advancing the art & science of medicine in the midwest

WMJ

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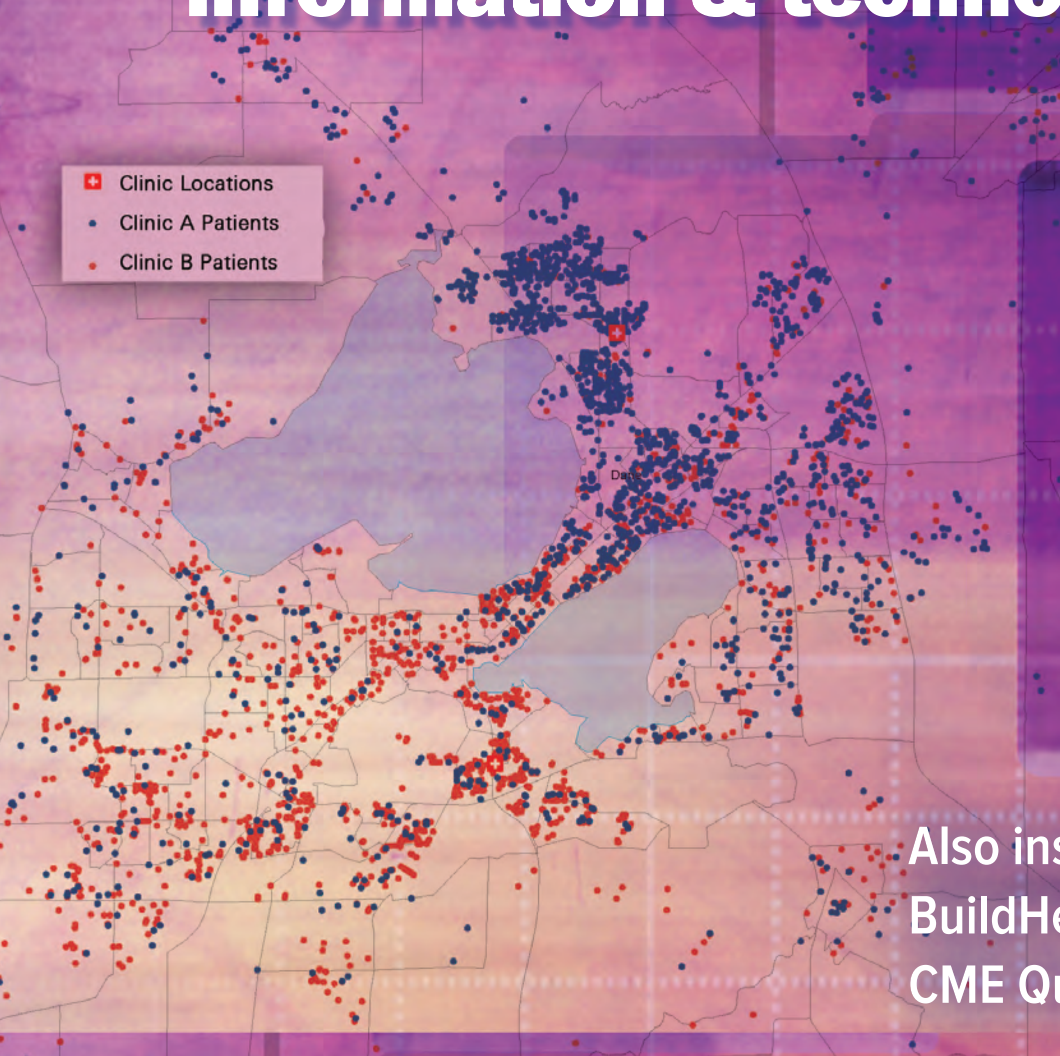
Supporting better practices & improvement with clinical information & technology



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WMJ

COVER THEME

Supporting better practices & improvement with clinical information & technology

Today someone with reasonable skills and database knowledge can ask questions of clinical data sets that can support better practices and drive improvements. Work presented in this issue of *WMJ* illustrates the potential for new technologies such as Geographic Information Systems (GIS) and Internet search engines to affect clinical decisions, placement of clinical resources, and creative approaches to improving quality and linking health care to the environment.

Cover design by
Mary Kay Adams-Edgette.

The mission of *WMJ* is to provide a vehicle for professional communication and continuing education for Midwest physicians and other health professionals. *WMJ* is published by the Wisconsin Medical Society.

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advancing the art & science of medicine in the midwest

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The *WMJ* (ISSN 1098-1861) is published by the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in the Midwest. The managing editor is responsible for overseeing the production, business operation and contents of the *WMJ*. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic, or organizational articles. All articles published herein, including commentaries, letters to the editor and editorials represent the views of the authors, for which neither *WMJ* nor the Wisconsin Medical Society take responsibility, unless clearly stated. Advertising content is the responsibility advertiser and does not imply an endorsement or sponsorship by *WMJ* or the Wisconsin Medical Society and its affiliates unless specified. *WMJ* is indexed in Index Medicus, Hospital Literature Index, and Cambridge Scientific Abstracts.

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Integrating behavioral health records into EHRs

Electronic health records (EHRs) allow improved communication between primary care and other health care clinicians. However, exactly how the records of behavioral health providers should be included in the EHR has generated some debate.[1] One approach is to keep behavioral health records in restricted areas of the EHR or behind "break the glass" firewalls. The issue of whether and how to include behavioral health records in the EHR has become more salient as behavioral health services increasingly have become integrated into primary medical care services.[2,3] The collaborative behavioral health model, which has been described in this journal,[4] is an example of such integration. In the implementation of the model as described by Serrano and Monden, behavioral health records are integrated into the EHR and are fully accessible to other medical providers just as are the records of the primary care clinicians.

Over the period of a year, I had a natural experiment to study primary care patients' consent to inclusion of behavioral health records in the general EHR. I am a psychologist practicing part-time in a family medicine clinic that is a training site of a family medicine residency. In January 2010, my clinic affiliated with Access Community Health Centers, the same organization described by Serrano and Monden. In order to conform to the practice of their behavioral health consultation service, I began placing my notes in the EHR. Over the first year of the affiliation, I solicited written consent from each patient to allow me to do so. For those patients who did not consent, I dictated separate notes and placed the hardcopies in a locked drawer. During that year, I had 484 clinical encounters with 282 unique patients. Eleven patients (4%) withheld their consent to allow me to place notes in their EHRs.

My experience indicates that when properly explained, the great majority of primary care patients will consent to the placement of behavioral health records in the EHR. Further, many patients were enthusiastic that their primary care clinicians would have ready access to their behavioral health notes. My findings are similar to those of Flynn et al,[5] who found that 5% of patients in an outpatient psychiatric clinic declined allowing their records to be place in the EHR.

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Research doesn't support mandatory influenza vaccination

While the intent of Aurora's mandatory influenza vaccination[1] of health care workers might be noble, ie, patient protection, the research on the subject is lacking. Only 2 studies have tracked hospital-acquired worker-to-patient influenza (a relatively simple infection control metric) and both reported cases in the single digits for an average-sized hospital over multiple complete flu seasons.[2,3] In fact, the latter demonstrated that influenza made up only 23% of strains causing influenza-like illness (ILI), such that the rate for true worker-to-patient influenza infection for a 400-bed hospital is less than 1 case per year. Why? Influenza is a community-acquired disease, and standard infection control precautions (hand-washing, masking those with a cough, isolation, and visitor control) curb transmission in hospitals. Ironically, vaccination is possibly the least effective of these measures, and CDC data and at least 1 study cited below have demonstrated that over the recent past, influenza vaccine is between 40% and 63% effective, on average. Influenza is only one of a host of viruses that can sicken a hospitalized patient, but is the only one for which we have a vaccine. Yet the other control measures I mentioned are efficacious against ALL such organisms. Why don't we make those measures mandatory?

Last year at Mayo Clinic Rochester, we instituted mandatory compliance with an influenza control program for all employees with patient contact: get vaccinated or sign an electronic declination that included education. With over 25,000 such employees, everyone complied, no one lost a job, and 93% chose vaccine vs declination. We emphasized personal, family, and patient protection, and it was perceived as a benefit. We also emphasized other control measures, such as handwashing and staying home when ill, to control the ILIs for which we have no vaccine. Call it "Minnesota nice," but it can be done. Influenza vaccination is important but not worth terminating employment or disgracing a worker by forcing him or her to wear a mask the entire flu season (an alternative control at other medical centers) when there is no evidence that it will prevent infections.

In due time, possibly the next 5 years, we will have a better influenza vaccine that targets common antigens on all strains of influenza and that may not require annual vaccination. Employees who choose not to be vaccinated are not lunatics; they have endured the long lines to be vaccinated, they have been turned away during rationing, they (or co-workers) have gotten influenza despite vaccination. When we have a decent vaccine, like MMR or dT, we won't have to twist arms; everyone will get it. If we are going to regulate and scrutinize our dedicated health care workers any further, let's do it for the right reason. The American College of Occupational and Environmental Medicine's guidance statement[4] outlines a more balanced approach to this issue.

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Occupational, and Aerospace Medicine,
Rochester, Minn

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For patients with severe COPD associated with chronic bronchitis and a history of exacerbations

COPD EXACERBATIONS

are serious events...

Reducing Patient Risk Is Critical

INDICATIONS AND USAGE

DALIRESP is indicated as a treatment to reduce the risk of COPD exacerbations in patients with severe COPD associated with chronic bronchitis and a history of exacerbations. DALIRESP is not a bronchodilator and is not indicated for the relief of acute bronchospasm.

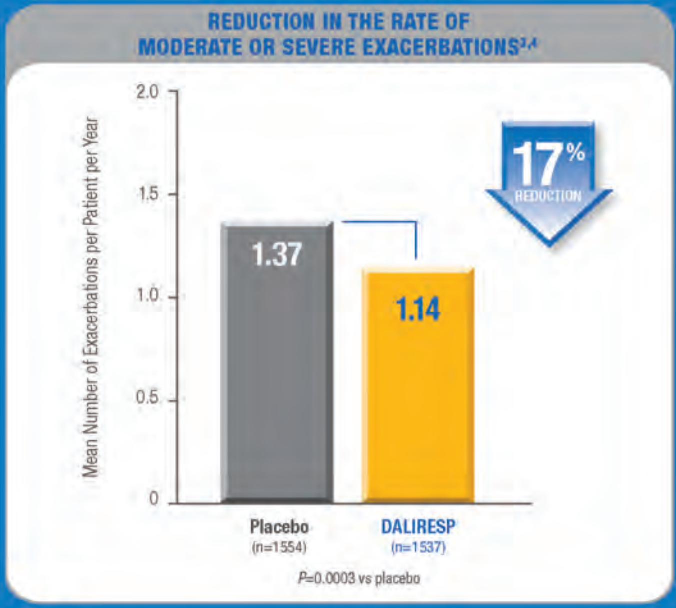
Please see Important Safety Information and Brief Summary of full Prescribing Information on the following pages and at www.DALIRESP.com.

COPD=chronic obstructive pulmonary disease.

