

Long-Term Impact of an EHR-Enabled, Team-Based, and Scalable Population Health Strategy Based on the Chronic Care Model

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Disclosures

- In the past year, I have been a consultant or sponsored researcher on clinical decision support (CDS) for:
 - Office of the National Coordinator for Health IT*
 - McKesson InterQual
 - Hitachi
- I was formerly a consultant and co-owner of Clinica Software, which provided commercial services using a CDS technology (SEBASTIAN) used in the project
 - I no longer have a financial relationship with Clinica

*via ESAC, SRS, and Hausam Consulting

Background

- Effective and scalable population health strategies are needed for chronic illnesses such as diabetes
 - Half of all U.S. adults have at least 1 chronic illness
 - Chronic diseases are the leading cause of death
 - Shift from “volume-based” to “value-based” payment
- Chronic Care Model (CCM) is promising approach:
 - Delivery system redesign and organizational support
 - Clinical information systems
 - Clinical decision support (CDS)
 - Self-management support and community interaction

Challenges

- CCM is generally effective for improving process measures but impact on clinical outcomes vary
- CCM often requires resources not generally available in primary care
 - E.g., chart auditors, on-site diabetes educators
 - Makes programs difficult to scale
- Limited literature on long-term clinical impact of CCM-based population health programs

Need

- Evaluations of long-term impact of CCM-based, pragmatic, and scalable population health strategies



Study Overview

- Setting: 18 Duke Primary Care clinics
- Population: 6,768 patients with diabetes seen at least once at clinics every study year as well as year prior
- Intervention: CCM-based, technology-facilitated population health program for multiple chronic illnesses
 - Technical interventions powered by standards-based decision support Web service to enable scalability¹
- Historical control: labor-intensive, disease-registry based population health program
- Timeframes: 2007-2008 (pre), 2009-2010 (post)

Ref 1: Lobach DF, Kawamoto K, et al. Development, deployment and usability of a point-of-care decision support system for chronic disease management using the recently-approved HL7 Decision Support Service standard. *Stud Health Technol Inform.* 2007;129:861-5.



Point-of-Care Decision Support System

https://clinapp6.duhs.duke.edu:8081 - Patient Summary for [REDACTED] - Microsoft Internet Explorer

Allergies/ADE Problems Medications Medications From Notes Vitals Cautions Disease Mgmt. Print ? Send Feedback Close

All Health Maintenance Diabetes* Hypertension*

Re-Evaluate Input Observations Last evaluated Mon Jan 12 21:09:31 EST 2009

Diabetes Remove from Diabetes List

Focus	Status	Relevant Data	Last Done	Guidelines
Height	Not Due	Height: 154.9cm (61.0in)	12/15/08(age 61y 3m)	21+yo: once after age 21
Weight/BMI	DUE NOW	Weight: 77.1kg (170.0lb) BMI: 32.1	01/08/09 (0m 4d ago)	21+yo: q visit. Goal: BMI <25
B.P.	DUE NOW	BP: 120/69 mm Hg <i>Patient has diabetes or GFR <60</i>	01/08/09 (0m 4d ago)	18+yo: annual; if diabetic or HTN q visit. Goal <140/90, 130/80 if diabetic or GFR <60.
Alcohol Screen	Not Due	Abstains	01/08/09 (0m 4d ago)	10+yo: check alcohol use yearly (excessive: males >2/d, females >1/d)
Visual Foot Exam	DUE NOW		01/08/09 (0m 4d ago)	q visit
Foot Monofilament	Not Due		01/08/09 (0m 4d ago)	annual
HgbA1C	Not Due	HgbA1C: 6.2%	01/08/09 (0m 4d ago)	21+yo: q6mo if <7%, q3mo if >= 7%. Goal: <7%.
Urine Micro alb/cr	Not Due	alb/cr ratio: * mg/g	10/08/08 (3m 4d ago)	10+yo: annual
Total Chol.	Not Due	Total-C: 151 mg/dL	12/15/08 (0m 28d ago)	annual, goal <200
LDL Chol.	Not Due	LDL-C: 94 mg/dL	12/15/08 (0m 28d ago)	annual, goal <100
Eye Exam	DUE NOW	<i>Intervention considered but not delivered on 01/08/09. Reason: Scheduled</i>		10+yo: annual
Flu Vacc.	CONSIDER		>2y ago	annual, unless egg allergic
Pneum. Vacc.	Not due		01/01/06 (3y 0m ago)	once; revacc if >=65 and last 5+ yrs ago when <65
ASA (81 mg)	Not Due	Not known to be allergic to aspirin Aspirin listed as prescribed		40+yo: no contraindications

