Cardiovascular Disease Prevention and Control: Clinical Decision-Support Systems (CDSS)

Summary Evidence Tables

Non-RCTs focused on CVD Prevention from Bright et al. Review*

Study	Study and Sample Characteristics	CDSS Intervention Characteristics	Results	Applicability and Summary
Study Authors (Year): Dorr, Wilcox, Donnelly, et al. (2005) **Study Focus:** Diabetes management **Suitability of design:** Greatest **Quality of Execution:** Fair (1 limitation) **Limitations:** Interpretation of results: contamination as control patients were seen in the same intervention clinic or similar clinics by the same physicians as intervention patients	**Geographical location:** Utah and Idaho **Study dates:** March 1, 2001 – September 30, 2002 **General setting:** Non-academic **Specific setting:** - Outpatient **Study design:** Other design with concurrent comparison **Duration of ongoing intervention:** 4-18 months **Sampling Frame (specify):** Individual HCP (N=11) A total of 7 IHC (intermountain healthcare clinics) clinics augmented their services by installing care managers and adding specific information technology. Four clinics without care managers served as control sites. > MDs (N=450); throughout IHC), 65 physicians in 7 intervention clinics > Care managers (N=7)	**Basic description of system:** Care managers utilized information technology which provided access to patient information, reminders and structures for best practices and enabled virtual communication integrated within IHC EHR system. The CDSS alerted and reminded care managers of specific tasks to perform and reminders when patients were overdue for various diabetes tests and displayed who needed follow-up calls for missed tests and patients with high test values. Care managers were able to store and retrieve information specific to workflow. **Evidence-based guidelines incorporated into CDSS:** Chronic disease guidelines developed by IHC from national resources for diabetes and hyperlipidemia **Other interventions delivered:** team-based care **Source/origin of system:** NR **Content:** **Objective(s):** - Chronic disease management - Initiating discussion with patient	**Recommended clinical test ordered/completed** **HbA1c testing completed if overdue** Baseline: Comparison (n=4,470): NR Intervention (n=1,185): NR F/U: 4-18m: Comparison (n=4,470): NR Intervention (n=1,185): NR **Odds ratio (95%CI): 1.49 (1.3, 1.71)** **LDL testing completed if overdue** Baseline: Comparison (n=4,470): NR Intervention (n=1,185): NR F/U: 4-18m: Comparison (n=4,470): NR Intervention (n=1, 185): NR **Odds ratio (95%CI): 1.26 (1.02, 1.57)** **CVD risk factors** **Lipids** ***Change in LDL (mg/dL)*** Baseline: Mean (SD) Comparison (n=4,470): 104.3 (33.2) Intervention (n=1,185): 102.8 (32.7)	**Applicability:** From this study, mainly to primary care providers and care managers working in a large health system with established EHRs enhanced with clinical information systems to provide alerts, reminders and virtual communication between team members. Applicable majority white, middle-aged (60 yrs.) patients with diabetes **Summary:** This study demonstrates a statistically significant improvement in adherence to diabetic guidelines when generalist care managers with enhanced computer support are involved in the care of people with diabetes. However, patients between the age of 20-29 or 80 years and older, higher risk patients, and those with an irregular testing history

*Bright TJ, Wong A, Dhurjati R, et al. Effect of Clinical Decision-Support Systems: A Systematic Review. *Ann Intern Med* 2012; 157(1): 29-43. Evidence tables for all RCTs from Bright review can be found at: http://www.ncbi.nlm.nih.gov/books/NBK97318/pdf/TOC.pdf.

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See Previous	Patients (N=25,273) as determined by a diabetes registry from patients seen in both intervention and control clinics. A total of 1,185 exposure patients were analyzed. A total of 4,470 controls were matched to the study subsets. **Unit of allocation (if applicable):** Clinic **User level of expertise/proficiency/ training (specify):** Providers at IHC clinics already had information technology through EHRs **Patient Demographics:** **-** Age (mean): 59.9 yrs.	**Relationship to point of care:** - Can't tell **Response requirement:** - NR (assume no response requirement) **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE **Delivery mode:** - System-initiated ("push") **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** none **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** CDSS accompanied by conventional education **Comparator(s):** - Another CDSS/KMS: control clinics had access to information technology integrated within their EHR system which provided access to patient information, reminders and structures for best practices and enabled virtual communication. They did not have access to the enhanced alerts and reminders used by intervention care managers	F/U: 4-18m: Comparison (n=4,470): 100.6 (30.4) Intervention (n=1,185): 96.7 (28.3) **Change in mean difference: -2.4 (p=0.09)** **Diabetes** ***Prop. with A1c control*** Baseline: Comparison (n=4,470): 43.6% Intervention (n=1,185): 43.6% F/U: 4-18m: Comparison (n=4,470): NR Intervention (n=1,185): NR **Odds ratio (95%CI): 1.31 (1.14, 1.51)** ***Change in A1c level*** Baseline: Mean (SD) Comparison (n=4,470): 7.71 (1.53) Intervention (n=1,185): 7.96 (1.74) F/U: 4-18m: Comparison (n=4,470): 7.53 (1.36) Intervention (n=1,185): 7.41 (1.38) **Change in mean difference: -0.28 (p<0.01)** **all results adjusted for: age, sex, race, risk score (number of co-morbidities), testing history, and control history.*	had worse odds of being tested when overdue for HbA1c and LDL and were less likely to have their A1c levels controlled.

Study	Study and Sample Characteristics	CDSS Intervention Characteristics	Results	Applicability and Summary
Study Authors (Year): Gill, Ewen, and Nsereko (2001) **Study Focus:** Multiple disease conditions including CVD prevention **Suitability of design:** Least **Quality of Execution:** Fair (3 limitations) **Limitations:** Description: Race and SES not reported; Sampling: Potential selection bias with 3,000 'active' patients considered Data analysis: Underestimation of the interventions due to accuracy of data source – potential overlap with receiving services at other points of care not addressed	**Geographical location:** Wilmington, Delaware **Study dates:** pre-1998-1999 (unclear how far back they went before EMR implementation in July 1998 but post-EMR data was extracted in November 1999 but considered at 1 year after EMR implementation) **General setting:** Academic **Specific setting:** Outpatient: Family Medicine Center of Christiana Care Health System **Study design:** Uncontrolled before/after (data reported as before/after) **Duration of ongoing intervention:** Data considered 12 months after EHR implementation **Sampling Frame (specify):** Family Medicine Center (N=1): Approximately 15,000 visits per year, 6 faculty, and 25 resident physicians (31 MDs); all see patients on a part-time basis. Patients (N=3,740) Included active patients in the center prior to implementation of EMR and at time of data extraction. This included 1148 eligible patients for cholesterol screening and 117 with diabetes eligible for cholesterol testing and	**Basic description of system:** System provided (1) Better organization of traditional medical chart with problem list and medication list automatically updated at the end of each office visit; (2) EMR flow sheets with data on tests, procedures etc. allowing physicians to access any of multiple flow sheets; (3) Use of locally developed protocols based on USPSTF and ADA guidelines; (4) Automated reminders to physicians whenever recommended interventions are due; and (5) EMR provision of reports to identify patients in need of interventions provided to either patient or PCPs **Evidence-based guidelines incorporated into CDSS:** USPSTF and ADA guidelines **Other interventions delivered:** NR **Source/origin of system:** - Commercially available **Content:** **Objective(s):** - Immunization - Lab test ordering - Preventive care **Relationship to point of care:** - Synchronous **Response requirement:** - NR (unclear) **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE **Delivery mode:** - System-initiated ("push") **Contextual factors/features**	**Recommended preventive care ordered/completed:** **Change in Cholesterol screening for all eligible adults (male: 35-64; female: 45-64):** Baseline: (%) Intervention (n=1148): 27.6% F/U: 12m Intervention (n=1148): 46.8% **Absolute percentage point change: +19.2 pct pts** **Recommended clinical test ordered:** **Change in Cholesterol testing for diabetes patients** Baseline: (%) Intervention (n=117): 38.5% F/U: 12m Intervention (n=117): 60.7% **Absolute percentage point change: +22.2 pct pts** **Change in Hemoglobin A1c testing for diabetes patients** Baseline: (%) Intervention (n=117): 53.0% F/U: 12m Intervention (n=117): 80.3% **Absolute percentage point change: +27.3 pct pts**	**Applicability:** Applicable to an academic family medicine center with an EHR system with locally developed protocols based on USPSTF and ADA guidelines. Applicable to 'active' patients with preventive care needs, as well as 'active' patients specifically diagnosed with diabetes. **Summary:** This study demonstrates that one type of EHR with CDSS capabilities providing better organization of data, flow sheets, protocols based on guidelines, reminders for providers, and reports for patients and/or PCPs is associated with substantial improvements in uptake of a number of preventive services; both general services (e.g. immunizations) and services specific to diabetes populations (e.g. HbA1C testing and cholesterol screening).