Daliresp®
(roflumilast) tablets
500 mcg

For patients with severe COPD associated with chronic bronchitis and a history of exacerbations

DALIRESP® is the first and only selective PDE4 inhibitor to reduce the risk of COPD exacerbations[1,2]



REDUCTION IN THE RATE OF MODERATE OR SEVERE EXACERBATIONS[3,4]

P=0.0003 vs placebo

Study design: A pre-specified pooled analysis from 2 identical, 52-week, double-blind, placebo-controlled trials in patients with severe COPD associated with chronic bronchitis and a history of exacerbations (N=3091). Median patient age was 64 years; 76% male, 84% Caucasian. LABAs or short-acting anticholinergics were allowed as concomitant treatment. The reduction in the rate of moderate (requiring treatment with systemic glucocorticosteroids) or severe (resulting in hospitalization and/or leading to death) exacerbations and change in lung function (pre-bronchodilator FEV_1) were co-primary endpoints. Each study met both co-primary endpoints.

- Moderate exacerbations were defined as those requiring treatment with systemic corticosteroids[1]
- Severe exacerbations were defined as resulting in hospitalization and/or death[1]
- DALIRESP is not a bronchodilator and is not indicated for the relief of acute bronchospasm[1]

IMPORTANT SAFETY INFORMATION

Contraindications

DALIRESP is contraindicated in patients with moderate to severe liver impairment (Child-Pugh B or C).

Warnings and Precautions

- DALIRESP is not a bronchodilator and should not be used for the relief of acute bronchospasm.
- Prescribers should advise patients, their caregivers, and families to be alert for the emergence or worsening of insomnia, anxiety, depression, suicidal thoughts or other mood changes, and if such changes occur, to contact their healthcare provider. Prescribers should carefully evaluate the risks and benefits of continuing treatment if such events occur. Before using DALIRESP in patients with a history of depression and/or suicidal thoughts or behavior, prescribers should carefully weigh the risks and benefits of treatment with DALIRESP.
  - Treatment with DALIRESP is associated with an increase in psychiatric adverse reactions. In controlled clinical trials 5.9% of patients treated with DALIRESP reported psychiatric adverse reactions vs 3.3% treated with placebo. The most common psychiatric adverse reactions were insomnia (2.4% vs 1.0%), anxiety (1.4% vs 0.9%), and depression (1.2% vs 0.9%). Three patients treated with DALIRESP experienced suicide-related adverse reactions (one completed suicide and two suicide attempts) compared to one patient (suicidal ideation) treated with placebo.

References: 1. DALIRESP (roflumilast) Prescribing Information. Forest Pharmaceuticals, Inc. St. Louis, MO. **2.** US Food and Drug Administration. FDA news release. March 1, 2011. http://www.fda.gov/NewsEvents/newsroom/PressAnnouncements/ucm244989.htm. Accessed February 13, 2012. **3.** Data on file. Forest Laboratories, Inc. **4.** Calverley PMA, Rabe KF, Goehring U-M, Kristiansen S, Fabbri LM, Martinez FJ; for the M2-124 and M2-125 study groups. Roflumilast in symptomatic chronic obstructive pulmonary disease: two randomised clinical trials. *Lancet.* 2009;374:685-694.

In the same studies:

DALIRESP significantly reduced the rate of exacerbations vs placebo in patients using a bronchodilator[1,3]

CONSISTENT EFFECT WITH A CONCOMITANT BRONCHODILATOR[1,3]

DALIRESP with LABAs (Long-acting β_2 Agonists)	✓
DALIRESP with Short-acting Anticholinergics	✓

- The effect with concomitant LABAs or short-acting anticholinergics was similar to that seen in the overall population[1,3]

ONCE-DAILY
ORAL

Tablet shown not actual size.

- Patients should have their weight monitored regularly. If unexplained or clinically significant weight loss occurs, weight loss should be evaluated and treatment discontinuation considered.
  - In addition to weight loss being reported as a common adverse reaction (7.5% of patients treated with DALIRESP vs 2.1% placebo), weight was prospectively assessed in two 1-year clinical trials. In these studies that compared DALIRESP to placebo, 20% vs 7% experienced moderate weight loss (5-10% of body weight) and 7% vs 2% experienced severe weight loss (>10% body weight). During the follow-up period after discontinuing DALIRESP, the majority of patients regained some of the weight they had lost.
- Use with strong cytochrome P450 enzyme inducers (eg, rifampicin, phenobarbital, carbamazepine, phenytoin) is not recommended, as they decrease the exposure and may reduce the therapeutic effectiveness of DALIRESP.

Adverse Reactions

In clinical trials the most common adverse reactions (≥2% and greater than placebo) were diarrhea (9.5% vs 2.7%), weight loss (7.5% vs 2.1%), nausea (4.7% vs 1.4%), headache (4.4% vs 2.1%), back pain (3.2% vs 2.2%), influenza (2.8% vs 2.7%), insomnia (2.4% vs 1.0%), dizziness (2.1% vs 1.1%), and decreased appetite (2.1% vs 0.4%).

Please see Brief Summary of full Prescribing Information on the following page and at www.DALIRESP.com.

Forest Pharmaceuticals, Inc.
Subsidiary of Forest Laboratories, Inc.
St. Louis, Missouri 63045

Daliresp®
(roflumilast) tablets
500 mcg

DALIRESP® (roflumilast) tablets **Rx Only**
Brief Summary of Full Prescribing Information
Initial U.S. Approval: 2011

INDICATIONS AND USAGE

DALIRESP® is indicated as a treatment to reduce the risk of COPD exacerbations in patients with severe COPD associated with chronic bronchitis and a history of exacerbations.

Limitations of Use

DALIRESP is not a bronchodilator and is not indicated for the relief of acute bronchospasm.

CONTRAINDICATIONS

The use of DALIRESP is contraindicated in the following conditions: Moderate to severe liver impairment (Child-Pugh B or C) [*see Clinical Pharmacology (12.3) and Use in Special Populations (8.6)*].

WARNINGS AND PRECAUTIONS

Treatment of Acute Bronchospasm

DALIRESP is not a bronchodilator and should not be used for the relief of acute bronchospasm.

Psychiatric Events including Suicidality

Treatment with DALIRESP is associated with an increase in psychiatric adverse reactions. In 8 controlled clinical trials 5.9% (263) of patients treated with DALIRESP 500 mcg daily reported psychiatric adverse reactions compared to 3.3% (137) treated with placebo. The most commonly reported psychiatric adverse reactions were insomnia, anxiety, and depression which were reported at higher rates in those treated with DALIRESP 500 mcg daily (2.4%, 1.4%, and 1.2% for DALIRESP versus 1.0%, 0.9%, and 0.9% for placebo, respectively) *[see Adverse Reactions (6.1)]*. Instances of suicidal ideation and behavior, including completed suicide, have been observed in clinical trials. Three patients experienced suicide-related adverse reactions (one completed suicide and two suicide attempts) while receiving DALIRESP compared to one patient (suicidal ideation) who received placebo.

Before using DALIRESP in patients with a history of depression and/or suicidal thoughts or behavior, prescribers should carefully weigh the risks and benefits of treatment with DALIRESP in such patients. Patients, their caregivers, and families should be advised of the need to be alert for the emergence or worsening of insomnia, anxiety, depression, suicidal thoughts or other mood changes, and if such changes occur to contact their healthcare provider. Prescribers should carefully evaluate the risks and benefits of continuing treatment with DALIRESP if such events occur.

Weight Decrease

Weight loss was a common adverse reaction in DALIRESP clinical trials and was reported in 7.5% (331) of patients treated with DALIRESP 500 mcg once daily compared to 2.1% (89) treated with placebo [*see Adverse Reactions (6.1)*]. In addition to being reported as adverse reactions, weight was prospectively assessed in two placebo-controlled clinical trials of one year duration. In these studies, 20% of patients receiving roflumilast experienced moderate weight loss (defined as between 5-10% of body weight) compared to 7% of patients who received placebo. In addition, 7% of patients who received roflumilast compared to 2% of patients receiving placebo experienced severe (>10% body weight) weight loss. During follow-up after treatment discontinuation, the majority of patients with weight loss regained some of the weight they had lost while receiving DALIRESP. Patients treated with DALIRESP should have their weight monitored regularly. If unexplained or clinically significant weight loss occurs, weight loss should be evaluated, and discontinuation of DALIRESP should be considered.

Drug Interactions

A major step in roflumilast metabolism is the N-oxidation of roflumilast to roflumilast N-oxide by CYP3A4 and CYP1A2. The administration of the cytochrome P450 enzyme inducer rifampicin resulted in a reduction in exposure, which may result in a decrease in the therapeutic effectiveness of DALIRESP. Therefore, the use of strong cytochrome P450 enzyme inducers (e.g. rifampicin, phenobarbital, carbamazepine, phenytoin) with DALIRESP is not recommended. [*see Drugs That Induce Cytochrome P450 (CYP) Enzymes (7.1) and Clinical Pharmacology (12.3)*].

ADVERSE REACTIONS

The following adverse reactions are described in greater detail in other sections:

- Psychiatric Events Including Suicidality *[see Warnings and Precautions (5.2)]*
- Weight Decrease *[see Warnings and Precautions (5.3)]*

Adverse Reactions in Clinical Studies

Because clinical trials are conducted under widely varying conditions, adverse reaction rates observed in the clinical trials of a drug cannot be directly compared to rates in the clinical trials of another drug and may not reflect the rates observed in practice.

The safety data described below reflect exposure of 4438 patients to DALIRESP 500 mcg once daily in four 1-year placebo-controlled trials, two 6-month placebo-controlled trials, and two 6-month drug add-on trials *[see Clinical Studies (14.1)]*. In these trials, 3136 and 1232 COPD patients were exposed to DALIRESP 500 mcg once daily for 6 months and 1-year, respectively.

The population had a median age of 64 years (range 40-91), 73% were male, 92.9% were Caucasian, and had COPD with a mean pre-bronchodilator forced expiratory volume in one second (FEV_1) of 8.9 to 89.1% predicted. In these trials, 68.5% of the patients treated with DALIRESP reported an adverse reaction compared with 65.3% treated with placebo.

The proportion of patients who discontinued treatment due to adverse reaction was 14.8% for DALIRESP-treated patients and 9.9% for placebo-treated patients. The most common adverse reactions that led to discontinuation of DALIRESP were diarrhea (2.4%) and nausea (1.6%).

Serious adverse reactions, whether considered drug-related or not by the investigators, which occurred more frequently in DALIRESP-treated patients include diarrhea, atrial fibrillation, lung cancer, prostate cancer, acute pancreatitis, and acute renal failure.

Table 1 summarizes the adverse reactions reported by ≥ 2% of patients in the DALIRESP group in 8 controlled COPD clinical trials.

Table 1: Adverse Reactions Reported by ≥ 2% of Patients Treated with DALIRESP 500 mcg daily and Greater Than Placebo

	Treatment	
Adverse Reactions (Preferred Term)	**DALIRESP**	**Placebo**
	(**N=**4438)	(**N=**4192)
	n (%)	n (%)
Diarrhea	420 (9.5)	113 (2.7)
Weight decreased	331 (7.5)	89 (2.1)
Nausea	209 (4.7)	60 (1.4)
Headache	195 (4.4)	87 (2.1)
Back pain	142 (3.2)	92 (2.2)
Influenza	124 (2.8)	112 (2.7)
Insomnia	105 (2.4)	41 (1.0)
Dizziness	92 (2.1)	45 (1.1)
Decreased appetite	91 (2.1)	15 (0.4)

Adverse reactions that occurred in the DALIRESP group at a frequency of 1 to 2% where rates exceeded that in the placebo group include:

Gastrointestinal disorders - abdominal pain, dyspepsia, gastritis, vomiting

Infections and infestations - rhinitis, sinusitis, urinary tract infection,

Musculoskeletal and connective tissue disorders - muscle spasms

Nervous system disorders - tremor

Psychiatric disorders - anxiety, depression

DRUG INTERACTIONS

A major step in roflumilast metabolism is the N-oxidation of roflumilast to roflumilast N-oxide by CYP3A4 and CYP1A2 [*see Clinical Pharmacology (12.3)*].

