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# Factors Affecting Physicians Compliance with Enrollment Suggestions into a Clinical Reminders Intervention

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**Abstract**

*Clinical reminders can promote adherence with evidence-based clinical guidelines, but they may also have unintended consequences such as alert fatigue, false alarms and increased workload, which cause clinicians to ignore them. The described clinical reminder system identifies patients eligible for primary prevention of cardiovascular diseases and lets the physician to choose which patients will be included in the reminders intervention. We analyzed data of 87,165 visits of 35,699 patients and evaluated factors which may affect clinicians' decision to enroll patients to the intervention. The physicians included most of the patients suggested for inclusion (85.7%). Yet, they skipped the enrollment suggestion in 62.6% of the visits. Patients with a cardiovascular disease, dyslipidemia, diabetes, or hypertension were more likely to be included in the intervention, while older patients were less likely to be included. Insights regarding the usability of clinical reminders are discussed.*

***Keywords:***

Guideline adherence, Clinical decision support systems, Reminder systems, User-computer interface.

## Introduction

Although risk factors contributing to the development of Coronary Artery Disease (CAD) are well known and effective interventions exist, the majority of patients are sub-optimally treated [1]. Clinical reminders (CR) have become a major component in many clinical interventions to promote adherence with evidence-based clinical guidelines [2]. These systems generate patient-tailored reminders for physicians at the point-of-care. The effects of such systems were extensively described in some reviews [3-6]. Many studies showed positive effects on clinical performance [4, 7-9], while others found limited and variable usage [9-13]. Computerized decision-support systems may have unintended consequences, such as alert fatigue, increased workload, workflow issues, communication flaws, and dependence on the technology [14, 15], as well as negative emotions among physicians [16]. Although clinical reminders may provide clinicians with important information, many clinicians may perceive them as a burden and ignore them even when they are critical. We sought to evaluate the extent to which physicians follow a reminder system's suggestions to enroll eligible patients to the prevention program, and the factors effecting this decision.

## Method

### Setting

The "Computerized Community Cardiovascular Control" (4C) is a nationwide intervention, aimed to promote prevention of clinical atherosclerosis. It is operative since 2007 by "Clalit Health Services", a nationwide HMO serving more than 3.7 million patients in Israel.

### Workflow

The system identifies patients at high risk for cardiovascular events (such as cardiovascular disease, dyslipidemia, diabetes, hypertension, smoking, high SCORE [17] or Framingham [18] risk). Once such a patient visits the primary care physician, the system evaluates available clinical information and decides if the patient should be included in the intervention according to the guidelines. If so, it presents an enrollment screen to the physician (Figure 1). The physician can now choose: (1) to include the patient in the intervention, (2) to include the patient, but to postpone the follow-up for one year, or (3) to exclude the patient from the intervention. The physician can also "escape" from the screen by clicking the [X] (in the upper right corner of the screen), which will close the enrollment screen and will end the process without including or excluding the patient. If the patient was excluded from the intervention, the system will ask for the exclusion reason, and will re-suggest inclusion after 6 months. Once a patient was included in the intervention, the system will periodically suggest the physician about therapeutic actions, such as further screenings, pharmacotherapy and expert consultations. After a patient was included in the intervention, the physician can postpone the follow-up or exclude the patient from the intervention at any time.