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See Previous	HbA1C testing. **Unit of allocation (if applicable):** N/A **User level of expertise/proficiency/ training (specify):** NR **Patient Demographics:** **-** Age (%): >0-14 (12.2%) >15-24 (10.8%) >25-44 (39.3%) >45-64 (24.8%) >Over 65 (12.9%) **-** Gender > Male: 41.7% > Female: 58.3% - Race/Ethnicity: NR	**influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow + No need for additional clinician data entry **+** Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** Local user involvement in development process **+** Provision of decision support results to patients as well as providers **+** CDSS accompanied by periodic performance feedback **Comparator(s): N/A**	See Previous	See Previous
Study Authors (Year): Goldberg, Neighbor, Cheadle, et al. (2000) **Study Focus:** Screening **Suitability of design:** Greatest **Quality of Execution:** Fair (3 limitations) **Limitations:** Interpretation of results:	**Geographical location:** Seattle, Washington **Study dates:** July 1 - November 30, 1996 **General setting:** Academic **Specific setting:** Outpatient: Satellite clinic of the Family Medical Center at the University of Washington **Study design:** Non-randomized trial with time-series data **Duration of ongoing**	**Basic description of system:** The CDSS ran against the center repository (pre-existing), and based on age, sex, and diagnoses, the CDSS reminder prompted the performance of indicated preventive and chronic disease processes and the collection of both physiological and functional outcome measures. The program acts as a population monitor, preprocessing the current status of all primary care patients on all reminders each evening so that this information can be stored and displayed the following day. A printed one-page sheet was also placed on top of the clinic chart of each patient visiting the center. Prior to the trial's conclusion, output of the	**Recommended preventive care ordered/completed** **Change in cholesterol screening rates:** Baseline: (%)Comparison (n=1,222):13.0% Intervention (n=1,433):18.0% F/U: 2m Comparison: (n=1,222): 7.0% Intervention (n=1,433): 11.0% **Absolute percent pt. change: -1.0 pct pts**	**Applicability:** Applicable to academic family medicine clinics with a team consisting of a resident physician, physician assistant, and faculty members. The CDSS was applied to a pre-existing repository. Applicability of findings might be limited by update of USPSTF guidelines during the study recommending cholesterol screening for a smaller proportion of the population. Applicable to middle-aged (43 yrs. old)

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Possible contamination due to co-location of the intervention and control group + Analysis did not control for USPSTF guidelines and other recommendations changing during the intervention period+ study reported race for one population group (whites), but did not report for others	**intervention:** 2 months **Sampling Frame (specify):** Satellite facility of a family medical center (N=~7,700 patients): Each of the three small teams within the center is staffed with 2-3 faculty members, a resident physician, and a fulltime physician assistant. Each team had dedicated nurses, medical assistants, and receptionists. Patients (N=2,655): Established patients between the ages of 18-75, with visit during the last two years, were sampled. Of the 2, 655 patients, 1,433 were in the intervention group and 1,222 in the control group. Clinicians (n=42) Intervention and control groups both had 21 physicians. Clinicians were geographically divided into two teams, each with its own personnel, exam room, and waiting area. Each team was staffed by three small teams of 2-3 faculty members, a representative of each of the three residency class years, and a fulltime physician assistant. **Unit of allocation (if applicable):** Team **User level of expertise/proficiency/ training (specify):**	reminder system was also available online. **Evidence-based guidelines incorporated into CDSS (specify):** USPSTF and the National Committee for Quality Assurance guidelines (were updated during the study period) **Other interventions delivered:** NR **Source/origin of system:** Can't Tell **Content:** **Objective(s):** - Lab test ordering - Preventive care **Relationship to point of care:** - Synchronous **Response requirement:** - NR (unclear whether response requirement) **Information delivery:** **Delivery format:** - Paper-based (during the study). At the end of the study, the CDSS was made available online. **Delivery mode:** - System-initiated ("push") **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow **+** No need for additional	See Previous	white women with private health insurance seeking care in one of the facilities of the University of Washington Medical Centers **Summary:** This 4-month non- randomized study examining the effectiveness of a clinical reminder system (embedded in a pre-existing repository) resulted in a modest decrease in cholesterol screening activity for both the intervention and control groups. This could be due to the USPSTF changing its guidelines on cholesterol screening during the study period and recommending that young adults at low risk for ischemic heart disease not be screening for cholesterol. This updated recommendation while actively discussed among study providers was not incorporated into the CDS system during the study period. Additionally, mammography screening increased for the intervention group by 154 percent, and no effect was observed for fecal occult blood testing.

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See Previous	University of Washington Academic Medical Centers previously employed the Medical Information Network Database (MIND) repository, which used information such as billing, pharmacy, laboratory, radiology, pathology, and transcription computing systems to generate patient records. The CDSS reminder system was a new aspect of this study. **Patient Demographics:** **-** Age (mean): 42.9 yrs. **-** Gender (n=1433) > Male: 33.7% > Female: 66.3% - Race/Ethnicity: > White: 79.1% > Black: NR > Hispanic: NR Insurance Type: (if reported) >Private: 71.2% >Public: 19.9% >Other: 8.9 (%) Co-morbidities: Ischemic heart disease: 5.7%	clinician data entry **+** Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** Local user involvement in development process **Comparator(s):** - Usual care/no CDSS or KMS: The facilities of the UW Academic Medical Centers had a pre-existing clinical data repository which was implemented in 1989. This repository would later be used collaboratively with the CDSS clinical reminder system implemented in 1995.	See Previous	See Previous
Study Authors (Year): O'Connor, Crain, Rush, et al (2005) **Study Focus:** Diabetes Management **Suitability of design:** Greatest **Quality of Execution:** Fair (2	**Geographical location:** Minnesota, US **Study dates:** 1994-2000 **General setting:** Non-academic **Specific setting:** - Outpatient: Community primary care practice (HealthPartners)	**Basic description of system:** Intervention utilized a commercially available EHR system used to provide all office care (not just diabetes) including visit notes, automated ordering of pharmaceuticals, current displays of all laboratory and test results on request, and a problem list. Specific to diabetes: prompts to physicians if a patient with diabetes had no HbA1C test within 6 months or no urine microalbuminuria test within 1 year, and prompts to physicians when	**Recommended clinical test ordered/completed** **Number of HbA1c tests performed (per patient per year)** Baseline: Mean Comparison (n=65): 1.75 Intervention (n=57): 1.67 F/U: 48m. Comparison (n=65): 1.63 Intervention (n=57): 2.46 **Change in mean difference: +0.91 (p=0.001; f/u only)**	**Applicability:** This study involved a, community outpatient clinic which is a leader in quality care within a large multispecialty medical group with 4-5 physicians per clinic using a commercially available EHR system providing physician prompts for diabetes and lipid testing and also part of a larger

Study	Study and Sample Characteristics	CDSS Intervention Characteristics	Results	Applicability and Summary
limitations) **Limitations:** Description: No race/ethnicity or SES data reported Interpretation of results: >10% difference between intervention and comparison group sample sizes	**Study design:** Other design with concurrent comparison **Duration of ongoing intervention:** 48 months **Sampling Frame (specify):** Clinicians/practices/hospitals - Individual HCPs (N=18): A total of 2 clinics from HealthPartners (a multispecialty medical group providing care to 175,000 adults in 18 clinics) were included in this study, one EMR intervention clinic and one comparison clinic (without EMR) > MDs: (N=4 to 5 per clinic) - Patients (N=122): patients meeting inclusion criteria were included: n=57 in the EHR (intervention) group and n=65 in the comparison clinic **Unit of allocation (if applicable):** Clinic **User level of expertise/proficiency/training (specify):** Providers in the EHR clinic received extensive formal and ongoing one-on-one support through Information Services at HealthPartners, with expert consultation from Epic (EHR developer) as needed. All clinical data were loaded from several previous years, and after EHR implementation, paper charts were no longer available	diabetic patients had blood pressures of ≥130/85 mmHg, LDL levels of ≥130 mg/dL, HbA1c levels ≤8% or no aspirin use if aged 40 years or older. **Evidence-based guidelines incorporated into CDSS:** Not specified but seems like standard American guidelines **Other interventions delivered:** Team-based care; Intervention clinic also participated in a multifaceted improvement strategy to enhance diabetes care including one-on-one phone counseling on weight management, physical activity, stress management, and smoking cessation; provider performance feedback; and ongoing provider education. All clinics in the medical group had access to physician-specific diabetes registries that were distributed quarterly in printed form, in-clinic diabetes teaching nurses for patient education, and a common diabetes clinical guideline developed regionally. **Source/origin of system:** - Commercially available **Content:** **Objective(s):** - Pharmacotherapy - Lab test ordering - Chronic disease management **Relationship to point of care:** - Synchronous **Response requirement:** - No response requirement **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE	**Number of LDL tests performed (per patient per year)** Baseline: Mean Comparison (n=65): 0.49 Intervention (n=57): 0.54 F/U: 48m. Comparison (n=65): 0.92 Intervention (n=57): 1.45 **Change in mean difference: +0.48 (p=0.19; f/u only)** **Prop. of patients with ≥2 HbA1c tests as recommended** Baseline: (%) Comparison (n=65): 55.4 Intervention (n=57): 47.4 F/U: 48m. Comparison (n=65): 53.9 Intervention (n=57): 78.9 **Absolute percentage point change: +33.0 pct pts (p=0.002; f/u only)** **Prop. of patients with ≥1 LDL tests as recommended** Baseline: (%) Comparison (n=65): 46.2 Intervention (n=57): 42.1 F/U: 4yrs. Comparison (n=65): 72.3 Intervention (n=57): 84.2 **Absolute percentage point change: +16.0 pct pts (p=0.12; f/u only)** **Prop. of patients with ≥2HbA1c tests AND ≥1 LDL tests as recommended** Baseline: (%) Comparison (n=65): 30.8 Intervention (n=57): 29.8	multifaceted improvement strategy to enhance diabetes care. Findings are applicable (albeit from this small sample size study) to community primary care practices with EMRs and CDS for middle-aged patients (60 years) receiving diabetes management with a Charlson comorbidity score <2. **Summary:** In this study, EHR use was associated with improved process of care for adults with diabetes. Patients who attended the EHR clinic had more HbA1c tests than patients in the comparison clinic, and more patients in the EHR clinic met recommended thresholds for HbA1c an LDL test frequency than did patients in the comparison clinic. There was no evidence however, that this change in process of care led to better glycemic control in the EHR clinic patients during the 4-year follow-up period. Minimal changes in A1c level could be due to the fact that A1c was already improving steadily for 4 years independent of EHR implementation. Of note, HbA1c levels in the EHR