Drugs That Induce Cytochrome P450 (CYP) Enzymes

Strong cytochrome P450 enzyme inducers decrease systemic exposure to roflumilast and may reduce the therapeutic effectiveness of DALIRESP. Therefore the use of strong cytochrome P450 inducers (e.g., rifampicin, phenobarbital, carbamazepine, and phenytoin) with DALIRESP is not recommended *[see Drug Interactions (5.4) and Clinical Pharmacology (12.3)]*.

Drugs That Inhibit Cytochrome P450 (CYP) Enzymes

The co-administration of DALIRESP (500 mcg) with CYP3A4 inhibitors or dual inhibitors that inhibit both CYP3A4 and CYP1A2 simultaneously (e.g., erythromycin, ketoconazole, fluvoxamine, enoxacin, cimetidine) may increase roflumilast systemic exposure and may result in increased adverse reactions. The risk of such concurrent use should be weighed carefully against benefit. *[see Clinical Pharmacology (12.3)]*.

Oral Contraceptives Containing Gestodene and Ethinyl Estradiol

The co-administration of DALIRESP (500 mcg) with oral contraceptives containing gestodene and ethinyl estradiol may increase roflumilast systemic exposure and may result in increased side effects. The risk of such concurrent use should be weighed carefully against benefit *[see Clinical Pharmacology (12.3)]*.

USE IN SPECIFIC POPULATIONS

Pregnancy

Teratogenic effects: Pregnancy Category C: There are no adequate and well controlled studies of DALIRESP in pregnant women. DALIRESP was not teratogenic in mice, rats, or rabbits. DALIRESP should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

DALIRESP induced stillbirth and decreased pup viability in mice at doses corresponding to approximately 16 and 49 times, respectively, the maximum recommended human dose (MRHD) (on a mg/m^2 basis at maternal doses > 2 mg/kg/day and 6 mg/kg/day, respectively). DALIRESP induced post-implantation loss in rats at doses greater than or equal to approximately 10 times the MRHD (on a mg/m^2 basis at maternal doses ≥ 0.6 mg/kg/day). No treatment-related effects on embryo-fetal development were observed in mice, rats, and rabbits at approximately 12, 3, and 26 times the MRHD, respectively (on a mg/m^2 basis at maternal doses of 1.5, 0.2, and 0.8 mg/kg/day, respectively).

Nonteratogenic effects: DALIRESP has been shown to adversely affect pup post-natal development when dams were treated with the drug during pregnancy and lactation periods in mice. These studies found that DALIRESP decreased pup rearing frequencies at approximately 49 times the MRHD (on a mg/mg^2 basis at a maternal dose of 6 mg/kg/day) during pregnancy and lactation. DALIRESP also decreased survival and forelimb grip reflex and delayed pinna detachment in mouse pups at approximately 97 times the MRHD (on a mg/m^2 basis at a maternal dose of 12 mg/kg/day) during pregnancy and lactation.

Labor and Delivery

DALIRESP should not be used during labor and delivery. There are no human studies that have investigated effects of DALIRESP on preterm labor or labor at term; however, animal studies showed that DALIRESP disrupted the labor and delivery process in mice. DALIRESP induced delivery retardation in pregnant mice at doses greater than or equal to approximately 16 times the MRHD (on a mg/m^2 basis at a maternal dose of > 2 mg/kg/day).

Nursing Mothers

Roflumilast and/or its metabolites are excreted into the milk of lactating rats. Excretion of roflumilast and/or its metabolites into human milk is probable. There are no human studies that have investigated effects of DALIRESP on breast-fed infants. DALIRESP should not be used by women who are nursing.

Pediatric Use

COPD does not normally occur in children. The safety and effectiveness of DALIRESP in pediatric patients have not been established.

Geriatric Use

Of the 4438 COPD subjects exposed to DALIRESP for up to 12 months in 8 controlled clinical trials, 2022 were > 65 years of age and 471 were > 75 years of age. No overall differences in safety or effectiveness were observed between these subjects and younger subjects and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out. Based on available data for roflumilast, no adjustment of dosage in geriatric patients is warranted *[see Clinical Pharmacology (12.3)]*.

Hepatic Impairment

Roflumilast 250 mcg once daily for 14 days was studied in subjects with mild-to-moderate hepatic impairment classified as Child-Pugh A and B (8 subjects in each group). The AUCs of roflumilast and roflumilast N-oxide were increased by 51% and 24%, respectively in Child-Pugh A subjects and by 92% and 41%, respectively in Child-Pugh B subjects, as compared to age-, weight- and gender-matched healthy subjects. The C_{max} of roflumilast and roflumilast N-oxide were increased by 3% and 26%, respectively in Child-Pugh A subjects and by 26% and 40%, respectively in Child-Pugh B subjects, as compared to healthy subjects. DALIRESP 500 mcg has not been studied in hepatically impaired patients. Clinicians should consider the risk-benefit of administering DALIRESP to patients who have mild liver impairment (Child-Pugh A). DALIRESP is not recommended for use in patients with moderate or severe liver impairment (Child-Pugh B or C) *[see Contraindications (4) and Clinical Pharmacology (12.3)]*.

Renal Impairment

In twelve subjects with severe renal impairment administered a single dose of 500 mcg roflumilast, the AUCs of roflumilast and roflumilast N-oxide were decreased by 21% and 7%, respectively and C_{max} were reduced by 16% and 12%, respectively. No dosage adjustment is necessary for patients with renal impairment *[see Clinical Pharmacology (12.3)]*.

OVERDOSAGE

Human Experience

No case of overdose has been reported in clinical studies with DALIRESP. During the Phase I studies of DALIRESP, the following symptoms were observed at an increased rate after a single oral dose of 2500 mcg and a single dose of 5000 mcg: headache, gastrointestinal disorders, dizziness, palpitations, lightheadedness, clamminess and arterial hypotension.

Management of Overdose

In case of overdose, patients should seek immediate medical help. Appropriate supportive medical care should be provided. Since roflumilast is highly protein bound, hemodialysis is not likely to be an efficient method of drug removal. It is not known whether roflumilast is dialyzable by peritoneal dialysis.

Manufactured by:
Nycomed GmbH.
Production Site Oranienburg
Lehnitzstrasse 70 – 98
16515 Oranienburg
Germany

Manufactured for:
Forest Pharmaceuticals, Inc.
Subsidiary of Forest Laboratories, Inc.
St. Louis, MO 63045, USA

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084-12000414-BS-RMC17137-SEP11

Please also see full Prescribing Information at www.daliresp.com.

The Question of Computerization

Editor's note: "Looking Back" usually features excerpts from *WMJ*s 100 years or older. However, the focus of this themed issue of *WMJ* led us to look to the more recent past. The following excerpt is an introduction to the first in a series of informational articles about computers published in 1982. (*WMJ.* 1982;81[4]:40.) How things have changed in just 30 years!

Since about 1950, we have witnessed the growth of a new technology, of electronic information processing. Slowly at first, but at an ever-accelerating rate, digital computers of all sizes have diffused throughout the fabric of our culture. First, the universities and all branches of the government, then industry and commerce, and now our homes have welcomed this versatile assistant, advisor, and entertainer; to the point that, even now, it would be highly inconvenient (if not indeed disastrous) if all the computers were to be removed. And still the proliferation advances apace.

In particular, the field of medicine has seen the steady computerization of its activities; from the largest hospital complex to the smallest individual office; from accounting and billing to diagnostic aids, statistical recordkeeping, and intensive-care monitoring. Tomography, blood-chemistry, and dietetic planning are now fully computerized; as are the physician's quartz-digital watch, his bank-account, his microwave oven, his flight reservation, his camera (and the design of its lenses), his insurance premiums, …

In this environment, more and more people are wondering how soon and in what manner to begin using computers in their own activities, what computer systems to adopt, which services to employ, how much of their work to computerize, what software to purchase, how much to spend; and perhaps, too, they wonder how it all works and what the jargon means. The choices offered, and the attendant claims, are bewildering; and it is not too wise to buy a computer system first and learn the facts later.

Community members address health care challenges during hack-a-thon

Lisa Hildebrand

Experts across the country – physicians, employers, legislators, insurers, and others—are working every day to reduce the costs and improve the quality of health care. So, too, are community members like those who participated in the BuildHealth event in Milwaukee in April.

Engineers, students, nurses, and educators were among the 34 people who shared their skills and interests during the 28-hour BuildHealth (www.buildhealth.org) “hack-a-thon.”

The goal of the event was to generate positive dialog among community members with the intent of generating creative solutions to pressing problems in health care, according to Tim Syth, who produced the event. “The idea is to start the dialogue, get the conversation going and then carry it forward,” Syth said. “There are a lot of passionate and informed people who want to contribute. This is a way to bring together different skillsets to address community challenges.”

Five teams emerged from an opening conversation Saturday, April 14 about various health care issues. Society Chief Operating Officer Linda Syth, Society Chief Medical Officer (CMO) Tim Bartholow, MD, and Mary Reinke of Aurora Health Care shared their expertise as team members researched and discussed the challenges they selected. The Society, University of Wisconsin-Madison Population Health Institute, US Department of Health and Human Services (HHS) and other organizations supported the event at Bucketworks, a non-profit organization that provides collaborative and creative space for individuals, businesses, and community groups in Milwaukee.

“The Wisconsin Medical Society is honored to play an important role in fostering the development of the kind of cutting-edge solutions that are so critically needed to improve access and provide the best possible care to all patients,” said Wisconsin Medical Society CEO William “Rick” Abrams, JD.

About BuildHealth

A program of the School Factory (http://schoolfactory.org/), BuildHealth was designed to activate community members in Milwaukee and throughout the state around health care issues. The School Factory is non-profit organization based in downtown Milwaukee that supports and creates communities that transform education. Designed to align with the US Department of Health and Human Services’ Health Data Initiative (www.hdiforum.org/), BuildHealth was conceived and produced independently to focus on community solutions to community challenges.

BuildHealth: Fall 2012 is scheduled October 15-21 and will include listening sessions in the broader Milwaukee community, an “unconference” to crowdsource the health care challenges brought forth by community members, and a 2-day hack-a-thon.