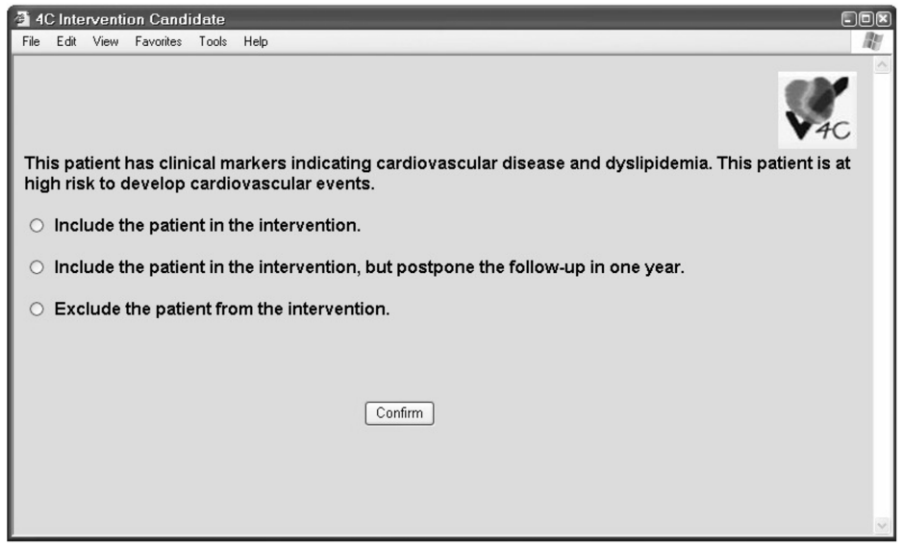


*Figure 1 - Enrollment screen*

**Sample**

The data include 87,165 visits in 50 primary care clinics of 35,699 patients (average 2.4 visits per patient), treated by 379 physicians, between 16/10/2007 and 14/12/2008.

**Analysis**

We analyzed log files collected by the 4C system. We calculated the probabilities to eventually include or exclude patients in the intervention. We analyzed only cases in which the system suggested to enroll the patient to the intervention. We used a logistic regression model with backward elimination for model selection with the binary outcome variable (patient included or not) and patient characteristics of age, gender, and markers of hypertension, diabetes, dyslipidemia, diagnosis of cardiovascular disease, and smoking status as predictors.

## Results

**Descriptive statistics**

Most patients identified for inclusion by the system were male, with an average age of 60 years, diagnosed with hypertension, diabetes, and dyslipidemia. Only about one third of the patients were already diagnosed with cardiovascular disease (due to the primary prevention nature of the project) and about a fifth of them were smokers (Table 1).

**Enrollment rates**

The system evaluated that patients should not be included in the intervention in 75.4% of the total 355,371 visits analyzed, and hence the enrollment screen was not presented to the physician. The physicians did not make any choices regarding these cases. In the remaining 87,165 visits in which the enrollment screen was presented, the physicians chose to include patients in 30,999 visits (35.6%, with 0.5% postponed inclusions), exited the enrollment screen without explicitly excluding the patient in the intervention in 54,554 visits (62.6%) and excluded patients from the intervention in 1612 visits (1.8%) (see Figure 2). Yet, 85.7% of the 35,669 patients suggested by the system for inclusion were eventually included, 0.2% were literally excluded, and for the rest 14.1% (4,989 patients), the physicians kept ignoring the enrollment suggestion. Apparently, the physicians enrolled the most of the patients (85.7%) in the 35.6% of the visits, and mostly escaped the enrollment screen in the rest of the visits.

*Table 1 - Predictors' descriptive statistics*

| Predictor | Descriptive |
|---|---|
| Age (Mean±Sd) | 60.7±9.6 |
| Gender (% female) | 44.2% |
| Hypertension (% patients) | 58.9% |
| Diabetes (% patients) | 56.8% |
| Dyslipidemia (% patients) | 69.6% |
| Cardiovascular disease (% patients) | 32.1% |
| Smoker (% patients) | 24.6% |

