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Creating a medical home through Care Management Plus

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The Care Management Plus Team

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What is "Care Management?"

Case study

Ms. Viera

a 75-year-old woman
with diabetes,
systolic hypertension,
mild congestive heart failure,
arthritis and
recently diagnosed dementia.

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Ms. Viera and her caregiver come to clinic with several problems, including

1. hip and knee pain,

2. trouble taking all of her current 12 medicines,

3. dizziness when she gets up at night,

4. low blood sugars in the morning, and

5. a recent fall.

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Ms. Viera's office visit

And Out in the hall:

6. The caregiver confidentially notes he is exhausted

7. money is running low for additional medications.

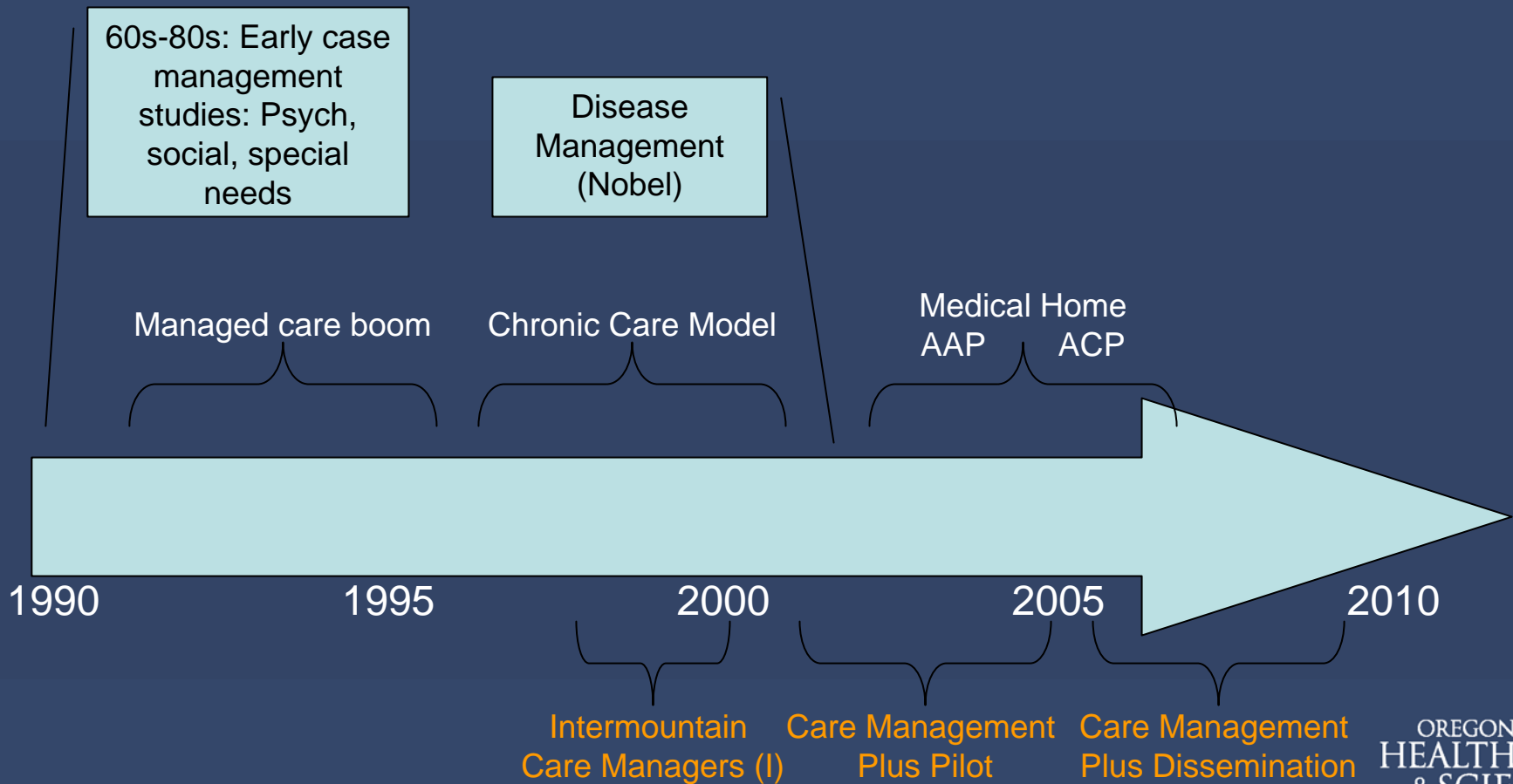How can Dr. Smith and the primary care team handle these issues?

We are not doing well…

- 56% success rate with chronic illness quality measures, declines as # of chronic illness increases [McGlynn, others]

- Improvement in care for the chronically ill could save billions of dollars (theoretically) [Hillestad, Wennberg]
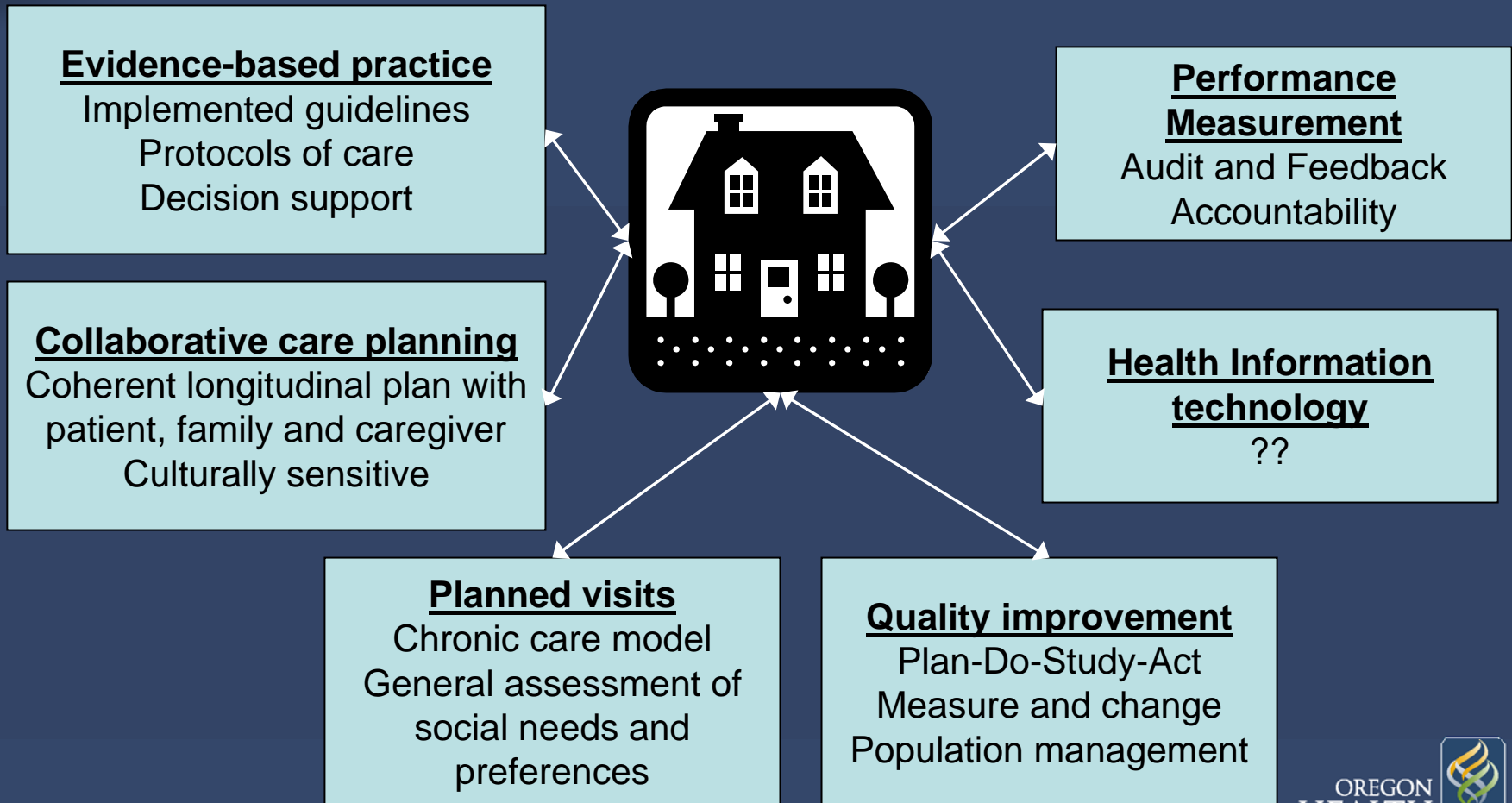
Partial solutions exist

- Care, case and disease management models address various aspects of the issue
  - Usually completely general or specific (each disease independently)
  - More frequent with capitated or single payer

Systems to care for patients with complex and chronic illness have evolved over time.

60s-80s: Early case management studies: Psych, social, special needs

Disease Management (Nobel)

Managed care boom

Chronic Care Model

Medical Home
AAP   ACP

1990   1995   2000   2005   2010

Intermountain Care Managers (I)

Care Management Plus Pilot

Care Management Plus Dissemination
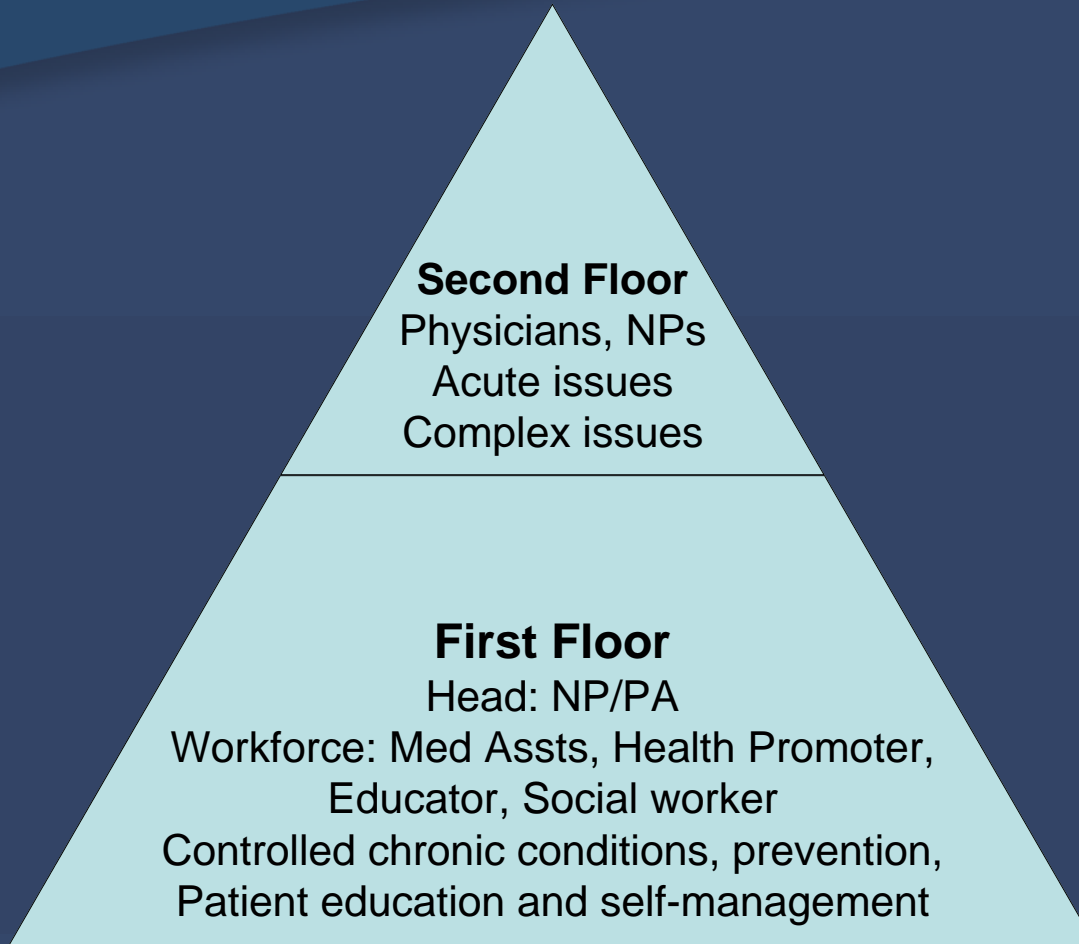
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Medical home: concepts

Health care teams partner with patients & caregivers to ensure that all of their health care is effectively managed and coordinated.

Evidence-based practice
Implemented guidelines
Protocols of care
Decision support

Collaborative care planning
Coherent longitudinal plan with patient, family and caregiver
Culturally sensitive

Performance Measurement
Audit and Feedback
Accountability

Health Information technology
??

Planned visits
Chronic care model
General assessment of social needs and preferences

Quality improvement
Plan-Do-Study-Act
Measure and change
Population management

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Primary care home example: New Primary Care Home (Bodenheimer)

Second Floor
Physicians, NPs
Acute issues
Complex issues

First Floor
Head: NP/PA
Workforce: Med Assts, Health Promoter, Educator, Social worker
Controlled chronic conditions, prevention, Patient education and self-management

Evidence-based practice: by entire practice, with protocols divided.

Planned visits: First floor, with high emphasis on education and self-management.

Comprehensive care planning: More time on second floor.

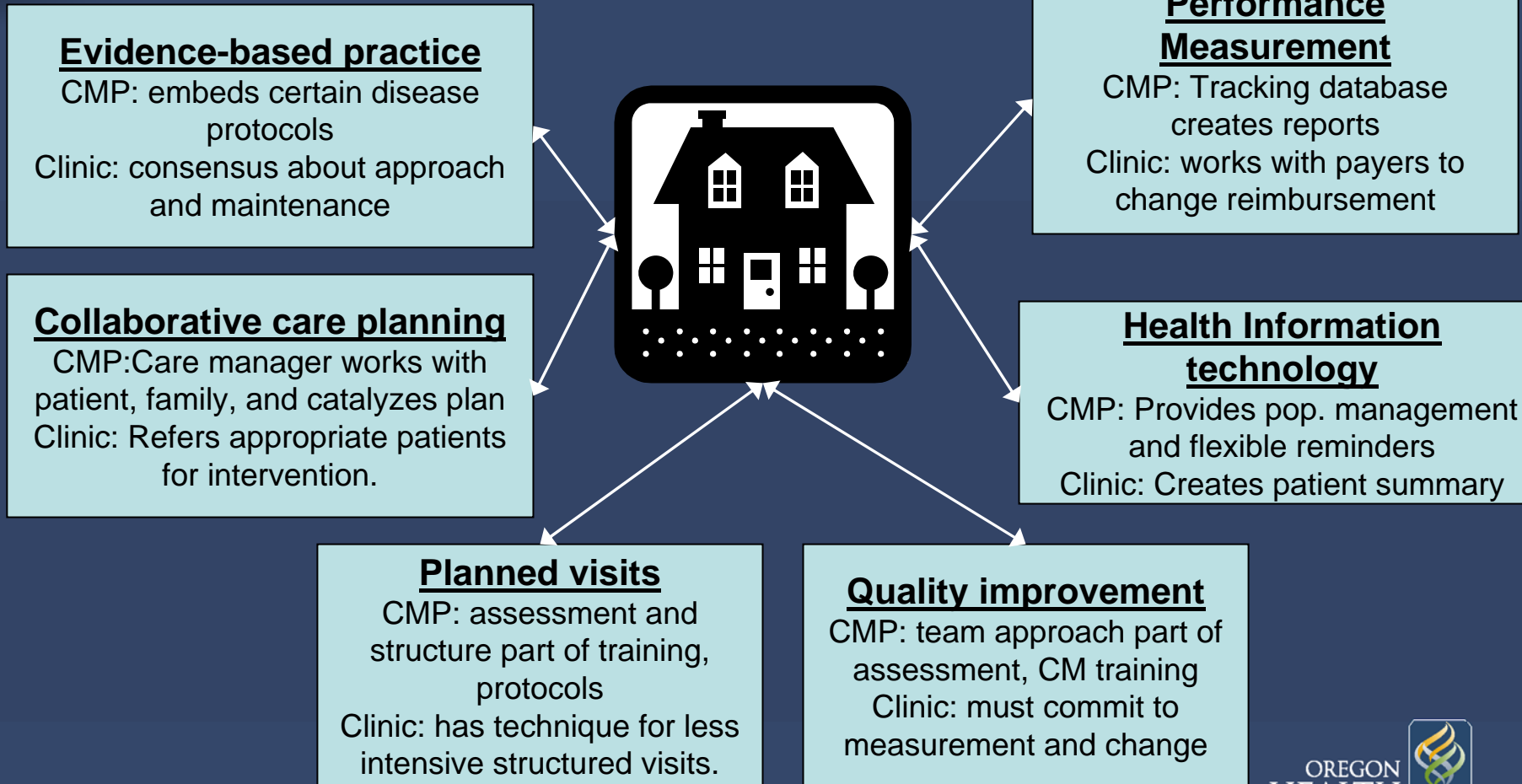HIS: Tailor to workflow of practice – e.g., more patient-entered data, more registry on first floor.

Care management varies by intensity and function for different populations and needs.
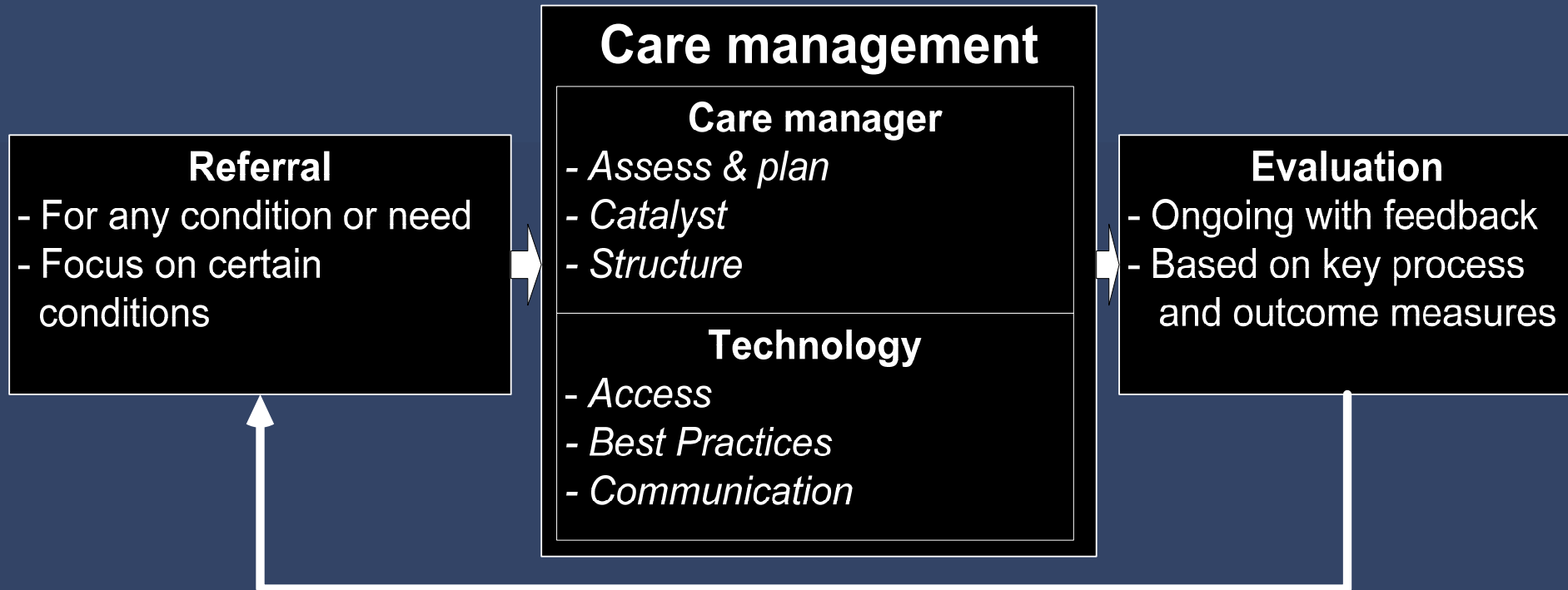
**Care Management Plus
Caseload 250-350**

Most intense
(e.g., Homeless,
Schizophrenia)

Intense
Complex illness
Multiple chronic diseases
Other issues (cognitive, frail elderly,
social, financial)

Mild-moderate
Well-compensated multiple diseases
Single diseases

< 1% of population
Caseload 15-45

3-5% of population
Caseload 90-350

50% of pop.
Case
load ~1000

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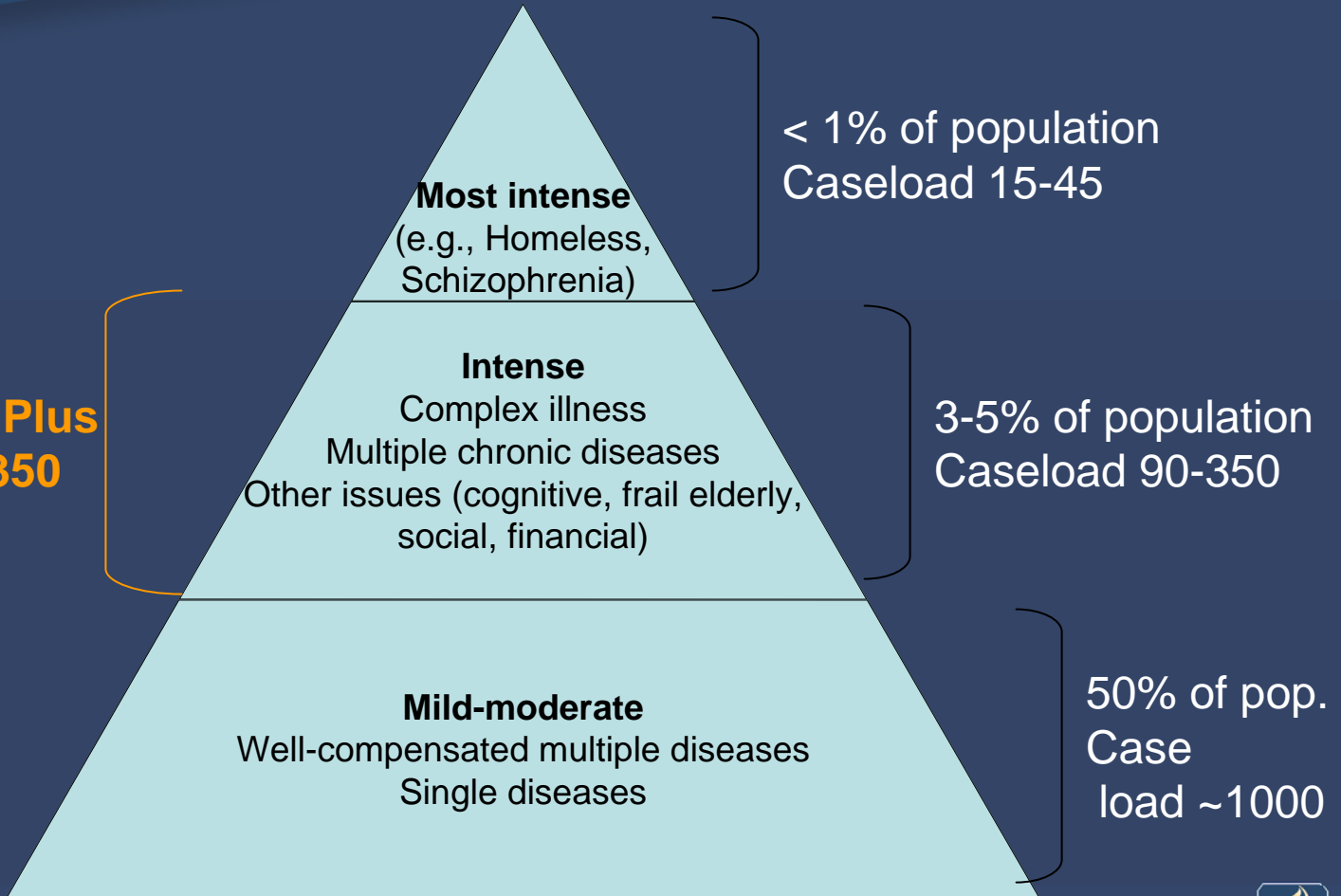
Care Management Plus can help create a medical home.

Care Managers act as a guide, coordinator, and helper to facilitate patients receiving coordinated, sensitive care.

Evidence-based practice
CMP: embeds certain disease protocols
Clinic: consensus about approach and maintenance

Collaborative care planning
CMP:Care manager works with patient, family, and catalyzes plan
Clinic: Refers appropriate patients for intervention.

Performance Measurement
CMP: Tracking database creates reports
Clinic: works with payers to change reimbursement

Health Information technology
CMP: Provides pop. management and flexible reminders
Clinic: Creates patient summary

Planned visits
CMP: assessment and structure part of training, protocols
Clinic: has technique for less intensive structured visits.

Quality improvement
CMP: team approach part of assessment, CM training
Clinic: must commit to measurement and change

Care Management Plus is a comprehensive solution.