The Top Two Concepts

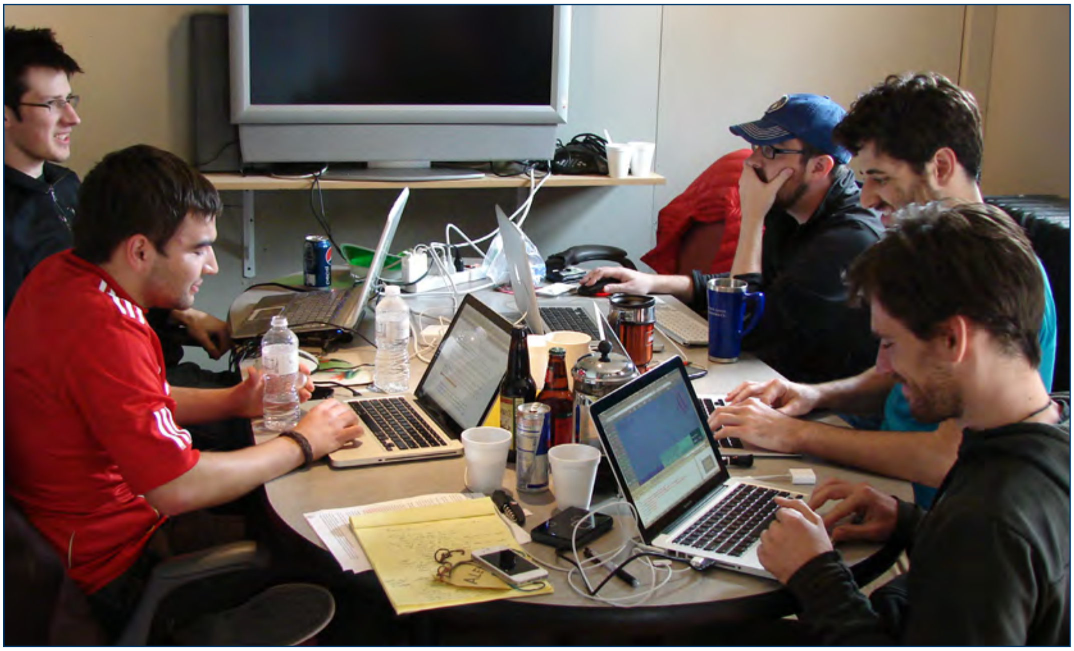
By noon the second day and after several participants worked throughout the night, the 5 teams presented their projects to a panel of 3 judges. The winning team—The Hardware Guys—developed a multi-surface ultraviolet (UV) room sanitation system to help reduce the incidence of health-care–acquired infections in hospitals and other medical facilities.

Jesse Robinson of Beloit came to the BuildHealth event with a basic idea for the automated UV system, and Steve North and Alex Lee partnered with Robinson to refine the 3-device concept. The system is designed to supplement and reduce current cleaning procedures and improve efficiency. While current devices rely on extended exposure time to kill pathogens in shadows, this system cuts sanitation times and provides direct light to all areas in a room to improve effectiveness.

“A lot of great work was done by all of the groups,” said Society Treasurer John Hartman, MD, of Green Bay, who served as one the judges. “It was an honor for me to participate.” The other judges were Tina Chang, CEO of SysLogic, Milwaukee; and Greg Tracy, chief technology officer of Asthmapolis, Madison.

In addition to a $1,500 cash prize for their winning concept, which Dr. Hartman called “an innovative approach to a problem that’s been around a long time,” The Hardware Guys received the People’s Choice Award (and $500) after a vote by all of the participants.

The first-place prize also included an invitation to the 2012 Health Data Initiative Forum, a national competition for the best new apps and services created using health and health care-related data. However, the



The triage.me team puts the finishing touches on its application to help guide patients to the most appropriate care option. At left are Mark Wolters and Stuart James. Alex Luger, MD, is at the head of the table. Mark Olschesky (with baseball cap) and Dan Wilson—both of moxeHealth—are seated next to Dr. Luger. Olschesky and Wilson presented the application at the 2012 Health Data Initiative Forum in June—a national competition in Washington, DC.

financial resources to develop a more presentable prototype in that timeframe were unavailable, and The Hardware Guys "passed the torch to 'triage.me'," Tim Syth said.

The Challenge

Geared toward underserved and uninsured patients, 'triage.me' tackles the education, transportation, and incentive factors that lead people to rely on their local emergency departments (ED) for routine care. Two team members—Dan Wilson and Mark Olschesky of MoxeHealth—presented the triage.me application at the Health Data Initiative Forum in Washington, DC, in June.

The application grew out of a challenge Reinke posed to the BuildHealth participants: How can technology help overcome and change behaviors associated with using the emergency department for routine care? The challenge stated that from March 2011 through February 2012, more than 21,000 of the ED cases at Aurora Sinai Medical Center were categorized as non-emergent/low-severity.

"My initial reaction was that I wasn't sure what technology could do to solve this problem," said Wilson, CEO of MoxeHealth in Madison. "At the same time, that's what made it the most compelling. We were there to think completely outside the box. The more Mark and I thought about it, we realized the potential."

Triage.me uses highly scalable web and short message service (SMS) technologies to provide real-time decision making that helps patients locate the nearest open free clinic, federally qualified health center (FQHC), urgent care or ED based on the acuity of their medical condition and their insurance status. The application, which is designed to help patients find appropriate care and to reduce the inappropriate use of ED services, includes a web-based portal for triaging care needs and a database to help the patient locate the closest and most appropriate care provider (along with directions and public transportation options).

Other triage.me team members were Alex Luger, MD, Stuart James, Mark Wolters, and Tom Kaczmarek. An internal medicine resident in California, Dr Luger traveled to Milwaukee for the BuildHealth event after learning about it from Mark Ratzburg, an adviser for the event. "I thought it was an excellent opportunity to visit Wisconsin," said Dr Luger, who received his bachelor's degree from the University of Wisconsin-Madison and is originally from the Minneapolis area. "I've always had an interest in both technology and health care."

Doctor Luger was glad he made the trip. "It was amazing how everyone collaborated so well together," he said. "It was clear that everyone was there for a common goal of creating solutions." He's excited about triage.me receiving national attention and said, "I think it's commendable that they wanted to focus on patients who otherwise don't have good access to care."

Taking it to The Next Level

After learning that they would be participating in the national Health Data Initiative Forum, Wilson and Olschesky rebuilt the triage.me application to include the necessary security and make it more stable. They also researched the factors most often attributed to inappropriate ED use.

In many cases, people simply are unaware of the resources and care options available to them, Wilson said, adding that "access is another issue." As reimbursements by Medicare and Medicaid continue to decrease, physicians are limiting the number of their patients who receive these benefits.

"In addition, clinic hours are listed for only one of the free clinics on the Wisconsin Department of Health Services website," said Wilson, who graduated from the University of Michigan and met Olschesky when they both were working for Epic Systems Corporation in Verona, Wisconsin.

The redesigned triage.me application addresses the lack of information regarding clinic hours. “We’ve put a system in place to handle the randomness of their schedules,” Wilson said. “Clinics can send a text message to triage.me to say when they are open or closed, and triage.me can better expose that information to patients.”

Another factor leading to inappropriate ED use is misaligned financial incentives, Wilson. “Bad debt is rising for health care organizations, and it is being compounded by people who have other options for routine care but for whatever reasons are not utilizing them,” he said. “Inefficiency is reinforced because it seems like it’s free to go to the emergency department. We’re looking at ways to incentivize patients to seek appropriate care in an outpatient setting, where they would be better served.”

Wilson never imagined he would be presenting an application like triage.me at a national competition when he founded MoxeHealth less than a year ago. His original intent for the company was to focus on outpatient case management. Then he heard about the BuildHealth event through the Madison Health Tech group (www.madisonhealthtech.com).

“The core issues with this and other challenges facing health care are operational process and policy,” Wilson said. “Very few problems in health care are directly related to technology. What technology can do, though, is expose operational weaknesses, support better practices and prompt improvements.”

Community Action to Improve Health

Also known as the Health Datapalooza, the Health Data Initiative Forum (www.hdiforum.org) highlights the creativity of inventors using health data to develop applications that raise awareness of health and health system performance and spark community action to improve health.

Now in its third year, the Health Datapalooza is organized by the public-private Health Data Consortium. The national competition brings together data experts, technology developers, entrepreneurs, policy makers, health care system leaders and community advocates to support innovative applications of health and health care data. The Institute of Medicine and US Department of Health and Human Services originally launched the event in 2010 as the Community Health Data Initiative.

Winning team members and judges join Kenneth Munson, far right, of the U.S. Department of Health and Human Services for the BuildHealth award ceremony. From left to right are judge Tina Chang, judge John Hartman, MD, team member Steve North, judge Greg Tracy, team members Alex Lee and Jesse Robinson, and Munson.

“This is a wonderful opportunity for MoxeHealth to showcase what we’re trying to do,” Wilson said. “Triage.me is about serving the underserved, who are consistently overlooked in our health care system. There’s a large societal cost to care for these patients, and we’re excited to introduce new technologies to help clinicians spend more productive time with them while hopefully reducing overall expenditures. Triage.me sends the right message for what we’re about as a company.”

Other Concepts

Third place in the BuildHealth event was awarded to the Reality (Check) team, which developed a website that helps patients align their medical choices with their expectations. A database of information from patients about their expectations, experiences, and outcomes for specific conditions (eg, diabetes) or procedures (eg, knee replacement surgery) serves as the foundation for the virtual network. Other patients then could use this information in consultation with their physician when considering treatment options.

“Physicians could direct patients with a specific medical condition to the Reality (Check) site for information from other patients who experienced the same diagnosis,” said Linda Syth, who participated on the team. “Shared decision making is the foundation to the patient-physician relationship, and it’s helpful for patients to have appropriate information from the perspective of other people in similar situations.”

Physicians and other health care professionals also could use the information to learn about trends in patient expectations and to enhance future conversations with patients. The group suggested a partnership with local support groups to encourage and assist with participation by patients and physicians. Mark Huber and Paul Sanchez led the Reality (Check) team, which also included Tom Bach, Heidi Massey, JoAnne Penney, Kathy Walters, and Mike Zielinski.

The other two concepts developed at the BuildHealth event focused on interactive patient education to enhance shared decision making and a system of data entry and management to speed up patient admissions and paper-to-digital data input.

“BuildHealth brought together programmers and other community-minded individuals with health care workers who know the challenges of getting health care to those that need it—together they created innovative solutions that neither alone could have produced,” said Dr. Bartholow.

Data is not 'meaningful' unless used to improve care

John J. Frey, III, MD, *WMJ* Medical Editor

Prior to the advent of computers, log books of data from British general practitioners like Will Pickles were the chief source of patterns of community care. These logs served as a foundation for understanding many of the infectious diseases of the time, such as Hepatitis A and influenza.[1] Epidemiology was pencil and paper and "shoe leather," but it was done well and thoroughly and we learned. In the 1960s when office-based research began to force physicians to look the process of care, not simply a series of patient interactions, most of the data were collected through the rudimentary office billing systems of that time. One of the first large studies of the content of primary care in 1975 was a simple list of diagnoses painstakingly accumulated over 2 years by hand and transferred to a, then, new process of computerized data.[2] Such work presented the idea that we could move office-based research beyond arithmetic and into more relational patterns.

Then computers arrived and anyone who tried practice-based research, as I did in the early days, with large reels of data in large rooms full of whirring computers saw the flaws with lists of pregnant men, 10 patients with the same age and name, and other frustrating aspects of "simple" computer-based research. Research confirmed that the computer adage "garbage in, garbage out" was truer than we had wanted. While the trustworthiness became better, the adage still held, as large data sets were mined repeatedly for increasingly irrelevant "associations" that have set the tone for newspaper headlines for years. Who could forget the "coffee and pancreatic cancer" study and its subsequent rebuttals?[3]

Today someone with reasonable skills and knowledge of databases can ask questions of clinical data sets that can illuminate much of the work of medicine. New technologies such as Geographic Information Systems (GIS) and Internet search engines have increased the ability to put many things together from communities and electronic health records in important and creative ways. This issue of the *WMJ* presents work that shows how this new technology might affect clinical decisions, placement of clinical resources, and creative approaches to improving quality and linking health care to the environment.