Feedback Report – Clinic Comparison

DukeMedicine		Clinic Group Summary Overall								Chronic Disease Population Management			
Clinic Group: DPC													
Condition: Diabetes													
Guidelines													
Clinic Name	A1c		Aspirin Therapy		BP	Eye Exam	Flu Vaccine	Foot Monofilament Exam	LDL		Urine Micro alb/cr	Weight	
	<7	>9	Done	Done 2X	<130/80	Done	Done	Done	Done	LDL < 100	Done	BMI < 25	
	60.0%	12.0%	96.0%	68.0%	0.0%	16.0%	24.0%	32.0%	0.0%	96.0%	68.0%	12.0%	4.0%
	61.0%	12.2%	91.5%	69.5%	29.1%	13.4%	44.4%	37.8%	30.0%	91.5%	50.0%	18.3%	2.4%
	50.0%	25.0%	75.0%	75.0%	0.0%	50.0%	25.0%	75.0%	0.0%	75.0%	75.0%	0.0%	25.0%
	50.0%	0.0%	100.0%	75.0%	0.0%	0.0%	0.0%	50.0%	0.0%	100.0%	50.0%	0.0%	0.0%
	50.9%	11.8%	91.8%	70.9%	27.1%	40.0%	44.5%	42.7%	24.5%	84.5%	62.7%	61.8%	12.7%
	21.1%	21.1%	89.5%	73.7%	5.3%	52.6%	42.1%	31.6%	0.0%	84.2%	63.2%	21.1%	21.1%
	61.0%	4.5%	93.5%	82.0%	46.7%	15.0%	46.0%	37.0%	14.0%	83.0%	56.5%	22.0%	3.5%
	100.0%	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%
	41.5%	19.5%	92.7%	70.7%	9.8%	34.1%	24.4%	19.5%	4.9%	80.5%	61.0%	26.8%	14.6%

Feedback Report – Provider Comparison

DukeMedicine		Clinic Summary Overall							Chronic Disease Population Management					
Clinic Group: DPC										Clinic: [REDACTED]				
Condition: Diabetes														
Guidelines														
Provider Name	A1c		Aspirin Therapy		BP	Eye Exam	Flu Vaccine	Foot Monofilament Exam	LDL		Urine Micro alb/er	Weight		
	<7	>9	Done	Done 2X	<130/80	Done	Done	Done	Done	LDL < 100	Done	BMI < 25		
[REDACTED]	50.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%	50.0%	0.0%	0.0%	
[REDACTED]	68.4%	10.5%	100.0%	73.7%	16.7%	10.5%	21.1%	36.8%	26.3%	89.5%	84.2%	5.3%	5.3%	
[REDACTED]	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
[REDACTED]	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
[REDACTED]	0.0%	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	50.0%	0.0%	0.0%	
[REDACTED]	66.7%	0.0%	100.0%	100.0%	0.0%	66.7%	66.7%	0.0%	0.0%	100.0%	33.3%	33.3%	33.3%	
[REDACTED]	25.0%	25.0%	75.0%	50.0%	0.0%	0.0%	0.0%	50.0%	25.0%	50.0%	25.0%	25.0%	0.0%	
[REDACTED]	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	

Feedback Report – Patient Panel

DukeMedicine		Clinic Summary Patients				Chronic Disease Population Management							
Clinic Group: DPC		Clinic: [REDACTED]				PCP: [REDACTED]							
Condition: Diabetes													
Guidelines													
Patient Name	A1c		Aspirin Therapy		BP	Eye Exam	Flu Vaccine	Foot Monofilament Exam	LDL	Urine Micro alb/cr	Weight		
	<7	>9	Done	Done ZX	<130/80	Done	Done	Done	Done LDL < 100	Done	BMI < 25		
XXXXXXXX, XXXXX	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	No
XXXXXXXX, XXXXX	Yes	No	Yes	Yes	No	No	No	Yes	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	Yes	No	Yes	Yes	No	No	No	No	No	No	No	Yes	No
XXXXXXXX, XXXXX	No	No	Yes	No	No	No	No	No	No	Yes	No	No	No
XXXXXXXX, XXXXX	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	No	Yes	Yes	No	No	No	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	No	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	Yes	No	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	Yes	No	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	No	Yes	Yes	Yes	No	No	No	No	No	Yes	Yes	No	No
XXXXXXXX, XXXXX	No	Yes	No	No	No	No	No	No	No	No	No	No	No

Typical Point-of-Care Workflow

- Clinic staff prints care reminders for provider
- Clinic staff performs required interventions per standing orders
- Providers engage patients in care through discussion of care reminder summary

Key characteristics:

- No new clinical staff required
- Leveraged existing EHR data (biggest difference with prior workflow, which required extensive data entry)