Study	Study and Sample Characteristics	CDSS Intervention Characteristics	Results	Applicability and Summary
See Previous	**Patient Demographics (n=57):** **-** Age (mean): 60.6 yrs. **-** Gender > Male: 54.4% > Female: 45.6% - Race/Ethnicity: NR - Co-morbidities: Charlson co-morbidity score > Charlson <2: 73.7% > Charlson = 2: 15.8% > Charlson > 2: 10.5%	**Delivery mode:** - System-initiated ("push") **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow **+** No need for additional clinician data entry **+** Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** none **Other (specify):** CDSS was updated periodically covering new processes **Comparator(s):** - Usual care/no CDSS or KMS: comparison clinic did not use an EHR	F/U: 4yrs. Comparison (n=65): 46.2 Intervention (n=57): 70.2 **Absolute percentage point change: +25.0 pct pts (p=0.03; f/u only)** **CVD risk factors** **Diabetes** ***Change in A1c levels (%)*** Baseline: Mean Comparison (n=50): 7.35 Intervention (n=46): 7.80 F/U: 4yrs. Comparison (n=50): 7.11 Intervention (n=46): 7.71 **Change in mean difference: +0.15% (p=0.27; f/u only)** **Change in LDL could not be calculated as there were too few patients with LDL measurements during the 3 periods to provide stable statistical estimates. There was no evidence, however that EMR use led to lower LDL levels*	clinic worsened for a period of about 2 years potentially for having to adjust to new clinical workflow processes. Authors suggest that the EHR performance needs major improvement including more sophisticated clinical decision support and effective use of the EHR as a patient education and patient activation tool.
Study Authors (Year): Toth-Pal, Nilsson, and Furhoff (2004) **Study Focus:** Screening **Suitability of design:** Greatest **Quality of**	**Geographical location:** Stockholm, Sweden **Study dates:** April 1993-December 1994, then a 20 month follow-up from February 1995 to September 1996 **General setting:** Non-academic	**Basic description of system:** All four primary health centers used Swedestar, a problem-oriented electronic patient record system used widely in Sweden. The system allowed for recording of diagnoses and laboratory tests results, searching of events via integration with a medical query language program, and provided a list of recommended tests for individual patients. The intervention	**Recommended preventive care ordered/completed** **Change in hypertension screening rates** Baseline: (%) Comparison (n=1822): 84.1% Intervention (n=769):80.1% F/U: 20m: Comparison: (n=1989): 84.3% Intervention (n=602):97.6%	**Applicability:** From this study, mainly to primary care clinics in Sweden using electronic medical records integrated with a reminder system for screening. Applicable to mainly women seeking care at a primary care center in Sweden.

Study	Study and Sample Characteristics	CDSS Intervention Characteristics	Results	Applicability and Summary
Execution: Fair (3 limitations) **Limitations:** Description: Race/ethnicity or SES not provided Interpretation of results: Possible contamination due to co-location of intervention group and one of the control groups; + Baseline groups not comparable for number of patients who had undergone test.	**Specific setting:** - Outpatient **Study design:** Other design with concurrent comparison group **Duration of ongoing intervention:** 20 months **Sampling Frame (specify)** Primary health care center (N=4): The intervention center had five physicians and one trainee doctor. The three control centers had 12 physicians and two trainee doctors. Patients (N=~32,000): Intervention patients: n= 602; control patients: n=1989 **Unit of allocation:** Clinic **User level of expertise/proficiency/ training (specify):** All four clinics used an electronic patient record system, which had been available to them since the 1980's. Providers were given a brief introduction to the system prior to the study. **Patient Demographics:** **-** Age (mean): NR **-** Gender: > Male: 35% > Female: 65% - Race/Ethnicity: NR -Comorbidities:	was voluntarily triggered by the GP at the time of patient encounter. It adjusted the list of the five screening tests to the patient and removed the test in question if the system already included: (1) the concerned diagnosis; (2) specified medical treatments (cobalamin or levothyroxin) or (3) a note that the test had already been done within the past 6 months (12 months for *S*-cobalamin and *S*-thyrotropin) and that the result was not pathological. A list of recommended tests for the individual patient was then presented on the screen within a few seconds. The GP thereafter decided which tests should be done **Evidence-based guidelines incorporated into CDSS:** N **Other interventions delivered:** NR **Source/origin of system:** - Commercially available **Content:** **Objective(s):** - Diagnosis - Preventive care **Relationship to point of care:** - Synchronous **Response requirement:** - NR (unclear whether response requirement) **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE **Delivery mode:**	**Absolute percentage point change: +17.3 pct pts; p<0.05** **Change in diabetes screening rates** Baseline: (%) Comparison (n=1822): 61.4% Intervention (n=769):35.3% F/U: 20m Comparison: (n=1989): 67.0% Intervention (n=602):93.2% **Absolute percentage point change: +52.3 pct pts; P<0.05** **CVD risk factors** **Blood Pressure** ***Prop. With BP control (SBP >160 mmHg)*** Baseline: Mean (SD) Comparison (n=1822):NR Intervention (n=769):NR F/U: 20m Comparison (n=1989):62.0% Intervention (n=602):49.9% **Absolute pct. pt. change (95% CI): -12.1 pct pts (-17.5, -6.7); p>0.05** ***Prop. With BP control (DBP >90 mmHg)*** Baseline: Mean (SD) Comparison (n=1822):NR Intervention (n=769):NR F/U: 20m Comparison (n=1989):76.2% Intervention (n=602):75.9% **Absolute pct. pt. change (95% CI): -0.3 pct pts (-5.0, 4.4); p>0.05** **Diabetes**	**Summary:** The 20-month intervention increased the number of patients screened for hypertension and diabetes when clinical reminder systems were used by providers. Improvements were also noted for the proportion of patients with controlled BP and diabetes.

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See Previous	> Hypertension: 31% > Diabetes: 12.1%	- System-initiated ("push") **<u>Contextual factors/features influencing the implementation and use of CDSS included in CDSS:</u>** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow + Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** none **Other (specify):** NR **<u>Comparator(s):</u>** - Another CDSS/KMS; the control centers used the same electronic medical record system used by the intervention; however, screening was only conducted in the intervention clinic.	***Prop. with diabetes control (fasting blood glucose ≥120.7 mg/dL; non fasting blood glucose ≥144.1 mg/dL)*** <u>Baseline: Mean (SD)</u> Comparison (n=1822):NR Intervention (n=769):NR <u>F/U: 20m</u> Comparison (n=1989):3.60% Intervention (n=602):4.90% **Absolute pct. pt. change (95% CI): 1.3 pct pts (-0.7, 3.4); p>0.0**	See Previous

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Studies Focused on CVD Prevention from Updated Search Period (Jan 2011 – Oct 2012)