While the concerns about garbage still hold, the chief pushback against using data to understand patterns of health, identify high risk populations, or look for areas where quality needs improvement comes from 2 sources: the unrealistic sense of privacy that the public expresses in light of the reality that Google, and likely many government sources as well, knows where you are all the time, what you like to buy, where you buy it, and often for whom you buy it. Secondly, electronic health information, which has the potential to teach us about health care in ways that we only dreamed of 40 years ago, is blocked by the deluded belief by some health systems that interoperability (the ability for physicians and qualified health professionals to see data from wherever the patient has obtained care) is a competitive disadvantage. So if a patient faints and crack his or her head while on a trip to Illinois, the local data from that patient's health insurance company cannot be easily seen by the emergency department doctor to determine if he or she is on warfarin.[4] I asked a patient who works for a health information company why her company made it so difficult for us to see data from a health system across town and she said, "It is not us, it is you guys that are the problem, your health systems create the firewalls."

So in the interest of a more open approach to sharing information and learning, collectively, from what we see, this issue includes 4 papers that relate to the possibilities for technology and health going forward.

Khan and colleagues[5] wanted to create a live data analysis to identify patients at risk for early rehospitalization and succeed in identifying those at low risk, better than those at high risk. However, when applied to large populations such as those cared for by health systems and hospitals, their instrument might help focus hospitalists and intensivists to make better plans for transitioning care and assuring follow-up for a select group.

Buckingham[6] brings skills as a medical geographer to show how geocoding health data in a way that is protective of patient information but specific enough to find patterns of health problems that might be "seen" from separate patient encounters.

Gabbert and colleagues[7] use a combination of data from clinical encounters and GIS services to show how such data might be applied to getting care closer to the populations in rural parts of the state. In the new "enlightened" era of data sharing, perhaps multiple systems could work together rather than compete to get service so communities in need.

Serrano and colleagues[8] demonstrate the challenges and opportunities for developing a clinical management registry from 2 high-need populations—Federally Qualified Health Centers and the US Department of Veterans' Affairs—to deliver collaborative care and moniter depression in at-risk patients. While requiring registries for chronic illness as part of the Medical Home idea, this paper is both exciting about how such registries can improve quality of care but is also cautionary about the ease with which those registries can be integrated into existing EHRs.

Finally, the paper by Guilbert and colleagues[9] shows the enormous potential from "mashing up" data from large health systems and their EHRs along with public health and population and census data that could show patterns of illness and could lead to a remarkable understanding of the interrelationships of medicine, society, and the environment. The impressive ability to look both at the 50,000-foot and ground levels from their data holds the potential for transforming the way we understand the origins of disease and possible interventions at the level of communities.

Together, these articles show the potential for clinical information to change medicine, if medicine looks to engineering and the social sciences to help doctors not only see patients, but to "see" populations and patterns that have always been there but have been invisible to many of us. The future is bright if we can, in fact, demonstrate that sharing information helps not only our patients and communities, but ourselves.

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The Potential and Pitfalls of Geocoding Electronic Health Records

William R. Buckingham, PhD

ABSTRACT

Background: Geocoding electronic health records (EHRs) provides novel insights for clinicians, but it is important to understand and address key issues, including privacy and protection of patient records, in order to realize potential benefits.

Methods: This paper discusses the issues surrounding geocoding and illustrates potential benefits through 3 case studies of no-shows to clinical appointments, patient analysis for a merged clinic site, and multi-clinic patient overlap.

Conclusion: Geocoding EHRs provides a new contextual understanding for clinicians to understand patients and provide targeted interventions that patients can implement. While geocoding EHRs presents a need for high data security, the benefits outweigh the risks when proper protections are observed.

INTRODUCTION

Geocoding electronic health records (EHRs) offers novel and exciting benefits that allow clinicians and researchers to develop a place-based understanding of a patient's health environment as well as the assets and obstacles that are present for each patient. This understanding can allow the clinician to provide advice that can be directly implemented when it comes to chronic conditions such as obesity, asthma, and diabetes. Similarly, geocoded EHRs can allow clinicians to partner with public health officials to monitor infectious diseases such as influenza, a current focus for many health officials in light of the H1N1 scare of 2009. By geocoding EHR data, geographic analysis of health becomes possible at scales that are meaningful to both patient and physician. This paper will discuss the issues that surround geocoding EHRs, including the privacy protections that are a must for work of this nature. Subsequently, the paper suggests methods for handling geocoded data, both in public presentation and research. The final section highlights 3 case studies to demonstrate the potential benefits when using geocoded EHRs,, and considers areas for expansion and improvement of the process.

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GEOCODING BACKGROUND AND PITFALLS

Geocoding of health records has a history dating back decades, especially in public health-related endeavors. Vital records from state and local public health offices have been used to analyze birth data and birth disparities,[1,2] evaluating differences in gender, race, and inequality,[3-6] as well as general research practice in public heath.[7-9] However, these efforts have focused largely in the arena of vital records for the purpose of public health understanding. The use of geocoded EHRs in medical research has been largely absent. Nevertheless, the utility of EHRs to provide both context and depth to understanding the clinical population is encouraging. It is critical at this juncture to step back and define precisely what geocoding is and to discuss the issues surrounding geocoding.

EHRs present a complex use case when it comes to geo coding. While vital records have the ability to pinpoint a person at an address, it is common for identifying information such as the name of the person to be removed from the vital record. With EHRs, however, names as well as in-depth medical information are often a part of the record, making the records highly sensitive.

The actual geocoding procedure involves utilizing the address and a zone delimiter (often a ZIP code) to interpolate the location of the record on a street segment in a geographic information systems (GIS) database and place a point on the correct side of the street. It is common to use multiple geo coding engines to cross-validate the data points and to capture locations that may not be identifiable with a single dataset. Once the points are geocoded, the researcher often undertakes 2 basic tasks. The first is to append contextual data, often from the US Census Bureau. The second is to create maps that enable the visualization of both the population distribution and the underlying contextual association. Both of these steps involve privacy concerns that the researchers must address.

Connecting detailed location with medical history requires a strong security regime. In the majority of cases, researchers separate the location information from the medical history and maintain 2 files on separate systems to protect confidentiality. A limited file provides the basis for the geocoding information and the census block group is appended for reconnection to the clinical data. The census block group is chosen because the US Census Bureau has defined the block group as the lowest unit of analysis available with non-physically identifying features published (eg, data about income or education as opposed to data about gender or age). Steps are then taken to ensure that the point locations are not accessible when publishing maps that require a connection between the patient location and the medical condition of interest. To accomplish this, a 3-step process is put into place. First, the geocoded records are aggregated to the census block (Figure 1). This is done to ensure a general distribution correctness (ie, avoiding areas such as lakes where people obviously do not live). Second, the block-level data are presented at random point locations within the block (Figure 2). This randomization removes the strict point location correlation with a person and begins the process of masking the actual location of the patient. Finally, the block boundaries are completely removed, any street data also is removed, and only the block group boundaries are presented (Figure 3). This masking maintains some geographic correctness but reduces the potential that someone could pinpoint a patient. This process is used only when point representation is critical on the map. In most other instances, the geocoded data are summarized into block or block group totals and these totals are presented on a choropleth map providing no point location issues.

By disassociating the location and medical condition information in the EHR, patient confidentiality is maintained while allowing for the geographic context to be brought to bear on the question at hand. For presenting and visualizing data, this disassociation is not possible; however, following strict masking processes as described above allows the researcher to overcome the privacy concerns and protect patient confidentiality.

Figure 1. Geocoded patient points with no identifying geographic feature to protect privacy.

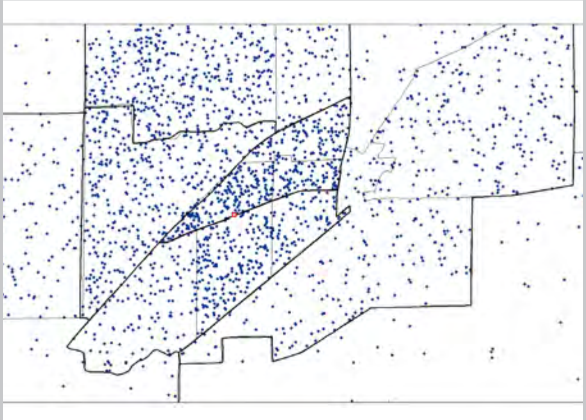

Figure 2. Random patient point locations with census block (thin lines) and census block group (thick lines) boundaries.

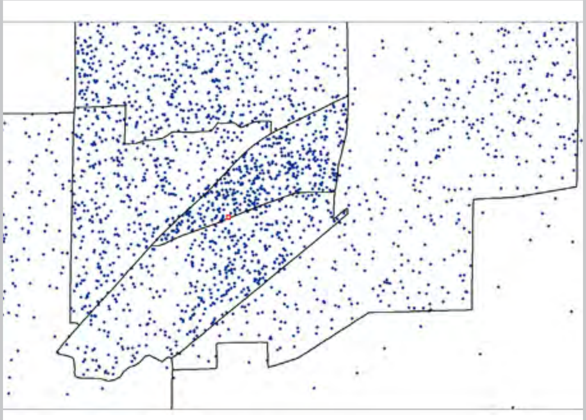

Figure 3. Random patient point locations with census block group boundaries.

CASE STUDIES WITH GEOCODED EHRs

Using the privacy preserving methods mentioned above, 3 case studies are described below demonstrate how the use of geocoded EHRs can be used to improve both service delivery and contextual understanding of the primary care doctor in treating patients.

Understanding Where Patients (Don't) Come From

At the Wingra Family Medical Center in Madison, Wisconsin, the occurrence of missed appointments is a daily issue. Missed appointments influence not only the patient's health, but also the clinic's ability to serve the patient population. While the effects of missed appointments are recognized, understanding how to combat missed appointments is difficult.

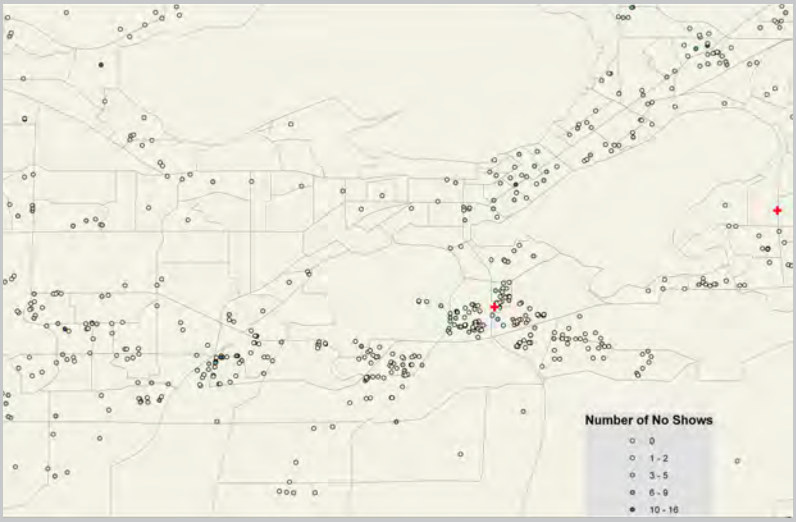

Figure 4. Map of randomized geocoded patients who failed to attend an appointment. Legend indicates the frequency of missed appointments per patient.