Analysis Approach

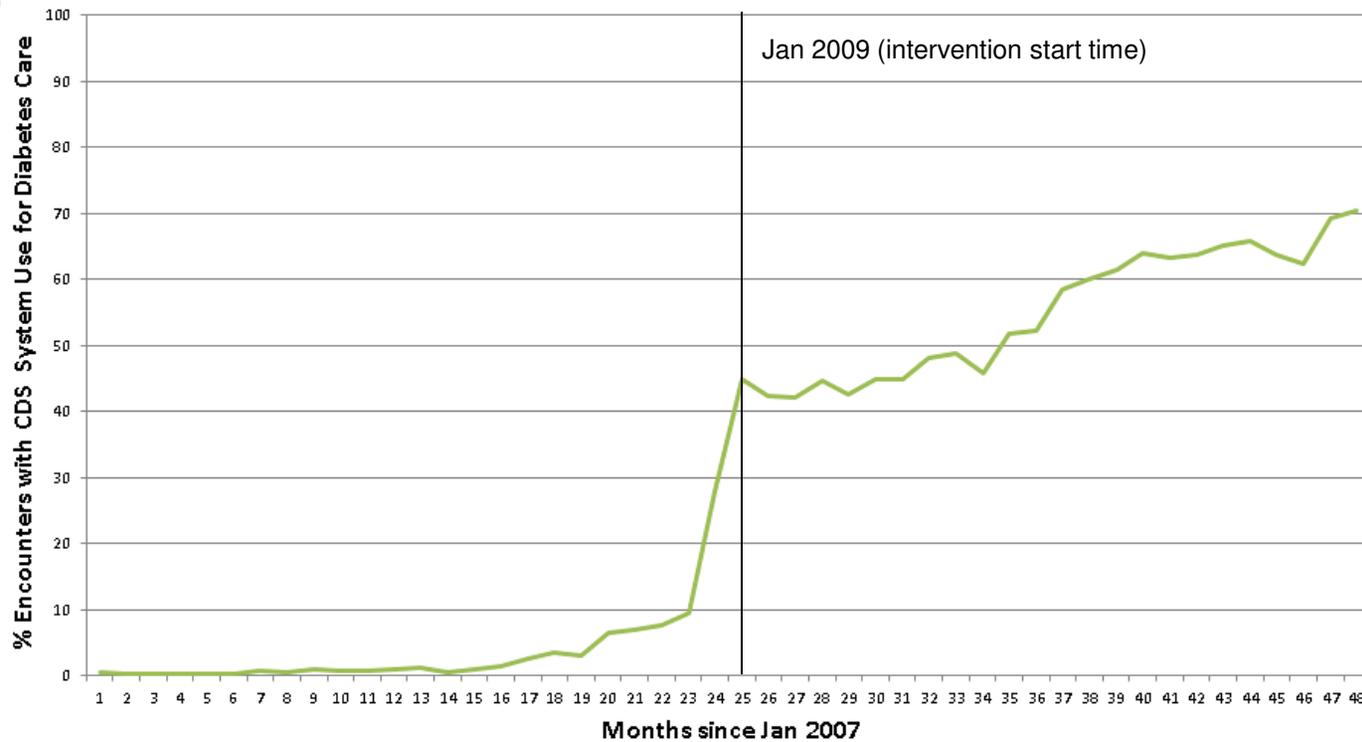
- Focus on diabetes *a priori*
 - Inclusion in program from the start
 - Good disease control measure: hemoglobin A1c (A1C)
- Primary outcome measure: A1C levels
 - Monthly interpolated estimates to account for biased sampling (poor control leads to more frequent testing)
- Primary analysis: difference in A1C slopes between pre and post periods
- Estimate of expected A1C progression
 - U.K. Prospective Diabetes Study (UKPDS) Outcomes Model



Statistical Analysis Details

- Interrupted time series analysis
- Mixed linear model using PROC MIXED procedure with maximum likelihood estimation
- Indicator variables for months of year to adjust for seasonal A1C variation

Usage of Point-of-Care CDS System



Average A1C Levels Over Time



Statistical Analysis Results

- A1C slope, historical control: 0.01%/year
- A1C slope, intervention period: -0.02%/year
- Difference in slope: statistically significant ($p = 0.01$) but clinically insignificant

- Overall A1C trend essentially flat throughout
 - Jan 2007: 7.17% (beginning of historical control)
 - Jan 2009: 7.24% (beginning of intervention period)
 - Dec 2010: 7.24% (end of intervention period)

Summary of Findings

- Pragmatic CCM-based population health strategy evaluated in 18 primary care clinics for diabetes
- Key intervention component (point-of-care decision support system) well accepted
 - Use in 70% of primary care encounters by end of study
- A1C levels were essentially flat through 4 study years (increase of 0.07%), compared to 0.42% increase expected from UKPDS Outcomes Model
 - Indicates effective disease control in both pre and post periods
- Main benefit of intervention was to replace labor-intensive processes with more efficient, automated processes (time savings estimate from CMO: at least 1 hr/day per clinic)



Limitations and Strengths

- Limitations
 - Lack of concurrent control group
 - Inability to distinguish impact of intervention components
 - Estimate of times savings based on expert opinion
 - Did not evaluate process measures
- Strengths
 - Large sample size (increased precision)
 - Long-term assessment (4 years)
 - Historical control (some protection against confounding)
 - Population-based (vs. only poorly controlled patients)
 - Pragmatic and scalable

Implications and Future Directions

- Team-based, EHR-enabled population health programs based on CCM can effectively manage a population of patients with diabetes
- Automated approach to population health management can be just as effective as a highly labor-intensive approach
- Anticipate continuing research on how best to leverage the EHR to improve population health and achieve high-value care¹

Ref 1: Lee VS, Kawamoto K, et al. Implementation of a value-driven outcomes program to identify high variability in clinical costs and outcomes and association with reduced cost and improved quality. *JAMA*. 2016;316:1061-72.



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HEALTH CARE

Thank You!

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