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
Study Authors (Year): Eaton, Parker, Borkan, et al. (2011) **Study Focus:** Lipid screening and management **Suitability of design:** Greatest **Quality of Execution:** Fair (3 limitations) **Limitations:** Interpretation of results: Baseline groups not comparable for physicians having experience using PDA devices + Recruitment rate < 20% + some data for analyses came from telephone interviews and in-person questionnaires, thus recall bias may be an issue	**Geographical location:** Southeastern New England **Study dates:** June 2003 - June 2006 **General setting:** Non-academic **Specific setting:** - Outpatient (30 primary care practices throughout Southeastern New England) **Study design:** Cluster RCT **Duration of ongoing intervention:** - 12 months (main outcome was patients at LDL and non-HDL goal within 1 year of the intervention). Baseline data collected June 2003 to May 2005. Follow-up data collected October 2005 to June 2006. **Sampling Frame (specify):** Clinicians/practices/hospitals - Individual HCPs (N=30): Thirty primary care physician practices were randomized to either the intervention or control group (n=15 practices in the intervention group, n=15 practices in the control group) > Family Practice (N=15): 7 clinics in the intervention group and 8 clinics in the control group were family practices > Internal Medicine (N=15):	**Basic description of system:** It is not reported whether practices already some type of EHR or other CDSS in place prior to study start. All practices (intervention and control) received a 1-hour academic detailing session where ATP III cholesterol guidelines were discussed and abbreviated guideline pocket guides were given to each physician. The intervention group received a PDA-based decision support tool and 4 booster academic sessions which included a PowerPoint presentation on the ATP III guidelines, reprints of the ATP III guidelines and NHLBI ATP III pocket guides, review of new clinical trial evidence regarding lipid management and coronary heart disease, updated guidelines, barriers and facilitators of the use of PDA decision support tool, the patient activation tool, and use of the patient education toolkits. The PDA software determined the patient's lipid diagnosis, calculated the ATP III LDL and non-HDL cholesterol goals, made recommendations regarding therapeutic lifestyle management, provided optimal dosage of lipid-lowering drugs tailored to the patient's risk factor status to meet the ATP III goals, and provided an interactive shared decision making page for physicians to discuss lowering lipid values in the context of HeartAge, absolute and relative risks, and other CHD risk factor management. **Evidence-based guidelines incorporated into CDSS:** ATP III cholesterol guidelines **Other interventions delivered:**	**Recommended clinical test completed** **Cholesterol Screening** Baseline: % Comparison (n=NR): NR Intervention (n=NR): NR F/U: 12m Comparison (n=2,105): 89.0% Intervention (n=2,000): 89.0% **Absolute pct pt change: 0** **CVD risk factors** **Lipids** ***Prop. with LDL at goal (goal not specified)*** ***CHD Equivalent Risk group** Baseline: (%) Comparison (n=368): 53.0% Intervention (n=405): 61.0% F/U: 12m Comparison (n=425): 45.0% Intervention (n=450): 46.0% **Absolute percentage point change: -7.0 pct pts** ***High Risk Group** Baseline: (%) Comparison (n=213): 66.0% Intervention (n=180): 70.0% F/U: 12m Comparison (n=248): 47.0% Intervention (n=208): 59.0% **Absolute percentage point change: +8.0 pct pts** ***Moderate Risk Group** Baseline: (%) Comparison (n=475): 68.0% Intervention (n=360): 74.0% F/U: 12m	**Applicability:** From this study, mainly to primary care physicians practicing medicine on average for 15 years in family medicine, internal medicine, or hospital affiliated clinics in Southeastern New England implementing a multimodal intervention using a PDA decision support system for lipid diagnosis and management accompanied with academic detailing sessions and a patient focused component including patient education tool kits, and a patient kiosk for calculation of CHD risk. This study is applicable to married white women patients with a Low CHD risk (1 CHD risk factor). **Summary:** A well-designed multimodal practice guideline implementation study in primary care practice employing a PDA decision support system, patient education toolkit, and patient kiosk allowing patients to calculate their own HeartAge, showed no benefit to the intervention and found a strong secular trend of increased cholesterol screening and

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See Previous	8 clinics in the intervention group and 7 clinics in the control group were internal medicine clinics >Hospital affiliated (N=5): 3 clinics in the intervention group and 2 clinics in the control group were hospital affiliated > MDs (N=55): a total of 26 physicians were assigned to the intervention group and 29 physicians assigned to the control group. Physician specialty not reported > Nurse Practitioner/Physician's assistant (N=12): A total of 7 in the intervention clinics and a total of 5 in the control clinics - Patients (N=4,105): A total of 2,105 patients attended the intervention clinic and 2,161 patients attended the control clinic **Unit of allocation (if applicable):** - Clinic **User level of expertise/proficiency/ training (specify):** Approximately 50% of physicians in intervention group had previous experience with some type of PDA device **Patient Demographics (n=2,000):** - Age (mean): 54.0 yrs. - Gender > Male: 39.7%	Physicians also received a patient education toolkit which consisted of smoking cessation, weight loss, healthy diets, exercise, and lipid-lowering medication adherence materials. A companion website was developed to download these materials and to allow patients or physicians to recalculate the patient's HeartAge. In addition, patients utilized a patient activation tool. Using touch-screen technology, patients answered questions regarding their risk factors for CHD into a computerized kiosk. The subsequent 10-year CHD risk was calculated. **Source/origin of system:** Can't Tell **Content:** **Objective(s):** - Diagnosis - Chronic disease management - Pharmacotherapy **Relationship to point of care:** - Synchronous **Response requirement:** - NR (assume no response requirement) **Information delivery:** **Delivery format:** - Standalone system (PDA with CDSS software integration) **Delivery mode:** - System-initiated ("push") **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** none **Clinician-System Interaction Features:** Automatic provision of	Comparison (n=536): 55.0% Intervention (n=448): 61.0% **Absolute percentage point change: 0 pct pts** ***Low Risk Group** Baseline: (%) Comparison (n=1049): 90.0% Intervention (n=1055): 92.0% F/U: 12m Comparison (n=896): 73.0% Intervention (n=894): 74.0% **Absolute percentage point change: -1.0 pct pts** ***Prop. with non-HDL at goal (goal not specified)*** **CHD Equivalent Risk group** Baseline: (%) Comparison (n=368): 52.0% Intervention (n=405): 61.0% F/U: 12m Comparison (n=425): 43.0% Intervention (n=450): 46.0% **Absolute percentage point change: -6.0 pct pts** **High Risk Group** Baseline: (%) Comparison (n=213): 64.0% Intervention (n=180): 75.0% F/U: 12m Comparison (n=248): 47.0% Intervention (n=208): 61.0% **Absolute percentage point change: +3.0 pct pts** **Moderate Risk Group** Baseline: (%) Comparison (n=475): 69.0% Intervention (n=360): 79.0% F/U: 12m Comparison (n=536): 56.0% Intervention (n=448): 61.0%	goal attainment in both intervention and usual care groups. Post hoc analysis showed some potential benefit from the use of patient activation and physic ian decision support using a shared decision-making tool to improve cholesterol screening and management in primary care practices.

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See Previous	> Female: 60.3% - Race/Ethnicity: > Black: 1.3% > White: 95.8% > Hispanic: 1.3% > American Indian: 0.5% > Asian: 0.7% > Missing: 0.2% - Current Smoker: 10.8% - Comorbidities: > Diabetes: 11.2% > Hypertension: 41.9% > Lipid Disorder: 56.9% > Obese: 17.5% > Metabolic syndrome:1.6%	decision support as part of clinician workflow **+** Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** CDSS accompanied by conventional education **Comparator(s):** - Usual care/no CDSS or KMS: Comparison group received a 1-hour academic detailing session along with intervention group (see description in basic description of system). Comparison practices also received a PDA but without the decision support tool and had minimal further contact to mimic usual care.	**Absolute percentage point change: -5.0 pct pts** **Low Risk Group** Baseline: (%) Comparison (n=1049): 92.0% Intervention (n=1055): 92.0% F/U: 12m Comparison (n=896): 74.0% Intervention (n=894): 75.0% **Absolute percentage point change: +1.0 pct pt** **CHD equivalent = diabetes, coronary heart disease, or 20% or greater 10-year risk of CHD* **High risk = 2 or more risk factors and a 10% to 20% 10-year risk of CHD* **Moderate risk = 2 or more risk factors but less than 10% 10-year risk of CHD* **Low risk = 1 CHD risk factor*	See Previous
Study Authors (Year): Herrin, Graca, Nicewander, et al. (2012) **Study Focus:** Diabetes Management **Suitability of design:** Greatest **Quality of Execution:** Fair (3 limitations) **Limitations:** Description: Race/ethnicity and SES not reported Interpretation of	**Geographical location:** Northern Texas **Study dates:** January 1, 2005-December 2010 **General setting:** Academic; Health Texas Provider Network, Baylor Health Care System **Specific setting:** - Outpatient **Study design:** Prospective cohort **Duration of ongoing intervention:** - 42 months (Since EHR was	**Basic description of system:** Paper records were used by HTPN prior to implementation of the EHR evaluated in this study. The EHR incorporated clinical content and decision support, physician-physician message and implements one single patient record throughout HTPN. When a physician selects “diabetes” from the problem list, two automated reminders related to evidence-based diabetes care recommendations appear as screen pop-ups and reminders for overdue diabetes-related tests and examinations. Selecting “yes” on these prompts auto-fills the relevant fields in all related sections of the medical record automatically creating orders for all needed laboratory tests and services. A second tool utilized was a	**Recommended preventive care ordered/completed** **Smoking assessment** Baseline: (%) Comparison: NR Intervention: NR F/U: 6 months** Comparison: (n=NR): 94.3% Intervention (n=NR): 98.6% **Absolute percentage point change: +4.3 pct pts** **Recommended clinical test ordered/completed** **Prop. of patients with A1C test ordered** Baseline: (%) Comparison: NR Intervention: NR F/U: 6 months**	**Applicability:** From this study, mainly to a large ambulatory provider network transitioning from paper-based records to a comprehensive commercially available EHR system with clinical decision support. For patients, applicable to adults >40 years who seek care in primary care centers with EMRs in Texas. **Summary** Implementation of a comprehensive EHR system with decision support over a 4-year