In 15 primary care clinics at Intermountain Healthcare

Referral
- For any condition or need
- Focus on certain conditions

Care management

Care manager
- *Assess & plan*
- *Catalyst*
- *Structure*

Technology
- *Access*
- *Best Practices*
- *Communication*

Evaluation
- Ongoing with feedback
- Based on key process and outcome measures

Larger infrastructure: Electronic Health Record, quality focus
Primary Care Clinical Programs: sets standards, teams adhere

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The physician refers Ms. Viera to a Care Manager

- The care manager starts:
  - building rapport with the patient
  - understanding the patient's concerns
  - coaching them to work through the barriers that keep them from self-management.
    - Why do you think that the doctor sent you to see me?
    - What is your biggest concern or fear?

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Case help: care manager and Ms. Viera

The care manager then

- **assesses** – readiness to change, disease states, cognitive status, safety

- **prioritizes** – cognition / depression, social issues then disease states

- **co-creates** a care plan

- **facilitates** that care plan

- **documents** progress …

The right people on the team with the right training is a core principle.

Patients are taught to self-manage and have a **guide** through the system.

Care managers receive special training in

- Education, motivation/coaching
- Disease specific protocols (**all staff included**)
- Care for seniors / Caregiver support
- Connection to community resources

Our care managers are currently all RNs; other models are possible.

Curriculum Content

Topical Area	Delivery Strategy	Methods
Orientation, Role, Technology training	~10 hours in person (divided)	Power point presentation; Case examples, role playing
Managing Chronic Illnesses Mental Health Issues Senior Patient Management Patient Coaching	On-Line (~10 hours, divided) Case studies	Asynchronous and Synchronous faculty discussion. Posted power-point slides.
Community Resource Acquisition Final Case Study (See evaluation)	In-Person Seminar	Internet search activities Case Study Presentations

Technology **helps the team plan and enact high quality care.**

- Care management tracking database
  - Available free of charge (requires MS Access)
  - Training manuals
- Patient worksheet (summary sheet)
- Dosage expertise / specification

www.caremanagementplus.org

An Information System is **not a computer, but a set of functions to transmit information.**

- *Access* to a co-created, structured care plan over a population
    - Protocols and flowsheets
    - Summary sheets
    - Population tracking
- *Best Practices*
    - Ticklers / reminders / alerts (*carefully*)
    - Context-specific
- *Communication*
    - Valid, actionable communication strategies

Examples: what most clinics don't have implemented

- Population management which integrates into workflow
  - Care Management Tracking: Individual reports, ticklers cognizant of context
- Communication
  - Flexible strategy with key documentation and reminders
- However, most places *could* create these systems

Patient Worksheet

Wilcox, Proc of AMIA Symp, 2005

Chronic conditions

Medications

Allergies

Functional status

Preventive care summary

Pertinent labs

Pertinent exams

Passive reminders
Organized by illness

Population Tickler

Patient Information

ID Number: [____] Last Name: TEST First Name: TEST DOB: 8/16/1977 [*] Age: 19-44 ▾ Race: Black/African A ▾ Sex: M ▾

Phone: (800) 800-8000 Cell Phone: [____] Email: [____] PCP: Allen, Mitch ▾ PCP Phone: (800) 888-8888

Insurance: Mailhandlers ▾ Facility: ABC Clinic ▾ ☐ Diab Collaboration FPP: 2.Confused/Chaotic ▾

Date of Referral: 3/30/2004 [*] Care Mgr: John ▾ Status: Active ▾

Patient Search
ID Number: [____]
Last Name: [____] ▾
First Name: [____] ▾
Care Mgr: [____] ▾
[Search for Patients]
[Show All Patients]

	Diag. Date	Diagnosis	Status
		CHF	Active
Edit	3/30/2004	Anxiety	Active
Edit	3/30/2004	Depression	Active

	Sched Date	Sched Time	Encounter Type	Status
Edit			Telephone Contact	Pending
Edit			Home Visit	Resolved
Edit	1/26/2005		Telephone Contact	Resolved
Edit	10/18/2004		Telephone Contact	Resolved

	MH Packet Date	Symp	Severity	Fctnal Diff	Dysth.	Q9	Suicide State	Suicide Risk	[Mood 1 2 3]	MoodImp	MoodSx	AnxImp	AnxSx
Edit	1/26/2005	1	3	Somewhat	☑	0		No Risk					
Edit	9/1/2004	0	4	Not	☑	0		No Risk		16	45	14	52
							1. Thoughts Only	Low Risk					

Diab Assess Date
3/4/2005

[Diagnosis] [Encounter] [Meds] [MH Instruments] [Pediatric Assess]

[New Patient] [Save Patient] [Delete Patient] [Generate Clinical Note by Date] [____] [*]

[Diabetes History] [Diab Pre/Post Knowledge Assess] [Patient Goals] [HF Follow-Up]

CMT database - example

Record: |◀ ◀ [1] ▶ ▶| ▶* of 1

The evidence on Care Management Plus

Results from Intermountain Healthcare

What services does Care Management Plus provide?

In all, 4,735 patients (1,582 seniors) were seen in 2004-05, receiving 22,899 services (9,434 for seniors).

Service category	All patients	Seniors
ALL	22,899	9,434
Following evidence-based protocols	12,955 (56.6%)	4,421 (46.9%)
General education	6,808 (29.7%)	2,252 (23.9%)
Communication	6,789 (29.7%)	4,199 (44.5%)
Motivating patients	6,243 (27.3%)	2,247 (23.8%)
Social issues / barriers	8,221 (35.9%)	3,608 (38.2%)

What was the effect of CMP on patient outcomes?

- Study design:
- Retrospective cohort
- Comparison of care managed (CM) patients (7 clinics) with patients from similar clinics w/out care managers (n=4)
- CM patients matched to controls on key characteristics

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Study 1: adherence to diabetes guidelines.

- 1,185 CM patients matched to 4,740 control patients (1:4)
- Outcomes:
  - Overdue for HbA1c testing
  - HbA1c tested
  - HbA1c level <7.0
  - Mean HbA1c level

Guideline Adherence: Results

Outcome	Odds Ratio
Overdue for HbA1c test	0.79*
HbA1c Tested	1.42*
HbA1c in control (<7.0)	1.24*

*$p<0.01$

Dorr, HSR, 2005

Study 2: Changes in death and hospitalizations

- Seniors enrolled in Medicare
- 1,144 CM patients with diabetes matched to 2,288 control patients (1:2)
- Outcomes:
  - Death
  - Hospital admission
  - Admission for ambulatory care sensitive conditions

Dorr, AcademyHealth, 2006

Odds of dying were reduced significantly.
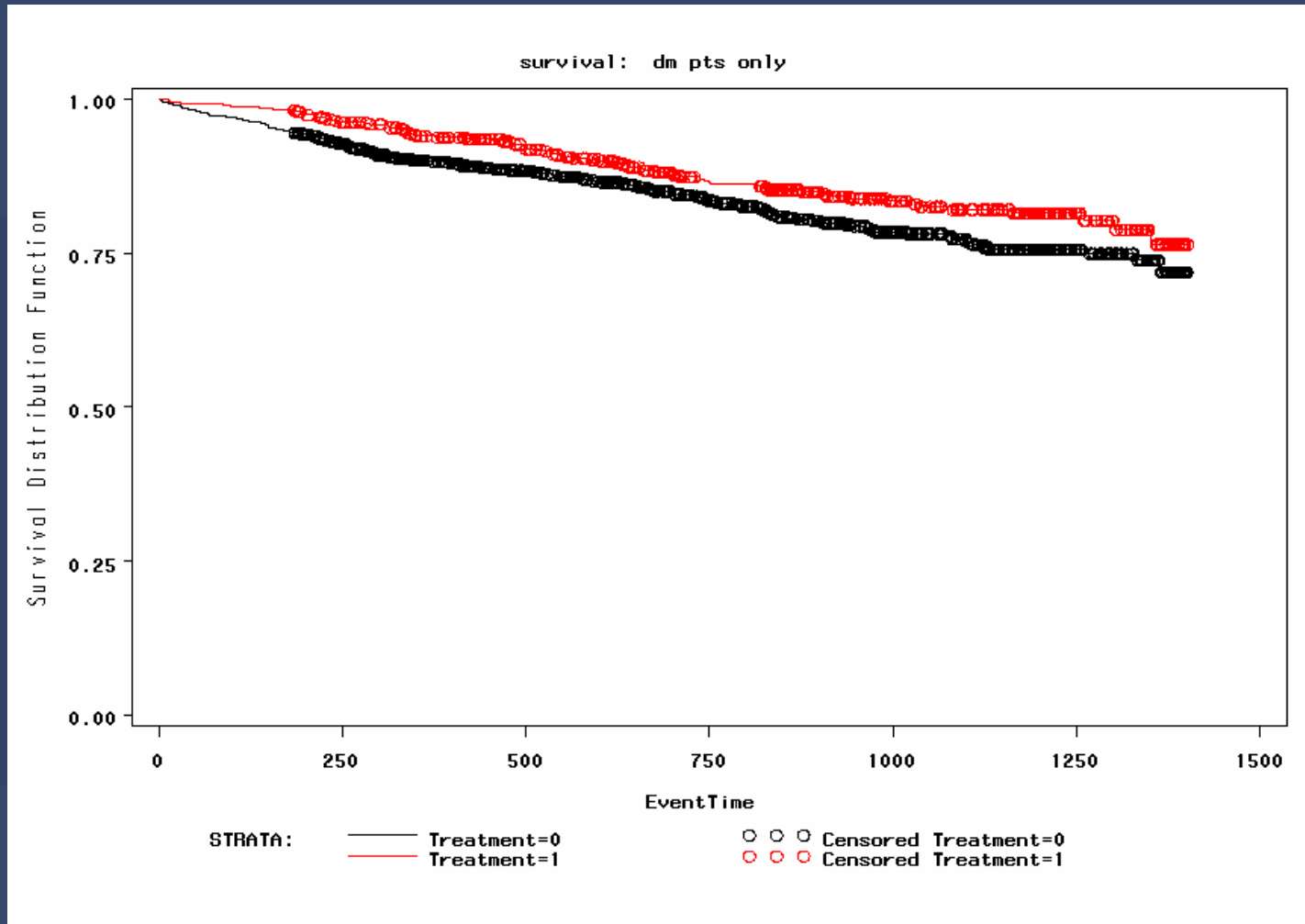
Odds of admission (any cause) were reduced by 27-40%.
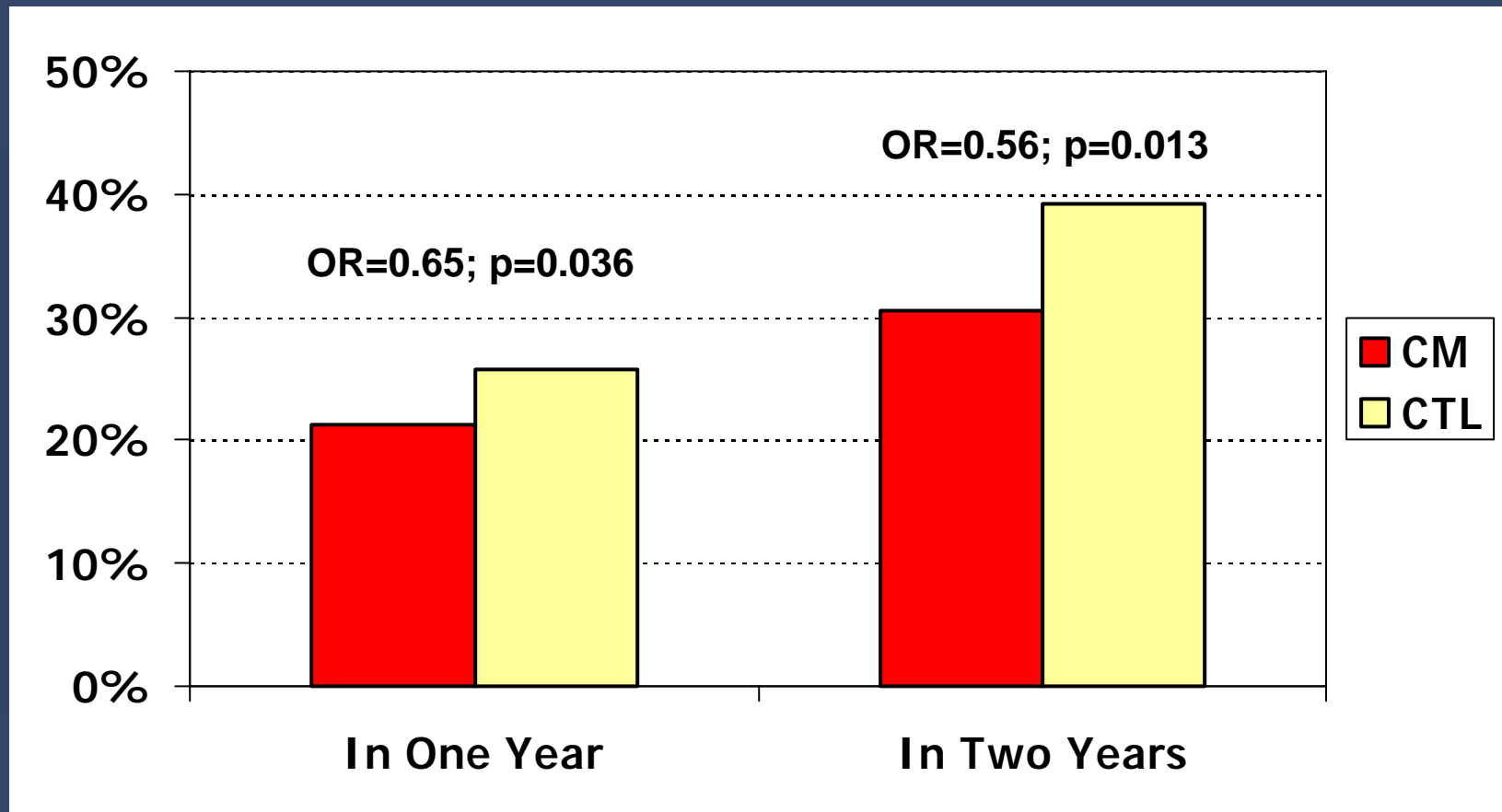
Odds of being admitted for a ambulatory care sensitive condition were reduced by 60%.
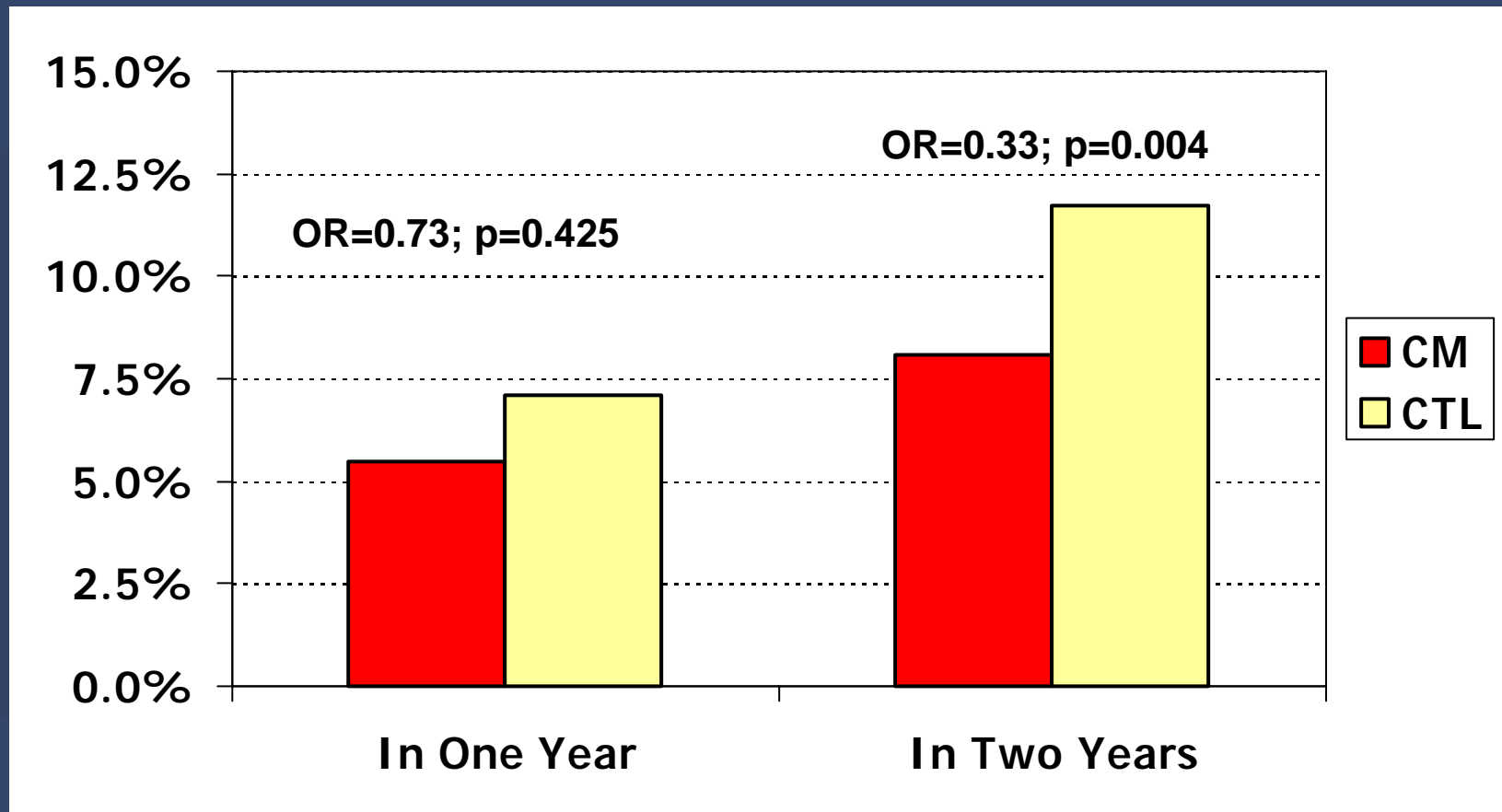
Care Management Plus has other benefits…

- Not just for the patient (who has better outcomes)

- But for the primary care physician (who can improve efficiency by offloading some complex care to a care manager)

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Physicians were more efficient through better documentation, a slight increase in visits, and a change in practice pattern.

- Physicians who referred to care managers:

8% more productive

- Than peers in same clinic

Use efficiency gains to increase capacity

WRVU Mean

500

398.17

400   368.00

300

Non-user   User

8%
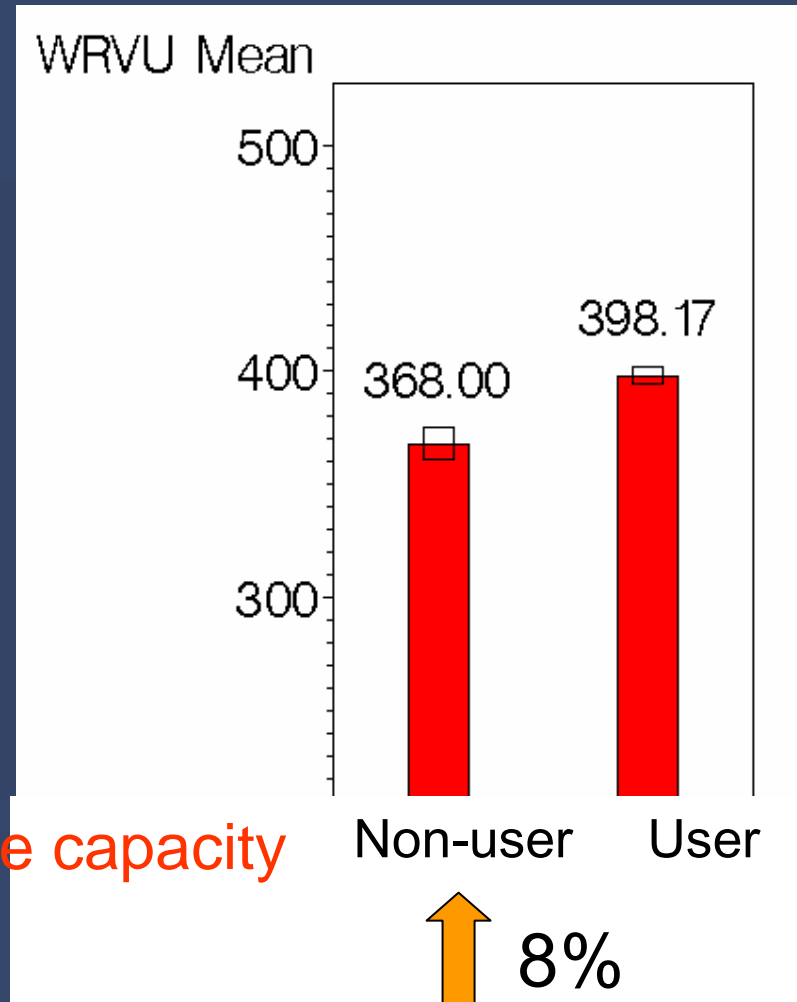
Given the increase in productivity, a clinic in the right environment could pay for the care manager.

Costs/Clinic	
Salary + training + admin	**$92,077**
Benefits/Clinic	
Productivity (7 MD's)	$99,986
Utilization ↓ *	*$0*
Nurse visits	$10,394
Benefits sum	**110,380**
Total (benefits – cost)	**+$18,303**

* Society would save, per clinic, $230,000 in reduced utilization.

Dorr et al, AJMC, 2007

Note: overhead costs, IS costs are assumed to be constant. Equipment costs included.

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Care Management Plus: good for patients, good for physicians…

- What about the cost to society?
  - Some evidence of cost-savings, e.g.:
    - $360 per patient per year for all Medicare patients
    - $1620 per pt per year for Medicare patients with complex illness
  - But
    - Preliminary results
    - Not robust to all specifications
    - Care Management Plus patients qualitatively different than other patients:
      - Sicker with upward trajectory in cost

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Summary of benefits

- Quality benefits of the program include
  - 24-47% reduced mortality and hospitalizations for our sickest patients,
  - improved disease control, and
  - high patient and physician satisfaction
- Efficiency benefits can
  - Improve fee-for-service productivity;
  - Reduce costs to payers; and
  - Make the clinic a better place to work.

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The Next Phase…Dissemination

- Care Management Plus Dissemination
- New 4-year $2.5M grant from John A. Hartford Fund
  - Focus on seniors

Adding learners: OHSU Chronic Illness Management
Judith Bowen, Albert DiPiero, D. Dorr

- Regular 4 week rotation for Internal Medicine residents at OHSU

- Learn skills related to education, motivation, QI process, and population management

- Complete a project related to improving quality.

  - Goal to prepare them for practicing with structured care management approaches.

CIM ambulatory block

- Pre-clinic planning
  - DM summary sheets for scheduled patients distributed ahead of time
  - Everyone has responsibility to review the chart from own perspective & role
- 7:30 a.m. Teaching Session ("Decision Support")
- 8:00 a.m. PDSA meeting with Team
- 8:40 a.m. "Huddle" to plan visits
- 9:00 a.m. to 11:45 a.m. Planned visits
- 11:45 a.m. "Huddle" to plan follow-up

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Future steps

- Collaborative of implementors / interested parties
  - Adding HIV patients and other groups
  - Sharing protocols
- IT co-development and configuration
  - Large vended systems (EPIC)
  - Middleware

Thank you!

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Implementing a Multidisease Chronic Care Model in Primary Care Using People and Technology

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ABSTRACT

Management of chronic disease is performed inadequately in the United States in spite of the availability of beneficial, effective therapies. Successful programs to manage patients with these diseases must overcome multiple challenges, including the recognized fragmentation and complexity of the healthcare system, misaligned incentives, a focus on acute problems, and a lack of team-based care. In many successful programs, care is provided in settings or episodes that focus on a single disease. While these programs may allow for streamlined, focused provision of care, comprehensive care for multiple diseases may be more difficult. At Intermountain Health Care (IHC), a generalist model of chronic disease management was formulated to overcome the limitations associated with specialization. In the IHC approach, which reflects elements of the Chronic Care Model (CCM), care managers located within multipayer primary care clinics collaborate with physicians, patients, and other members of a primary care team to improve patient outcomes for a variety of conditions. An important part of the intervention is widespread use of an electronic health record (EHR). This EHR provides flexible access to clinical data, individualized decision support designed to encourage best practice for patients with a variety of diseases (including co-occurring ones), and convenient communication between providers. This generalized model is used to treat diverse patients with disparate and coexisting chronic conditions. Early results from the application of this model show improved patient outcomes and improved physician productivity. Success factors, challenges, and obstacles in implementing the model are discussed. (Disease Management 2006;9:xx–xx)

INTRODUCTION

IT HAS BEEN ARGUED that the current primary care model in the United States is better suited to treat acute, time-limited illnesses than to address chronic illnesses.[1–5] With increasing time demands, primary care physicians often treat patients in a reactive fashion, with short appointments and limited patient instruction.[2] Given a particular patient's unique needs, busy practitioners may not know or follow established practice guidelines, or have the time or the facilities to coordinate care between all the people who need to be involved in the care of

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a particular patient.[6] In other words, these providers are susceptible to the "tyranny of the urgent"[7]—with more acute patient needs taking precedence over chronic ones. These problems are only magnified by the highly fragmented nature of medical care in the United States, which often leads to poor communication and less than optimal follow-through for chronically ill patients.[3,8,9] Therefore, chronically ill patients are often themselves responsible to initiate care needed to comply with standard guidelines (either preventive or specific for their illnesses). As a result, up to 50% of chronically ill patients in the United States—especially the elderly—receive inadequate care.[1]

Successful models of chronic care and disease management in primary care have been created, but these successes generally have been achieved in limited settings[2,10–12] such as single-payer managed care systems (eg, Kaiser Permanente) or health plans (eg, Group Health Cooperative).[11–13] Conversely, care management approaches are less frequent in independent provider clinics, where the majority of patient contacts occur and where the opportunity for intervention is greater. The sporadic implementation of these care management approaches in typical clinic settings may be due in part to the recognized fact that the financial benefits that result from improved patient health most often accrue to the payer and not to the provider.[14] In fact, there may be perverse incentives for quality for providers.[11] For example, expenses incurred by physician groups may be higher when providing high-quality care, leading to less ability to accept discounts from payers. Since payers do not generally recognize higher quality, high-quality providers may be shifted out of the market; pay-for-performance projects attempt to remedy these issues.