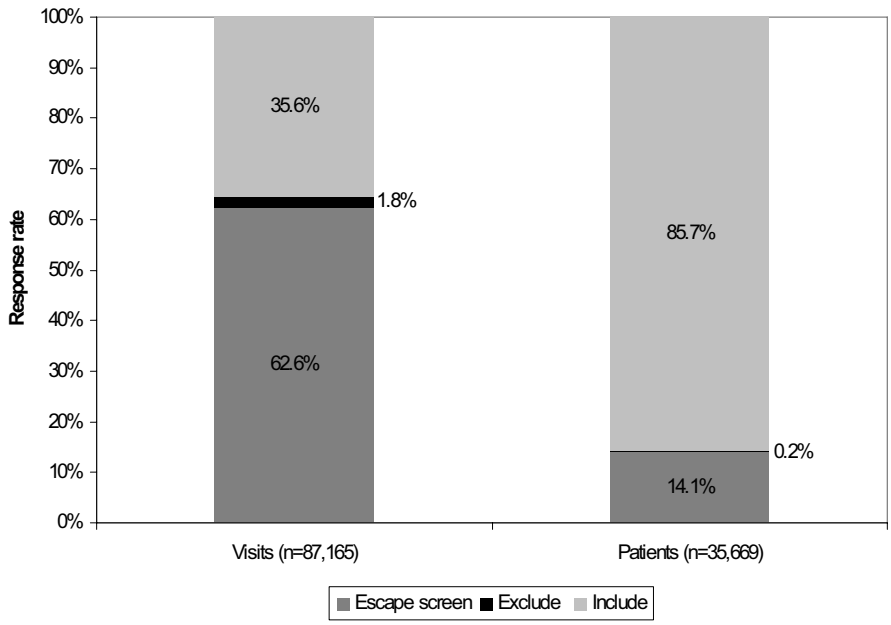


*Figure 2 - Inclusion, exclusion and escape rates*

**Enrollment prediction**

The logistic regression model (after backward elimination iterations) yielded that patients with a cardiovascular disease, dyslipidemia, diabetes or hypertension had a better chance to be included in the intervention (OR=1.880, 1.868, 1.729 and 1.278 respectively). Older patients had lower chance to be included (OR=0.991). Patient's gender and being a smoker did not play a significant role to predict the chance of being included in the intervention. Having a cardiovascular disease, dyslipidemia or diabetes were apparently more prominent factors for inclusion than hypertension (Table 2).

*Table 2 – Odds-ratios to include patients in the reminders intervention from the logistic regression model (n= 35,669 patients).*

| Predictor | OR (95.0% CI) |
|---|---|
| Age | 0.991 (0.988, 0.995) |
| Hypertension | 1.278 (1.198, 1.363) |
| Diabetes | 1.729 (1.616, 1.849) |
| Dyslipidemia | 1.868 (1.753, 1.990) |
| Cardiovascular disease | 1.880 (1.744, 2.027) |

*Note: This table shows the odds ratio of the estimated regression coefficients of the probability to enroll patients to the intervention with their 95% confidence intervals.*

## Discussion

CR systems are implemented under the assumption that they will be beneficial for the patient and the physician. The effectiveness of these systems relies almost entirely on physicians' compliance with them, and the patient's compliance with the physician. Physicians may respond to information from such systems in various behavioral responses [19].

The described system provides physicians with information about patients who can benefit from being included in a prevention intervention. Ideally, patients identified by the system as eligible for intervention (according to the evidence-based guidelines) should be included in the intervention. Nevertheless, one cannot expect the physicians to include all suggested patients and to include patients necessarily during their first visit (although this may have advantages). The data show that most patients suggested to be included in the intervention were eventually included (85.7%). However, these patients were included in only about one third of the visits (35.6%), and in the remaining 62.6% of the visits the physicians simply ignored the enrollment suggestion (i.e., escaped the enrollment screen). In other words, the physicians could actually prevent 54,554 interruptive pop-ups (62.6% of the total 87,165 visits) by either including or excluding the patient once the enrollment screen appeared. These 54,554 visits were "wasted", both because the patient was not enrolled in the intervention for the benefit of improved prevention, and because the system kept "nudging" the physicians in subsequent visits. This is a seemingly irrational

behavior of the physicians, and the reasons of such behavior require deeper exploration.

