).

Visit Analysis

There were 22,264 clinic visits during the one-year time period. Figure 2 shows the distribution of the number of visits per paneled patient. Almost half (46.5%) of paneled patients did not visit our clinic during the one-year period. One-fifth (20.9%) made exactly 1 visit, while one-third (32.6%) made multiple visits. Of those visiting the clinic, the median number of visits during the one-year period was 2, with a mean of 2.67 and a maximum of 36. The majority (83.3%) of visits during the one-year time period had a preceding visit within twelve months.

Discussion

Results of the visit-driven CDS-assisted preventive service process are disappointing and declining. No changes were made to the visit-driven CDS system that explain the observed special cause variation. In July 2014, all patients at the clinic were
Third, time constraints prevent adequate discussion of acute visits. Continuity of care is essential to the delivery of preventive care, is disrupted by allowing nursing staff to practice at the maximum extent of their licensure. Physicians are freed from unnecessary distractions and able to focus on the patient’s problems at the visit, reducing the potential for medical errors and increasing visit efficiency. Continuity is improved by directing preventive screening results to the primary physician. This may overcome patient reluctance to obtain recommended preventive services when informed through electronic messaging, letters, and phone calls rather than a face-to-face visit with their primary physician. As derived in Appendix A, Equation 1 shows the anticipated steady-state performance of the PSR system based upon 3 factors, the screening interval S, the review interval R, and the practice’s acceptance rate A for the recommended preventive service. This allows setting realistic and achievable quality goals.

\[
p_{\infty} = \frac{1}{1 + \frac{R}{AS}}. \quad (1)
\]

**Conclusion**

Preventive service screening tied to the visit process, even when using a CDS systems, produced disappointing results for a variety of reasons. Improving delivery of preventive services may require a paradigm change to proactively screen populations independent of the visit process.
Appendix A

The performance of the preventive service ranger (PSR) system can be predicted mathematically. The screening interval S is recommended by evidence-based guidelines, for instance, lipids should be checked every 5 years.\(^{18}\) The review interval R is chosen as annual by the clinic. There is an acceptance rate A < 100% at which patients actually obtain a recommended screening test. This rate varies depending on the screening test and local population. It can be easily determined by dividing the number of screening tests completed by the number of screening tests recommended.

The proportion of people who are up to date on the recommended preventive service \(p\) at time t is shown by the recursive Equation A1 explained subsequently.

\[
p_t = p_{t-1} - \frac{1}{S}p_{t-1} + \frac{A}{R}(1 - p_{t-1}). \tag{A1}
\]

The first term represents the proportion up to date at the previous time interval. Then, the second term subtracts those whose screening expired. Assuming a uniform distribution of screening dates, the proportion expiring is 1/S times the proportion up to date. Finally, the third term adds those who are newly screened. The preventive service is offered to 1/R times the proportion not already up to date each interval. This needs to be multiplied by the acceptance rate A to determine the proportion of people who actually complete the recommended preventive service.

A, S, and R are all predetermined constants. So, using techniques for solving linear recurrence relations, Equation A2 can be expressed as the following closed form solution:

\[
p_t = p_0 r^t + c \cdot \frac{r^t - 1}{r - 1},
\]

where

\[
r = 1 - \frac{1}{S} - \frac{A}{R} \tag{A2}
\]

and

\[
c = \frac{A}{R}.
\]

Since \(|r| < 1\), the limit of Equation 3 can be calculated and represents the maximum proportion up to date once the system reaches steady state, given the screening interval S, the review interval R, and the acceptance rate A. This is shown in Equation A3.

\[
\lim_{t \to \infty} \left[ p_0 r^t + c \left( \frac{r^t - 1}{r - 1} \right) \right] = p_0 \lim_{t \to \infty} r^t + c \lim_{t \to \infty} \frac{r^t - 1}{r - 1} = p_0 (0) + c \frac{1}{r - 1} = \frac{c}{1 - r} = \frac{\frac{A}{R}}{1 - \left( 1 - \frac{1}{S} - \frac{A}{R} \right)}.
\]

For example, in lipid screening, the screening interval S is every 5 years per USPSTF recommendations and the review interval R is annual. Your practice assumes or determines that 50% of patients offered lipid screening will actually complete the test. Then the expected maximum steady-state proportion of patients up to date on lipid screening would be 71% \((A = 50\%, S = 5\text{years}, R = 1\text{ year})\). If the acceptance rate could somehow be increased to 75%, the maximum steady-state proportion up to date on lipid screening would increase to 79% \((A = 75\%, S = 5\text{years}, R = 1\text{ year})\).

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Dr James Gregoire, a nephrologist at the Mayo Clinic, coined the term “renal ranger” in a memorable talk to primary care physicians about recognizing kidney disease. His wit inspired us to adopt “preventive service ranger” as the title of the person responsible for coordinating preventive services.

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Author Biographies

**Gregory M. Garrison** joined the faculty of the Mayo Clinic Family Medicine Residency Program in 2001 and completed a fellowship in Medical Informatics at Stanford University. His research interests include care management of depressed patients, hospital readmissions, and clinical systems improvement.

**Chelsea R. Traverse** is a third year family medicine resident at the Mayo Clinic Family Medicine Residency Program. She has led quality improvement projects focusing on preventive service delivery.

**Robert G. Fish** joined the faculty of the Mayo Clinic Family Medicine Residency Program in 1989 as a core preceptor. He has been actively engaged in clinical practice and teaching residents ever since.