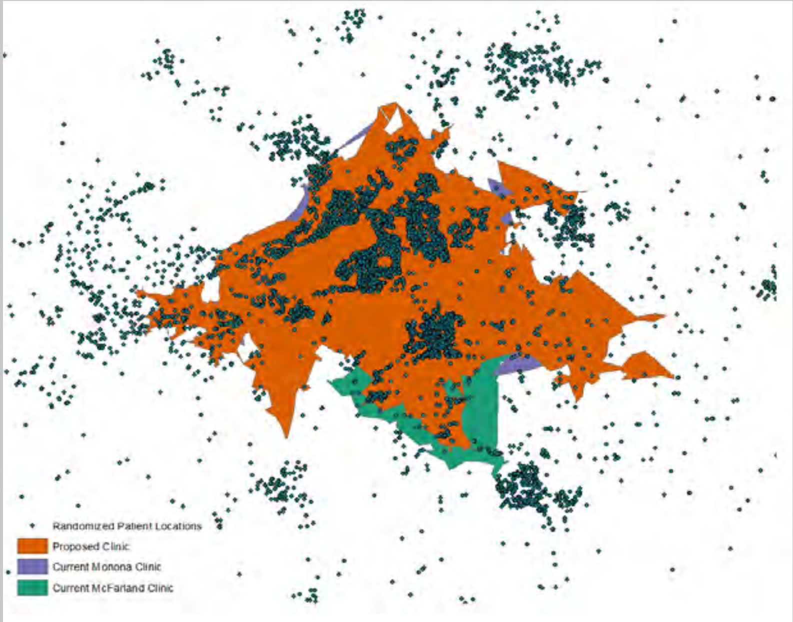

Figure 5. Ten-minute network buffers representing the reach of the proposed clinic vs the existing clinics. Randomized patients within census blocks displayed as points.

It was from this jumping-off point that the University of Wisconsin-Madison Department of Family Medicine and the Applied Population Laboratory began an analysis of no-shows to appointments at the Wingra clinic. EHRs were used to pull a set of records detailing only the address of the patient and the number of times the patient missed an appointment. By reducing the necessary information to just these 2 components, the privacy of the individuals was maintained. The EHRs were geocoded and the locations were randomized within block groups. The resulting points were then coded based on the number of times an individual record failed to appear for an appointment. The classification for the resulting color scheme was created using ArcGIS software[10] and applying a modified Jenk's Natural Breaks classification scheme.

Two immediate trends were noticeable from the resulting map (Figure 4). First, a cluster of no-shows appeared in the 3-block groups immediately adjacent to the clinic. This may be in part due to a self-selection by residents in these areas to pursue health care at the Wingra clinic. Second, the spread of patients was city-wide (the dataset was restricted to Madison). However, areas in southwest Madison and the northern sections of the city of Fitchburg appeared as areas of a high preponderance of missed visits. These findings were presented to the faculty at the Wingra clinic, where the intent was to develop strategies to facilitate better attendance at appointments, either through transportation arrangements or scheduling changes. In this case, the geocoded records not only inform the location of the no-shows but also clarify potential solutions based on geography.

Using EHRs to Site a Merging Clinic

In 2009, 2 clinics in suburban Madison within the UW Health network were targeted for merging into a single location. Again, the use of geocoded EHRs was brought to bear, this time to assess patient access. Patient lists from both clinics were

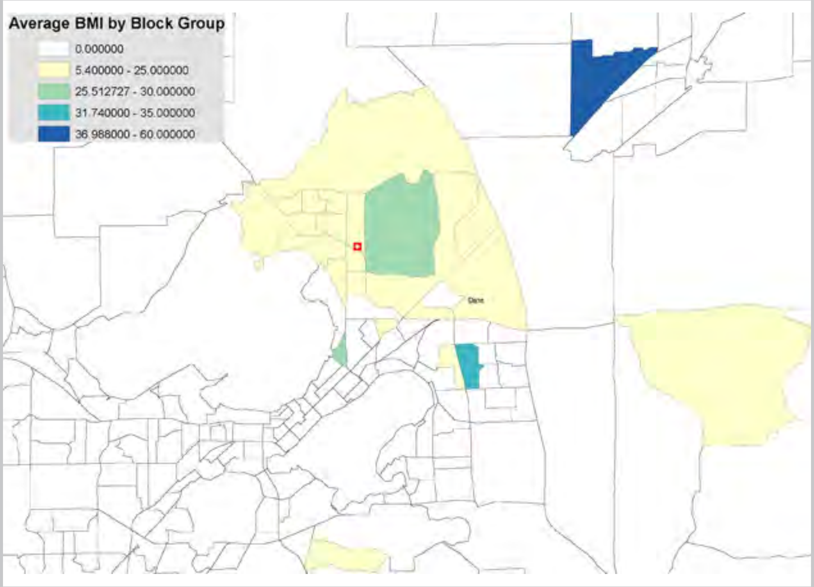

Figure 6. Average BMI value by block group based on aggregation of geocoded patient records.

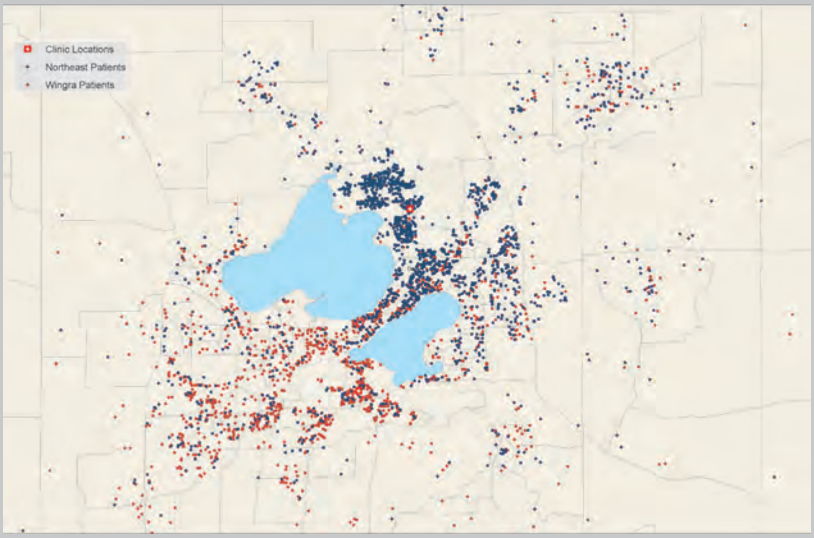

Figure 7. Map illustrating the overlap between 2 clinical populations within the Madison, Wisconsin metropolitan area.

geocoded and placed on a networked road dataset, although these images were never published even to ephemeral computer images. The existing clinic locations also were placed on the road network, as was a hypothetical location in the vicinity of a possible new clinic. Each of the clinics—the 2 existing locations and the potential new site—were then analyzed on the road network to construct 5-, 10- and 20-minute drive shapes from the clinics. Again, researchers used ArcGIS to conduct this network analysis and produce the 9 drive-time areas.

These shapes were then intersected with the patients from each of the clinics to evaluate the potential gain or loss based on the proposed location (Figure 5). In discussions, there had been some concern that walkability and neighborhood ties would be lost with the new clinic site. And indeed, within a 5-minute drive more patients were near the old clinics than the new site. However, within a 10-minute drive, the new clinic site captured a greater volume of patients than the other 2 sites combined. These findings were presented at a meeting with the majority of clinicians from each site to allow for discussion and to illustrate the benefits and drawbacks of the proposal. Ultimately, the project went forward and the merged clinic, now known as the Yahara Clinic, was opened in 2011 in roughly the location proposed in the initial drive-time analysis.

Describing the Population of Clinics Within a Provider Network

The final case study centers on the use of geocoded EHRs to help assess the distribution of clinical diagnoses within the clinic population for the purpose of developing actionable recommendations for the affected patients. Geocoding and mapping the distribution and prevalence of clinical data such as high A1C values, high BMI, and location of diabetic patients was a first step. Once the data were mapped, family physicians at the clinic could evaluate where high values of these conditions exist and begin to develop intervention schemes to offer solutions to these problems. For example, the high average body mass index (BMI) values in conjunction with the clinical population distribution allowed clinicians to understand where exercise opportunities may or may not exist. Also, data may be sorted by race and ethnicity information obtained through initial patient registration.

In Figure 6, the green-shaded area represents high average BMI values for the aggregated patient population. Both of these areas are somewhat isolated due to either industrial features or high economic, social, or racial contrasts between neighborhoods. These observations provided the clinicians a place-based understanding of this issue and allowed them to begin seeking local opportunities for patients to combat isolation and poor BMIs with geographically targeted programming.

Joining clinical data from multiple locations provides the benefit of a more complete geographic picture of the patient and health landscape. Geocoding the patients in a complete network and mapping separate clinics together (Figure 7) makes it apparent how difficult it is for clinicians to account for geography in a clinical setting. Interventions must be planned at a health system level to be effective for an area, as patients overlap considerably yet visit different clinics, where 2 different recommendations are possible despite identical geographic conditions.

CONCLUSION

None of the case studies illustrated above provides a complete assessment of the effect of the geocoded EHR. In each case ,the collaboration ended once the data were presented, and the ultimate use of these data was not reported. Unsatisfying as this may be, the use of geocoded EHRs is encouraging for analysis of factors ranging from clinic siting to geographic barriers to healthy lifestyles. While this type of analysis is more prevalent in the public health sphere than in the clinical arena, the ability to understand the geographic constraints on a patient may help a physician prescribe a more effective means of intervention in a given diagnosis. Geocoding EHRs is not without challenge—privacy is a paramount concern that requires vigilance from both researcher and clinician at all times. However, the potential benefit to the patient outweighs the risks, so long as good custodianship is practiced. Providing a clinician with a spatial perspective can lead to better service delivery and a better prescription for combating chronic and infectious disease.

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Exemplars in the Use of Technology for Management of Depression in Primary Care

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ABSTRACT

Purpose: Depression care management as part of larger efforts to integrate behavioral health care into primary care has been shown to be effective in helping patients and primary care clinicians achieve improved outcomes within the primary care environment. Central to care management systems is the use of registries which enable effective clinic population management. The aim of this article is to detail the methods and utility of technology in depression care management processes while also highlighting the real-world variations and barriers that exist in different clinical environments, namely a federally qualified health center and a Veterans Administration clinic.

Methods: We analyzed descriptive data from the registries of Access Community Health Centers and the William S. Middleton Veterans Administration clinics along with historical reviews of their respective care management processes.

Results: Both registry reviews showed trend data indicating improvement in scores of depression and provided baseline data on important system variables, such as the number of patients who are not making progress, the percentage of patients who are unreachable by phone, and the kind of actions needed to ensure evidence-based and efficient care. Both sites also highlighted systemic technical barriers to more complete implementation of care management processes.

Conclusions: Care management processes are an effective and efficient part of population-based care for depression in primary care. Implementation depends on available resources including hardware, software, and clinical personnel. Additionally, care management processes and technology have evolved over time based on local needs and are part of an integrated method to support the work of primary care clinicians in providing care for patients with depression.