One way to explore this behavior is by looking at patients' characteristics, which may affect the physician's decision to include the patients in the intervention. The data show that patients with a cardiovascular disease, dyslipidemia, diabetes and hypertension had a better chance to be included in the intervention. Older patients had lower chance of being included in the intervention. Older patients' usually have more complex clinical conditions and co-morbidities, and the prevention of cardiovascular disease may be only one of conditions to handle. Patients' gender and being a smoker did not play a significant role for predicting the chance of being included in the intervention.

These data show that physicians apparently weighted these clinical markers when deciding whether a patient should be included to the intervention. The physicians are aware that once a patient will be enrolled, the system will send them treatment reminders and suggestions, which may interrupt future clinical encounters. Hence, they carefully pick the patients that will be included. Although they included the majority of the suggested patients, they did not automatically include all suggested patients, but apparently weighted their clinical markers.

The high "escape" rate can be explained by the nature of the reminders, as being interruptive to the current visit. Inclusion will result in further "interruptions", and when the physician chose to exclude a patient, the system will ask the physician to specify the exclusion reason. These two tasks may be unrelated to the reason for which the patient came to the visit, and may distract the physician from the patient's current complaints. "Escaping" the screen may seem to be an easy and less time-consuming option, since the physician can focus on the patient's complaints. Other reasons can be suggested for the high "escape" rate, such as alert fatigue, increased workload, deviance from traditional workflow, low motivation to use, emotional reasons, low perceived alert validity, usability issues, and system-specific reasons (e.g., physicians may ignore alerts when they sense that the specific guideline is not suitable for the specific patient, overall disagreement with a guideline, patient non-compliance, etc). Moreover, because the system was in an operative pilot at this period, it is possible that the physicians didn't know how to use the system, or were unaware of the benefits of using it, and hence chose to "escape" from the screen. The findings may suggest these as possible reasons, yet further research should explore the various reasons for such behaviors and physicians' motives for choosing them.

This system is unique in the physician's ability to choose which patients will be included in the intervention. CR systems typically generate reminders according to automatic patient identification without giving physicians control over the inclusion of patients. Hence physicians' usage of our system may be different from systems with forced reminders in which the physicians cannot choose upon which patients reminders will be given.

These results raise questions regarding the design of such system. System designers should be aware of such unintended consequences and strive to avoid them, either by using alternative ways to disseminate the information to physicians, improved user interfaces, organizational measures such as incentive systems, etc. Physician involvement in the design process, which is a theme which the MEDINFO conference is trying to highlight, is crucial to ensure competent and valuable systems.

## Conclusions

We evaluated factors which may affect clinicians' responses to suggestions to enroll patients to a CR intervention. The majority of the patients suggested for inclusion were eventually included. However, these patients were included in only about one third of the visits, and in the remaining visits the physicians ignored the enrollment suggestion. Patients with a cardiovascular disease, dyslipidemia, diabetes, hypertension or younger age had a better chance to be included in the intervention. System designers should be aware of such usage of reminder systems and regard to human-computer interface design and physicians' expectations and motives for use them. Further research should explore the various reasons for such behaviors, aiming at providing physicians with efficient and useful systems.

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## References

[1] Agency for Healthcare Research and Quality. National healthcare quality report. Available at: http://www.ahrq.gov/qual/nhqr04/nhqr04.htm. Accessed March 11, 2009.

[2] Chaudhry B, Wang J, Wu S, Maglione M, Mojica W, Roth E, Morton SC, Shekelle PG. Systematic review: impact of health information technology on quality, efficiency, and costs of medical care. Ann Intern Med 2006;16;144(10):742–52.

[3] Hunt DL, Haynes RB, Hanna SE, Smith K. Effects of computer based clinical decision support systems on physician performance and patient outcomes: a systematic review. J Am Med Assoc 1998;280,1339–46.

[4] Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, Sam J, Haynes RB. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. J Am Med Assoc 2005;293(10),1223–38.