The nature of processes associated with primary care also contributes to the lack of appropriate care management systems being integrated at the point of care. Healthcare teams, composed of patients, nurses, physicians, social workers, therapists, and others, in which participants work together to regularly communicate about, create, and implement plans of care, are important for successful care management. Often, these teams do not function well in primary care settings.[15] The historical autonomy of providers and fragmentation of care delivery due to lack of incentives to collaborate may work to prevent formation of such teams.[16] In addition, in a generalist setting, the knowledge of specialists and experts, either directly or through guidelines, is necessary for optimal care but not always easily available at the point of care.[17] The additional perceived burden of accessing and adhering to guidelines may limit provider adoption of best practices.[13]

As described recently by Casalino,[18] one approach to solving these problems with quality of healthcare delivery focuses on insurers or external companies communicating frequently with patients (usually via telephone) to improve adherence to guidelines. These programs attempt to overcome fragmentation, misaligned incentives, and physician resistance by educating and motivating the patient directly. However, they also add a layer to a complex and often dysfunctional system. Another way to solve this problem was elucidated by Bodenheimer et al. in the Chronic Care Model (CCM).[19] The CCM identifies elements desirable for an effective system-based model for chronic disease management: patient self-management support, clinical information systems, delivery system redesign, decision support, and healthcare organization and community resources.[19,20] All these components, especially delivery system redesign,[21] combine to create a proactive healthcare delivery team that communicates regularly with self-activated patients to improve care.[15]

Successful implementation of these components requires significant amounts of information in the hands of providers in order to change care and encourage best practice. In the case of multiple diseases and illnesses in a diverse patient population, it is easy to see how higher information needs might overwhelm a generalist care management implementation; thus, single disease implementations[22–26] are logical answers to cope with information overload.[27] For patients with multiple diseases, multiple insurer or single disease management programs could be used. If the information overload problem could be solved, however, the benefits of a CCM implementation for multiple diseases are substantial. For instance, up

to half of patients with chronic disease who are seen in the ambulatory care setting have multiple chronic diseases. In addition, an efficient primary care team has been shown to be instrumental in providing a seamless care experience and comprehensive plan for the patient who moves between specialists' offices, the hospital, and other settings.[1,17] From a workflow perspective, optimal distribution of tasks between team members and efficient use of patient and provider time may be more easily achieved in the generalist setting if the delivery system can be optimized.[15,28] General problem-solving and self-care skills can be taught, and patient readiness to change can be addressed; these techniques have been shown previously to lead to improved outcomes for a variety of chronic diseases.[29,30]

In this paper, we describe efforts at Intermountain Health Care (IHC) to address this acknowledged lack of collaborative, patient-centered, effective, and efficient care by intervening in two specific ways. First, generalist care managers were installed as part of the primary care teams, and second, an information system was installed to provide information and knowledge at the point of care, improving communication between all members of the team, including the patient and his or her caregivers.[31] In our case, we address the myriad of specific recommendations and reminders needed for multiple diseases with supportive information technology (IT). As part of delivery system redesign, we use a designated team member called a care manager to teach the patient general skills and self-management, and to improve team processes. Together, these two elements help provide just-in-time specialized knowledge while minimizing time constraints on physicians and still ensuring that patients get individualized education and attention.[32,33] Our hypothesis is that an adapted version of the CCM model will be heavily used for multiple diseases, and that care of patients will be efficient and quality of care will improve.

METHODS

The purpose of this paper is to describe the IHC implementation of care management in the context of the CCM, and to provide statistics about its use. To do so, we qualitatively describe our implementation in accordance with each of the components of the CCM. Then, we provide data that reflect the adoption of each aspect of the program and the resulting effect on clinical outcomes.

Healthcare organization: CCM element 1

In the CCM, appropriate top-level support and commitment to quality in the healthcare community are necessary to implement innovations in the process of care delivery. The primary setting of our intervention is in seven clinics operated by IHC. IHC is a not-for-profit, integrated healthcare delivery organization located in Utah and Idaho that serves over 1 million patients. In 2003, IHC's primary care clinicians, located in over 70 clinics, provided care for 1.3 million unique patients and generated more than 4 million clinic visits. Specialists are present in some clinics. Pay for care comes from multiple sources.

In harmony with the vision foreseen in the CCM, IHC's administrative and clinical management teams support process and quality improvement at all levels of the organization, and these leaders encourage open discussion of key safety and quality concerns.[34] IHC has an infrastructure for innovations in the treatment of chronic disease that revolves around primary care teams and involves multiple stakeholders; this infrastructure supports the development of enterprise-wide guidelines for asthma, diabetes,[34] depression, cardiovascular disease,[35] and other diseases as recommended by the CCM. Enterprise-wide, measurable goals are then set for key elements of the guidelines in order to determine and improve the quality of care provided. IHC actively works to facilitate process changes that must occur to achieve these improvements, as recommended by the CCM.

Delivery system design and team-based care: CCM element 2

IHC redesigned care delivery by adding care managers to teams and by inserting IT into the workflow in an effort to improve adherence to evidence-based guidelines and to improve con-

tinuity of support for the patient. The job descriptions for our "care managers"[a] are derived from the Case Management Society of America's definition of case management: "a collaborative process of assessment, planning, facilitation, and advocacy for options and services to meet an individual's health needs through communication and available resources to promote quality, cost-effective outcomes." The care managers "serve as a catalyst for quality, cost-effective care by linking the patient, the physician, and other members of the care coordination team, the payer and the community."[36] Training for care managers is formal and addresses new standards of care as they are adopted by IHC as well as ongoing refresher updates on chronic disease management. One generalist care manager is located in each of seven primary care clinics that serve adult patients with a diverse spectrum of diagnoses and needs. Referral to the care managers is not based on a particular illness or algorithm, but is based on need as perceived by the team members. In order to apply the model to such a diverse set of patients, the care manager prioritizes the care plan for the referred patient and the team. The care manager assesses the patient's psychosocial, economic, environmental, and cultural background as well as other factors that affect the patient's health within the context of the patient's chronic conditions. Care manager efforts are focused to reduce variation in care and to provide a wide range of chronic illness services within the primary care team's work flow.

The care manager acts as a catalyst to bring the team together; primary care teams are retrained to improve work flow and collaboration. The most basic unit of the team consists of a physician, medical assistant, the care manager, and the office manager. Depending on the patient's needs, the care manager augments this team with specialists such as endocrinologists or cardiologists, social workers, educators, counselors, and community advocates. These flexible and expandable teams help to

make the care plan individualized, but also consistent and seamless.

Self-management support: CCM element 3

In our general setting, educating the care managers to inculcate general self-management skills is essential. The care managers have been trained in behavior change counseling and are given a thorough understanding of the clinical guidelines adopted by the system. Care managers are trained to assess the patient's readiness to change,[37,38] to coach and motivate the patient, and to educate the patient about his or her responsibility to care for the illness and to discuss the benefits of being proactive in managing his or her health. More of the care managers' resources are focused on those patients who are contemplating or ready to begin self-managing behaviors; those who are not ready receive encouragement to consider change.

The care manager and patient meet face-to-face to create a care plan that is structured to reflect clinical guidelines and the patient's personal challenges and goals; elements of this plan are entered into the care manager's electronic system for follow-up.[39] Home environment, patient preferences, and support system are considered and integrated into the plan as needed. Patient education is a crucial part of the self-management strategy, the goal being to improve patients' health literacy with regard to their health and illnesses. Self-monitoring assists in systematically identifying patterns of behavior and helps to improve awareness of triggers that spawn unhealthy patterns. Although the care manager represents a knowledgeable advocate, the patient and the family or caregivers are trained to take care of themselves when they can, speak up when they cannot, and access clinic and other community resources to ensure such needs are met in predictable and appropriate ways.

Connecting to community: CCM element 4

In accordance with the description by Netting and Williams[40] of an expanded version of the CCM which highlights the significance of connections to the community, our care managers and the care team focus on linking the

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[a]"Care manager" is used in preference of "case manager" as "case" is felt to be more inclusive and less distancing to the patient, per the American Association of Retired Persons (AARP).

patients and their caregivers to community resources. They strive to balance the healthcare needs of the patient with the resources available through insurance benefits, publicly funded programs, and private dollars available from the patient. We view the community resources as essential to reduce inefficient utilization of high-intensity interventions.[41,42]

We facilitated connection to community resources in several ways in our implementation. First, we performed a thorough assessment of community resources available to meet the unique needs of the patients. Next, the teams—especially the care managers—were trained to perform a clinical and social assessment of the needs of and resources available for patients. Community resources were introduced to the care managers in a series of educational events using real-life case studies. Finally, the training was supported with electronic external references maintained via a Web page that was available to all team members, including the patient and the caregiver. These on-line resources include such diverse topics as respite and tax breaks for caregivers, community meal provision, different housing options, and obtaining health and environment assessments at home. Since eligibility and available resources vary by county, links are provided to a set of geographically specific Web sites. The specific resources allow further individual care planning and education by the care managers as they help connect patients to the community.

Support for evidence-based practice: CCM element 5

We provide the two major components of organizational decision support as defined by the CCM (ie, clinical practice guidelines and physician education in several ways.[43] At IHC, clinical practice guidelines are developed by an organized group of clinician experts and opinion leaders who review current research.[34] They create quality improvement-based practice guidelines as both a decision support and measurement tool (ie, the adherence to and the outcomes from the guidelines are routinely reviewed by the clinical program leadership, and adjustments are made to improve outcomes.[44] These practice guidelines are distributed

through workshops incorporated in the electronic health record (EHR). IHC also provides modest financial incentives to providers when these goals are achieved.

The group of experts who focus on primary care comprise the Primary Care Clinical Program (PCCP). This group has defined guidelines as well as goals for adherence and outcomes for several chronic conditions. For example, goals for glycosylated hemoglobin (HbA1c) testing frequency (eg, up to once per quarter for those with HbA1c of >8% and at least yearly for other patients known to have diabetes) and target reduction in levels (eg, HbA1c reduced to <7.0%) are defined, and these goals are delivered to clinicians through medical directors and physician leaders.

Care managers in IHC support the same clinical guidelines as clinicians and attend the same interdisciplinary workshops. In addition, care managers develop their own guidelines and processes to support the clinical program goals. Care managers also meet together monthly to collaborate on methods for improving patient outcomes and practice efficiencies and to receive training in disease management.

Information systems: CCM element 6

Information systems supporting collaborative care for multiple diseases need to provide three core functionalities, which we refer to as the ABCs of collaborative care: enable *Access* to relevant patient information, encourage *Best practices*, and facilitate *Communication* between providers.

Access to relevant patient information is provided by a longitudinal EHR, which supplies a single consistent access point for multiple clinicians. Our current information system contains the six components identified as important for chronic disease by Casalino et al.—a standardized problem list, progress notes, lists of prescribed medications, drug-drug interaction reminders, laboratory results, and radiology results.[12] We also have information regarding allergies, other tests such as electrocardiograms, procedures, provider messages, and 1–2-page patient summaries. A longitudinal EHR with these types of information is available to all clinicians, including care man-

agers, in all IHC clinics and provides information across time and from multiple settings, including hospitals, emergency rooms, specialty practices, and general outpatient practices. The comprehensive view provided by the EHR is especially important for patients with chronic illness because their care may involve multiple providers and settings.[17]

IHC has multiple programs to support *Best Practices*. In addition to our experience in generating alerts, reminders, and suggestions based upon automatic evaluation of rules, we generate report cards regarding the level of attainment of clinical goals for each physician. By clicking an "infobutton" within the EHR[45] at the point of care, it is possible to access context-specific reference literature describing the best available evidence for treating a specific condition or understanding a test result. In addition to these important mechanisms, the care management structure has two additional information system components to address the need to increase best practices within the context of the primary care work flow: the Patient Worksheet and the Care Management Tracking (CMT) system.

The Patient Worksheet is a patient summary that provides a condensed view of the patient record that can be reviewed easily either electronically or on paper. The summarized, structured Patient Worksheet was designed to interlace pertinent clinical data for multiple chronic illnesses and alerts into a document that can be reviewed quickly at the point of care, thus allowing it to be easily integrated into work flow. The content of this summary is dynamically generated based on one or more of the patient's chronic conditions (up to five) that are listed within the EHR. This worksheet displays patient demographic information, specific problems and conditions, the patient's current medication profile, laboratory test results, and other diagnostic and physical exam results related to each patient's specific problems, as well as disease-specific or preventive care advisories.[46] The advisories to be presented are determined through the automatic application of computer-based logic rules to clinical data available in the EHR. For patients seen by a care manager, the last care manager

progress note also is included. Typically, the creation of the worksheet is prompted by the clinic schedule and is available to team members prior to the beginning of a patient visit, and the clinician reviews the information with the patient. The advisories are written in the same format as the necessary orders to make it easy for the physician to comply. After explaining the pertinent recommendations, many clinicians give the worksheet directly to the patient and his or her caregivers along with verbal and written directions to aid in self-management.

We have developed a CMT system for care managers that allows them to schedule tasks and receive automated reminders, or "ticklers," about planned chronic care visits or follow-up. The CMT system allows care managers to schedule a follow-up visit or phone call with a patient at the same time as they are documenting the care of the patient. The care manager can create reminder lists based on patient criteria (ie, tickler lists) which enable them to call or meet with patients to ensure high adherence; examples include calling to remind patients to come in for laboratory tests such as HbA1c or lipid panels that need to be drawn at certain intervals, or to assess symptoms and the need for care after hospitalization. The CMT also facilitates time tracking of care management activities for each patient so that the team can review where the care management effort is spent and determine what activities are most productive.

Finally, one of the most important components of the information system is the facilitation of *Communication*. Our information system does so by providing transmission of secure, patient-oriented comments and messages among team members and between team members and others involved in care, including specialists; these comments are linked to the patient chart automatically. Communication also occurs in person via shared team meetings and visits and by phone.

Data collection

Our CMT system implementation based on the CCM was installed in seven clinics. Data collec-

tion took place during 2003. The care managers used the CMT to store structured information about their daily activities. The care managers tracked the type of encounter (eg, education session, phone call), reason for the encounter (eg, following guidelines, medication assistance), and the conditions treated during the encounter. The value and utility of the computer-generated alerts used to remind the care manager of guideline compliance issues were assessed by self-report of the care managers. All use of the longitudinal clinical information system by providers was tracked and analyzed whether or not the patients in question were part of the CMT system. Audit tables containing information about the patient whose information was accessed, the provider who was accessing the record, and the particular purpose of the access were used to examine use of the messaging system, patient worksheet, alerts, and other information system applications. Administrative data for billing and demographics collected as part of usual care was used to aggregate characteristics of the population being treated in the clinics as a whole and in the subset of care management patients. The Chronic Illness and Disability Payment System (CDPS) was used to compare the case-mix of practice populations.[47] Outcome and process metrics used to assure guideline adherence and to measure the quality of care were abstracted from information system data.

The data collected from these sources were grouped and analyzed according to previously defined categories.[48] Previous analyses for clinical, cost, and process outcomes are described elsewhere; in brief, care managed patients were matched by age, gender, comorbidity, and previous utilization to non-care-managed controls in a series of retrospective cohort studies, and then compared on changes in clinical and process indicators. Clustering was done by physician and clinic to account for cohort differences.

Statistical analysis

As analysis intent was primarily descriptive, statistical analysis was limited to Student's t-text and two-way analysis of variance for continuous variables and Fisher's exact tests for 2×2 tables.

RESULTS

Health care organization

The provider clinics selected for this implementation are similar to medium-sized primary care clinics elsewhere in the United States. As shown in Table 1, seven urban health centers, with 54 primary care providers (7.7 providers per clinic) who see adult patients (excluding Pediatricians), form the primary setting of the intervention. Each provider in the clinic sees, on average, 292.6 ± 104.3 patients per month. The age of providers, their experience, and the case-mix of patients they see also match the characteristics described in other, similar studies of physician demographics in primary care clinics. The volume and complexity of patients seen in the clinics is also similar to internal medicine and family practice populations reported in these studies.[49,50] Table 1 also shows that the clinics' revenues stem from multiple payers, including public, several private, and self-pay or charity sources. In all, 46 of the physicians referred patients to care management during the study period, and eight did not use this resource.

T1

TABLE 1. DESCRIPTION OF IMPLEMENTATION CLINICS AND PHYSICIAN POPULATION

	n (%)
Number of clinics	7
Number of physicians	54
Number of physicians per clinic	7.7 (5–10)
Specialty	
Internal medicine	21 (39%)
Family practice	33 (61%)
Physician characteristics	
Age	42.8 ± 11.8[a]
Years in system	6.8 ± 4.5[a]
Appointments per full month, average	292.6 ± 104.3[a]
Productivity per month, with relative value units	383.9 ± 117.0[a]
Payer by clinic	
Government (Medicare, Medicaid, other)	17.6%
IHC health plan	35.0%
Self-pay/charity	20.1%
Other private insurances	27.3%

[a]Mean $\pm$ SD.
IHC, Intermountain Health Care.

As seen in Table 2, care management services were given to 2,356 patients, or 1.7% of the 106,766 adult patients seen in these clinics in 2003. Each care manager, on average, saw 336.7 ± 116.4 unique patients. On average, patients referred for care management had double the CDPS case-mix scores of the non-referred patients in the population, indicating that a resource intensive subpopulation was referred. The high utilization of the referred population is further evidenced by the fact that these patients had 6.5 visits per year on average (or 15,134 physician visits for 2003), compared with 2.6 visits for the rest of the clinic population. Those referred were more likely to be female, single, and of a non-white race than the others (factors that were found to indicate care management need in other studies).[51,52]

Care management services provided according to condition addressed and CCM category

The 2,356 patients seen had a total of 3,146 problems or chronic conditions addressed by the care managers, or an average of 1.5 ± 1.2 problems per patient. Table 3 displays the wide variety of conditions treated. Patients with diabetes ($n = 866$, 36.8% of all patients) and mental health issues ($n = 774$, 32.9%) were treated most commonly. Social and organizational needs such as caregiver fatigue, medication assistance, and financial needs accounted for

18.6% ($n = 438$) of problems treated. Beyond the diagnoses or problems listed, 27 additional chronic diseases and conditions (eg, arthritis, cognitive issues such as Alzheimer's disease) account for 45.4% of the remaining problems treated in patients.

These problems are treated through various types of care management encounters. In addition to the traditional physician-only visits, there were 10,194 encounters or tasks completed by the care manager, or an average of 4.3 ± 3.9 encounters per patient. These types of encounters are displayed in Table 3. The care team used various redesigned modalities to provide care. Special care manager and care team face-to-face visits with patients accounted for 3,415 (or 33.5% of all) activities, while telephone calls with patients accounted for 4,094 (or 40.2%) activities. Individual efforts by a medical team member on behalf of a patient (eg, calling a specialist individually) accounted for 16.4% of activities, while care conferences (ie, team meetings about a patient) accounted for 9.9% of activities. Both coordination and care conferences included specialists in addition to the primary care team in a number of cases. Activities such as medication assistance (3,565 encounters, or 35% of the total) sometimes included both a face-to-face visit (eg, education about programs and assessment of financial need) and a coordination aspect (eg, filling out provider paperwork to initiate pro-

TABLE 2. DIFFERENCES BETWEEN ADULT PATIENTS REFERRED TO AND NOT REFERRED TO CARE MANAGEMENT IN SEVEN CLINICS				
	Total	*Care manager*	*No care manager*	
Number of patients	106,766	2,356 (1.7%)	104,410 (98.3%)	
	Mean ± SD	*Mean ± SD*	*Mean ± SD*	*Student's t*
Case-mix score[a]	0.73 ± 0.61	1.45 ± .88	0.71 ± 0.59	$p < 0.001$
Age (years)[b]	48.8 ± 18.8	54.9 ± 18.6	48.6 ± 18.9	$p < 0.001$
Visits/year	2.7 ± 3.0	6.5 ± 6.4	2.6 ± 3.1	$p < 0.001$
	n (%)	n (%)	n (%)	*Fisher's exact*
Female, %	56.4%	62.2%	56.3%	$p < 0.001$
Caucasian, %	92.8%	90.3%	92.9%	$p < 0.001$
Married, %	65.4%	57.7%	65.4%	$p < 0.001$

[a]The Chronic Illness Disability Payment Score (CDPS) was used, adjusted for a general health plan population.
[b]Adult was defined as age ≥ 18.

TABLE 3. CONDITIONS TREATED BY CARE MANAGER AND CHRONIC CARE MODEL TEAM
ACTIVITIES/ENCOUNTERS

Category	n	%[a]
Total patients seen	2,356	100%
Conditions treated		
Average conditions treated per patient (SD)	1.5	(1.2)
Patients with 2+ treated conditions	463	19.7%
Diabetes	866	36.8%
Mental health	774	32.9%
Social/organizational needs	438	18.6%
Hypertension	154	6.5%
Preventive needs	117	5.0%
Asthma/COPD	93	3.9%
Other	1,069	45.4%
Care team activities/encounters		
Care management encounters	10,194	100%
Average per patient (SD)	4.3	(3.9)
Face to face visits	3,415	33.5%
Telephone calls	4,094	40.2%
Coordination[b]	1,674	16.4%
Care conferences	1,011	9.9%
Self-management support		
Education sessions	2,615	25.7%
Motivation of patient	3,223	31.6%
Connection to community		
Electronic accesses	1,044	N/A[c]
Connection to external programs	4,782	46.9%
Support for evidence-based practice		
Protocols followed	4,748	46.6%
Diabetes	2,265	22.2%
Mental health	1,748	17.1%
Combined protocols	715	7.0%

[a]Percentages exceed 100%, as multiple diagnoses or types of activities are possible for each patient or encounter.
[b]Coordination activities include gathering and filling out forms, accessing local resources, and arranging for appointments.
[c]Data available for 6 months only.
SD, standard deviation; COPD, chronic obstructive pulmonary disease.

grams). Empowering the patient or their caregiver to understand and control the care of their conditions reduced the burden of coordination. To this end, self-management support was provided in 2,615 encounters (25.7%) involving patient education in either group or individual formats. Motivation support for the patient to continue self-managing behaviors was included in another 3,223 encounters (31.6%). The patients and their caregivers were provided connections to community programs in 4,782 (46.9%) of the encounters, with 1,044 of these via electronic access. Finally, the care team utilized computer-based support for evidence-based practice, following specific, previously defined protocols for conditions in 4,748

(46.6%) of their activities, including combined protocols in 715 (7.0%) of the activities.

Substantial use of the information system, decision support and communication components are described in Table 4. In July 2003, care managers saw 410 patients and accessed the EHR for each patient. During the same month, the 54 primary care physicians saw 19,582 patients and accessed 18,486, or 94.4%, of the EHRs for the patients they saw. Summarized patient records with built in support for best practice in the form of the patient worksheet were used by care managers for 22.7% of the patients they saw, whereas physicians viewed the patient worksheet for 7.8% of their patients. Because not all patients have chronic disease,

TABLE 4. MONTHLY INFORMATION SYSTEM USAGE FOR ACCESS, BEST PRACTICE SUPPORT, AND COMMUNICATION BY PARTICIPATING CARE MANAGERS AND PHYSICIANS

	Care manager	Physician
N of sample	7	54 (primary care)
Patients seen in July 2003	410 (2.1% of physician seen) patients	19,582 patients
Access patient data		
Number of patients accessed (% of all patients)	410 patients (100%)	18,486 patients (94.4%)
Best practice—decision support		
Patient worksheet pulls (% of all patients seen)	93 (22.7%)	1,442 (7.8%)
Reference information accesses	Senior web resources	Physician e-Resources
Total per month	174 ± 20 hits/month	554 hits/month
Per clinician-month	24.9 hits/care manager	10.2 hits/physician
Alert type	Tickler list	Patient worksheet diabetes alert
Probability of receiving an alert per clinician day	63% ± 17%[a]	28% ± 4%[b]
Communication		
Patients with 1 or more electronic message generated (% of all patients seen)	302 (73.7%)	7,578 (38.7%)

[a]Applied to multiple patients simultaneously, so usage statistics are generated per day rather than per patient.
[b]Calculated per day for comparison with care manager statistic.

we looked at the subset of patients with diabetes and found that appropriate standards-based alerts were seen by physicians for 28% of patients with diabetes. Care manager alerts, or "tickler" lists, were triggered on 63% of their working days (alerts are generated on multiple patients at once). The care managers accessed Web-based best practices or connections to community resources 24.9 times per month, on average, about 2.5 times more than the average physician access of 10.2 times per month, even though the physicians averaged 6.3 times as many patient visits. Care managers and physicians sent or received messages on 73.7% and 38.7% of their patients, respectively.