INTRODUCTION

Depression is a common condition often managed solely in the primary care setting because of poor access to mental health specialists, poor referral completion rates to specialty mental health, and patient preference in maintaining care with their primary care clinic.[1] Many patients initially seek attention for their symptoms in a primary care clinic, rather than with a mental health specialist.[2] This model is not ideal for the chronic and complex nature of mental health problems routinely seen by primary care physicians. In response, care management models have been created and adopted as a way to treat chronic mental health issues such as depression in the primary care setting.[1]

Care management is an inherent element of the chronic-disease model and commonly is used by primary care practices for chronic illnesses such as asthma, diabetes, and hypertension.[3] The care management framework works well within the primary care model because it allows for a substantial portion of chronic care, including patient self-management, delivery system design (including information systems and delivery support), and connection to community resources, to take place outside of the physician visit.[4] Care management programs function to improve coordination of care and wellness while providing cost-effective, efficient services.[5]

Key elements of care management models include population identification processes; evidence-based practice guidelines; collaborative practice models; patient self-management education; process and outcomes measurement; and routine reporting/feedback involving patients, physicians, plan, and care team.[2]

While earlier studies focused on the effectiveness of integrated care models, recent research has focused on methods of clinical implementation. In the last decade, several large trials have investigated the implementation of care management models, such as the Primary Care Research in Substance Abuse

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and Mental Health for the Elderly (PRISM–E) project,[6] the Improving Mood: Promoting Access to Collaborative Treatment (IMPACT) project,[7] and others.[8-10] These studies demonstrate a variety of ways in which care management can be delivered; for instance, via a central telephone resource serving multiple practices, or directly, within a practice, using internal or shared personnel.[4] These studies demonstrate significantly improved outcomes compared to usual care and improved patient engagement compared to specialty referral alone. As chronic care management continues to gain momentum, the need for continued refinement of the structure and implementation of such models is needed, particularly related to the use of clinical information systems that undergird these processes.

This report details the ways in which care management processes for depression have been implemented and evolved in 2 high-needs populations in Wisconsin: a federally qualified health center and a US department of Veterans Affairs (VA) clinic system.

ACCESS COMMUNITY HEALTH CENTERS BEHAVIORAL HEALTH CONSULTATION MODEL

Access Community Health Centers (ACHC) is a federally qualified health center that serves approximately 80,000 medical patient visits annually and 10,000 patient visits as part of its integrated Behavioral Health Consultant (BHC) program in Madison, Wisconsin. The behavioral consultant model is a model of care in which a mental health generalist provider works alongside the primary care clinician allowing for same-day, same visit access to all patients the primary care clinician chooses to refer for a variety of mental health and behavioral (eg, chronic disease management, medication adherence) concerns.[11,12] This population-based care model is further supported by a consulting psychiatry service and a care management system whose chief purpose is to ensure that individual patients in a population-based care approach are monitored and receiving care that follows evidence-based pathways. The system also provides for feedback in a clinical quality improvement process.

The Care Management Protocol

Patients identified as having depressive symptoms across a range of medical and psychiatric diagnoses are routinely administered a 9-question depression inventory designed for use in primary care called the Patient Health Questionnaire (PHQ9). Patients who score 15 or higher on the instrument and/or 11 or higher on a companion instrument called the Generalized Anxiety Disorder Questionnaire (GAD7) are added to a care management list. Patients on this list receive quarterly chart reviews by the care manager to examine the nature of the care they have been provided and their response to that care. This ensures that patients who are experiencing severe symptoms are not allowed to "fall through the cracks" of primary care processes.

Each time a patient completes a PHQ9/GAD7 screener, the scores are entered into a section of the patient's electronic medical record called "questionnaires." Each quarter, the PHQ9/GAD7 scores are extracted from patient charts, exported into a spreadsheet, and imported to a database application called Bento (Filemaker; Santa Clara, California) on an iMac desktop computer and an iPad tablet computer. The Bento application assists in keeping the care management process organized.

The information assessed during chart reviews includes the following questions:

1. When was the patient last seen by the primary care clinician or the BHC team?
2. Does the patient have an upcoming appointment scheduled with the primary care clinician or the BHC team?
3. Is the patient prescribed any psychotropic medications?
4. When was the last time any changes were made to psychotropic medications?
5. What was the plan for follow-up with the primary care clinician or the BHC team?

The electronic medical record also is used to document care management phone calls made to patients.

From the chart review of the electronic record, several decisions are possible based on factors such as when the patient was last seen in the clinic and what the chart note indicates is the current plan for care and follow-up. If the patient was seen recently and documentation indicates that the patient is stable, it may mean no action needs to be taken. If the patient was seen recently in the clinic and medications were added or changed, the patient is called to assess efficacy and tolerability. If a patient has not followed up as recommended, the patient is called to assess current needs and to recommend follow-up with his or her primary care clinician and/or the BHC team and/or administer phone-based cognitive-behavioral interventions.

In addition to patient-level data, the information collected provides a global view of what is happening with this portion of the clinic population. For example, if in reviewing the aggregate care management data for an entire year it was discovered that a subset of patients kept reappearing on the care management lists, then further investigation into this subset of the population would be warranted. Investigation could result in a change of approach within the clinic systems to work with these patients more productively. This feedback loop is a crucial component of the chronic care management model that has shown effectiveness in sensitizing systems to improved clinical pathways.[13]

The Technology behind Care Management Processes

Several components make up the infrastructure of this care

Table 1. Access Community Health Centers Depression Average Score Changes From Baseline[a]

Quarter	N	PHQ9 Differential	STD	GAD7 Differential	STD	Day Differential	STD
3rd 2010	15	3	6.7	-1.2	3.7	254	111
4th 2010	32	4.1	5.6	2.3	5.1	173	74
1st 2011	54	3.3	6.7	2.3	5.0	135	82
2nd 2011	38	4.3	6.2	3	5.2	103	73
Totals (AVG)	139	3.675	6.3	1.6	4.75	166.25	85

Abbreviations = PHQ9, Patient Health Questionnaire; GAD7, Generalized Anxiety Disorder Questionnaire; STD, Standard Deviation.

[a] Positive numbers reflect drops in scores, negative numbers reflect increases. Data represents samples consisting of 20% of patients reviewed per quarter. All patients in care management reflect patients with PHQ9 scores of 15 or greater and/or GAD7 scores of 11 or greater.

Table 2. Access Community Health Centers Care Management Patient Review Data, 2010 to 2011

Quarter	Number of Reviews	No Action	Provider/BHC/ Patient Contact	Unreachable	Average Baseline PHQ9	Average Baseline GAD7
3rd 2010	76	37	20	19	20	15.8
4th 2010	152	93	28	31	19.8	16.1
1st 2011	265	119	61	85	19.8	16.3
2nd 2011	166	68	83	15	19.7	16
Totals	659	317	192	150	19.825	16.05

Abbreviations: PHQ9, Patient Health Questionnaire; GAD7, Generalized Anxiety Disorder Questionnaire.

Average PHQ9 score of 19.8 = severe depressive symptoms; Average GAD7 score of 16 = severe anxiety symptoms.

management process, including Epic's electronic health record system (Epic; Verona, Wisconsin) which stores the screening data and care management-related documentation, the data extraction methods for mining the database, and the care management database housed in the Bento application. From a hardware standpoint, because the care manager works at all 3 clinics, a mobile solution was required. Therefore, an iPad (Apple; Cupertino, California) and wireless network became necessary. An iMac (Apple; Cupertino, California) desktop computer was purchased to allow ease of synchronization and secure backup with the iPad, since most of the computers in the clinic context were Citrix-based terminals. In total, the hardware and software expenditures, not including the electronic health record (EHR) already in place, were approximately $2000.

History of the Development of the Technology Infrastructure

Technology can limit the scope and efficacy of any care process, as exemplified by the history of revisions of the ACHC care management protocols from 2006 to 2011. In the first iteration between 2007 and 2008, depression inventory scores were housed in a spreadsheet on a single computer. The lack of a "questionnaires" section in the electronic health record at the time resulted in a much less efficient process because clinicians often would forget to populate the spreadsheet outside of their normal note documentation.

By 2009 the process included documentation of depression inventory scores and other patient care data in portable handheld devices (iPods [Apple; Cupertino, California]) which all clinicians carried and periodically synchronized with 1 desktop machine. This improved the documentation of scores, but still proved inefficient. The synchronization lag made the databases on each device incomplete until synchronization occurred, leading to decreased utility of the database for clinicians. The synchronization process also was cumbersome and fraught with error.

The current iteration, developed in 2010, is a significant improvement; however, it too has its drawbacks. Ideally, each clinician would have access to the care management data. However, because the EHR does not allow for ease of data management and extraction except through specialized processes, and because the Bento database is a separate software package, clinicians do not have direct access to the data. So, for example, they could not review all patients they have seen for the last 2 weeks sorted by PHQ9 score. Future changes must add this capability, which would increase a clinician's management of his or her own patient panels, further improving the feedback loop. In addition, there are cumbersome synchronization processes that are necessary to import data into the Bento database. Ideally, any EHR should have the functionality to allow it to serve as a care management system.

Care Management Findings

Data from the 3rd quarter of 2010 through the 2nd quarter of 2011 (Table 1) reveal trend data showing consistent decreases in PHQ9 scores across the population in the range of 4 points in a population with significant symptomatology (Table 2). This is trend data; it is not the product of an experimental study. For example, because of the lack of stringent inclusion criteria (by design), patients in the database have a range of diagnoses, including severe psychotic disorders with affective components. This is also one of the reasons why care management data will often have skewed and/or less robust findings when compared to experimental studies that have strict inclusion criteria and control groups. Of the 659 chart reviews completed, 13.5% represent repeat patients or patients who appeared in more than 1 quarter (Figure 1). This kind of data is important to the care management process because it establishes a baseline of patients who are consistently symptomatic and for whom extra care of resources may be needed.

Unsuccessful patient contacts resulted from 22.8% of the chart reviews. While some of this may be due to uncontrollable factors such as homelessness, the data may inform changes to clinical processes (eg, shortening of patient follow-up visit algorithms for certain patients) and/or administrative procedures (eg, more aggressive alternative contact information collection by registrars). Forty-eight percent of the chart reviews resulted in no action needed, indicating that at least half of the cases in the registry needed some between-office visit action (Table 2). Increases to the percentage of patients needing some contact and/or unreachable patients could be an indicator of a need for review of clinic processes or individual provider skill/educational development.

Patient Exemplar

After reviewing the chart of a 54-year-old man suffering from depression with psychotic features, chronic pain, and hepatitis C, a behavioral health consultant called to inquire regarding his ongoing symptoms and medication adherence, and to encourage follow-up (the patient had missed his scheduled follow-up appointment). The patient indicated that he had discontinued his medication due to side effects and listed a number of bothersome symptoms that were contributing to severe functional impairment. The behavioral health consultant also learned that the patient was experiencing psychotic symptoms and was no longer leaving his house. The patient was pleasantly surprised to receive a call from the clinic, stating his appreciation and reporting that he had given up on the treatment of his mental health needs. Utilizing motivational interviewing skills and empathy, the consultant was able to schedule the patient for a follow-up visit and instill hope that further treatment options were available and that his providers at the clinic would work collaboratively to improve his functioning.