[5] Kuperman GJ, Bobb A, Payne TH, Avery AJ, Gandhi TK, Burns G, Classen DC, Bates DW. Medication-related clinical decision support in computerized provider order entry systems: a review. J Am Med Inform Assoc 2007;14(1),29–40.

[6] Dexheimer JW, Talbot TR, Sanders DL, Rosenbloom ST, Aronsky D. Prompting Clinicians about Preventive Care Measures: A Systematic Review of Randomized Controlled Trials. J Am Med Inform Assoc 2008;15(3),311–320.

[7] Bates DW, Kuperman GJ, Rittenberg E, Teich JM, Fiskio J, Ma'luf N, Onderdonk A, Wybenga D, Winkelman J, Brennan TA, Komaroff AL, Tanasijevic M. A randomized trial of a computer–based intervention to reduce utilization of redundant laboratory tests. Am J Med 1999;106(2):144–50.

[8] Dexter PR, Perkins S, Overhage JM, Maharry K, Kohler RB, McDonald CJ. A computerized reminder system to increase the use of preventive care for hospitalized patients. N Engl J Med 2001;345(13),965–70.

[9] Demakis JG, Beauchamp C, Cull WL, Denwood R, Eisen SA, Lofgren R, Nichol K, Woolliscroft J, Henderson WG. Improving residents' compliance with standards of ambulatory care, results from the VA cooperative study on computerized reminders. J Am Med Assoc 2000;284(11),1411–6.

[10] Sequist TD, Gandhi TK, Karson AS, Fiskio JM, Bugbee D, Sperling M, Cook EF, Orav EJ, Fairchild DG, Bates DW. A randomized trial of electronic clinical reminders to improve quality of care for diabetes and coronary artery disease. J Am Med Inform Assoc 2005;12(4),431–8.

[11] Murray MD, Harris LE, Overhage JM, Zhou XH, Eckert GJ, Smith FE, Buchanan NN, Wolinsky FD, McDonald CJ, Tierney WM. Failure of computerized treatment suggestions to improve health outcomes of outpatients with uncomplicated hypertension, results of a randomized controlled trial. Pharmacotherapy 2004;24(3),324–37.

[12] Tierney WM, Overhage JM, Murray MD, Harris LE, Zhou XH, Eckert GJ, Smith FE, Nienaber N, McDonald CJ, Wolinsky FD. Effects of computerized guidelines for managing heart disease in primary care. J Gen Intern Med 2003;18(12),967–76.

[13] Ansari M, Shlipak MG, Heidenreich PA, Van Ostaeyen D, Pohl EC, Browner WS, Massie BM. Improving guideline adherence: a randomized trial evaluating strategies to increase beta-blocker use in heart failure. Circulation 2003;10, 107(22),2799–804.

[14] Ash JS, Sittig DF, Poon EG, Guappone K, Campbell E, Dykstra RH. The extent and importance of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc 2007;14(4),415–23.

[15] Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc 2006;13(5), 547–56.

[16] Sittig DF, Krall M, Kaalaas-Sittig J, Ash JS. Emotional aspects of computer-based provider order entry, a qualitative study. J Am Med Inform Assoc 2005;12(5),561–7.

[17] Conroy RM, Pyörälä K, Fitzgerald AP, Sans S, Menotti A, De Backer G, De Bacquer D, Ducimetière P, Jousilahti P, Keil U, Njølstad I, Oganov RG, Thomsen T, Tunstall-Pedoe H, Tverdal A, Wedel H, Whincup P, Wilhelmsen L, Graham IM; SCORE project group. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. Eur Heart J 2003; 24(11):987–1003.

[18] Grundy SM, Pasternak R, Greenland P, Smith S Jr, Fuster V. AHA/ACC scientific statement: Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. J Am Coll Cardiol 1999;34(4):1348–59.

[19] Vashitz G, Meyer J, Parmet Y, Peleg R, Goldfarb D, Porath A, Gilutz H. Defining and measuring physicians' responses to clinical reminders. J Biomed Inform 2009;42(2):317-26.

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