Benefits to clinical care and costs

T5 Table 5 displays the results of analyses assessing the benefits of the program over three broad categories: clinical outcomes and process indicators, satisfaction of providers, and the cost benefit as calculated from productivity gains. Patients with diabetes had better odds of not being overdue for HbA1c testing and bet-

ter completion rates if overdue for bothHbA1c and LDL.[53] Care managed patients had 0.55% reduction in HbA1c versus only 0.18% reduction in controls. Care managed patients with diabetes also had 3.2% fewer hospitalizations. Physicians who participated significantly in the care management program increased their productivity by 8% compared to low-use controls within care management and 5.5% compared to controls in other clinics.[54] A separate analysis showed the costs of intervention patients with depression decreasing by 8% while control patients' costs increased by 19%.[55] Of 18 physicians surveyed for satisfaction with care management, 16 (88.9%) were very satisfied with the program.[56] Physicians less likely to use the system were less satisfied and either had initial failures with the system or saw it useful primarily for clerical help such as medication assistance programs.

In all, the CMT system was estimated to cost $100,000 per year for the training program and care manager salary per seven-physician clinic (information systems were available to control clinics, so these costs are not included), and to

TABLE 5.   SELECTED INITIAL RESULTS OF CARE MANAGEMENT

	Exposure		Control
N of clinics	7	30	
N of physicians	50	112	
Diabetes[53]			
Number of patients	1,185		4,740 (4:1 matching)
Process	Odds ratio (95% CI)		Odds ratio (95% CI)
HbAlc overdue	0.79[a](0.72, 0.85)		Reference (=1.0)
HbAlc completed if overdue	1.49[a](1.30, 1.71)		
LDL completed if overdue	1.26[a](1.02, 1.57)		
Outcome	%HbAlc		%HbAlc
Baseline HbAlc	7.96% ± 1.74		7.71% ± 1.53
Post HbAlc	7.41% ± 1.38		7.53% ± 1.36
Difference	−0.55%[a]		−0.18%
Hospitalizations (per year)	21.0%		24.3%
Difference	(−3.3%)		
Depression[55]			
Change in costs per patient 2001 to 2002	8% decrease		19% increase

Productivity	High use of care managers (<2% of patients)	Low use of care managers (<2%)
Number of physicians	32	90
Physician-months	990	2,840
Average work RVUs	398.9 ± 61.1	377.9 ± 55.1
[difference]	[+22.0[a] (5.5%)]	
Within CM clinics	398.17 ± 60.0	368.0 ± 95.4
[difference]	[+30.1[a](8%)]	
Satisfaction		
Physicians who were very satisfied with program	16/18 (88.9%)	N/A

Cost-benefit	Per clinic (7 physicians)	Per physician
Costs		
Care managers	$75,000	$10,714
Training program	$25,000	$3,571
Benefits		
Productivity changes[b]	$88,200	$12,600
Hospitalization reduction[c]	$79,092	$11,299
Depression cost reduction[d]	$135,218	$19,317
Benefits—costs (society)	+$202,510	+$28,930
Benefits—costs (clinic)	−$11,800	−$1,686

[a]$p < 0.001$ when compared to controls.
[b]Based on 2003 Medicare level per RVU (formula = change in RVUs per year × number of physicians × $ per RVU).
[c]Savings/costs per hospitalization per clinic: average charge for age mix ($22,201) × Medicare discount rate (48.9%) ÷ number of clinics.
[d]Estimated average yearly direct and indirect costs for treated patient with CM 2002, $2,300; non-CM control, $2,975.
HbAlc, Hemoglobin A1c test; LDL, low-density lipoprotein; RVU, relative value units; CM, Care Management

generate efficiency savings of $302,510 for society, a net benefit of $202,510 when considering additional costs. The clinics, however, lost $11,800 because much of the benefit accrued to payers and patients in the form of reduced utilization.

DISCUSSION

We have successfully implemented a generalist care management model based on the CCM in seven primary clinics. Patients with a variety of diagnoses and issues are treated, and patient

care is provided according to the modalities defined by the CCM. Our primary innovations of generalist referral to a particular team member, the care manager, and enhanced information system components have been used in 1.7% of the patient population seen in these primary care clinics. In our model, information system components are used to increase teamwork and to target information appropriate for each specific individual within the diverse, complex patient population. Care managers help to bridge the gaps in the system as well as formulate, interpret, and apply care plans with the patient and the rest of the team. Preliminary data indicates this team-based approach allows the physician to increase his or her efficiency by as much as 8%, most likely by reducing time spent on inefficient tasks.[54] We found that care managers read and valued the computer-generated reminders. Initial data show that diabetes[53] and mental health care processes and outcomes were improved compared to our clinics that did not use care managers, with more patients meeting disease control goals. If these gains were maintained, they would lead to a 15%–20% decrease in complications from diabetes over time.[57,58] Multiple co-existing diseases also were uncovered. For instance, administration of the PHQ-9 (a depression screening instrument) in patients with diabetes revealed that as many as 20% were also suffering from depression; as many as one third of these were untreated (A. Larsen, personal communication). An initial qualitative study also suggests that patients and physicians are very pleased with care management. Cost studies show that the societal benefits of increased organization of care and improved health of patients exceeds the costs to society but incurs a slight cost to the provider group. Other benefits to society, such as the long-term reduction in complications from diabetes and depression, reduction in utilization for other diseases, and reduced indirect costs such as missed work, are likely to accrue from the program but are left out of the analysis due to their complexity. In addition, the satisfaction improvement may reduce turnover in provider groups; this, in turn, would decrease the cost of training new physicians.

The IHC approach is different from most previous implementations. First, it is integrated into primary care clinic work flow (with the addition of the generalist care manager) and does not rely on the creation of specialized clinics, clinic sessions, or outside personnel. This has the logical advantage of requiring less specialization but increases the risk of information and care management overload. Second, multiple conditions were treated by the care management system, both singly and when co-occurring. This required the development of multiple protocols to support best practice for a variety of conditions. These standards of care were taught to the entire care team and care was redesigned to facilitate the implementation of these protocols, with a broad role given to the generalist care manager to improve protocol compliance. The information system was used to reinforce expected standards of care by the patient care team. We recognize that approaching chronic disease in this way is controversial, as specialized knowledge that is required for patient-centered, evidence-based practice may not translate into protocols but may be found only via specialty referral. Such referrals to specialists occurred when anyone on the team felt that the specific patient's needs exceeded the scope of the care management system. Third, information systems were used more extensively than previously to enhance the collaboration and support best practices. The information system components provide access to role-specific and general information, generate alerts, reminders, and suggestions based on best practice, and help to track the components of the care process itself. We feel that the components of the information system used in our model are much broader than the information system components specified in the CCM. Fourth, we have implemented this system in multipayer provider clinics. We have previously made the case that care management in a primary care office is not a widespread model because of fragmentation and misaligned incentives. Rather, care management is seen most often in single-payer systems like Kaiser and Group Health Cooperative; in these cases the payer benefits from the patient's improved health status. Our model addresses this difficulty by spreading the care of the patient with chronic conditions among multiple members of the care team and encouraging

self-management. Wide adoption of our program may be facilitated by the positive cost-benefit ratio and the similarity between our clinics and others with regard to the patients seen and the physician characteristics. Pay-for-performance demonstration programs with care management will likely further increase the benefit as services such as education and guideline adherence are reimbursed. Our clinics have a variety of patients with a variety of insurance carriers, and the providers are reimbursed on relative value unit productivity. Finally, the model is scalable, with a care manager initially addressing one or more diseases, and gradually adopting more as protocols are developed or adopted within the clinic.

Several implementation challenges have to be overcome in order for others to adopt our implementation of the model. The first is the necessity for information systems at the clinic level that provide several different kinds of information and knowledge; current information system adoption is limited in the outpatient setting.[59] While other practices are increasing their investment in IT, less than 20% of physicians who practice in the ambulatory setting currently have similar functionality.[59] Improved access to patient information, best practice knowledge, reminders at the point of care, and improved communication certainly contribute to the system's success; we are in the process of assessing the relative importance of each of these capabilities. Similarly, the care manager's specific contributions are as yet uncertain; others have reported that integration of care managers has sometimes proved challenging.[41] We are evaluating the breadth and amount of care manager contact needed, as well as the contribution of the care manager-specific components of the information system. Finally, the clinic size needed to support a care manager within the clinic is at least six physicians; as many of our own clinics are small and in rural areas, we are experimenting with shared care managers.

Additional investigation is needed to define the criteria for referral and the impact of the CCM on patients with multiple chronic diseases. In our model, less than 2% of patients are referred; the selection of patients for referral seems to be appropriate in terms of their many illnesses and high utilization, but it is difficult to define appropriate referrals and the amount of care management that will be most effective. Our high satisfaction rates and initial analyses show the unconstrained referral process is working reasonably well; working with the low-use physicians to improve appropriate referrals is still ongoing. Recent reports have suggested some care management programs may not be cost-effective;[60] our initial results also show that this model may be more cost-effective at the provider level than previous models. Identifying and quantifying the benefit of the case manager to patients, individual physicians, clinics, health system, and payers continues to be a primary objective for our group and others such as the Center for Medicare and Medicaid Services.[61,62] Based upon our experience with generalist care managers and specific information system initiatives, we feel that it is possible to implement a cost-effective, high-quality, high-utility model for general primary care clinics.

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Specialist and Generalist Services

Impact of Generalist Care Managers on Patients with Diabetes

David A. Dorr, Adam Wilcox, Steven M. Donnelly, Laurie Burns, and Paul D. Clayton

Objective. To determine how the addition of generalist care managers and collaborative information technology to an ambulatory team affects the care of patients with diabetes.

Study Setting. Multiple ambulatory clinics within Intermountain Health Care (IHC), a large integrated delivery network.

Study Design. A retrospective cohort study comparing diabetic patients treated by generalist care managers with matched controls was completed. Exposure patients had one or more contacts with a care manager; controls were matched on utilization, demographics, testing, and baseline glucose control. Using role-specific information technology to support their efforts, care managers assessed patients' readiness for change, followed guidelines, and educated and motivated patients.

Data Collection. Patient data collected as part of an electronic patient record were combined with care manager-created databases to assess timely testing of glycosylated hemoglobin (HbA1c) and low-density lipoprotein (LDL) levels and changes in LDL and HbA1c levels.

Principal Findings. In a multivariable model, the odds of being overdue for testing for HbA1c decreased by 21 percent in the exposure group ($n = 1,185$) versus the control group ($n = 4,740$). The odds of being tested when overdue for HbA1c or LDL increased by 49 and 26 percent, respectively, and the odds of HbA1c < 7.0 percent also increased by 19 percent in the exposure group. The average HbA1c levels decreased more in the exposure group than in the controls. The effect on LDL was not significant.

Conclusions. Generalist care managers using computer-supported diabetes management helped increase adherence to guidelines for testing and control of HbA1c levels, leading to improved health status of patients with diabetes.

Key Words. Patient care management, chronic illness, diabetes mellitus, medical informatics

Diabetes mellitus and its complications comprise one of the most expensive categories of chronic disease in the United States, contributing to at least 213,062 deaths in 2000 and $132 billion in costs in 2002. There is significant

potential for improvement when appropriate medical care is provided (American Diabetes Association 2003). The highest potential for improvement comes from the capability to prevent the deadly complications of this disease; careful control of blood pressure, control of glycoslylated hemoglobin (HbA1c) and low density lipoprotein (LDL) level, and administration of appropriate medications (including ACE inhibitors, statins, aspirin, and β-blockers) have been shown to slow, and, in many cases, stop the progression of microvascular disease in people with diabetes (Matthews 1999; Nicollerat 2000).

However, the United States' success in achieving tight control of HbA1c levels and appropriate medication administration in these patients has been limited at best (Toth et al. 2003). Despite implementation efforts at over half of the major health systems in the United States, compliance with management guidelines remains low. In a recent study, only 10.4 percent of patients met HbA1c, blood pressure, and LDL goals and only 13 percent met medication standards after guideline implementation (Toth et al. 2003). Clearly, people with diabetes and those caring for them have difficulty adhering to these guidelines.

Guideline compliance can be increased through improved processes of care or disease management. One heavily studied approach involves an additional team member called a care manager who facilitates changes in clinic processes and patient knowledge and behaviors. Several studies have shown that interventions involving care managers can help patients and other care providers improve the quality of care and outcomes in diabetes (Pan et al. 1997; Tuomilehto et al. 2001; Knowler et al. 2002; New et al. 2003; Taylor et al. 2003; The California Medi-Cal Type 2 Diabetes Study Group 2004) and other diseases (Bond et al. 1988; Allen 1994; McGrew et al. 1995; Crystal, Lo Sasso, and Sambamoorthi 1999; Naylor et al. 1999; Bull, Hansen, and Gross 2000).

These studies focus almost entirely on specific diseases or conditions and are mostly efficacy-style trials of disease management, or "a coordinated system . . . for a specific chronic illness" (AHM 2001), as opposed to a more

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broadly defined vision of care management, e.g., "a collaborative process of assessment, planning, facilitation and advocacy" (CMSA 2003). Disease management programs frequently create specialized clinics, which represent a highly focused setting where providers have in-depth training in a single disease whether they are specialists or trained primary care providers. In these specialized clinics or disease-specific clinic sessions, processes can be more easily controlled than in a general clinic where a multitude of acute and chronic illnesses are treated. In contrast, we studied the impact when care management was used to help treat a patient population with multiple chronic and acute illnesses and needs; care management was characterized by generalist care managers and specially developed information technology to support collaboration during the general primary care workflow. As persons with multiple chronic illnesses are known to suffer higher rates of complications and mortality, the generalist approach has the theoretical advantage of treating the whole person with one or more chronic disease rather than focusing on one disease (Rothman and Wagner 2003; Norris and Olson 2004). In practice, however, this approach is challenging. One study in which a broader patient population was treated demonstrated increases in adherence to guidelines and patient satisfaction, but did not find reductions in HbA1c in the patients with diabetes (Wagner et al. 2001). In other studies, it was found that care management programs increased the use of resources (D'Ercole et al. 1997). This finding is of special concern for overworked primary care clinics that frequently only receive a fraction of the savings that result from improving the health of their patients (Casalino 2003). Thus, it is important that implementation of such programs be carried out carefully, especially in real-world settings with diverse patient populations and limited resources.

Given these concerns, we hypothesized that specialized care could be generalized into a multidisease care management model. To do so, we implemented Wagner's Chronic Care Model (CCM) (Bodenheimer, Wagner, and Grumbach 2002a, b) in a way different from many of the previous studies. At Intermountain Health Care (IHC) in Salt Lake City, we adopted a team approach (with the patient at the center) to encourage patient self-management and improved connection to community resources, and created core health care organization goals as part of a model to improve the care of chronic illness; these interventions are all standard parts of Wagner's CCM. Two major capabilities from the CCM were implemented to address the need to integrate the care management program into primary care workflow. Care managers were placed in the clinics and trained to facilitate team collaboration and general patient education, a more central role than advocated for in the

CCM. In addition, existing information technology was leveraged and new applications were created to enable the primary care teams (including the care manager) to adopt many different guidelines at once. We hypothesized that the use of computerized alerts, summarized patient information, and electronic communication would allow an integrated approach to successfully meet the needs of patients with chronic illnesses without the need for specialized clinics for each disease or patient population. This information technology would aid the care manager, who would also work with the patient to assess their readiness to change and create a specific care plan based on any of the patient's particular chronic illness(es) (Spencer et al. 2002; Duran 2003). The generalist care manager, with support of the information system, can then act as a catalyst in each clinic, creating and then helping enact the care plan with the patient.

We also hypothesized that the care of patients with diabetes would especially improve in our multidisease, collaborative care management model as patients with diabetes have a very high rate of co-occurring conditions that can worsen disease outcomes (Rothman and Wagner 2003). Improvement was measured by assessing changes in processes (such as timely testing for disease markers), and outcomes (changes in the levels of these markers indicating control) as defined by current diabetes guidelines (AACE 2000; ADA 2003; Goldstein et al. 2004; Haffner 2004). The demands and benefits of successful multidisease care management programs that can be implemented in the workflow of primary care clinics need to be defined, especially in diseases where they have the most impact. When one attempts to integrate multidisease care management systems into primary care, one may dilute the benefit, that might accrue to patients who are treated in a specialized setting. Integrated care management systems offer the promise to improve quality in a cost-effective manner. By examining the changes in adherence and outcomes in a generalist implementation within diabetes, we hoped to determine whether positive effects can be substantial when examining the impact on a single disease.

METHODS

Health Care Organization

IHC is an integrated delivery network consisting of 20 hospitals and more than 1,200 employed and affiliated physicians in Utah and Idaho. The 450 physicians employed by IHC work in one of 92 clinics, and provide for more than

three million outpatient visits each year. For this study, IHC augmented the services of selected primary care providers in seven IHC-owned ambulatory clinics by installing care managers on-site and adding specific information technology. On average, each care manager serves as a resource to 6 to 10 primary care physicians and has a panel of 350 to 500 active patients. Care managers are trained professionals; all seven in this study were either registered nurses or social workers. Four similar reference clinics without care managers, but serving a similar patient population, were used to generate a control population. The control clinics were matched on provider type and experience, staffing, and variety of patient conditions. This study was approved by the local Institutional Review Board as meeting the criteria for ethical human subjects research.

Care Delivery Design and Information Technology

Exposure to the intervention was defined as referral to, and at least one visit with, a generalist care manager who adhered to the care management delivery model, and used the advanced information technology applications. Patients were referred to care managers by primary care physicians at the physicians' discretion; the providers were encouraged to refer when the patient or their family needed education, cognitive, and community/social support to deal with illness. Referral was not based on specific criteria as perceived need was felt to be the most inclusive indicator for the effectiveness study. For instance, only a subset of patients with diabetes are sent; reasons for referral range from out-of-control glucose levels to those with complicating conditions (e.g., non-supportive home environment).

Once a patient is referred, the care managers offer all pertinent services to the patients and their families, regardless of diagnosis. The general care management program of which they are a part has several components. With referral, a care management team is activated with the care manager acting to provide continuity, regular follow-up, and collaboration. The care managers meet initially with patients, providing education for disease-specific and general problem-solving skills, motivation to encourage self-management, and development of care specific plans, which frequently include several diseases. The self-management component is facilitated by a care manager assessing the patients' readiness to change to self-managing behaviors, providing ongoing motivation/feedback, and encouraging patient independence, usually through a series of phone calls to patients. The care managers put the patients and their caregivers in touch with community resources and advocate for the patient

within and beyond the immediate care team both in person at case conferences and via the phone.

Substantial informational technology access was given to all team members, whether care managers were involved or not. The information technology provided *Access* to patient information, provided reminders and structures for *Best practices*, and enabled virtual *Communication*. For *Access*, team members have access to a longitudinal electronic health record (EHR). The EHR includes the option to use a summarized patient worksheet for chronic diseases. The patient-specific electronic summary gives an overview based upon the chronic conditions of the patient. Team members have access to computer alerts (such as drug–drug interactions) and chronic disease reminders on the summarized form to help support *Best practices*. The logic in guidelines is extracted in order to generate reminders automatically either via active alerts or on the patient summary as passive prompts.

For the exposure group only, care managers have an additional alerting system that reminds them of specific process-based tasks to perform, such as calling a set of people with diabetes when their tests are overdue. The care management system also has a specific interface that allows care managers to store and retrieve information specific to their workflow. For example, a phone contact for depression has coded elements that easily link to standardized mental health forms.

Finally, all team members have access to an electronic *Communication* system that allows providers to exchange electronic messages that are ultimately attached to a specific patient's chart. As both control and intervention patients cared for in this study have providers who have the option to use the clinical information system, the information technology portion of the intervention is restricted to the specific care management components and the activities of the care managers themselves.

The diabetes-specific component of this intervention is two-fold. First, all team members are trained in several chronic disease guidelines further developed by IHC from national sources, including ones for diabetes and hyperlipidemia (AACE 2000; ADA 2003; Goldstein et al. 2004; Haffner 2004). From these guidelines, specific diabetic reminders are built into the general information system in the summarized, structured form. In addition, tickler lists in the care manager application display lists of patients who need follow-up calls for missed tests and patients with high test values. Another aspect of the care model is the specific diabetes education provided by care managers; although two of the seven are Certified Diabetes Educators, all are trained in basic diabetes education.

Sample Size and Eligibility

For the purposes of this study, a diabetes registry containing 25,273 patients (as shown in Figure 1) was created by analyzing data from patients seen in the seven care manager clinics and four control clinics. The diabetes registry was created by identifying patients with two or more separate ambulatory visits within the 5-year period between January 1, 1997 and August 1, 2002 with an ICD-9 code of 250.*xx* (where *xx* indicates a subdiagnosis of diabetes). Patients were assigned to the exposure group if they had had any encounter with a care manager from March 1, 2001 to September 30, 2002 (the study period). This criterion produced a total of 1,185 exposure patients, who were seen in seven clinics and were co-managed by any of 65 physicians and 7 care managers. Of the 24,088 patients remaining who did not see a care manager, 9,813 had no outpatient encounters during the study period and were excluded. The remaining patients ($n = 14,275$) were used to match control patients in a 4:1 ratio ($n = 4,740$ matches); clinics with and without care managers contributed similar numbers of controls.

The exposure group start date was defined as the first outpatient encounter with a care manager during the study period, and the start date of the

Figure 1: Sample Size and Eligibility
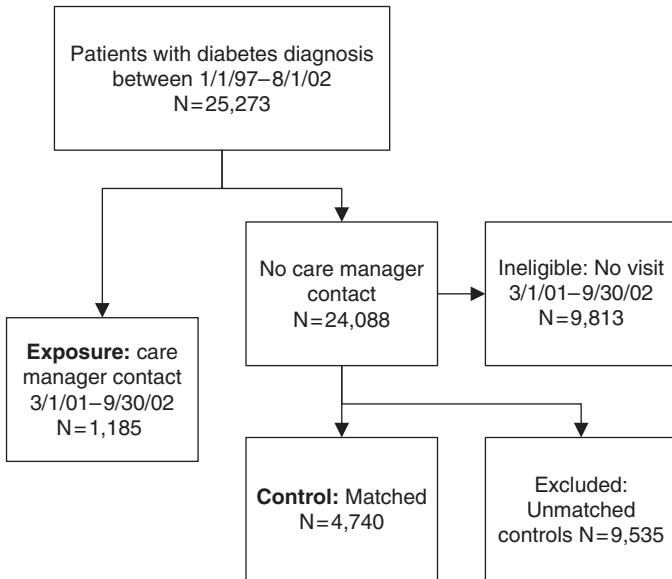
control group as the first outpatient encounter during the study period in which diabetes was included on the diagnosis list. Follow-up time, which began accruing after the individually defined start date, ranged from 4 to 18 months.

DESIGN

The study design was a retrospective cohort design with matched controls in a 4:1 ratio. Each case was matched to four controls by sex, age, a comorbidity index, the testing regularity pattern (regular, irregular, no testing, or unknown), and previous pattern for glycemic control (controlled, uncontrolled, or unknown) of LDL or HbA1c. Ages were grouped in 10-year intervals based on clinically significant formulations from previous studies (Turner et al. 1999; Mokdad et al. 2003; Engelgau et al. 2004). Regularity and control definitions were based on patient data during the 2-year period prior to the start date, and are described in Table 1. The target goal for desirable HbA1c levels changed from the eligibility period (2001–2002) to the study period (2002–2003) from 7.2 to 7.0 percent; this change is reflected in the differences between baseline control and study control definitions in Table 1. The comorbidity index was based on the work by Deyo, Cherkin, and Ciol (1992). In their approach, the co-existing diseases in a single patient during the baseline period (represented by ICD-9-CM codes from outpatient visit billing codes) are weighted and summed, with a maximum score of 14 comorbidities. This scale was collapsed into three categories (1, 2, or 3 or more comorbidities) for matching and data analysis purposes.