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results: Groups not comparable at baseline for age, A1C, and insulin + inability to differentiate between true changes in practice and changes in documentation for healthcare process measures	rolled out in a staggered basis, clinic by clinic, length of exposure to the EHR varied for patients) **Sampling Frame (specify):** A large, not-for-profit integrated health system with >100 practices, 450 physicians, and >1 million patient encounters annually. - Family and internal medicine clinics (n=34) were included in this study. - Patients (n=14, 051) >40 years old with diabetes + ≥2 ambulatory visits during the preceding 12 months were included in the year cohort. 6,376 patients were eventually seen in practices using the EHR at the time of their visit. Clinicians/practices/hospitals - Individual HCPs (N=34): A total of 34 practices met inclusion criteria, of which 29 had implemented the EHR before the first day of the last study year. **Unit of allocation (if applicable):** - NA; all clinics within the HealthTexas provider Network (HTPN) eventually received the new EHR system. The EHR was implemented on a staggered scheduled over several years. **User level of expertise/proficiency/training (specify):** Inclusion criteria required	voluntary Diabetes Management Form (DMF), a documentation tool that provides prompts which focus on important diabetes-related facets of the clinical encounter, and asks specific diabetes-related questions and actions to improve documentation practices. The system provided real-time evidence based clinical decision support in the form of reminders prompting compliance with clinical guidelines. **Evidence-based guidelines incorporated into CDSS:** Yes, but not specified **Other interventions delivered:** NR **Source/origin of system:** - Commercially available **Content:** **Objective(s):** - Immunization - Pharmacotherapy - Lab test ordering - Chronic disease management **Relationship to point of care:** - Synchronous **Response requirement:** - NR (unclear whether response requirement) **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE **Delivery mode:** - System-initiated (“push”) **Contextual factors/features influencing the implementation**	Comparison: (n=NR): 92.7% Intervention (n=NR): 97.6% **Absolute percentage point change: +4.9 pct pts** **BP screening** Baseline: (%) Comparison: NR Intervention: NR F/U: 6 months** Comparison: (n=NR): 99.9% Intervention (n=NR): 100.0% **Absolute percentage point change: + 0.1 pct pts** **Prop. of patients with cholesterol testing ordered** Baseline: (%) Comparison: NR Intervention: NR F/U: 6 months** Comparison: (n=NR): 87.4% Intervention (n=NR): 93.7% **Absolute percentage point change: +6.3 pct pts** **Prop. of patients with triglycerides testing ordered** Baseline: (%) Comparison: NR Intervention: NR F/U: 6 months** Comparison: (n=NR): 89.7% Intervention (n=NR): 94.9% **Absolute percentage point change: +5.1 pct pts** **Recommended treatment ordered/prescribed:** **Prop. of patients using Aspirin/Anti-platelet therapy** Baseline: (%) Comparison: NR	period across a large ambulatory provider network increased the percentage of patients meeting the standards of “optimal care” when compared with the non-EHR group. There was significantly greater compliance with all process measures except for measurement of HbA1c, and lipids which showed significant declines. Performance on individual outcome measures was significantly improved for aspirin use, blood pressure control (SBP and DBP) and smoking status. There were small but significant declines for HbA1c control, lipid control, and triglyceride control. In additional analyses, there was a significant improvement with increasing exposure to the EHR observed in the diabetes “optimal care” score.

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See Previous	See Previous	See Previous	Comparison (n=NR):52.0% Intervention (n=NR):54.8% **Absolute percentage point change: +2.9 pct pts** **Diabetes** ***A1C at goal (≤8%)*** <u>Baseline: %</u> Comparison: NR Intervention: NR <u>F/U: 6 months**</u> Comparison (n=NR):80.7% Intervention (n=NR):78.9% **Absolute percentage point change:-1.8 pct pts** **Semi-annual chart reviews were conducted up until 4 years post EHR implementation. Follow-up data are taken data in one or more of these semi-annual reviews up until 4 year post implementation	See Previous
Study Authors (Year): Holbrook, Pullenayegum, Thabane, et al. (2011) **Study Focus:** CVD Prevention **Suitability of design:** Greatest **Quality of Execution:** Fair (4 limitations) **Limitations:** <u>Sampling:</u> sampling frame not clearly described; discrepancy regarding number of included practice listed	**Geographical location:** Ontario, Canada **Study dates:** February 1-September 30, 2005 **General setting:** NR (community-based but unclear whether academically affiliated) **Specific setting:** - Outpatient; community-based primary care practices **Study design:** RCT **Duration of ongoing intervention:** 12 months (mean: 51.7 weeks)	**Basic description of system:** All included practices already utilized some type of EHR system within their practice. The COMPETE III intervention used a web-based individualized tracking advice and decision-support system (CIIIVT) outlining 8 of the top vascular risk factors (blood pressure, LDL-cholesterol, weight, aspirin use, smoking, exercise, diet, and psychosocial index) plus 2 additional risk factors (A1c and urine albumin) for patients with diabetes. The CIIVT showed the patient's current and previous values for each risk factor, the relevant target, the last time it had been checked and brief advice summaries. Physicians or staff could update the patient's tracker profile data at any time; the decision support algorithms ran nightly to update the	<u>**Recommended preventive care ordered/completed**</u> **Change in process composite score (PCS) –** ***Change in total PCS*** <u>Baseline: Mean (SD)</u> Comparison (n=557): 8.59 (2.63) Intervention (n=545): 8.46 (2.62) <u>F/U:12m</u> Comparison: (n=557): 9.49 (2.83) Intervention (n=545): 14.08 (5.36) **Change in mean difference (95% CI): +4.67 (3.63 to 5.71) (p < 0.001)** ***Change in BP PCS for screening***	**Applicability:** From this study, mainly to family physicians within community primary care practices across Ontario already implementing general EHR systems with an average 20.8 years of practice experience. Applicable to practices implementing a web-based individualized vascular tracking and advice decision support systems aimed at both providers and patients targeting 8 of the top vascular risk factors for prevention of vascular disease. This study is applicable to female

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throughout the paper. Measurement: Composite score for healthcare process outcomes was not validated Interpretation of results: Recruitment rate < 20% + possible contamination as intervention and control physicians practiced within same clinic	**Sampling Frame (specify):** - Patients (N=1102): A total of 545 patients were randomized to the intervention and a total of 557 patients were randomized to the control group. Patients were randomized by physician in blocks of 6 - Individual HCPs (N=18): A total of 18 sites were included in the study **Unit of allocation (if applicable):** - Patient (stratified by physician in blocks of 6) **User level of expertise/proficiency/training (specify):** All included practices utilized EHRs so physicians have previous experience with general EHRs **Patient Demographics (n=545):** - Age (mean): 69.3 yrs. - Gender > Male: 46.8% > Female: 53.2% - Race/Ethnicity: NR - Education: > Elementary only: 6.6% > Secondary only: 35.4% > College or University: 48.6% > Postgraduate school: 8.6% > Unknown: 0.7% - Smoking Status: > Current smoker: 12.7% BMI (mean): 27.5	recommendations. CIIVT was shared by patients and their physicians and the targets were based on the latest prognostic evidence. Patients were also provided with color print versions of their tracker page more than a week before their next appointment with a suggestion to take it with them to their visit. **Evidence-based guidelines incorporated into CDSS:** Yes, targets based on the latest prognostic evidence but not specified **Other interventions delivered:** Intervention patients also had telephone access to a clinical resource person (a pharmacist or a nurse) who provided advice and served as a liaison with the physician. **Source/origin of system:** Locally developed **Content:** **Objective(s):** - Chronic disease management - Lab test ordering **Relationship to point of care:** - Synchronous: **Response requirement:** - NR (unclear whether response requirement) **Information delivery:** **Delivery format:** - Online access - Integrated with EHR/CPOE - Paper-based (patients were mailed a colored print version of their tracker page) **Delivery mode:**	Baseline: Mean (SD) - NR F/U:12m Comparison: (n= 557): 0.14 (1.22) Intervention (n= 545): 0.74 (1.32) **Change in mean difference (95% CI): +0.61 (0.46 to 0.76) (P<0.001)** ***Change in BMI PCS*** Baseline: Mean (SD) - NR F/U:12m Comparison: (n= 557): 0.14 (0.98) Intervention (n= 545): 0.86 (1.38) **Change in mean difference (95% CI): +0.71 (0.48 to 0.94) (p<0.001)** ***Change in Exercise PCS*** Baseline: Mean (SD) - NR F/U:12m Comparison: (n= 557): 0.05 (0.35) Intervention (n= 545): 0.96 (1.21) **Change in mean difference (95% CI): +0.91 (0.67 to 1.14) (p<0.001)** ***Change in Diet PCS*** Baseline: Mean (SD) - NR F/U:12m Comparison: (n= 557): 0.03 (0.18) Intervention (n= 545): 0.91 (1.17) **Change in mean difference (95% CI): +0.88 (0.62 to 1.14) (p<0.001)** ***Change in Aspirin Therapy PCS***	patients 55 years or older who are college graduates with at least one vascular risk factor (diabetes, hypercholesterolemia, hypertension, previous MI, angina, CAD, stroke, or vascular disease) **Summary:** A web-based individualized tracking advice and decision support system aimed at both providers and patients had a significantly greater improvement in mean process composite score for healthcare process outcomes. The clinical outcomes of blood pressure, cholesterol levels, BMI, exercise, diet, and psychosocial scores showed no significant difference between groups. Only prescribing of aspirin therapy improved (OR: 1.44, 95%CI: 1.07-1.94; p=0.02). For patients with diabetes, intervention patients had a significantly greater improvement in the recommended monitoring of hemoglobin A1c and urine albumin levels. However, neither value was significantly improved in the intervention compared to the control group.