Outcome Measures

Outcomes were process and health status indicators as shown in Table 1. Process variables were adherence to established diabetic and hyperlipidemia guidelines, including the conformity to testing frequency. Use of information systems by the care managers was assessed by audit trails and self-report. Beginning from the treatment initiation date, automated retrospective analysis was carried out for each individual to determine whether laboratory tests were current or overdue based on agreed-upon standards of care and whether observed laboratory test values fell above or below a desired threshold. Patients were overdue for testing if 7 months (for HbA1c) or 13 months (for LDL) had elapsed since the last abnormal test. The desired guideline thresholds were set at HbA1c ≤ 7.0 and LDL ≤ 100 during the period demarcated by

Table 1:   Definitions of Regularity of Testing and Control Categories for Matching, Process Measures, and Outcomes

Category	Definition	Reference
Matching		
Previous regularity of HbA1c or LDL testing*		
Regular	Patient was tested yearly for previous 2 years	AACE (2000), Goldstein et al. (2004)
Irregular	Patient was tested once in previous 2 years	
No testing	Not tested in previous 2 years	
Previous HbA1c or LDL control[†]		
Controlled	One or more test and Mean HbA1c ≤ 7.2 Mean LDL ≤ 100	AACE (2000), Haffner (2004)
Uncontrolled	One or more test and Mean HbA1c > 7.2 Mean LDL > 100	
Unknown	Not testing or unknown regularity	
Process measures		
Timeliness of testing		
HbA1c	Test ordered and . . . ≤ 6 months since last test	Goldstein et al. (2004), Haffner (2004)
LDL	< 1 year since last test	
Tested if overdue		
HbA1c	Test ordered and . . . ≥ 7 months since last test	Goldstein et al. (2004), Haffner (2004)
LDL	≥ 13 months since last test	
In control	Most recent test result	Goldstein et al. (2004), Haffner (2004)
HbA1c	< 7.0	
LDL	< 100	
Outcome measures		
HbA1c and LDL	Last level and adjusted change in level	

*Definitions are for those diagnosed 2 or more years prior to trigger date. If diagnosis was between 1 and 2 years from trigger date, testing was *regular* if conducted last year. If the patient was diagnosed within last year, testing regularity was *unknown*.

[†]Control was *unknown* if no testing was conducted or diagnosis was made within 1 year.

HbA1c, glycosylated hemoglobin; LDL, low-density lipoprotein.

this study. Health status outcome indicators were the levels of both HbA1c and LDL.

Statistical Analysis

The effects of generalist care managers on outcomes were assessed using logistic and linear regression. Estimates for the main effect of care management were adjusted for patient age (in 10-year age categories), sex, comorbidities, history of testing regularity, race, and history of HbA1c and LDL control. The monthly snapshots of the data presented the potential for each patient to have multiple observations, so variance estimation techniques clustered on patient identifier were used to correct for the effects of multiple observations (Huber 1967; White 1982). Although patients were matched on previous control of diabetes (see Table 1) as measured by HbA1c level at baseline, they were not matched on exact HbA1c levels as it was thought that this would lead to overmatching. Differences in baseline levels and subsequent changes were adjusted for possible regression to the mean using the method of Trochim (2003). In this conservative adjustment, intraindividual correlations (r) of change are used to estimate the proportion of change in HbA1c levels that may be because of statistical artifacts.

RESULTS

During the study period, 4,421 patients were referred to seven care managers by 65 physicians; of these referrals, 1,185 (26.8 percent) had diabetes and were assigned to the exposure group. From patients with diabetes seen by physicians and not care managers, 4,470 controls were matched to the study subsets via the criteria described in the methods. The demographic information for the exposure, control, and eligible registry patients is displayed in Table 2. For the unmatched categorical variables (including race), the exposure group distribution was not significantly different from the control one. As an entire group, the registry patients were different from exposure and control groups in that they had a slightly higher disease burden (29.7 percent with two or more diseases versus 26 percent for the other two groups), and had significantly less follow-up and thus more missing information.

  Care managers had encounters with patients an average of 4.5 ± 1.8 times per 1 year of follow-up. Diabetes was the most frequent reason for referral (26.8 percent), followed by mental health (24 percent), and resource assistance (12 percent) needs. Comparing patients referred for diabetes with others in the care

Table 2:   Group Baseline Characteristics

	Exposure		Control		Registry	
	N	%	N	%	N	%
Total	1,185	100.0	4,740	100.0	14,275	100.0
Female	603	50.9	2,412	50.9	7,170	50.2
Age						
18–29	52	4.4	208	4.4	787	5.5
30–39	74	6.2	296	6.2	929	6.5
40–49	199	16.8	796	16.8	2,049	14.4
50–59	264	22.3	1,056	22.3	3,053	21.4
60–69	296	25.0	1,184	25.0	3,249	22.8
70–79	219	18.5	876	18.5	2,995	21.0
80+	81	6.8	324	6.8	1,213	8.5
Mean (SD), years	59.9 (15)		59.8 (15)		60.1 (16)	
Race*						
American Indian	2	0.2	11	0.2	28	0.2
Asian/Pacific Islander	22	1.9	111	2.4	301	2.1
Black	9	0.8	30	0.7	123	0.9
Hispanic	67	5.7	15	6.4	918	6.4
Unknown	26	2.2	106	2.2	1,268	8.9
Caucasian	1,059	89.4	3,718	88.5	11,637	81.5
Risk score						
1	867	73.2	3,468	73.2	10,031	70.3
2	264	22.3	1,056	22.3	3,717	26.0
3+	53	4.5	212	4.5	527	3.7

	Exposure		Control		Registry	
	HbA1c (%)	LDL (%)	HbA1c (%)	LDL (%)	HbA1c (%)	LDL (%)
Testing history						
Unknown	0.9	6.9	0.9	6.9	8.5	15.2
Not tested	11.5	11.2	11.5	11.2	11.9	19.8
Irregular	34.3	32.1	34.3	32.1	28.2	31.8
Regular	53.2	49.8	53.2	49.8	51.4	33.1
Control history						
Unknown	11.8	17.6	11.8	17.6	20.2	34.4
Uncontrolled	44.6	40.3	44.6	40.3	45.3	34.7
Controlled	43.6	42.2	43.6	42.2	34.6	30.9

*Race was not a matching variable; the race distribution between control and exposure groups was not significantly different.

HbAlc, glycosylated hemoglobin; LDL, low-density lipoprotein.

management group, the patients with diabetes had more visits than care-managed patients with other diagnoses, or 5.8 ± 2.0 visits per year. In all, there were 6,876 visits completed by care managers for patients with diabetes; 39.4 percent

were via phone, 36 percent were visits with the patient, 11.9 percent were care conferences or other advocating activities, and 5.5 percent were in a group education session. Seventy percent of all encounters in patients with diabetes involved diabetic education or protocol adherence checks; 14 percent of encounters were for financial assistance with medications, and the remaining 16 percent of encounters in patients with diabetes were solely for other diseases, including depression, hypertension, and drug dependency. During the study period, care managers addressed at least one other major issue besides diabetes in 35 percent of patients with diabetes. Care managers *accessed* the electronic records of every patient at least once during the study period, using the computer to see laboratory and radiology test results, to read physician progress notes, or to review measures of chronic disease adherence on the patient worksheet. *Best practice* support provided by the patient worksheet or tickler lists to remind care managers of follow-up appointments were used daily by three (of seven) of the care managers, used weekly by three additional care managements, and used at least monthly by all seven. In addition to phone calls, *communication* among team members via the electronic messaging system was used by care managers at twice the rate of physicians per patient seen; as their receipt of messages was higher, physicians saw 29 percent more electronic messages in the care of exposure patients $(1.0 \pm 3.7$ messages per patient) versus controls $(0.7 \pm 2.1$ messages per patient). Physicians of control patients used the information system on 93 percent of all patients, including alerts, the summarized worksheet, and communication between providers about patient status. Beyond the care manager-specific applications and message log use, no significant difference in information system use by physicians was seen in the care of exposure versus control patients.

Table 3 shows the unadjusted and adjusted odds ratio (OR) for the exposure group versus the control group in adherence to the diabetes guidelines. Before adjustment for other variables, the patients in the exposure group had 20 percent lower odds of being overdue for HbA1c testing, were 42 and 20 percent more likely to be tested for HbA1c and LDL if overdue, and were 24 percent more likely to have an HbA1c under the goal threshold of 7.0. All of these values were significant at the $p < .01$ level in both the single and multivariable model except LDL testing when overdue ($p = .10$ for single and $p = .04$ for multivariable models).

In the multivariable model, the exposure group was 21 percent less likely to be overdue for HbA1c testing (OR 0.79, 95 percent confidence interval [CI] 0.72–0.85), and 31 percent more likely to have an HbA1c under 7.0 percent, as shown in Table 3. Also significant in the model were testing

Table 3:   Odds of Case-Managed Patients Being Adherent to Diabetes Guideline for HbA1c and LDL

Variable	HbA1c Overdue		HbA1c Completed if Overdue		HbA1c<7.0		LDL Completed if Overdue	
	Odds Ratio (95% CI)	p-Value	Odds Ratio (95% CI)	p-Value	Odds Ratio (95% CI)	p-Value	Odds Ratio (95% CI)	p-Value
Unadjusted odds: single variable model with exposure to case managers versus usual care								
Care manager	0.80 (0.74, 0.86)	<.01	1.42 (1.31, 1.64)	<.01	1.24 (1.08, 1.41)	<.01	1.20 (0.98, 1.54)	.10
Adjusted odds: multivariable model included age, sex, race, risk score (number of comorbidities), testing history, and control history								
Care manager	0.79 (0.72, 0.85)	<.01	1.49 (1.3, 1.71)	<.01	1.31 (1.14, 1.51)	<.01	1.26 (1.02, 1.57)	.04
Significant variables*	Age, risk score, testing history		Age, risk score, testing history		Age, race, risk score, testing history, control history		Age, control history	
Selected odds from model								
Age (reference = 60–69)								
20–29	1.8 (1.5, 2.15)	<.01	0.64 (0.48, 0.85)	<.01	0.45 (0.36, 0.58)	<.01	0.61 (0.41, 0.9)	<.01
80+	1.26 (1.08, 1.46)		0.84 (0.68, 1.05)		0.92 (0.81, 1.03)		0.5 (0.32, 0.77)	
Deyo risk score (reference = 1)								
2	1.25 (1.15, 1.36)	<.01	0.77 (0.67, 0.88)	<.01	0.87 (0.8, 0.94)	<.01	*Nonsignificant*	
3 or more	1.42 (1.11, 1.83)		0.9 (0.63, 1.29)		0.76 (0.59, 0.97)			
Testing history (reference = regular)								
No tests	10.85 (8.47, 13.87)	<.01	0.27 (0.19, 0.39)	<.01	0.1 (0.07, 0.15)	<.01		
Irregular	2.48 (2.28, 2.71)		0.69 (0.61, 0.79)		0.57 (0.52, 0.63)			

*Sex was not significant in any component, but was included in the final multivariable model.

HbA1c, glycosylated hemoglobin; LDL, low-density lipoprotein.

regularity, age (with the very young and the very old at higher risk of being overdue), and increasing comorbidity index score. The group of patients whose past testing was irregular or nonexistent had 2.5 and 10.9 times the odds of being overdue, respectively, versus patients in whom testing had been regular (no previous tests: OR 10.85, 95 percent CI 8.47–13.87; irregular testing: OR 2.48, 95 percent CI 2.28–2.71; $p = <.01$).

Exposure to care managers significantly increased the odds of completing the testing once the patient was overdue for HbA1c (OR 1.49; 95 percent CI 1.3–1.71) and LDL (OR 1.26; 95 percent CI 1.02–1.57) testing, as seen in Table 3. Patients in the exposure and control groups with age between 20 and 29 (younger) and older than 80 years (very old), higher risk patients, and those with an irregular testing history had worse odds of being tested when overdue for HbA1c. Being of younger and very old age also decreased the odds of being tested for LDL by 40–50 percent.

Table 4 compares the absolute and relative differences in HbA1c and LDL levels between the care-managed (exposure) and control groups. The average changes between the initial and final levels for HbA1c and final levels of LDL were significantly lower for the exposure group as compared with the control group (as shown in Table 4). Despite matching on history of glycemic control, the initial level of HbA1c in the exposure group was 0.25 percentage units higher than that of the matched controls. The correlation (r) between pretest and posttest was 0.64, and the maximum amount of decline in HbA1c levels because of regression from the mean is expected to be 0.09 percent HbA1c greater in the exposure than the control group; the 0.09 percent is subtracted from the exposure groups' difference. The odds of the HbA1c being in the controlled range were also significantly higher for the exposure group (Table 3; OR 1.19, 95 percent CI 1.10–1.28). Again, younger age, higher risk, and irregular testing history all lowered the odds of being in control; a history of being uncontrolled or being of nonwhite or unknown race also lowered the odds that the current test result demonstrated control. No significant difference was seen between the two groups for odds of LDL below 100 mg/dl.

DISCUSSION

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 as compared with

Table 4:   Reduction in HbA1c and LDL Levels in Case-Managed versus Reference Patients

| | HbA1c | | | | LDL | | |
| | Mean (SD) | | | | Mean (SD) | | |
	Baseline	Post	Reduction	Adj. Reduction*	Baseline	Post	Reduction
Care management	7.96 (1.74)	7.41 (1.38)	0.55%	−0.46%	102.8 (32.7)	96.7 (28.3)	−6.1 mg/dl
Reference	7.71 (1.53)	7.53 (1.36)	0.18%	−0.18%[†]	104.3 (33.2)	100.6 (30.4)	−3.7 mg/dl
Difference	0.25	(−0.12)	(−0.37)	(−0.28)	(−1.5)	(−3.9)	(−2.4 mg/dl)
p-value	<.01	.02	<.001	<.01	NS	<.01	.09

*Adjusted for regression to the mean; for details, see Davis (1976) or Trochim (2003).

[†]The baseline value for the lower mean does not change in the method.

HbA1c, glycosylated hemoglobin; LDL, low-density lipoprotein.

usual care—including computer support—for matched controls. In addition, the average values for LDL and HbA1c were ultimately lower for the care-managed group versus the controls, *and* the odds of having glycemic control were higher in the care-managed group. These improvements, if sustained, are predicted by previous studies to lead to a 15–20 percent reduction in complications (Viberti 2003; Vinik and Vinik 2003). A notable exception to these positive results were the very old (age 80 and older), who were less likely to achieve adherence to the guidelines at each step. These results are tempered by the nature of our effectiveness study, which makes it difficult to measure individual components of the intervention.

Evaluating our generalist care management system on a set of patients with diabetes—an expensive, complicated chronic disease with effective therapies—is an important component of the overall success of the system, especially given that patients with diabetes were only approximately 26 percent of the patients treated. Several recent studies demonstrate the differences between this study design and the current literature (Pan et al. 1997; Tuomilehto et al. 2001; Knowler et al. 2002; New et al. 2003; Taylor et al. 2003; The California Medi-Cal Type 2 Diabetes Study Group 2004). Most used an idealized trial format, with separate diabetes clinics, endocrinologists, and/or nurse specialists to improve out-of-control blood pressure and lipid levels in people with diabetes. These investigators have been able to show improvement in control, adherence, and even mortality of diabetics randomized to treatment clinics versus control. The effectiveness format in the present study uses a different implementation method. No specialized clinics were created; rather, the usual day-to-day activities of PCPs were augmented by the presence of the generalist care managers in a team-based approach. Wagner et al. (2001) conducted trials with both frail geriatric and diabetic patients using chronic care clinics that were closer to our approach (although still disease specific). Unlike the current study, the diabetic arm of Wagner's study showed improvement in adherence but no change in HbA1c in the intervention ($N = 278$) versus control patients (Wagner et al. 2001).

Our approach has a strong basis in theory; the care managers receive training in and apply the stages of change model (Prochaska 2003), the coaching model (Koenigsberg, Bartlett, and Cramer 2004), and Wagner's CCM (Wagner et al. 2001), as they care for patients with a variety of illnesses. Our implementation of the CCM is different from most, however, in that it adds several aspects of information system components. The care managers and other team members have access to and use multiple features of a shared electronic medical record, specifically a summarized, structured form with

patient-specific results; the success of the team approach with generalist care managers may indeed depend on this distributed, longitudinal technology, which enables the team to apply multiple guidelines with ease. Components that facilitate this process included the ability to access the entire patient record easily, specific decision support mechanisms that help them to efficiently address the needs of a population by providing lists of alerts for patients who require attention, and patient-specific electronic communication. Importantly, this intervention allows for smoother integration into the primary care workflow, as information technology helps facilitate communication and the application of multiple disease guidelines and other resources in a single visit rather than the creation of specialized clinics or additional visits for other comorbidities. Studies indicate that this is an important factor in the inefficiency of primary care clinics (Flocke, Frank, and Wenger 2001; Rothman and Wagner 2003). In addition, the generalist approach may allow the care managers to focus more on the needs of the patient than the needs of one particular disease, improving patient-centric care delivery and prioritizing care delivery (Allen 1994; Crystal et al. 1999; Naylor et al. 1999; Bull et al. 2000). Finally, this generalist implementation had all of the elements of the CCM, including health care organization, self-management support, clinical information systems, decision support, connection to the community, and delivery system redesign. We focused on delivery system redesign with team care and information system support; a previous study found the care delivery design to be the most influential component (Sperl-Hillen et al. 2004) but the information technology element included in our implementation is very broad and may contribute significantly to the success of our program, as described by Casalino et al. (2003).

Several potential biases exist in this study. First, referral bias may create differences between this population and other pertinent populations. Although attempts were made to match control and exposure variables based on available pertinent variables and risk factors, there are possibly other factors that would contribute to the effect seen in this paper. While it is possible that the patients who did not receive care management were in some way different from those who did, the matching variables were chosen to ensure similar previous outcomes and baseline probability of adherence and control of diabetes. Also, utilization was matched by determining the eligibility of controls based on previous visit history. Most biases in referral for this system (patients who are more ill or more difficult to control, for example) would favor a result of no differences between the groups. The higher baseline HbA1c confirms the direction of these biases; the correction for regression to the mean provides

an appropriate perspective given this bias. The inclusion of both Type I (estimated at <5 percent of the study population) and Type II diabetes as well as a broad range of ages indicates a number of potential different subpopulations who might have very different treatment recommendations. To account for these different subpopulations, the chosen process and control measures are the same in the various guidelines that cover these groups, while the differing treatment recommendations were largely excluded from analysis. Thus, recommendations exist to measure LDL in even the youngest groups with diabetes, but treatment recommendations differ. Adjusting for age and estimated Type I diabetics did not affect the significance of the results. Another source of bias was the initial selection of HbA1c 7.2 percent as the cutoff for control; at the start of the study, and this was the internal guideline at the health system under study; it was selected during a period when external guidelines were shifting from 8.0 to 7.0 percent as the goal. The results do not differ with control criteria set at 7.0 or 7.2 percent; for generalizability, 7.0 percent is given in the results.

Biases based on environmental variables, such as clinic milieu or other provider care, were minimized by including a large proportion of control patients who were seen in the same or similar clinics or by the same physicians but not referred. Biases as a result of information system effects were also minimized by ensuring that all clinicians included had access to and generally used the clinical information system. The effect of individual components of the care management system described in this study is difficult to disambiguate because of the study design. For instance, five of the care managers were not certified diabetic educators; although a separate analysis indicates that outcomes did not differ in these five care managers, the relative role of diabetic education is difficult to discern. All patients had access to diabetes education through groups and individual educators, but the kind, amount, and quality of diabetic education may differ; part of this difference is as a result of the design of the system, however. Finally, some of the improvements may be because of the increased scrutiny of these patients (Hawthorne effect) and could attenuate over time.

The averaged difference in HbA1c and LDL between the groups is consistent with previous studies, despite the fact that both the initial and final HbA1c levels of both our groups were lower than most studies. Many patients with out-of-control HbA1c and LDL levels were likely excluded from the control group in this study because they were never tested (substantiated by the data on irregular and unknown testing)—the effect of care manager is likely underestimated because of this difficulty in study design.

It would be important to study the persistence of this effect through a long-term prospective study to determine assessment of the reasons for referral and overall satisfaction with the system. The independent effect of computer assistance and other intervention components is also of interest; technological assistance likely contributes to the ability of the care managers to positively impact patient outcomes by facilitating access to patient data relevant to multiple guideline compliance, by meeting specific information needs of care managers, and through the messaging abilities of the system. In effectiveness studies such as this one, the generalizability of the intervention arm and the comparability of the control arm are important. In this study, the information system components are more advanced than many other systems; however, the improvement beyond the information systems indicates that such systems are not enough: a broader care management system can further improve care. As a significant problem in health care delivery is the inadequate application of known treatments for chronic diseases and most patients with chronic diseases received their health care from primary care providers, models that can improve adherence to guidelines of care in this setting are important (Glasgow, Vogt, and Boles 1999; Rothman and Wagner 2003). Overall, this study represents an important first step in evaluating a generalist multidisease care management program in a real-world setting.

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Productivity Enhancement for Primary Care Providers Using Multicondition Care Management

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Objective: To assess the impact of a multicondition care management system on primary care physician efficiency and productivity.

Study Design: Retrospective controlled repeated-measures design comparing physician productivity with the proportion of patients in the care management system.

Methods: The setting was primary care clinics in Intermountain Healthcare, a large integrated delivery network. The care management system consisted of a trained team with nurses as care managers and specialized information technology. We defined the use of the care management system as a proportion of referrals by the physician to the care manager. Clinic, physician, and patient panel demographics were used to adjust expected visit productivity and were included in a multivariate mixed model with repeated measures comprising work relative value units and system use.

Results: The productivity of 120 physicians in 7 intervention clinics and 14 control clinics was compared during 24 months. Clinic, physician, and patient panel characteristics exhibited similar characteristics, although patients in intervention clinics were less likely to be married. Adjusted work relative value units were 8% (range, 5%-12%) higher for intervention clinics vs control clinics. Additional annual revenue was estimated at $99 986 per clinic. These additional revenues outweighed the estimated cost of the program of $92 077.

Conclusions: Physician productivity increased when more than 2% of patients were seen by a care management team; the increased revenue in our market exceeded the cost of the program. Implications for the creation, structure, and reimbursement of such teams are discussed.

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For author information and disclosures, see end of text.

Almost half of the American population (125 million people) live with some type of chronic disease.[1] Evidence suggests that more than half of patients with hypertension, diabetes mellitus, hyperlipidemia, congestive heart failure, chronic atrial fibrillation, asthma, and depression are managed inadequately.[1,2] So great are the need and potential for improvement in chronic disease management that the Institute of Medicine specifically identified chronic disease care as a primary quality improvement area.[3]

Care management, which involves systematic restructuring of care to assure high quality, has been recommended as a potential solution to the challenges of chronic disease care.[4] The broad definition of care management described herein includes disease management programs and some case management programs that directly address medical care. By assuring life-saving treatment and by keeping people healthier, care management could save more than $100 billion and thousands of lives annually.[5] Many care management programs have taken the form of disease management (adopting guidelines into protocols to ensure higher adherence for specific diseases) or case management (focusing on the patient and his or her family, with patients often selected from among the small percentage that represent the highest cost and utilization). These programs have typically been initiated by the health plan or the employer with the intent to capture savings from the reduced costs of care. They are frequently delivered using telephone and information technology, and initial uncontrolled studies[4,6] show some promise for effect.

An alternative to disease management programs is care management in the form of the chronic care model. The chronic care model is a multistep program that creates a clinical care team in ambulatory settings, which has shown significant improvements in process and intermediate outcomes in a number of chronic conditions.[7] However, adoption of primary care–focused care management systems has been slow. In part, this is because of incentive structures within the reimbursement system.[4] Whereas health plans or employers can reap the benefits of reducing costs for their sickest patients, physician groups that incur the costs of implementing and operating programs often do not receive the associated savings of such an investment. For example, a

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physician's office with a robust program may generate less revenue because healthier patients need less care.[8]

One possibility is to create a business case for these programs (especially for the most complex patients) in the outpatient clinic through increases in productivity. Because most patients with chronic illnesses receive care in primary care settings, efficiencies may be gained if these sites of care could provide high-quality secondary preventive care for multiple disease states.[9,10] Care management programs can theoretically improve productivity. Because patients who present with multiple challenging problems often reduce productivity in a fee-for-service (or visit) system,[11] educating patients to manage their own diseases (self-management) and providing a more seamless interface for their interaction (part of the chronic care model) could reduce these inefficiencies, while improving outcomes.[12,13]

Augmentation of these models could also provide the flexibility and prioritization needed for patients with coexisting illnesses, who account for most of the expenditures in Medicare.[14,15] Furthermore, care management offers the promise of improved efficiency through minimization of patient barriers and reduction in the need to implement several different programs for each disease. However, empirical studies in this area are lacking.

The objective of this study is to address this need. We created a model for complex patients based in part on the chronic care model. In this model, called *Care Management Plus* (CMP), a team approach is used in an attempt to create efficient high-quality care. In the CMP model, nurse care managers are positioned in primary care clinics of moderate size (6-10 physicians) and are given extensive training in disease management protocols, motivational interviewing, and assessment of social, economic, and other patient barriers.

While the motivation for employing CMP care managers is to improve the quality of care, CMP may also help physicians to be more productive by reducing the complexity of the office visit, increasing patient understanding, and allocating team tasks more effectively. The opportunity costs for other clinicians relative to these largely unbilled or underbilled tasks may be less as well. In this article, we evaluate the effect of CMP on a specific measure of the productivity of physicians in fee-for-service systems (as measured by work relative value units [wRVUs]). This measure, while limited, relates immediately to revenue generation for these clinics. Our hypothesis is that, as a larger proportion of their regular panel is seen by care managers, physicians will have more productive visits with patients, creating capacity for additional revenue generation, which can allow the clinics to afford some of the costs of the programs.

METHODS

Environment

Intermountain Healthcare is an integrated delivery network consisting of 20 hospitals and more than 1200 employed and affiliated physicians in Utah and Idaho. The 450 physicians employed by the Intermountain Medical Group work in 1 of 92 clinics and provide more than 3 million outpatient visits each year. Clinics have multiple payers, including Intermountain Healthcare, private insurances, and Medicare and Medicaid. Within 7 of its ambulatory clinics that serve adult patients with a diverse spectrum of diagnoses and needs, Intermountain Healthcare augmented primary care services by hiring 1 onsite care manager per clinic. These care managers receive training to address new standards of care as they are adopted by Intermountain Healthcare, as well as ongoing reviews and updates on chronic disease management, care for senior patients, and assistance with barriers of care commonly faced by patients. They also use information technology to access patient information, ensure compliance with adopted standards of care, and improve communication with physicians and other care team members.

Selection of Participants

Physicians were the primary unit of analysis. We divided physicians into the following 4 groups: (1) physicians in the intervention group who did not use CMP or who used it at very low levels, (2) physicians in the intervention group who initially used low levels of CMP or no CMP and increased their use to high levels, (3) physicians in the intervention group who used CMP at high levels throughout the study period, and (4) physicians in the control group who had no access to CMP.

The use of CMP is voluntary, and physicians adopt it at various rates. However, the formal introduction to the program instructs physicians to refer the most complex subset of their patients (usually 3%-5% of the panel), focusing on patients with diabetes mellitus, depression (and other mental illness), cardiovascular disease, and significant social, age-related, and financial barriers.

To account for referral bias in a voluntary program, our empirical approach was designed to isolate the effect of CMP on physician productivity by focusing on the group of physicians who increased their use of CMP (to act as a set of pre-post control subjects) and by comparing their increased productivity with any changes in the baseline productivity of the control group. In a second set of analyses, we expanded our sample to include physicians in the intervention group whose use did not change over time (ie, they used low levels

of CMP or no CMP, or they used high levels of CMP). By increasing our sample, we improved the efficiency of our estimates, at the cost of introducing potential bias associated with greater self-selection.

We included providers who were primary care physicians who saw adults (internists and family practitioners). The providers had to practice at a clinic that had care managers or that was similar to the care manager clinics in terms of specialty, ancillary care, number of physicians, and access to information technology. Finally, the providers had to see patients at least 7 half days per week (80% of a full-time equivalent). Most were full-time providers (8-9 half days per week).

Intervention

The intervention is described in detail elsewhere.[9] Briefly, once patients are referred to the care management system, the care managers (all registered nurses [RNs]) assess patients and caregivers for readiness to change and for current needs, educate them in their diseases and self-management, and create a comprehensive care plan. Care managers also attend visits with other providers, advocate for their patients, and suggest changes in treatment plans as needed. Role-specific adaptations of the information systems allow easy access to various disease guidelines and to the patients' current adherence to them and summarize patient information, reminder lists, and previously formulated care plans.[16,17] The care managers are generalists in that they prioritize and treat a large number of illnesses, attempting to create a comprehensive plan that addresses multiple needs. Care managers are encouraged to not simply follow protocols but to create flexible care plans that specifically meet patient needs and to help the patients and caregivers to overcome barriers.

The benefit of the intervention to the physician would occur following the referral to care management, on the patient's return to the physician's practice, with the patient educated, motivated, and ready to manage his or her illnesses. Therefore, the intervention is measured as a percentage of the physician's unique patient population (referred to as a panel) seen by a care manager within 6 months. This percentage increases as the referrals by the physician increase and as the care manager continues to actively follow up the patients.[18] We estimated that 3% to 6% of the average clinic population in the study would be appropriate for care management based on age, comorbidities, and severity of chronic illness. Therefore, a cutoff of 2% was selected as the transition between low use and higher use of the care management system. This study was approved by the appropriate human subjects research ethics review committee.

Measurements

We defined the independent variable of interest, the percentage of patients in a physician's panel seen by care managers, as an indicator variable, assigning values of 1 for referral rates of 2% or more and 0 for referral rates less than 2%. To adjust for other factors that might affect physician productivity, we included random effects for the region and clinic, as well as physician-level variables, including time since last training, sex, specialty (internal medicine or family practice), age, and time in the system.[19]

Finally, patient-level variables known to affect productivity of outpatient visits were aggregated into summary variables for each physician. Patient panels were created for individual physicians from among patients who had 1 or more visits with the physician during the month in question; this method accounts for crossover of patients (managed by care managers but seen by more physicians than just the primary care provider). For each panel during each month, patient variables were aggregated by provider. These variables included the average case mix of patients seen and the percentages of female, married, and nonwhite patients. Case mix was calculated by means of the Chronic Illness and Disability Payment System, using the adjustment for a general adult outpatient population and averaging the score over the study period.[20] A comorbidity score derived from work by Deyo et al[21] was used to compare referred patients with nonreferred patients.

The work component of the resource-based wRVUs was used as the primary measure of productivity,[22] with adjustments for the number of clinic sessions per month for vacations. The number of patient visits was not found to be a useful measure of productivity because of the confounding effect of the intensity of care. To adjust for time spent seeing patients, wRVUs per month were adjusted for clinic days in the single and multivariate models.

Program costs were calculated using median wages for RNs from the Bureau of Labor Statistics (http://www.bls.gov/), with benefits calculated at 31% of the total salary. Overhead (computers, space, electricity, and other support) was calculated at 25% of the total costs. Sensitivity analyses were performed based on the mean clinic size (5-10 physicians), RN salary (variation of 10%), and overhead estimates (variation of 10%).

Statistical Analysis

Univariate analyses for baseline variables vs care management were calculated at each level (clinic, physician, and patient) and were tested for significance using t test or Mantel-Haenszel χ^2 test. Time-series analysis with multiple nested levels was performed using PROC MIXED in SAS

version 9.1 (SAS Institute, Cary, NC). Auto-regressive models with single lags, with moving average during 2 months, and with adjustment for heterogeneity were tested. These 3 models were compared to detect confounding effects in addition to the measurements already given.

RESULTS

In all, 176 providers were potentially eligible for the study. Of these, 56 did not practice continuously for the period required or maintain the necessary clinic sessions, leaving 120 physicians included in the study. As summarized in **Table 1**, 44% of these were internists, and the rest were family practitioners. They came from 30 different clinics within the integrated delivery system. The mean number of months of continuous practice was 22.5 months (of the 24-month maximum) for a total of 2701 physician-months of productivity data. The physicians had been in the system for a mean of 5.2 years and had a mean age of 44.4 years. On average, they saw 353 patients for 464 visits each month.

The care management team saw a mean of 2.5% of each physician's patients each month (with new referrals of 20-40 per physician per month), but this number varied significantly, as shown in **Figure 1**. Physician use was categorized as no or low use and as high use of care management based on their patients' mean utilization of care managers for that month, using 2% as the cutoff between categories. Of 120 physicians, 70 were in control clinics (never having the opportunity to refer), and 5 were in intervention clinics that were not referred patients in any substantial numbers (low/no use). Twenty-four physicians started using care managers during the study period (adopted use), moving from low or no use to high use at a mean of 4.5 months after the beginning of the study. The remaining 21 physicians were high users throughout the study period. The distribution reveals a wide variation in use, with a substantial number of physicians increasing their utilization over time.

Table 2 gives patient characteristics among physicians in the control and intervention clinics. Physicians using care management saw more unique patients, even when the visits per patient in that month were not different. This is especially pertinent for groups who are trying to work smarter (by increasing wRVUs per visit), not simply harder (by seeing more patients). Patient panels seen by physicians who used

■ **Table 1.** Baseline Clinic and Physician Data for Physicians Included in the Study

Variable	Value
No. of clinics	30
Mean No. (range) of physicians per clinic	4.0 (1-10)
Mean No. (range) of months of continuous practice	22.5 (7-24)
Total physician-months	2701
No. of physicians	
Total	120
Control clinics (n = 14)*	70
Intervention clinics (n = 7)	50
Use of care management, No. (%)	
No/low	5 (10.0)
Increased during study period	24 (48.0)
High, >2% of panel referred for most months	21 (42.0)
Physician characteristics	
Specialty, No. (%)	
Internal medicine	53 (44.2)
Family practice	67 (55.8)
Age, mean ± SD, y	44.4 ± 12.3
Years in system, mean ± SD	5.2 ± 3.2
Visits per month, mean ± SD	464 ± 76

*100.0% had no or low use of care management.

care management were significantly less likely to be married. However, all panels had a subset of patients who met potential criteria for referral, namely, multiple severe chronic illnesses (estimated as 5%-10% of panels by comorbidity score), with high utilization within the last year (2%-6% of the total panel), and complicated social factors (1%-2% of the total panel). Overall, about 3% to 6% of patients in a physician's panel met the general referral criteria. In practice, about 75% of those referred had multiple chronic illnesses, 20% had predominating social concerns, and the remainder had severe illness or other factors. Physicians with very high referral percentages tended to have more complex patient panels and to refer for single severe disease states.

Table 2 also gives unadjusted physician productivity for the control and intervention clinics. Physicians were more productive (based on wRVUs) during months when they used care management. The higher productivity associated with care management was evident among physicians in all 30 clinics and within the 7 clinics that used care managers.

Figure 2 shows the raw and predicted wRVUs from 3 multivariate models. In general, the effect was strong. The raw wRVU gain for care management was 8% (adjusted gain,

■ Figure 1. Percentages of Physicians' Patient Panels Seen by Care Managers
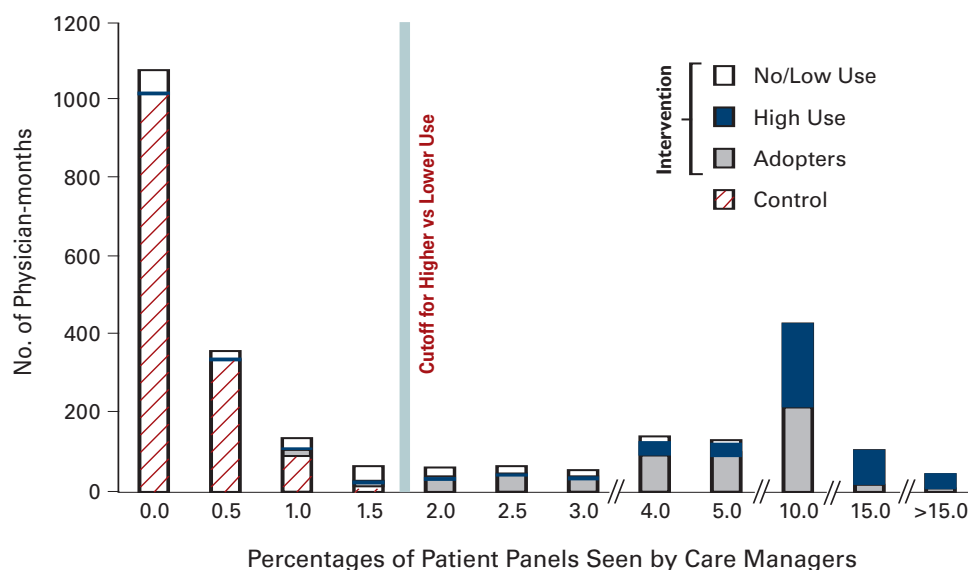
Control physicians, by default, refer no patients to the care managers; however, care management patients are frequently seen in those clinics in a crossover effect. The cutoff seeks to allow for this crossover while anticipating a threshold effect (approximately 50% of the 3%-6% of the most complex patients in a panel most likely to benefit from the program).

tors known to affect a physician's output over time. The primary effect was seen within 1 month after the care management team was managing about 2% of a physician's panel (all from voluntary referral) and persisted in a 1-month lag model and in a 3-month moving average model. This productivity gain was even more pronounced among physicians who started as low users and increased their use during the study period.

Are the potentially higher revenues from increased productivity enough to justify the costs associated with a program

5%-9%) when comparing all clinics and was higher (raw gain, 9%; adjusted gain, 8%-12%) when comparing physicians in clinics using care management.

Multivariate models, including the autoregressive form (model 1, 1 month: $P = .02$) and the moving average (model 2, 3 months' moving average: $P = .03$), exhibited a significant relationship between higher care management use and wRVUs earned. In an effort to isolate the benefits of adoption, we also provide estimated raw wRVUs and estimates from model 1 in which our analysis was restricted to the group of physicians who adopted care management during the study. This model was significant, and the predicted wRVUs showed a large increase (14% relative increase) for the months with high proportions managed by the care management team.

The cost of the program per practice was estimated at $92 077. At $36 per wRVU, the benefits per a 7-physician practice were $99 986 (derived from the mean increase per model, or 33 wRVUs per physician per month), a savings per clinic of $7909. Sensitivity analyses revealed the following break-even points: RN wages +9%, 6 physicians, and $33 per wRVU. Larger clinics (10 physicians) had break-even points beyond the bounds of the analysis.

DISCUSSION

Our model of care management had a significantly positive effect on physician productivity, even after adjusting for fac-

like CMP? A basic assumption is that CMP employees will be salaried and represent a fixed cost for the institution. We estimate that the revenue gains from physician productivity outweigh the costs of CMP when 1 full-time nurse manager equivalent can be shared between 7 to 10 physicians; at a 3% referral rate with a mean panel size of 2300, the care manager would cover 16 100 to 23 000 patients and would actively see 483 to 690 per year, matching the current number seen by care managers in our clinics.

The benefits of CMP extend beyond improved financial viability. At the clinic level, CMP offers the potential for reimbursement for patient education and for assistance in physician and staff retention through greater job satisfaction. At the societal level, CMP has been shown to improve patient health and may lead to fewer sick days.[9] It is our expectation that studies such as the present one will convince clinics, provider organizations, and integrated delivery networks that investment in collaborative care agents and technology is not only beneficial to society by improving patient health but also economically sustainable.[23]

Changes in reimbursement to reward the higher quality of care from these programs may be forthcoming. For instance, the Medicare Prescription Drug Improvement and Modernization Act of 2003 explores incentives for physicians to implement interventions like CMP through a series of programs. The combination of these trends with the efficiency benefits may make this model more appealing.[24]

■ **Table 2.** Patient Characteristics Among Physicians in the Control and Intervention Clinics

Variable	Control Clinics	Intervention Clinics Low (≤2%) CM Use	All High (>2%) CM Use	Adopted Use Before CM	Adopted Use After CM	P*
Physician Characteristics						
Physician-months	1487	253	961	108	425	—
No. of unique patients seen, mean ± SD	360.7 ± 142.8	363.6 ± 152.1	357.6 ± 171.8	357.0 ± 107.7	395.3 ± 166.6	.35
No. of visits per patient per month, mean ± SD	1.1 ± 0.8	1.2 ± 0.9	1.3 ± 0.9	1.2 ± 0.7	1.1 ± 0.8	.32
Patient Panel Characteristics						
Age, mean ± SD, y	44.5 ± 8.3	43.8 ± 7.9	42.8 ± 8.8	40.5 ± 8.8	41.7 ± 8.6	.45
CDPS score, mean ± SD	0.77 ± 0.26	0.92 ± 0.26	0.79 ± 0.24	0.78 ± 0.24	0.75 ± 0.26	.84
White race/ethnicity, %	6.8	6.8	7.0	7.2	7.1	.40
Married, %	57.9	58.2	56.8	58.9	60.1	.35
Adjusted wRVUs, mean ± SD	379.3 ± 114.8	388.8 ± 115.2	412.2 ± 133.2	356.4 ± 108.3	405.5 ± 118.3	<.001

*High-use intervention clinics vs control clinics (t test for means and Fisher exact test for proportions).
CM indicates care management; CDPS, Chronic Illness and Disability Payment System; wRVUs, work relative value units (adjusted for clinic sessions per month [mean, 36 half-day sessions per month]).

This work has several limitations. First, the observational nature of this study makes it difficult to establish a direct causal link between CMP and physician productivity, especially the potential for confounding between the outcome variable (physician productivity) and the independent variable of interest (care management). However, the pre-post nature of our analysis, in conjunction with a comparison group that had no access to CMP, should minimize this potential bias. Furthermore, the results of this study match those of a recent qualitative study[25] of perceived physician benefits; in that study, 7 of 10 physicians who had started using care managers believed that they were more productive after their patients had been seen by a care manager.

Second, wRVUs may not reflect the productivity goals for society or even some formal economic definitions of productivity. These wRVUs were drawn from estimates of actual and perceived effort, a measure more of input than output. Because reimbursement is based on these scores, it was determined to be the best available estimate of physician output that would accrue directly to providers and their organizations.

Third, focusing only on adult primary care providers limits the analysis; subspecialists such as gastroenterologists and rheumatologists effectively act as primary care providers for the kinds of complex patients in this sample. Care manager contact was measured dichotomously herein, and a more accurate measure may be care manager "dosage" or effort over time.[26]

Fourth, the immediate costs of implementing the program assume some previous costs endured by the clinics or system. All clinics had significant health information technology. In addition, the time and resource cost to transform guidelines into protocols delivered at the point of care can be substantial, and these costs were already invested in these clinics. However, these previous investments were equal in all clinics in the study, including the control clinics. The ability to actually implement the protocols was aided by the care managers, as seen in previous research.[27] Only the 15% to 20% of clinics or systems that have made the decision to invest in these other components would gain immediate benefits from the adoption of CMP. The costs of the training are also not included; a 20-hour training program is now offered free to all interested clinics (http://www.caremanagementplus.org).

CONCLUSIONS

Clinic-based care management can significantly increase the productivity of physicians who refer patients to care management. The magnitude of this increase can provide a finan-

■ **Figure 2.** Raw and Adjusted Work Relative Value Units (wRVUs) per Physician per Month by Use and Model

Error bars indicate 95% confidence intervals; CM, care management.

cial benefit to moderately sized adult outpatient clinics that almost compensates for the cost of the care management program. This benefit is likely to grow even greater as the reimbursement system is changed to further reward the health benefits gained through this program and others like it.

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■ **Take Away Points** [Au: Please provide brief take-away points for your article; below is an example.]

Analysis of the article for several lines and then a listing of the points follows, decision makers should be aware that:

■ Patient use of medications is .

■ Compliance is greater among patients filling pharmacy claims for drugs that .

■ Potential impact on compliance should be considered when making .

■ Patients should be informed of their full range of medication options and the .

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Care Management Plus

Innovating Primary Care

OREGON HEALTH & SCIENCE UNIVERSITY

Intermountain Healthcare
Healing for life ℠

Care Management Plus in Primary Care

Like many health care providers, Intermountain Healthcare was **looking for better ways** to help treat the growing number of **elderly and complex patients.** At Intermountain, primary care teams adopted an approach to treat patients with **chronic diseases,** applying known **best practices. Nurse care managers** were hired for **primary care clinics** to work along with physicians to care for these patients. They tried to help patients overcome various challenges that make it difficult to manage their own care. While the care teams experienced successes and were appreciated, the care managers themselves were becoming overwhelmed in helping the growing number of patients who needed their care. A team of researchers funded by the **John A. Hartford Foundation,** worked with the care managers to create tools and **training** to help the primary care team **manage** patients **more effectively and efficiently.** They also studied the various care manager tasks to determine which were the most important to helping patients and they analyzed how the care managers helped both physicians and their patients. **Care Management Plus** is the result of this collaboration.

Care Management Plus Helps in Many Settings

Now administered through Oregon Health & Science University, Care Management Plus focuses on improving patients' **self-management** ability, especially the **elderly** and patients with **multiple chronic illnesses,** for whom self-management is most difficult. It uses both **computer-based tools** and **trained** clinicians to enhance primary care. The tools organize the delivery of care and track tasks and outcomes – helping both the **patient and family** and the primary care **team** to proactively identify patients' disease status, to help them receive recommended care and to **meet specific goals.** For those patients who have greater barriers to self-management, care managers work collaboratively with them and with their physicians to develop strategies to overcome these barriers, and then monitor progress. **Care Management Plus** works in many settings, such as **integrated** delivery networks and **independent** clinics who contract with many different payers. The system helps patients be **better prepared,** making their care both more efficient and more rewarding for the team.

More Effective Care

In Care Management Plus, the primary care team **treats patients' chronic diseases early,** trying to **prevent problems** rather than treating them after they occur. Computer-based tools help **monitor** a patient's status, and **remind** the team of what needs to be done. Easily adapted tools also identify which patients may not be getting monitored or treated appropriately; lab work that is due and indicated medications that should be prescribed are examples. A **Patient Summary Sheet** includes diagnoses, medications, recent test results and recommendations and helps the primary care team and the patient and family in identifying and achieving care goals. It can be used as a reminder and to reinforce these goals when it is sent home with the patient. See Tools for Care Management Plus for more information.

Care Management Plus Addresses Barriers

Some patients have challenges that can interfere with their self-management ability. In Care Management Plus, physicians identify these challenges and ask them to work with a care manager. The care manager partners with patients to help them overcome these challenges. For example, patients who have multiple chronic diseases, and lack sufficient confidence or social support to manage the diseases, may have a difficult time following through on a doctor's counsel without extra help. The care manager empowers such patients to organize and prioritize their tasks, and then monitors their progress. The care manager collaborates with the patient, the family and their physician(s) to adjust the plan as needed. The care manager uses computer-based tools to help assess and monitor patients, and to communicate with physicians. Care managers are also trained in assessing patient self-management ability, in overcoming issues related to multiple chronic diseases and in coordinating community resources.

Clinical Outcomes

Evidence-based model for primary care teams who manage patients with chronic disease

Multiple controlled studies have shown that **Care Management Plus** has a wide range of benefits for patients, their families, and the clinicians who care for them. Patients referred to Care Management Plus have multiple chronic conditions, social and behavioral needs, and financial and economic concerns. **Prior to this approach, each disease would require a special intensive visit** or a separate care management team. Care Management Plus creates a more efficient path to improved care and clinical outcomes through a simple, flexible system.

Improved Diabetes Control

As shown at right, diabetes monitoring and control was improved between 21% and 42% in care managed patients versus controls. Average HbA1c dropped by .38% *more* than controls; **these changes would lead to a 15-25% decrease in long term complications, a savings of over $10,000 per patient over their lifetime.**

Outcome	Odds Ratio
Overdue for HbA1c test	0.79*
HbA1c Tested	1.42*
HbA1c in control (<7.0)	1.24*

Decreased Mortality and Hospitalization

Seniors with multiple chronic conditions and needs had a 20% yearly relative **reduction in mortality,** a 24% relative **reduction in the odds of hospitalization,** and a 40% relative **reduction in hospitalizations related to the quality of ambulatory care** for elderly patients with complex diabetes compared to controls (see figure below).

Other patients were referred for different needs, and improved on their specific goals: patients with severe depression treated by care managers were far more likely to recover than controls; eligible patients were referred to hospice more quickly than controls; and patients with cardiovascular disease were more likely to be adherent to guidelines.

CM = 1,144 Care Management Plus patients; CTL = 2,288 Control patients

In all, each clinic reduced dozens of deaths and hospitalizations each year, reducing utilization by over $200,000 per year.

Care Management Plus Increased Satisfaction

Patients and providers were also extremely satisfied with the care management system. **Providers found significant improvement in time efficiency** and valued the unique skills in education and motivation of the care managers. Patients feel the care managers are a 'lifesaver' and highly appreciate the care received.

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The benefits of **Care Management Plus** extend beyond the improved quality of care and outcomes. The physicians who participate actively in the program are more *efficient,* saving the clinics money and paying for the care manager. In addition, healthier, more satisfied patients use fewer intensive health care services (such as Emergency Department visits and hospitalizations) and maintain or increase their outpatient utilization. This lower utilization results in fewer services overall, a benefit to society as well as payers, purchasers and integrated delivery networks.

Costs/Clinic	
Salary + training + admin	$92,077
Benefits/Clinic	
Productivity (7 MDs)	$99,986
Hospitalizations ↓ *	$0
Nurse visits	$10,394
Total (benefits - cost)	$18,303

For the forward-thinking clinic, two immediate factors and one future factor make up the business case. First, as shown in the figure and table, we showed an 8-12% increase in monthly relative value unit generation by physicians in the program who used Care Management Plus. This was due to higher billing codes rather than increased physician visits; care managers allow physicians to see higher billable visits, both from increased documentation and through a shift in procedures and other higher RVU codes. Second, many of these visits are billable under the nurse visit category. For smaller clinics, this, combined with the individual physician productivity gain, can easily make the program cost-neutral or cost positive. In the table, a seven-physician clinic shows a net positive of *$7,909*[1] from efficiency gains and *$18,303* when including nurse billing.

The future factor is pay-for-performance and societal benefit. Based on our studies, payers and purchasers would save, per clinic, $79,092 in reduced hospitalizations alone. Many clinics will have the opportunity to point to this benefit when negotiating future contracts around quality. In addition, the higher adherence seen in the program will immediately translate to programs suggested by the Centers for Medicare and Medicaid Services, Pacificare, Bridges to Excellence,

[1]Dorr et al, AJMC, in press

and many others. In addition, physician satisfaction was much higher amongst high users of the system in a qualitative study; this is anticipated to reduce turnover in primary care, a costly and growing problem for many organizations.

Care Management Tracking Software (CMT)

The CMT is usually implemented in a **standalone Access database.** It is not necessary to use the CMT to implement Care Management Plus; however, most electronic medical records do not include all the key functions that are available in the CMT.