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See Previous	See Previous	See Previous	*intervention* **<u>CVD risk factors</u>** **Blood pressure** ***Change in SBP (mmHg)*** <u>Baseline: Mean (SD)</u> Comparison (n=557): 133.6 (16.7) Intervention (n=545): 134.3 (15.6) <u>F/U:12m</u> Comparison (n=337): 132.53 (16.72) Intervention (n=394): 133.50 (15.60) **Change in mean difference (95% CI): +0.21 (-2.36 to 2.79) (p=0.87)** ***Change in DBP*** <u>Baseline: Mean (SD)</u> Comparison (n=557): 75.4 (9.4) Intervention (n=545): 75.4 (10.3) <u>F/U:12m</u> Comparison (n=337): 74.78 (9.25) Intervention (n=394): 74.04 (9.21) **Change in mean difference (95% CI): -0.61 (-2.30 to 1.07) (p=0.47)** **Lipids** ***Change in LDL-level (mg/dL)*** <u>Baseline: Mean (SD)</u> Comparison (n=557): 105 (34) Intervention (n=545): 100 (34) <u>F/U:12m</u> Comparison (n=464): 102.0 (36.0) Intervention (n=474): 100.0	See Previous

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See Previous	See Previous	See Previous	(32.0) **Change in mean difference (95% CI): -0.5 (-3.5 to 2.7) (p=0.77)** **Diabetes** ***Change in Hemoglobin A1c level (%)*** Baseline: Mean (SD) - NR F/U:12m Comparison (n=105): 0.07 (0.01) Intervention (n=133): 0.07 (0.01) **Change in mean difference: 0.00** **Distal Clinical Outcomes** **Morbidity** ***Proportion of Vascular Events*** Baseline: % - NR F/U:12m Comparison: (n=547): 5.4% Intervention (n=535): 5.0% **Absolute percentage point change: -0.4 pct pts (p=0.75)** **Health-related Quality of Life (HRQoL):** Quality of life as measured by the EQ-5D	See Previous
Study Authors (Year): Kelly, Wasser, Fraga, et al. (2011) **Study Focus:** Lipid management	**Geographical location:** Reading, PA **Study dates:** NR, but EMR implemented in 2005	**Basic description of system:** EMR was implemented in 2005 with an embedded suite of CDSS which interfaced with the health system laboratory and radiology departments. The CDSS determined patient's LDL	**CVD risk factors** **Lipids** ***Change in TC for patients at goal (mg/dL)*** Baseline: Mean (SD) Comparison (n=72): 190.9	**Applicability:** Applicable to primary care clinics with EMR systems embedded with CDSS. For patients, applicable to a geriatric population

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Suitability of design: Moderate **Quality of Execution:** Fair (2 limitations) **Limitations:** Description: Race/ethnicity and SES not reported; Study period and intervention duration not reported Interpretation of results: Baseline groups not comparable	**General setting:** Academic **Specific setting:** - Outpatient **Study design:** Retrospective Cohort **Duration of ongoing intervention:** NR **Sampling Frame (specify):** Clinic (n=1): Reading Professional Services Internal Medicine faculty practice, which is staffed by 5 providers; Patients (n=1402): between the ages of 50 to 75 were included. 832 patients received LDL goal via the EMR CDSS and 579 if not receive CDSS. **Unit of allocation (if applicable):** - Patient **User level of expertise/proficiency/training (specify):** each provider received a total of 8 hours CDSS training **Patient Demographics:** - Age (mean): 61.4 yrs. old - Gender > Male: 53% > Female: 47% - Race/Ethnicity: NR Co-morbidities: Hyperlipidemia: 100%	goal based on clinical guideline criteria (e.g., age, diabetes status, family history, prior CVD event, etc.) that the provider entered. The CDSS than displays the LDL and other lipid goals plus evidence-based recommendations. **Evidence-based guidelines incorporated into CDSS:** National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High blood Cholesterol in Adults (ATP III) **Other interventions delivered:** NR **Source/origin of system:** - Commercially available **Content:** **Objective(s)** - Pharmacotherapy - Lab test ordering - Chronic disease management **Relationship to point of care:** - Synchronous **Response requirement:** - NR (assume no response requirement) **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE **Delivery mode:** - System-initiated (“push”) **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration	(24.6) Intervention (n=41): 187.2 (33.8) F/U: NR Comparison (n=72): 192.6 (34.4) Intervention (n=41): 181.9 (41.4) **Change in mean difference: -7.0 mg/dL** ***Change in LDL for patients at goal (mg/dL)*** Baseline: Mean (SD) Comparison (n=72): 115.0 (23.4) Intervention (n=41): 112.9 (24.9) F/U: NR Comparison (n=72): 115.5 (28.8) Intervention (n=41): 111.9 (31.6) **Change in mean difference: -1.5 mg/dL** ***Change in HDL for patient at goal (mg/dL)*** Baseline: Mean (SD) Comparison (n=72): 58.7 (13.8) Intervention (n=41): 49.9 (15.5) F/U: NR Comparison (n=72): 59.2 (17.1) Intervention (n=41): 49.9 (14.9) **Change in mean difference: -0.5 mg/dL** ***Change in TG for patients at goal (mg/dL)*** Baseline: Mean (SD) Comparison (n=41): 99.6	diagnosed with hyperlipidemia seeking care at a hospital-based primary care clinic. **Summary:** The use of EMR with an embedded CDSS system did not lead to improvements in achieving lipid goals compared to a comparison group that did not use CDSS.

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	See Previous	**Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow + Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** none **Comparator(s):** - Usual care/no CDSS or KM	(80.3) Intervention (n=29): 169.3 (81.4) F/U: NR Comparison (n=41): 91.6 (56.5) Intervention (n=29): 107.2 (50.9) **Change in mean difference: -54.1 mg/dL; p>0.5** **Diabetes** ***Change in A1c for patients at goal (%)*** Baseline: Mean (SD) Comparison (n=1): 6.2 Intervention (n=3): 7.1 F/U: NR Comparison (n=1): 6.7 Intervention (n=3): 7.1 **Change in mean difference: -0.5%**	See Previous
Study Authors (Year): O'Connor, Sperl-Hillen, Rush, et al. 2011 **Study Focus:** Diabetes management **Suitability of design:** Greatest **Quality of**	**Geographical location:** Minneapolis, MN **Study dates:** October 2006-May 2007 **General setting:** NR **Specific setting:** - Outpatient **Study design:** RCT	**Basic description of system:** The CDSS (Diabetes Wizard) was implemented as part of the clinic workflow. The Wizard provided recommendations for (1) specific changes to medications; (2) treatment suggestions for patients with contraindications to existing treatments; (3) suggested overdue lab testing; and (4) suggested short follow-up intervals (e.g., monthly	**Recommended clinical test ordered/completed:** **BP measurements on patients with ≥1 encounter** Baseline: (%) Comparison (n=NR): 98.6% Intervention (n=NR):98.6% F/U: 12m Comparison: (n=NR): 98.1% Intervention (n=NR):98.8% **Absolute percentage point**	**Applicability:** From this study, mainly to a large health plan with a locally developed CDSS for diabetic patients. For patients, mainly to white diabetic patients living in Minnesota who seek care at primary care center affiliated with HealthPartners.

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
Execution: Good (1 limitation) **Limitations:** Interpretation of results: Groups not comparable at baseline for gender, race, DBP, LDL-C, and type of physician	**Duration of ongoing intervention:** - 6 months(s) **Sampling Frame (specify)** A large medical group, HealthPartners Medical Group (n=11; 6 intervention, 5 control), which provided care to approximately 9,000 adults with diabetes in 2007. The clinics used EHR for 2 or more years. - Patients (n=4,949) were recruited from the eligible clinics. Of that, 1,194 were eligible to be randomized to the intervention group or 1,362 to the control arm. Clinicians/practices/hospitals -40 physicians from the 11 clinics enrolled in the study(20 from each arm) **Unit of allocation (if applicable):** - Clinic **User level of expertise/proficiency/ training (specify):** nursing staff and physicians participated in a 1-hour training session during which they were instructed on use of the CDSS **Patient Demographics:** - Age (mean): 57.0 yrs. old - Gender > Male: 53.3% > Female: 46.7% - Race/Ethnicity: > Black: NR	visits) **Evidence-based guidelines incorporated into CDSS:** Detailed clinical algorithms consistent with evidence-based diabetes guidelines from the Institute of Clinical Systems Improvement and others **Other interventions delivered:** NR **Source/origin of system:** - Locally developed **Content:** **Objective(s):** - Pharmacotherapy - Lab test ordering - Chronic disease management - Other; recommendation of patient follow-up period **Relationship to point of care:** - Synchronous **Response requirement:** - Justification for not complying **Information delivery:** **Delivery format:** - Integrated with EHR/CPOE - Paper-based **Delivery mode:** - System-initiated (“push”) **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of	**change: +0.08 pct pts; p=0.28** **LDL-C test on patients with ≥1 encounter** Baseline: (%) Comparison (n=NR):84.6% Intervention (n=NR):81.9% F/U: 12m Comparison: (n=NR): 86.5% Intervention (n=NR):87.1% **Absolute percentage point change: +0.03 pct pts; p=0.14** **Hemoglobin A1C test on patients with ≥1 encounter** Baseline: (%) Comparison (n=NR):85.8% Intervention (n=NR): 82.9% F/U: 12m Comparison: (n=NR):92.9% Intervention (n=NR):94.0% **Absolute percentage point change: +0.04 pct pts; p<0.05** **CVD risk factors** **Blood pressure** ***Change in SBP (mmHg)*** Baseline: Mean (SD) Comparison (n=NR):141.6 (0.69) Intervention (n=NR):141.3 (0.70) F/U: 12m Comparison (n=NR): 131.5 (0.69) Intervention (n=NR): 130.5 (0.70) **Change in mean difference: -0.70 mmHg; p=0.56** ***Change in DBP (mmHg)*** Baseline: Mean (SD)	**Summary:** This CDSS intervention for diabetic patients significantly improved A1c measures and SBP at goal in the intervention group when compared to the control group; however, other clinical outcomes did not significantly improve.

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	> White: 82.8% > Hispanic: NR <u>Co-morbidities:</u> Coronary heart disease: 12.1% Congestive heart failure: 2.9%	decision support as part of clinician workflow **+** Request documentation of the reason for not following CDSS recommendations **+** Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment + Promotion of action rather than inaction **Auxiliary features:** Local user involvement in development process + CDSS accompanied by periodic performance feedback **<u>Comparator(s):</u>** - Usual care/no CDSS or KMS	Comparison (n=NR):84.6 (0.51) Intervention (n=NR): 85.1 (0.52) <u>F/U: 12m</u> Comparison (n=NR): 77.1 (0.51) Intervention (n=NR): 76.8 (0.52) **Change in mean difference: -0.82 mmHg; p=0.38** ***Prop. with SBP at goal (<130 mmHg)*** <u>Baseline: % (SD)</u> Comparison (n=NR): NR Intervention (n=NR):NR <u>F/U: 12m</u> Comparison (n=NR): 75.1% (1.6) Intervention (n=NR): 80.2% (1.6) **Absolute percentage point change: +5.1 pct pts** ***Prop. with DBP at goal (<80 mmHg)*** <u>Baseline: % (SD)</u> Comparison (n=NR): NR Intervention (n=NR): NR <u>F/U: 12m</u> Comparison (n=408): 81.7% (1.5) Intervention (n=377: 85.6% (1.4) **Absolute percentage point change: +3.9 pct pts** **Lipids** ***Change in LDL-C (mg/dL)*** <u>Baseline: Mean (SD)</u> Comparison (n=NR):124.1 (1.7) Intervention (n=NR): 122.3 (1.7) <u>F/U: 12m</u>	See Previous

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	See Previous	See Previous	Comparison (n=NR): 98.3 (1.8) Intervention (n=NR): 97.9 (1.8) **Change in mean difference: 1.37 mg/dL; p=0.62** ***Prop. with LDL-C at goal (<100 mg/dL or <70 mg/dL if heart disease)*** Baseline: % (SD) Comparison (n=NR):NR Intervention (n=NR):NR F/U: 12m Comparison (n=NR): 83.9% (1.5) Intervention (n=NR): 85.2% (1.6) **Absolute percentage point: 1.4 pct pts; p=0.53** **Diabetes** ***Change in A1c level (%)*** Baseline: Mean (SD) Comparison (n=NR):8.4 (0.08) Intervention (n=NR): 8.5 (0.09) F/U: 12m Comparison (n=NR): 8.1 (0.08) Intervention (n=NR): 7.9(0.09) **Change in mean difference: -0.26%; p=0.01** ***Prop. with A1C at goal(<7%)*** Baseline: % (SD) Comparison (n=NR):NR Intervention (n=NR):NR F/U: 12 months Comparison (n=NR): 79.2% (2.0) Intervention (n=NR): 78.4%	See Previous

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	See Previous	See Previous	(2.0) **Absolute percentage point: -0.8 pct pts; p=0.80**	See Previous
Study Authors (Year): Rodbard, Schnell, Unger, et al. (2012) **Study Focus:** Diabetes management **Exclusion reason(s):** Limited quality of execution **Suitability of design:** Greatest **Quality of Execution:** Limited (5 limitations) **Limitations:** Description: Poor description of where the clinicians were located or the demographics of the patients in the case studies Sampling: 582 participants were assessed for eligibility but no information on the sampling universe. Measurement: Unclear what the time element was for measurement of process outcomes.	**Geographical location:** NR **Study dates:** NR **General setting:** Not specified but probably non-academic since clinicians involved in medical education of any sort were excluded. **Specific setting:** - Outpatient **Study design:** RCT **Duration of ongoing intervention:** Unclear. Described as a "2 month study" but no further details. **Sampling Frame (specify):** No details on sampling frame. Study states that 582 clinicians were assessed for eligibility and 288 were randomized into 4 groups; complete data from 222 was available for analysis. Clinicians/practices/hospitals - Individual HCPs (n=222) > MDs (note specialty, if any) > FP MDs = 85 (38.3%) >IM MDs = 87 (39.2%) > NPs = 50 (22.5%) - Patients (N=30)	**Basic description of system** **Intervention arm 1 (CDSS only):** A blood glucose self-monitoring validated tool enabled patients to record and plot a seven-point SMBG profile (fasting, preprandial/2-h postprandial at each meal, bedtime) on 3 consecutive days. The tool allows patients to document meal sizes and energy levels and to comment on their SMBG experiences. (common to all groups and was the comparison condition). The CDSS developed to produce an automated analysis of a 3-day data period with medical. It is closely related to the self-monitoring tool and the content of an accompanying video on self-monitoring. **Intervention arm 2 (CDSS+DVD):** CDSS was developed to produce an automated analysis of a 3-day data period. It is closely related to the self-monitoring tool and the content of an accompanying video on self-monitoring. Plus, the Provider Education DVD program (Making Informed Therapy Decisions Using Structured SMBG) is a 28-min presentation that provides information about basic SMBG pattern management, identification of glycemic abnormalities, and use of SMBG data to initiate and adjust pharmacologic therapy.	**Recommended treatment ordered/prescribed:** **Change in percentage of clinicians who correctly identified primary glycemic abnormalities and selected the most appropriate treatment option** F/U (time point unclear): Comparison: 33% Int. Arm 1: 49% Int. Arm 2: 55% **Absolute percentage point change (Int. Arm 1): +16 pct pts (p<0.0001)** **Absolute percentage point change (Int. Arm 2): +22 pct pts (p<0.0001)** >90% of DST and DST+DVD clinicians were satisfied with the CDSS (thought it provided clinically useful info and enhanced interpretation of the SMG data);	**Applicability:** From this study it is difficult to generalize findings since little information is provided on setting and location; study is based on case studies; CDSS is not compared to "real world" practice; and time duration is unclear. **Summary:** The study reports that a higher proportion of primary care clinicians chose appropriate treatment for diabetes when provided with a CDSS alone and in combination with an educational DVD than the use of a patient self-monitoring tool for blood glucose alone. However, findings are difficult to generalize since the study did not involve real patient encounters and the time period of the intervention is unclear.