The Care Manager Tracking Database **enables the Care Manager** to:

- Flexibly **plan** chronic care tasks such as classes, lab work, referrals
- **Schedule** visits and phone calls
- **Create** reminder lists based on patient criteria **(tickler lists)** which facilitates patient contact and documentation of adherence to care plan
- Manage workflow and **evaluate** efficiency of **resource use**

The CMT Access database is not only a valuable clinical tool for the Care Managers, but is also helpful for **Clinic Managers** to evaluate the success of Care Management Plus. **Administrative Reports** generated from CMT demonstrate the **level of adoption,** list providers and their use of Care Managers and for what purposes, and the effectiveness and **productivity** of the Care Managers. The reports can be generated for any time period. Some of the more useful reports include:

- **Number** of patients **referred** by physician
- **Diagnoses** and **Payers**
- Trends in **outcomes** for depression (PHQ-9) and diabetes (Hemoglobin A1C, patient goals)
- **Work breakdown** by Encounter Type such as phone calls, face-to-face visits, administrative, clinic visits and the time for each

The database can be downloaded for free: http://caremanagementplus.org/
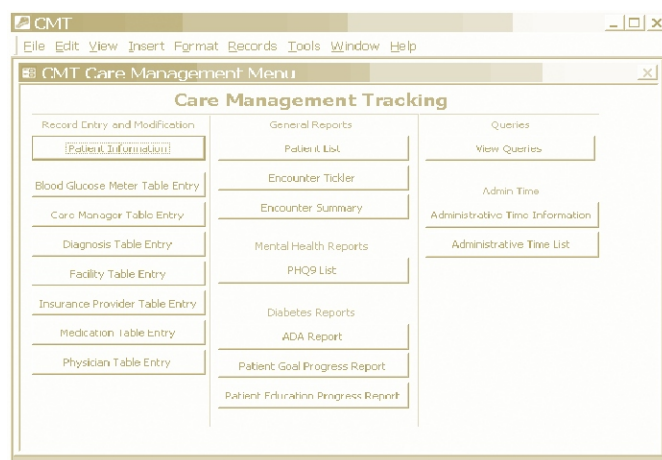
Patient Summary Sheet

The patient summary sheet is a one or two page document designed to **display** relevant **clinical data** and **alerts** about multiple chronic conditions. Many EMR systems can create these summary sheets when properly implemented. The core purpose is to display the *right information* and **reminders** without overwhelming the busy care manager, clinician, or patient; it is tied to a patient's known conditions.

The Patient Summary Sheet displays:

- Patient **demographic** information
- **Specific** problems and conditions
- Current **medications** and laboratory test **results**
- Other diagnostic and physical exam findings related to the patient's specific problems
- Disease-specific or preventive care **advisories**

For example, if a patient had diabetes, the summary for that patient would display Hba1c values and lipid profiles, as well as the last recorded foot or dilated retinal exams. It lists recommendations for treatment based on the data and accepted clinical guidelines that are pulled from the patient's problem list. Finally it would list available preventive care data, such as the date of the most recent Pap smear and give reminders for tests that are due.

Care managers who complete the training are able to:

- **Empower patients** with multiple chronic diseases to organize, prioritize, and implement suggested self-management strategies
- Identify barriers to outcomes and intervene to overcome or eliminate these when possible
- **Coordinate resources** to ensure that necessary services are provided at the most appropriate level of care and at the appropriate time
- Identify patient situations at-risk for destabilization and **intervene** to eliminate the risk when possible
- Gather, interpret, and use data to **identify problems** and trends and to demonstrate outcomes and cost-effectiveness

There is no tuition for Care Management Plus Training, which is funded by The John A. Hartford Foundation. The **learning modules are taught on-line** and can be reviewed at the convenience of the student. The course takes between 35-40 hours to complete. Learning modules, discussions, and assignments will be hosted by Oregon Health & Science University in Portland at **http://ohsu.blackboard.com**. Faculty and mentors include instructors from Intermountain Healthcare, Oregon Health & Science University, University of Utah Health Sciences Center, University of Iowa, and The **John A. Hartford** Nursing Initiative.

Learning Modules

Care Manager Fundamentals
Roles & Responsibilities
Care Management Plus Outcomes
Patient Coaching & Motivational Interviewing
Technology Training: tools for care management
Building a Community Resource Team

Geriatric Training
Geriatric Assessment
Cognitive Assessment
Dementia Care Management
Dizziness and Falls
Polypharmacy and Aging

Chronic Disease Management
Diabetes Care Management
Depression Care Management
Asthma and COPD
Heart Failure
Sleep Disturbances
Hypertension
DNR Orders & Advance Directives
Palliative Care

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Alexis Turner — Technical support, Blackboard Academic Suite, Oregon Health & Science University, Portland, Oregon

Purpose

To work collaboratively with physicians and clinical staff to support patients with chronic conditions and/or complex needs according to guidelines established by the primary care and other clinical programs.

To facilitate communication, coordinate services, address barriers, and promote optimal allocation of resources while balancing clinical quality and cost management.

Dimensions

A Care Manager works in the ambulatory setting, and is a member of the physician led interdisciplinary team. Care Manager understands and adheres to established care management standards of care: screen, assess, plan, and facilitate. Care Manager understands and coordinates care using evidence based clinical guidelines for chronic disease management.

Minimum Qualifications

Three to four years RN experience

Effective communication – both verbal and written

Excellent interpersonal skills

Ability to affect change

Ability to perform critical analysis

Self-directed

Positive attitude

Ambulatory and/or care management experience preferred

License and Education Requirement

Current State RN License

Current Drivers License in good standing and reliable and insured transportation

Bachelors degree in nursing or other related clinical field

Care Management Certification preferred

Essential Job Responsibilities

Support Chronic Disease Management and Patient Care Needs:

- Respond to physician referrals and/or identify patients who meet established criteria for care management (e.g. HgA1c > 8, elevated LDL and/or blood pressure, Mental Health Integration referral, complex needs)
- Assess patients readiness to change and family resources for support
- Monitor compliance with plan of care and problem solve barriers to patient self-management
- Provide support for patient and family issues, resource needs, and answering general healthcare questions
- Do ADL assessment and home safety assessments based on patient interview

- Obtain physician order for home health services for monitoring in home if medical necessity
- Teach patient how to self monitor conditions if no medical necessity to justify home health
- Assess need and provide basic diabetic teaching (glucometer testing, etc)
- Assess need and obtain MD order for patient to receive comprehensive diabetic teaching or counseling from CDE (MD referral required for billing)
- Document CM interventions in Care Management Tracking database and patient record
- Refer non-nursing functions, such as assisting patients with completion of Medicaid, disability, pharmacy program or other eligibility applications, and scheduling appointments to designated resources in the region
- Coordinate with care managers in other settings as appropriate (e.g. Case Managers of payers, etc.)

Scope limitations:
May not provide therapy or counseling to suicidal patients (refer to 911 and notify provider)

Support Chronic Disease Management and Patient Care Needs:
- Instruct patients on how to fill out screening and assessment tools for chronic conditions (depression, Alzheimer's, etc.)
- Score and document results
- Explain results from screening based on protocol and guidelines

Patient Education:
- Provide pre-printed educational materials as needed, or at MD or patient request
- Do needs assessment and develop patient education plan
- Answer basic clinical questions
- Provide group education for established patients
- Must understand professional boundaries and appropriately refer diagnostic questions to MD

Coordinate referrals to community resources (e.g. home health, Durable Medical Equipment, support groups)
- Forward written physician orders for treatment
- Assess patient for additional needs, develop nursing plan of care and contact physician for order-dependent items
- Negotiate payment for non-covered benefits based on assessment of medical needs and projection of outcomes of care

Professional:
- Provide suggestions for the purpose of improving care process models, evaluating opportunities for appropriate cost-containment, and improving patient satisfaction

Care Management Plus will work in any size practice with different levels of efficiency; initial studies were in practices of 6-10 physicians. We work with smaller practices to find cost-effective solutions.

Certain components are necessary for successful implementation:

- a designated care manager with office/treatment space located in a group practice of primary care physicians;
- who are using an effective electronic medical record (described below); and
- willingness to adapt a new strategy of care for difficult and complex patients who require more time

The **Electronic Medical Record** should include the ability to:

- create and access notes by multiple team members, including the care managers;
- facilitate *communication* between team members (e-mail or internal messaging systems are acceptable); and *optionally,*[1]
- display or output full ('longitudinal') records of patients for easy review, design structured templates; or
- store and display *best practice* alerts about patients (a form of *decision support*).

The Care Management Plus team, at no cost to you, will help assess your current electronic record functionality, implement the specialized tools of Care Management Plus, and streamline workflow to facilitate communication and referrals. The practice is responsible for ongoing maintenance of electronic hardware and tools; a community of learning will provide upgrades to the CMP tools and be made available to the practice.

Hiring and training your Care Manager

The practice must invest in a care manager who will be able to manage flexible protocols, track complex patient populations, and interact with the primary care team (see the job description for details). The Care Management Plus program includes training for this care manager. As much as possible, the training will be facilitated through distance learning methods, such as web-based learning modules with conference calls to faculty. The training will require about 30 hours of student investment. Attending in-person lectures or viewing the lectures stored on available websites will supplement the web-based modules. The costs to host, facilitate, and update the training are covered by the John A. Hartford Foundation. The clinic is responsible for the time that the employee is paid to participate in the training.

Will this work in your clinic? The following questions will help you determine if this model would work in your clinic:

- Do you see a lot of older patients or patients with chronic diseases?
- Would your providers refer to a care manager to coach patients for self-management of their chronic disease?
- Is there a care manager currently in the clinic or a person who could be trained?

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[1] The care manager system can often accomplish these tasks through use of the electronic database, if necessary.

- Are your providers interested in redesigning care for chronic illness, complex, or time consuming patients?
- Are your providers using the electronic medical record or have plans to increase their use?
- Does your EMR have the ability to track patients by disease category?
- Does your current system include:
  - Current problem list?
  - Current medication list?
  - Ability to identify patients with a particular diagnosis?
  - Ability to identify patients overdue for a visit, lab test, preventive service?
  - Ability to produce a printed patient summary sheet with: current problems and med list, preventive services due, labs, alerts?
- Do you have one key provider that would champion this program in your clinic?

Use of Health-Related, Quality-of-Life Metrics to Predict Mortality and Hospitalizations in Community-Dwelling Seniors

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OBJECTIVES: To investigate whether health-related quality-of-life (HRQoL) scores in a primary care population can be used as a predictor of future hospital utilization and mortality.

DESIGN: Prospective cohort study measuring Short Form 12 (SF-12) scores obtained using a mailed survey. SF-12 scores, age, and a comorbidity score were used to predict hospitalization and mortality rate using multivariable logistic regression and Cox proportional hazards during the ensuing 28-month period for elderly patients.

SETTING: Intermountain Health Care, a large integrated-delivery network serving a population of more than 150,000 seniors.

PARTICIPANTS: Participants were senior patients who had one or more chronic diseases, were community dwelling, and were initially treated in primary care clinics.

MEASUREMENTS: SF-12 survey Version 1.

RESULTS: Seven thousand seventy-six surveys were sent to eligible participants; 3,042 (43%) were returned. Of the returned surveys, 2,166 (71%) were complete and scoreable. For the respondent group, a multivariable analysis demonstrated that older age, male sex, higher comorbidity score, and lower mental and physical summary measures of SF-12 predicted higher mortality and hospitalization. On average, nonresponders were older and had higher comorbidity scores and mortality rates than responders.

CONCLUSION: The SF-12 survey provided additional predictive ability for future hospitalizations and mortality. Such predictive ability might facilitate preemptive interventions that would change the course of disease in this segment of the population. However, nonresponder bias may limit the utility of mailed SF-12 surveys in certain populations. **J Am Geriatr Soc 54:667–673, 2006.**

Key words: quality of life; health status; hospitalizations; mortality; SF-12

Measures of self-perceived health status can be used to evaluate multiple dimensions of the burden of disease and the effect of specific treatments over time. Health-status measures can also play a role in patient assessment. Measurement tools such as the Short Form 12 (SF-12) or Short Form 36 (SF-36) are widely used, because they are brief yet comprehensive, readily available, psychometrically sound, and of proven usefulness in measuring and monitoring health status in general and specific populations.[1]

As the average age of the population increases and healthcare costs rise, there has been increased consideration of how to predict which segments of the population might benefit from focused allocation of resources to mitigate worsening health status. Health-related quality-of-life (HRQoL) surveys have been found to be useful in predicting costs,[2] future mortality, and hospitalization[3–8] in specific patient populations. In these studies, the predictive value of HRQoL extended beyond traditional models of prediction, including comorbidity and case-mix scores. Whether administration of HRQoL survey might further identify individuals at risk for death and hospitalization within a large, general population of seniors who had at least one chronic illness was questioned.

Questions also remain about the best way to distribute such surveys across a large population. One study compared administration of the SF-36 test via telephone, face-to-face interviews, and a mailing.[9] Mailing the self-administered surveys provided the ability to reach a widely dispersed population sample simultaneously at a relatively low cost. Some authors have found that face-to-face administration results in higher scores, possibly from the subjects' desire to please, and have concluded that individuals will be more honest in their answers when the survey is self-administered.[10] If prediction across a broad population is to be successful, respondents must provide accurate answers, and any biases in nonrespondent groups must be understood.

At Intermountain Health Care, a large integrated-delivery network serving a population of more than 1 million Utahans and more than 150,000 seniors, interventions designed to improve the care of seniors and patients with chronic illnesses are being evaluated. (See www.intermountainhealthcare.org/cmt for details.) As part of efforts to focus resources on at-risk patients, the SF-12 survey was mailed to a set of community-dwelling elderly patients with at least one chronic disease to assess their current health status. It was hypothesized that lower mental and physical SF-12 scores would predict higher hospital utilization and mortality rates in this broad population over the following 2 years, even after adjusting for important predictor covariates. This study provides information about the diagnostic usefulness of the SF-12 as a predictor of future utilization and the potential response bias from mailing SF-12 surveys to seniors.

METHODS

Patient Selection and Eligibility Criteria

To help select community-dwelling patients with one or more chronic illnesses who would receive a survey, a comorbidity-scoring algorithm based upon billing codes associated with ambulatory visits for senior patients from 1998 to 2001 was used. The comorbidity score was generated by adapting methods of Charlson[11] and Deyo[12] to an administrative data set with the study population through revalidation. Initial score creation took place by identifying the combined set of conditions used by both groups; detecting the presence of the conditions in patients by matching a set of predefined *International Classification of Diseases, Ninth Revision*, codes[11] to Medicare billing data generated in 2 years; and weighted calculation by determining the odds of death for a randomly selected half of the population during the following year and using the rounded odds ratio (OR) as a weight. Multivariable logistic regression was used to create the weights and account for multiple co-occurring conditions. Validation took place by weighting conditions in the other half of the population and testing for relationship to death and hospital admission. There were 152,163 beneficiaries with 2,525,663 encounters in the data set used to create the weights for the comorbidity score. A monotonic relationship between comorbidity score and both death and hospitalization was found in the validation set. The comorbid conditions and their weights are as follows: peripheral vascular disease, rheumatic disease, myocardial infarction, chronic obstructive pulmonary disease, and diabetes mellitus without complications received a weight of one; acute liver disease, diabetes mellitus with complications, malignancy (excluding solid tumor), hemi/paraplegia, and renal disease were weighted as two; chronic liver disease, congestive heart failure, and solid tumor were weighted as three; and dementia was weighted as four. Comorbid scores ranged from 1 to 13, with a higher score representing a greater burden of disease.

Patients who received the survey met the following eligibility criteria. They had seen their primary care provider within 14 months, had a comorbidity score of 1 or higher, were enrolled in Medicare, and were living outside of an institution as of September 2002. Surveys were sent out in May 2002, and the survey return period ended September 2002. Addresses were rechecked in 2004, and those who had moved or died before the end of the survey return
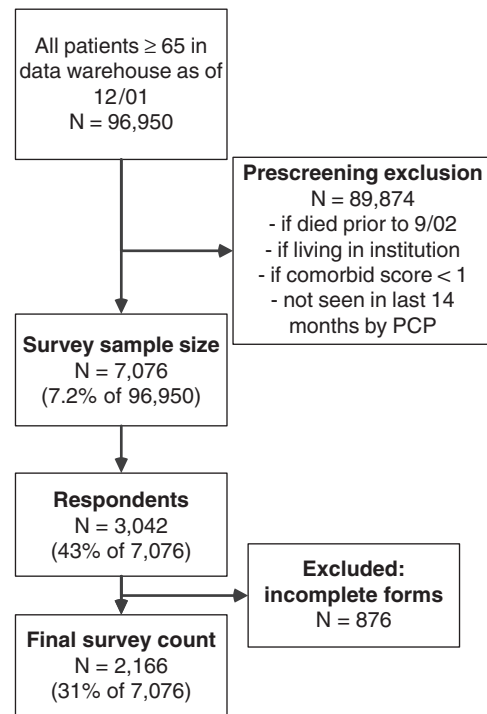

Figure 1. Population screening and survey return rates.

period were excluded from analysis. From a set of 96,950 patients aged 65 and older, 7,076 surveys were sent to eligible patients. Figure 1 displays response rates and reasons for exclusion. Patients were encouraged to ask family members for help in filling out the survey. The mailed survey was formatted for senior patients, and the patient received only one mailing or contact, as mandated by the local administration. The local institutional review board approved the study, and consent was obtained from patients in the course of mailing the survey.

Predictor and Outcome Variables

Several hypothesized predictor variables in the model were identified. For HRQoL, the two summary scores from the SF-12 (the Mental Component Score (MCS) and Physical Component Score (PCS)) were used.[13,14] The PCS and MCS summary scores were created using norm-based methods that standardize the scores to a mean of 50 and a standard deviation of 10 in the general 1998 U.S. population, with higher scores indicating better self-perceived health. Other predictive covariates in the analysis were age at survey mailing (May 1, 2002), sex, and comorbidity score. Outcomes were death within 28 months as reported in the Utah Bureau of Vital Statistics and first hospitalization within 28 months as billed to Medicare. For logistic analyses, both were measured dichotomously. For the survival analyses, both were measured as time until outcome (if present) from the date of survey mailing. Population norms for death rate were generated from age- and sex-specific summary data at the Utah Department of Health.[15]

Statistical Analyses

To address the possibility of response bias, responders and nonresponders were compared using Student *t* test for

continuous variables (age and comorbidity score) and chi-square test for dichotomous variables (sex, hospitalization, and death).

Single-variable analyses were used to evaluate the ability of each covariate to predict mortality or hospitalization. All variables that were significant in single-variable testing or are common important covariates (e.g., sex) were entered into the multivariable model. For the continuous variable age, the respondents were grouped in 5-year age intervals, PCS and MCS scores were grouped based on the quartiles of the 1998 U.S. aged 65 to 74 scoring distribution, and comorbidity scores were grouped into four categories (low, low-moderate, high-moderate, and high) based on the distribution of the sample population. The multivariable logistic regression allowed adjusted ORs to be computed for each of the covariates. Survival analysis using Cox proportional hazards methods was used to build survival curves and compute hazard rate ratios for the predictive value of the SF summary scores and other covariates for mortality and hospitalizations over time. No therapeutic interventions based on predictive measures were performed on the study population during the period of investigation. Calibration and discrimination of the logistic regression models were tested using the c statistic and the Hosmer-Lemeshow (H-L) test. Cox models were evaluated by assessing the proportional hazards assumption using a supernum test based on cumulative sums of Martingale residuals. SAS software version 9.1 was used to perform all statistical analyses (SAS Institute, Inc., Cary, NC).

RESULTS

Response Rates and Responder Bias

Of the 7,076 surveys mailed to eligible patients, 3,042 (43%) were returned. Excluding incomplete forms (n = 876), 2,166 (31%) eligible forms could be scored. The number of incomplete forms included respondents who did not completely fill out the survey and those who completely filled out the survey but did not sign the necessary consent form.

To better understand the nonresponders, an analysis based on data from Medicare records was performed to compare the results of nonresponders and responders. Table 1 contains a comparison of their demographics, comorbidity scores, and subsequent deaths and hospitalizations. Nonresponders had a significantly higher burden of disease, were older, and had higher odds of death in the subsequent period than responders. The mortality rates for the responder group (15.3%, $P = .07$) and the nonresponder group (20.1%, $P < .001$) were higher than the age- and sex-adjusted death rate at 28 months for Utahans as a whole (13.7%). The higher rate is likely due to a utilization bias, with patients seeking health care being more likely to be ill than the general population, even those aged 65 and older.

Prediction of Death: Single-Variable and Multivariable Models

In single-variable logistic analysis for death, each of the covariates (age group, comorbidity score, and the two SF-12 summary scores) was statistically significant, with the exception of sex ($P = .36$), although sex was entered into the multivariable model and proved to be significant in the multivariable case. A multivariable logistic analysis controlling for age, sex, and comorbidity score demonstrated persistence of the predictive value of the physical and mental subscores for death or hospitalization over the 28-month study period. Table 2 shows the adjusted ORs computed for the covariates used in the multivariable model. For the SF-12 subscores, the OR for death in the lowest PCS group versus the highest PCS group was 6.25 (95% confidence interval (CI) = 1.95–20.06). The OR for respondents in the lowest MCS group versus the highest MCS group was 2.52 (95% CI = 1.74–3.64). For covariates, men's odds of death over the study period were 1.40 times (95% CI = 1.06–1.84) the odds of women, whereas respondents with comorbidity scores of 6 or higher had 2.12 times (95% CI = 1.39–3.23) the odds of death as those with a comorbidity score of 2 or less.

Prediction of Hospitalization: Single-Variable and Multivariable Models

All survey respondents who died before September 9, 2004, (n = 267) were removed from the logistic analyses for hospitalizations. Single-variable and multivariable analyses demonstrated increasing odds of hospitalization as the mental and physical scores decreased and the comorbidity score increased. The increase in odds of hospitalization for the SF-12 PCS and MCS scores was less than that for death, but both were significant when comparing the lowest and highest PCS and MCS score groups. Patients with comorbidity scores of 6 or higher had 1.94 times the odds of admission as those in the lowest group. Higher odds of mortality and hospitalization were observed in the older age groups, whereas sex was a significant predictor for death but not for hospitalization. Model calibration and discrimination were acceptable for both models (death: c = 0.77; H-L $P = .98$; hospitalization: c = 0.64; H-L $P = .46$).

Survival Analysis for Death and Hospitalization

Survival analysis using Cox proportional hazards revealed significant differences in mortality and hospitalization over time between the different PCS and MCS groups, as shown in Figure 2. For those in the low PCS group, the risk of death was 5.99 times (95% CI = 1.90–18.95) as great as that of those in the high PCS group (Figure 2A). Respondents in the

Table 1. Characteristics of the Responder and Nonresponder Groups

Chracteristic	Responder (n = 3,042)	Nonresponder (n = 4,034)
Age		
Mean ± SD	77.9 ± 6.8	78.3 ± 7.3*
≥85, %	15.8	20.1*
Male, %	45.1	45.7
Comorbidity score, mean ± SD	3.5 ± 1.7	3.7 ± 1.9*
Died (at 28 months), %	15.3	20.4*
Hospitalized (at 28 months), %	44.5	45.2

* Statistically significant ($P < .05$) differences between the two groups.
SD = standard deviation.

Table 2. Multivariable Logistic Analyses for Prediction of Death or Hospitalization in Community-Dwelling Older People

	Outcome			
	Death (n = 2,166)		Hospitalization (n = 1,899)	
Variable	Adjusted Odds Ratio P-value			
Primary association testing: Medical Outcomes Survey Short Form-12 Scale				
Physical Component Score Quartile				
4 (>53.16)	1.0 (referent)		1.0 (referent)	
3 (45.55–53.16)	1.34	.67	2.06	.002
2 (36.83–45.54)	3.23	.06	2.20	<.001
1 (<36.83)	6.25	.002	3.03	<.001
Mental Component Score Quartile				
4 (>58.46)	1.0 (referent)		1.0 (referent)	
3 (53.99–58.46)	1.21	.44	1.05	.73
2 (45.15–53.98)	1.75	.01	1.20	.20
1 (<45.15)	2.52	<.001	1.55	<.001
Important covariates				
Male	1.40	.02	1.14	.18
Age				
65–69	1.0 (referent)		1.0 (referent)	
70–74	1.15	.66	0.83	.23
75–79	2.21	.007	1.12	.47
80–84	2.98	<.001	1.14	.42
≥85	4.93	<.001	1.32	.15
Comorbidity score				
Low (≤2)	1.0 (referent)		1.0 (referent)	
Low-moderate (3)	1.30	.20	1.37	.01
High-moderate (4–5)	1.85	.001	1.46	.004
High (≥6)	2.12	<.001	1.94	<.001

low MCS group had 2.30 times (95% CI = 1.64–3.22) as great a risk of death as those in the high MCS group (Figure 2B). The PCS groupings reveal virtually no difference in the hazard functions of the two highest PCS quartile groups, although individuals with PCS scores in the range of the first and second quartiles had a greater risk of mortality over time than those with PCS scores in the first two quartiles. Like the PCS curves, the third and fourth MCS quartile groups appear to merge in Figure 2B, indicating poor discrimination between the hazard functions of these two groups, although they are separate from the first and second MCS quartile groups. As with the logistic analysis, the difference in MCS mortality was clear in the fourth quartile versus the first and second quartiles but not in the fourth versus the third quartile.