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
The study is described as a "2 month study" but no further details are provided. Interpretation of Results: <80% of enrolled clinicians had complete data available + No comparison of findings to "real world" performance makes generalizability difficult since patient encounters were simulated.	No actual patients but 30 case studies of patients with type 2 diabetes were used. **Unit of allocation (if applicable):** - Clinician **User level of expertise/proficiency/training (specify):** Clinicians were excluded "if they currently used specialized structured testing data collection forms in their practice". The decision support tool (DST) used in the study had a brief orientation video for clinicians. **Patient Demographics:** Not applicable since only patient cases were used in the study. Patients in all cases had type 2 diabetes and their HBA1C, age, ethnicity, height, weight, BMI, duration of diabetes, current meds, patient-reported information regarding disease management were available to clinicians in the study.	**Evidence-based guidelines incorporated into CDSS: Can't Tell** – an expert panel of 3 was constituted to decide on appropriate action for the case studies but the authors also briefly refer to what might be more standard practice guidelines **Other interventions delivered:** A third intervention arm with just the DVD was also implemented (outside the scope of this abstraction). **Source/origin of system:** - Commercially available **Content:** **Objective(s):** - Pharmacotherapy - Chronic disease management **Relationship to point of care:** Not applicable since there were no actual patients. **Response requirement:** - NR (unclear whether response requirement) **Information delivery:** **Delivery format:** Can't Tell **Delivery mode:** Can't Tell **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** none **Clinician-System Interaction Features:** No need for additional clinician data entry **Communication and content features:** Provision of a recommendation, not just an assessment	See Previous	See Previous

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	See Previous	**Auxiliary features:** CDSS accompanied by conventional education: **Y (for intervention arm 2 with DVD)** **Comparator(s):** A blood glucose self-monitoring validated tool enables patients to record and plot a seven-point SMBG profile (fasting, preprandial/2-h postprandial at each meal, bedtime) on 3 consecutive days. The tool allows patients to document meal sizes and energy levels and to comment on their SMBG experiences.	See Previous	See Previous
Study Authors (Year): Schnipper, Linder, Palchuk, et al. (2010) **Study Focus:** Diabetes management **Suitability of design:** Greatest **Quality of Execution:** Fair (2 limitations) **Limitations:** Interpretation of Results: Groups not comparable (percentage female, white) + low exposure of CDSS to intervention group	**Geographical location:** Eastern Massachusetts **Study dates:** March 2007 – September 2007; practices received CDSS ("Smart Form") on a rolling basis **General setting:** Academic **Specific setting:** - Outpatient **Study design:** RCT **Duration of ongoing intervention:** 1 month for outcomes. 9 months for ongoing intervention. **Sampling Frame (specify):** - Individual health care providers (N=239): primary care physicians recruited from 10 clinics that used EHR; randomly assigned to study group or usual care. - Patients had either	**Basic description of system:** The CAD/DM Smart Form is a documentation-based CDSS that the clinician has to open and choose to use within an existing EHR; the Form integrates patient demographic and clinical data with rule-based logic derived from guidelines for management of CAD and DM; output includes assessments of current state of clinical care and suggested orders for medication additions or changes, lab studies, appointments., referrals, and printing of patient education materials. **Evidence-based guidelines incorporated into CDSS:** Yes, but not specified. **Other interventions delivered:** NR **Source/origin of system:** -locally developed **Content:** **Objective(s):** - Chronic disease management (diabetes) - Pharmacotherapy - Lab ordering	**Recommended Preventive Care Ordered/Completed:** **Up-to-date BP result documented within 30 days of patient visit among those with a deficiency:** **CAD and DM patients:** F/U (4.5m)*[ITT]: Comparison (n=1275): 23.8% Intervention (n=1232): 31.7% **Absolute percentage point change: +7.9 pct. pts. (p>0.05)** **Smoking status documented within 30 days of patient visit:** ***CAD and DM patients:*** F/U (4.5m)[ITT]: Comparison (n=5887): 2.9% Intervention (n=6600): 2.7% **Absolute percentage point change: -0.2 pct. pts. (p>0.05)** **Recommended Clinical Test ordered/completed:** **Up-to-date LDL-C result documented within 30**	**Applicability:** From this study, mainly to primary care practices within a large academic center with a well-established EHR in place looking to incorporate CDSS. Generalizability is limited by low exposure to clinicians in intervention group. A higher proportion of addressed deficiencies was found for patients who were male, Hispanic, had private insurance, and had fewer visits per year. **Summary:** Researchers found that the use of a documentation-based clinical decision support incorporated within an existing EHR system led to a statically significant improvement in addressing deficiencies related to care of patients with diabetes (and CAD)

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	coronary artery disease (CAD) or diabetes (DM) indicated on HER and had a visit with PCP who belonged to one of the study practices; > entire sample (CAD and DM): N=7009 > DM sample: n= 5011 > Intervention group (CAD and/or DM): 3431 **Unit of allocation (if applicable):** - Clinicians **User level of expertise/proficiency/ training (specify):** Clinicians, already trained in using an existing EHR, received brief instruction on use of the CDSS ("Smart Form") at on-site practice meeting **Patient Demographics [for all intervention group patients]:** **-** Age (mean):64.5 **-** Gender: < Male: 46% < Female 54% - Race/Ethnicity: < Black: 17% < White: 54% < Hispanic: 18% < Other: 5.2% < Unknown: 5.3% - Income level: < Median household income (USD): 51,223 - Insurance type (%): < Private: 17% < Managed care: 13% < Medicare: 51% < Medicaid: 15% < Free care/self-pay/other:	- Other (patient education) **Relationship to point of care:** - Synchronous **Response requirement:** - NR (unclear whether response requirement) **Information delivery: Delivery format:** - Integrated with CPOE or EHR **Delivery mode:** - User-initiated ("pull") **Contextual factors/features influencing the implementation and use of CDSS included in CDSS:** **General System Features:** Integration with charting or order entry system to support workflow integration **Clinician-System Interaction Features:** Automatic provision of decision support as part of clinician workflow + No need for additional clinician data entry + Provision of decision support at time and location of decision making **Communication and content features:** Provision of a recommendation, not just an assessment **Auxiliary features:** Local user involvement in development process **Comparator(s):** - Usual care/no CDSS/KMS; used locally-developed pre-existing HER	**days of patient visit among those with a deficiency** ***CAD and DM patients:*** F/U (4.5m)[ITT]: Comparison (n=1383): 47% Intervention (n=1284): 48% Absolute percentage point change: +1 pct. pts. (p>0.05) **Up-to-date A1C result within 30 days of patient visit among those with a deficiency:** ***DM patients*** F/U (4.5m)[ITT]: Comparison (n=306): 55.9% Intervention (n=271): 60.5% **Absolute percentage point change: +4.6 pct. pts. (p>0.05)** **Recommended treatment prescribed:** **Change in antihypertensive therapy if BP above goal within 30 days of patient visit:** ***CAD and DM patients:*** F/U (4.5 months) [ITT]: Comparison (n=3490): 10.8% Intervention (n=3575): 12.6% **Absolute percentage point change: +1.8 pct. pts. (p>0.05)** **Lipid therapy started/changed if LDL-C above goal within 30 days of patient visit:** ***CAD and DM patients:*** F/U (4.5 months)[ITT]: Comparison (n=2134): 3.1% Intervention (n=2323): 3.2% **Absolute percentage point**	in primary care. They note that the overall use of the CDSS was low (<6% of eligible patients). Reasons for low use were likely related to usability and provider satisfaction. Results were more pronounced when comparing patient visits where the CDSS was used vs. patient visits where the CDSS was not used (regardless of study group).

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	4.1% - Co-morbidities: < Both CAD and DM: 10% < # of problems on problem list, mean (SD): 8.3 (4.9)	See Previous	**change: +0.1 pct. pts. (p>0.05)** **Smoking cessation medication started if active smoker within 30 days of patient visit:** ***CAD and DM patients:*** F/U (4.5 months)[ITT]: Comparison (n=982): 0.6% Intervention (n=1052): 0.6% **Absolute percentage point change: 0 pct. pts. (p>0.05)** **ACE-I/ARB medication use within 30 days of patient visit among those with a deficiency:** ***DM patients:*** F/U (4.5 months)[ITT]: Comparison (n=2865): 5.0% Intervention (n=2650): 5.1% Absolute percentage point change: +0.1 pct. pts. (p>0.05) **Change in diabetic therapy if A1C above goal within 30 days of patient visit among those with a deficiency:** ***DM patients:*** F/U (4.5 months)[ITT]: Comparison (n=3434): 14.1% Intervention (n=3232): 16.1% **Absolute percentage point change: +2.0 pct. pts. (p>0.05)** *****intervention was implemented on a rolling basis for 9 months. Because not all practices had the intervention for 9 months, we took the	See Previous

Study	Study and Sample Characteristics	CDSS/KMS Intervention Characteristics	Results	Applicability and Summary
See Previous	See Previous	See Previous	midpoint (4.5 months) for all analysis	See Previous