Low PCS and MCS scores and high comorbidity scores predicted shorter time until hospitalization, as shown in Figure 2C and D. The lowest PCS score group had 2.64 times the hazard rate ratio of hospitalization as the highest PCS score groups ($P < .001$), whereas the lowest MCS group had 1.40 times the hazard rate of the highest group ($P < .001$). The group with the highest comorbidity scores had 1.68 times the hazard rate ratio as the group with the lowest ($P < .001$). Figure 2C, the survival curve for the three PCS groups, shows a stable distribution of hospitalizations over time; the four groups separate almost immediately and remain so throughout the study period. For Figure 2D, there

is little differentiation between the third and fourth quartiles but obvious separation from the lower two quartiles.

DISCUSSION

This study has demonstrated that self-reported health status independently predicts hospitalization and mortality in patients. When used in conjunction with other predictors, the SF-12 provided additional value in the prediction of outcomes. A significant response bias was not found; on average, responders were younger and healthier than nonresponders and therefore less likely to die over the follow-up period. Despite this bias, the results are useful, because even the responders were at higher risk of death and hospitalization than the general population of seniors, and the power of the SF-12 to detect increased risk within this population was substantial.

Currently, health-status surveys are rarely used in clinical practice, especially for prediction of utilization. In part because of the fragmented and reactive nature of the U.S. healthcare system, population management through predictive models is still rare. With specific feedback on patients' physical and mental performance, it might become much easier for healthcare providers to focus a care-management system, such as geriatric care teams, on populations at risk of hospitalization or death. Because resources are limited, focusing the intervention on the
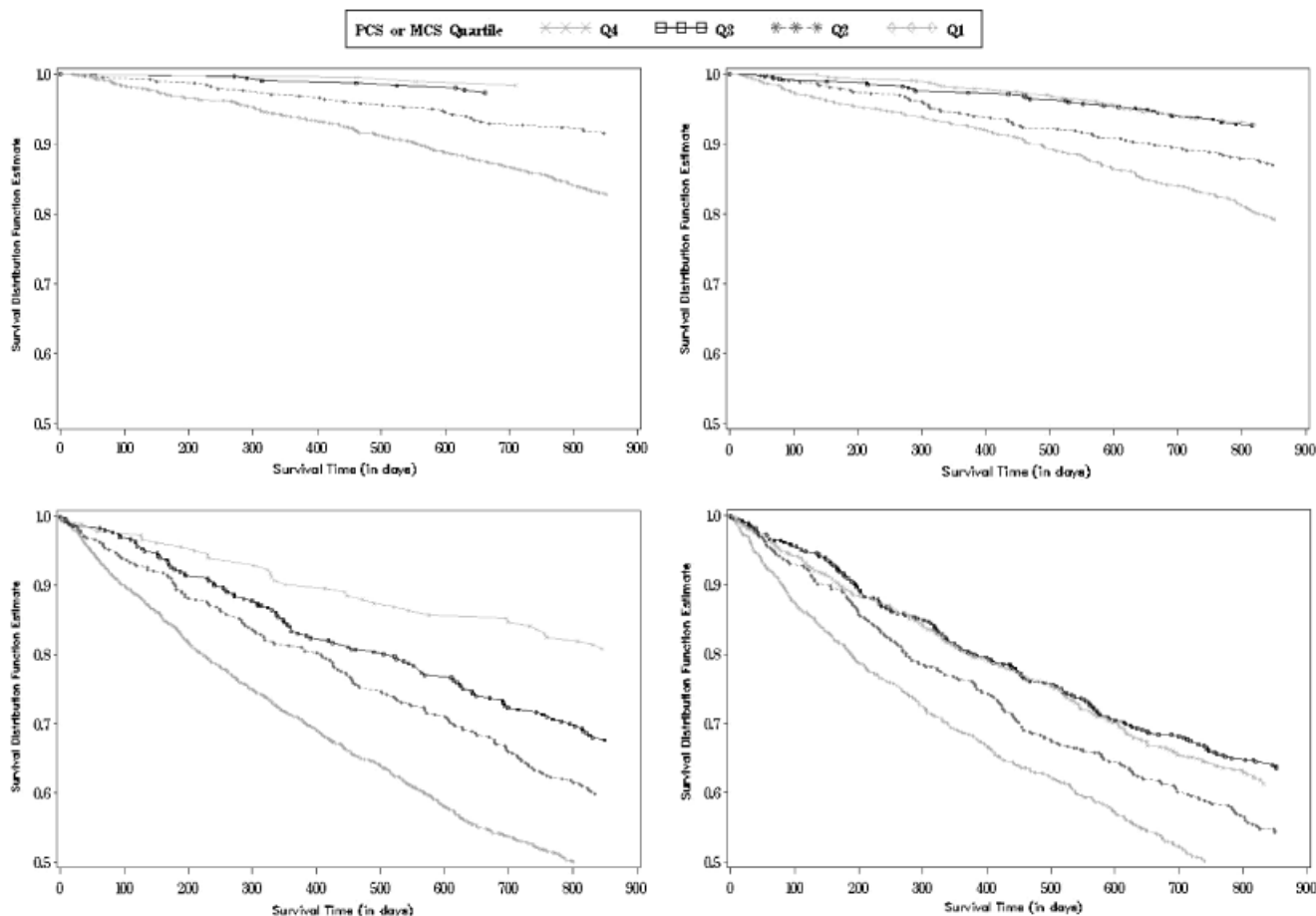
Figure 2. Survival distribution function for death as predicted by Short Form-12 quality-of-life (A) physical component score groups and (B) mental component score groups. Survival distribution function for hospitalization as predicted by Short Form-12 quality-of-life (C) physical component score groups and (D) mental component score groups.

population most likely to benefit is an important first step. It remains to be seen whether improved resource allocation efficiency could forestall death or hospitalization, but the sharpened focus may produce significant benefits. For instance, patients not able to complete regular daily activities as a result of emotional or physical problems (as recorded on the SF-12) might be proactively triaged into a care-management system, which could mitigate the functional problem. In addition, quality-of-life measures may help clinicians address issues beyond the scope of usual care that interfere with patients' social and physical wellness.

The results also indicate the potential power of the quality-of-life survey in prediction, even above conventional measures. In single-variable modeling, low physical SF-12 scores were powerful predictors of death and hospitalization. In multivariable modeling, low physical scores were stronger predictors of death and hospitalization than any other variable. Although a certain amount of correlation (Pearson correlation coefficient = 0.10–0.27) exists between the SF-12 scores and other variables, interaction terms did not alter the overall model. Thus, these results suggest that physical SF-12 scores can provide significant value, alone and when combined with traditional measures. Mental SF-12 score had significant effect, although of smaller magnitude. The comorbidity score also was a significant predictor of death and hospitalization. Age and sex

were significant only for death, not hospitalization, as other researchers have found.[16] Thus, these results indicate that appropriate measurement of SF-12 may be important in disease and population management.

This study reaffirms others that have demonstrated that health status independently predicts mortality in patients. One study that found self-reported functional impairment is an independent predictor of death in seniors.[17,18] Functional status assessments in hospitalized patients have also been reported as a predictor of many poor outcomes, including mortality.[19–23] The current study validates previous findings of the ability to predict male veterans' future mortality and hospitalizations from the SF-36, extending it to a different population (community-based primary care clinic) and with a different instrument (the SF-12).[4] In the current study, there was a much larger female population (55%) and an older population. Other notable differences between the current and previous studies include the use of administrative (specifically clinic billing) data for assessing comorbidities versus previous use of self-reported diseases and use of Medicare data to account for all hospitalizations. Because veterans may have multiple sources for payment, using only Department of Veterans Affairs data likely undercounts the number of total hospitalizations for Medicare-eligible patients.[24]

The current study indicates that response rate biases might influence outpatient assessment through a mailed

survey. In addition to the differences in adjusted death rates, the samples of nonresponders had significantly more co-morbidities and were older than the responders. In this study and others, there was a tendency for persons with dementia, higher risk or comorbidity scores, and greater age not to respond.[25,26] The survey administration technique had several factors associated with stimulating return rates, as demonstrated in a recent systematic review,[27] including short length, personalization, stamped return envelopes, and being sent via first-class mail. It was felt that the interest to participants would be maximized by the choice of scales, but this is debatable. Nevertheless, significant constraints prevented the use of money (both ethical and scarce resources) and repeat questionnaires (the administration felt this was burdensome to the patients, based on a recent series of complaints), concerns that plague a number of large institutions. The response group adequately represents a population of moderately ill cohorts in primary or geriatric care practices for which this predictive tool may be useful in allocating resources.[28] Nonetheless, self-administration in an office setting may be preferred to increase sample size and reach a broader population.[29]

There are several other limitations of this study. The primary drawback of using the SF-12 is that there is a much smaller set of validation literature. Although it was attempted to use similar measures, such as comorbidity, to see whether the results generated were from other confounders, further validation should occur to solidify the usefulness of the SF-12 as a predictor. Nevertheless, the SF-36 summary scores—a scale with much broader prediction literature—have been mapped onto the SF-12 scores with good correlation. The SF-12 is easier for older people to understand and complete. Indeed, other large assessment efforts are switching to the SF-12 from the SF-36, including the Health Outcome Survey administered by Centers for Medicare and Medicaid Services. Selection of the population of interest for prediction would still be important; administration of the survey to healthy older people as a predictive tool may not be useful or cost effective. Finally, the data on chronic conditions were identified from administrative data and did not formally include the severity of these conditions or a detailed analysis of previous hospitalizations or procedures. Because severity is expensive to measure for each disease, the combination of the SF summary scores and the comorbidity score may provide a useful surrogate for the severity of all diseases combined. The upside of this approach is that the administrative data are easier for many researchers to acquire than self-reported date. Finally, when the comorbidity score was revalidated, dementia was the most strongly weighted diagnosis, outweighing usual causes of death such as ischemic heart disease or cancer. Other studies have also found cognitive decline to be a strong predictor, attributing its predictive strength to late diagnosis and multifactorial etiologies.[30]

In summary, a simple, noninvasive, self-reported quality-of-life survey was more useful in predicting death and utilization than traditional measures used alone. This finding reflects common knowledge; people with disease and infirmities are more likely to die or become hospitalized than those who are not so burdened, but for those who wish to intervene proactively, an easy-to-implement predictive tool that can be applied to populations of patients could be valuable. Although the exact populations and techniques appropriate for this survey are unclear, these results can help guide groups attempting to manage resources and maximize population-based care. It should be emphasized that the elderly study population had at least one comorbid illness and at least one visit to an ambulatory care provider in the year before they were mailed the questionnaire. To fully realize value from a predictive tool, it will be necessary to assess whether provider practice patterns change given feedback about the emotional and physical function of the patient, to determine what interventions aimed specifically at these populations work, and to maximize the efficiency and effectiveness of those interventions.

ACKNOWLEDGMENTS

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Racial Disparity in Mortality After Injury

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April 10, 2007

Background

- There are well-documented, persistent racial disparities in life expectancy in the United States
  - Williams and Collins. *Annual Review of Sociology* 1995; 21:349-386.
  - Howard et al. *Annals of Epidemiology* 2000; 10(4):214-223.

- Attributed to a variety of factors
  - Differential exposure to health risks
  - Differential access to healthcare services

Injury

- Recent research has suggested that injury is the third leading contributor to racial disparities in life expectancy
  - Wong et al. *New England Journal of Medicine* 2002; 347(20): 1585-1592

- Could result from differential exposure to injury or
- Differences in quality of care received after injury

Limited previous research

- Two studies of care in emergency departments for minor head injuries found
  - African American patients more likely to receive care from a resident than staff physician
  - Less likely to be admitted to the hospital
  - Less likely to be referred for followup care

- Bazarian et al. *Academic Emergency Medicine* 2003; 10(11):1209-1217.
- Selassie et al. *American Journal of Emergency Medicine* 2004; 22(6):465-473.

My research

- Examines outcomes of hospitalized injured patients as an indicator of quality of care

  - Outcome=in-hospital mortality

Conceptually

- Donabedian's model of healthcare quality suggests three aspects
  - Structure
    - Availability and characteristics of healthcare facilities, providers and resources
  - Process
    - Delivery and timing of diagnostic and therapeutic interventions
  - Outcome
    - Illness, impairment, death

Data Source

- Healthcare Cost and Utilization Project Nationwide Inpatient Sample

    – 20% stratified random sample of community hospitals in the United States, selected from 36 states

    – Released annually, used data from 1998-2002

    – Standard administrative data

Patient sample

- Primary diagnosis of injury

- Age 18-64

- Excluding patients transferred to another hospital (2.5% of admissions)

Measurement: race

- Reported by hospitals as recorded at hospital arrival or admission
  - Accuracy, when compared to self-report, is highest for African-American patients
  - Hispanic ethnicity is inconsistently coded
  - Native American ancestry is known to be unreliably coded
  - 11 participating states do not report race (excluded)

Measurement: injury severity

- Use ICD-9-CM codes to calculate an ICISS score
- Each injury diagnosis is assigned a survival probability
- ICISS of 10= minor injury with virtual certainty of survival
- ICISS of 0=extremely severe injury with no chance of survival

Measurement: comorbidity

- Also using ICD-9-CM codes
- Identify 5 conditions known to affect trauma outcomes
  - Chronic obstructive pulmonary disease
  - Congenital coagulopathy
  - Diabetes
  - Liver disease
  - Coronary heart disease

Measurement: mechanism of injury

- Indicated by ICD-9 E-codes

  - Categorized to indicate
    - Motor vehicle crashes
    - Falls
    - Intentional injuries
    - Other mechanisms
    - Unspecified

Measurement: Income

- Ecological measure: median income of zip code of residence

Other variables

- Gender
- Age
- Primary payer (insurance status)
- Hospital type
- In-hospital mortality

Table 1: Demographic and hospital characteristics of patients

	White	Black	Hispanic	Asian	Native American	Other	Missing
N	328696	74336	59448	7903	2689	15953	33485
Mean age	41±13	37±12	35±12	39±14	36±12	36±13	39±13
% female	36.2%	28.5%	23.6%	37.1%	32.0%	25.8%	32.2%
Payer							
Private insurance	57.1%	33.1%	29.8%	53.3%	33.7%	40.4%	58.0%
Medicare	6.6%	6.0%	3.1%	2.6%	4.4%	2.8%	4.2%
Medicaid	**8.7%**	**20.7%**	**16.5%**	**11.5%**	**27.1%**	**11.4%**	**10.1%**
Selfpay	**12.9%**	**25.0%**	**27.1%**	**17.6%**	**15.5%**	**26.8%**	**14.4%**
No charge	0.8%	1.9%	1.5%	0.5%	0.2%	1.2%	0.2%
Other	13.9%	13.4%	22.1%	14.5%	19.2%	17.5%	13.1%
Zip income							
<=$25000	3.9%	21.2%	13.8%	3.4%	27.6%	8.2%	6.3%
$25000-$34999	26.3%	32.9%	27.3%	12.2%	32.9%	23.6%	24.3%
$35000-$44999	28.3%	23.3%	26.1%	22.6%	17.9%	26.7%	26.8%
>=$45000	**37.5%**	**18.9%**	**27.8%**	**57.9%**	**15.9%**	**36.9%**	**38.0%**
Missing	4.1%	3.7%	5.1%	3.8%	5.7%	4.6%	4.5%
Hospital type							
Urban teaching	48.2%	71.7%	59.8%	60.1%	58.9%	63.2%	71.6%
Urban nonteaching	37.5%	22.6%	36.2%	32.0%	19.8%	30.3%	18.1%
Rural	14.3%	5.8%	4.0%	7.9%	21.4%	6.5%	10.2%

Table 2: Injury, health and mortality of patients

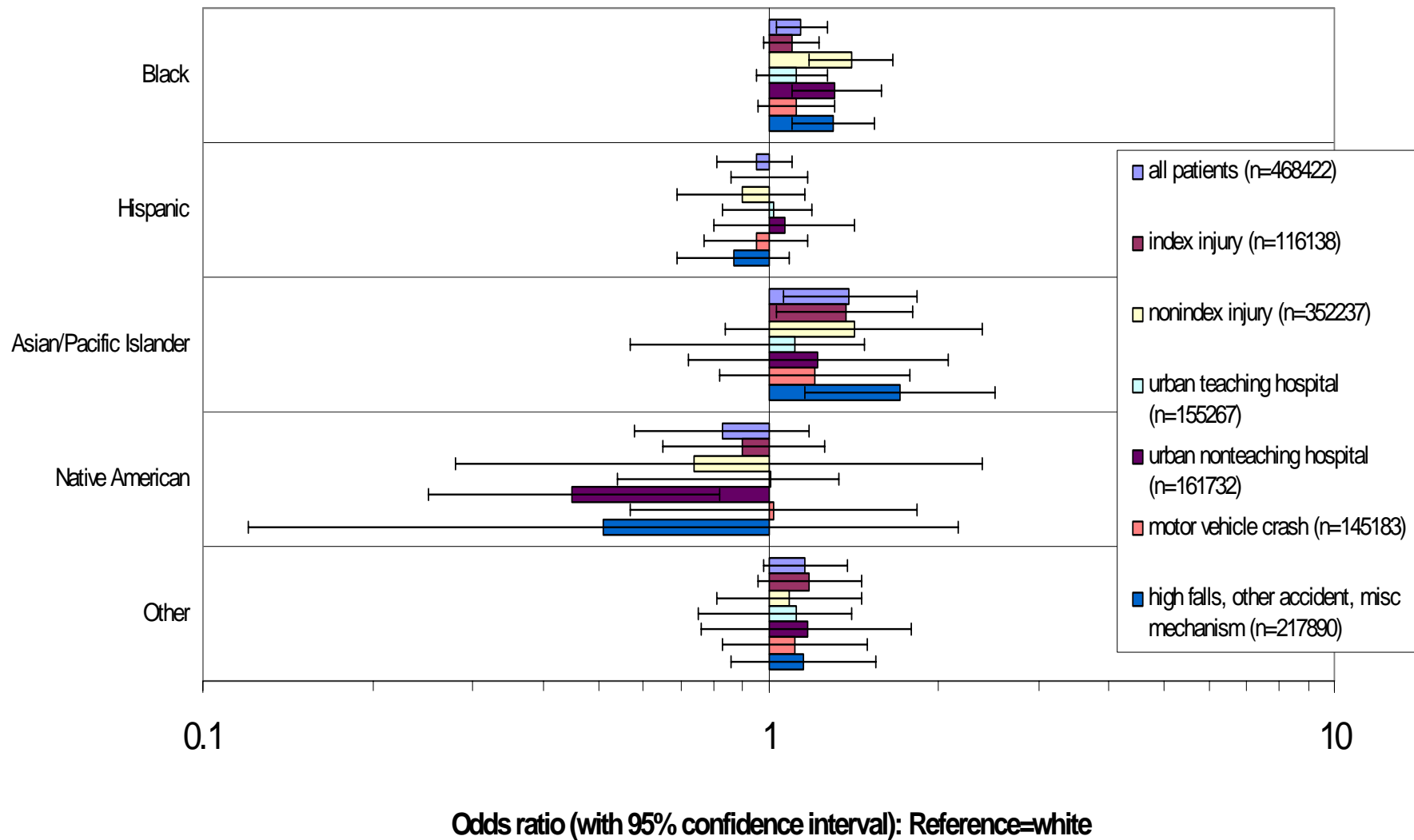|	White	Black	Hispanic	Asian	Native American	Other	Missing
N	328696	74336	59448	7903	2689	15953	33485
ICISS*10	9.4±1.1	9.3±1.2	9.4±1.1	9.4±1.1	9.3±1.2	9.3±1.2	9.3±1.3
Index injury (selected high risk injuries)	**24.5%**	**26.4%**	**25.5%**	**26.7%**	**25.5%**	**26.2%**	**30.3%**
Morris comorbidity	**13.9%**	**12.1%**	**9.2%**	**8.9%**	**14.5%**	**9.0%**	**11.1%**
COPD	6.0%	4.4%	2.3%	2.1%	3.0%	2.8%	4.3%
Coagulopathy	1.0%	0.9%	0.9%	0.9%	1.1%	0.8%	1.1%
Diabetes	6.0%	6.3%	5.6%	5.4%	9.2%	5.0%	4.7%
Liver disease	0.8%	0.5%	0.8%	0.4%	1.6%	0.5%	0.6%
Coronary heart disease	2.7%	1.5%	1.1%	1.4%	2.2%	1.3%	1.9%
Mechanism 　Motor vehicle crash	32.6%	25.1%	29.5%	37.3%	33.9%	32.3%	36.4%
Fall from height	12.9%	6.9%	10.3%	9.7%	9.6%	10.1%	12.2%
Low fall	17.3%	10.4%	10.5%	14.9%	11.8%	11.6%	15.0%
Intentional injury	**6.4%**	**26.9%**	**16.4%**	**10.7%**	**19.6%**	**16.2%**	**10.1%**
Other unintentional inj	15.6%	14.4%	18.0%	16.2%	13.5%	15.8%	16.6%
Other mechanism	4.0%	4.1%	2.9%	3.2%	5.3%	3.4%	4.1%
Unspecified	11.4%	12.2%	12.5%	8.1%	6.4%	10.8%	5.7%
Died in hospital	1.5%	2.1%	1.7%	2.0%	1.8%	2.0%	2.5%

Multivariate models

- Use generalized estimating equations to control for clustering of patients within hospitals

- Output comparable to logistic regression

- Coefficients expressed as odds ratios:

  >1=increased odds of death

  <1=decreased odds of death

Multivariate models
(see handout)

Variable	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)
Race White	Reference	Reference	Reference
Black	1.37 (1.23-1.52)***	1.21 (1.09-1.34)***	1.14 (1.03-1.27)*
Hispanic	1.11 (0.96-1.29)	0.97 (0.83-1.13)	0.95 (0.81-1.10)
Asian/Pacific Islander	1.35 (1.12-1.64)**	1.33 (1.01-1.75)*	1.39 (1.06-1.83)*
Native American	1.21 (0.86-1.72)	0.92 (0.67-1.28)	0.83 (0.58-1.18)
Other race	1.32 (1.09-1.60)**	1.18 (0.99-1.40)	1.16 (0.98-1.38)
Other variables	RACE ONLY	All other covariates except income	All covariates
N	489025	488971	468422

Figure 1: Stratified multivariate models of injury mortality*

Odds ratio (with 95% confidence interval): Reference=white

Legend:
- all patients (n=468422)
- index injury (n=116138)
- nonindex injury (n=352237)
- urban teaching hospital (n=155267)
- urban nonteaching hospital (n=161732)
- motor vehicle crash (n=145183)
- high falls, other accident, misc mechanism (n=217890)

Categories: Black, Hispanic, Asian/Pacific Islander, Native American, Other

Conclusions

- Suggests increased risk of mortality for African American and Asian patients compared to whites

- Among African American patients, the increased risk of death is most apparent for mild to moderate injuries and those treated outside of trauma centers

- Among Asian patients, the increased risk is concentrated among more severe injuries

Limitations

- Lack of physiologic data limits ability to assess injury severity

- Inadequate measures of socioeconomic status

- In-hospital mortality is a gross measure of outcome

Implications

- These data do not definitively demonstrate racial disparities in quality of care
- They suggest that further research should be undertaken to delineate the cause of racial disparities in mortality
  - Differences in availability of resources
  - Differences in processes of care
  - Differential patterns of injury

Arthur Handout: Multivariate models of mortality

Variable	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)
Race			
White	Reference	Reference	Reference
Black	1.37 (1.23-1.52)***	1.21 (1.09-1.34)***	1.14 (1.03-1.27)*
Hispanic	1.11 (0.96-1.29)	0.97 (0.83-1.13)	0.95 (0.81-1.10)
Asian/Pacific Islander	1.35 (1.12-1.64)**	1.33 (1.01-1.75)*	1.39 (1.06-1.83)*
Native American	1.21 (0.86-1.72)	0.92 (0.67-1.28)	0.83 (0.58-1.18)
Other race	1.32 (1.09-1.60)**	1.18 (0.99-1.40)	1.16 (0.98-1.38)
Age		1.02 (1.02-1.03)***	1.02 (1.02-1.03)***
Female		0.78 (0.73-0.83)***	0.78 (0.73-0.83)***
ICISS10		0.42 (0.41-0.43)***	0.42 (0.41-0.43)***
Hospital type			
Urban teaching		Reference	Reference
Urban non-teaching		0.73 (0.37-0.82)***	0.75 (0.66-0.84)***
Rural		0.39 (0.33-0.48)***	0.39 (0.32-0.48)***
Morris comorbidity		2.45 (2.25-2.67)***	2.46 (2.26-2.69)***
Payer			
Private insurance		Reference	Reference
Medicare		1.99 (1.74-2.27)***	1.96 (1.71-2.24)***
Medicaid		1.18 (1.03-1.35)*	1.14 (1.01-1.29)*
Selfpay		1.75 (1.54-1.98)***	1.71 (1.50-1.96)***
No charge		0.89 (0.49-1.61)	0.87 (0.51-1.46)
Other		No estimate	1.16 (0.98-1.38)
Zip income			
<=$25000			1.32 (1.14-1.53)***
$25000-$34999			1.16 (1.06-1.28)**
$35000-$44999			1.15 (1.05-1.26)**
>=$45000			Reference
N	489025	488971	468422

  * p<.05   **p<.01   ***p<.001