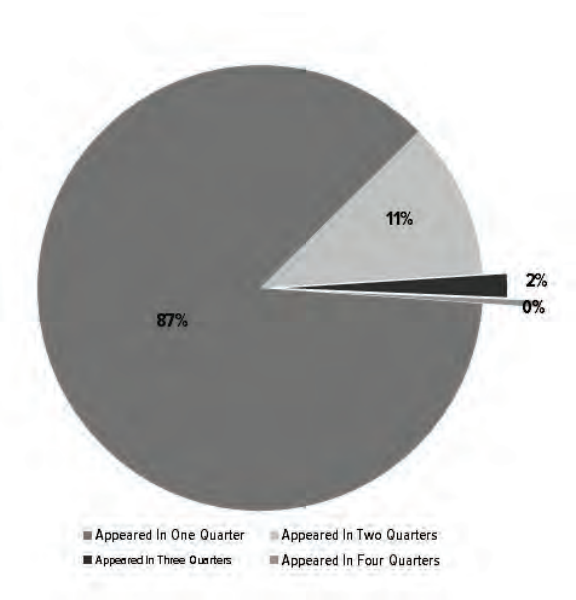

Figure 1. Percentage of patients who reappear on quarterly care management lists because their depression scores have not improved.

MADISON VETERANS ADMINISTRATION PRIMARY CARE – MENTAL HEALTH INTEGRATION MODEL

The William S. Middleton Memorial Veterans Hospital in Madison, Wisconsin (Madison VA) and associated rural Community Based Outpatient Clinics (CBOCs) serve approximately 36,000 primary care patients. Primary care clinic sites include 2 main clinics in Madison; a large CBOC in Rockford, Illinois; and 4 smaller CBOCs in Janesville, Beaver Dam, and Baraboo, Wisconsin and Freeport, Illinois. All Madison VA primary care patients, including those served at rural CBOC sites, have access to the Primary Care-Mental Health Integration program. From its inception, the model has included both colocated mental health providers working collaboratively with the primary care team and a care management program for depression. Compared to the national VA average of 5.3%, 12.8% of Madison VA primary care patients have had an integrated care visit. In the fiscal year 2011, the Madison VA's integrated care program completed 6240 patient encounters; 2016 of which were new assessments.

Integrated care staffing includes mental health workers, psychiatrists, and neuropsychologists who work collaboratively with primary care physicians and other staff to provide evidence-based interventions for mental health problems. At the larger primary care sites, these providers are colocated within the primary care clinic. At the smaller sites, consultation and treatment are done via telemental health services and phone.

Patients are referred for a same-day, open-access evaluation in primary care in a number of different ways, including verbal

Table 3. Madison VA Clinics Care Management Data, February 2010 to August 2011

Number Enrolled in Depression Care Management (DCM)	412
Average Baseline PHQ9	12.8
Average Number follow-up DCM Contacts	2.5
Number Completed ≥ 1 DCM Contacts	369 (89%)
Number Completed ≥ 2 DCM Contacts	287 (70%)
Average Final PHQ9 if had 2 or More Contacts	4.64
For Those Who Completed ≥ 2 DCM Contacts, Number with ≥ 50% Reduction in PHQ9	212 (74%)

or electronic request from their primary care physician, from a specialty service, or via self-referral. After an initial brief problem-focused assessment,[14,15] the mental health provider will triage a patient to the appropriate level of care which may include continued treatment in primary care or referral to a specialty mental health clinic. Patients who continue treatment in primary care work with the colocated mental health clinician and their primary care physician to develop a treatment plan that might include care management, psychiatric consultation, brief therapy, and/or referral to other VA resources such as the Pain Coping class or the Wellness Program (tai chi, yoga, mindfulness).

Care Management Protocol

Currently, care management is done only for depression, though plans are in place to add similar programs for anxiety and alcohol misuse in the coming year. The basic protocol for depression care management is largely based on the protocol used in the IMPACT Trial:[16]

1. Initial brief problem-focused assessment with a baseline depression scale (PHQ9), psychoeducation, and development of a shared treatment plan between patient, primary care physician, and integrated care staff. The treatment plan commonly includes an antidepressant medication and a behavioral activation plan.
2. A care manager (usually a social worker) will then contact the patient by phone at 2 weeks, 4 weeks, 8 weeks, and 12 weeks. In these phone contacts, the care manager follows a structured protocol that includes the PHQ9 and an assessment of compliance and tolerance (with both medication and the behavioral activation plan).
3. Based on information gathered in the phone contact, the care manager will encourage continued compliance with the treatment plan and perhaps set new behavioral activation goals, or will consult with the primary care physician and/or integrated care psychiatrist if the treatment plan needs to be changed (eg, medication not tolerated, or PHQ9 not improving).

Approximately 75% of patients are referred directly from their primary care appointment for a same-day baseline evaluation and enrollment in depression care management. The primary care physician also has the option to enter an electronic request for enrollment in depression care management after which the patient will be contacted by phone.

The Technology Behind Care Management Processes

Care managers use a program called The Behavioral Health Lab (BHL) to track patients enrolled in depression care management. The BHL software was initially developed and implemented out of the Philadelphia VA Medical Center.[17,18] BHL has specific protocols for care management of depression, alcohol, and anxiety disorders, in addition to a "Watchful Waiting" module for milder problems for which no specific intervention is being implemented. Currently, the Madison VA is using only the depression care management and "Watchful Waiting" modules, but it will implement the anxiety and alcohol care management modules in the coming year.

The BHL database is separate from the VA electronic medical record (though it is expected to be linked in 2012). All the data from the baseline and follow-up care management calls are entered into BHL and a brief note is copied into the electronic medical record. BHL software is set up to alert care managers when a patient is due for a phone contact, track changes in a patient's PHQ9 over time, and/or make changes in a treatment plan (eg, addition of brief therapy to medication). It also has a number of important administrative functions that allow tracking and reporting on the patient population as a whole (eg, number of patients enrolled in care management, rate of completed contacts, population outcomes).

History of the Development of the Technology Infrastructure

Nationally, the VA has sponsored different tools for care management, including *Translating Initiatives for Depression into Effective Solutions* (TIDES), and the Behavioral Health Lab (BHL). Both TIDES and BHL include software and structured scripted protocols, and both were designed to be utilized by health technicians. Initially, there was wide variation in the software being used at different VA sites across the country; however, it appears likely that BHL will become the standard across sites.

While the BHL is deemed superior for clinical and administrative tracking, it has not been as easy to readily implement given the necessary administrative steps to have the BHL software loaded on VA computer hard drives. Fortunately, the developers of the BHL software at the Philadelphia VA have a well-organized network of technical support and are available for both troubleshooting and implementation issues. They also offer a monthly BHL conference call for continued consultation on technical and administrative issues.

Table 4. Comparison of Care Management Models

Program Elements	Access Community Health Centers	Madison VA Clinics
Population assessed by care management process	Patients with PHQ9 scores of 15 or more and/or GAD7 scores of 11 or higher	All patients with depression as assessed with PHQ-9
Frequency of care management reviews	Quarterly	Ongoing
Database	Bento software, housed on a single computer and iPad	Behavioral Health Lab software, housed on a server
Integration with EHR	Not planned	Not currently, but planned
Care manager strategies	Chart review, as needed phone-based intervention, team care coordination	Phone-based intervention at regular intervals (2, 4, 8, 12 week post-identification), team care coordination
Staffing and Responsibilities		
Care Manager	Update, review database and contact patients and providers as needed to review progress, team care coordination	Contact all patients at set intervals (2, 4, 8, 12 weeks), re-administer PHQ-9, update database, team care coordination
Behavioral Health Consultant or Mental Health Specialist	Provide support for primary care clinicians via curbside consultations and same-day visits with patients in exam rooms as well as ongoing collaborative follow-up	Can provide same-day visits with patients when available and appointments by clinician or self-referral
Consulting Psychiatrist	Provide oversight of physician-prescribed psychotropic medications in addition to one-time evaluations	Provide oversight of physician-prescribed psychotropic medications, also may develop and prescribe for own caseload of patients

Abbreviations = EHR, Electronic health record; PHQ9, Patient Health Questionnaire; GAD7, Generalized Anxiety Disorder Questionnaire.

Care Management Findings

Care management contacts from February 2010 through August 2011 were reviewed to assess utilization and outcome data (Table 3). In approximately 20 months, a total of 412 patients were enrolled in the program with an average baseline PHQ9 of 12.8. Eighty-nine percent of the patients had at least the baseline contact plus 1 follow-up care management contact; 70% completed 2 or more follow-up care management contacts. For those who had 1 or more care management contacts, the average number of contacts was 2.5. For those veterans who completed 2 or more care management contacts, 74% had at least a 50% improvement in their PHQ9, and the average final PHQ9 measured for this group was 4.7. Some patients enrolled in the care management program eventually were referred out of primary care to the specialty mental health clinic either at baseline assessment or after some number of contacts. Thirty-one of the patients enrolled in the depression care management program were referred to specialty mental health over this period, 6 were referred right after their baseline assessment, and 25 were referred after 1 or more contacts.

Patient Exemplar

A 62-year-old Vietnam veteran was referred by his primary care physician for evaluation of depression and possible post traumatic stress disorder (PTSD). He had been referred in the past; however, integrated care staff had been unable to reach him for an initial assessment. On this occasion, the patient was introduced directly to an integrated care social worker at the time of his primary care appointment. The veteran's PHQ9 was 15 and he reported a remote history of combat PTSD symptoms, but these symptoms had largely resolved and he viewed depression related to increasing medical problems as his primary concern. The patient received psychoeducation regarding depression and the following treatment plan was agreed upon: an antidepressant trial, an activation plan that included walking 1 mile 4 days per week, and having breakfast with a friend weekly. Over the course of 4 care management contacts, the patient's medication was titrated, the behavioral activation plan was modified, and progress toward treatment goals were monitored with the outcome of improving his PHQ9 score from 15 to 1.

LESSONS LEARNED

Clinical information systems hold great promise for improving the quality and consistency of care delivered to patients for chronic diseases as varied as diabetes and depression. However, as shown by these 2 exemplars, implementation of population-based strategies for managing patients with depressive symptomatology will vary based on factors such as setting characteristics, technical limitations, and clinical resources (Table 4).

Resources Dictate Whether Care Management Processes Are Sustainable

In the community health center, care management reviews are done on a quarterly basis as a result of personnel limitations and the requisite data extraction process. The VA, by contrast, has a rolling review process because personnel are available to manage the registry on a full-time basis. Care management processes also require intensive monitoring and management including developing and fine-tuning the patient registry, which further taxes staff resources. These activities usually are not reimbursable by third-party payers. While community health centers and VA clinics have built-in incentives related to federal mandates to pursue this kind of activity, there is no direct reimbursement for these activities in these systems, either. Some studies have suggested cost savings related to integrated care programs which may pave the way for payers to recognize care management services as one of the core components of cost-effective care.[19,20]

Data and Processes Will Differ Based on Population Characteristics

The community health center reported less robust score differentials, in part because its care management scheme covers only the most symptomatic patients (average baseline PHQ-9: 19.8) and includes patients with a variety of diagnoses including severe and persistent mental illness, whereas the VA includes the entire range of patients with depression (average baseline PHQ-9: 12.8). These differences in protocols are directly attributable to population characteristics. For example, patients at the VA necessarily have access to certain resources such as psychiatry, whereas the community health center population often lacks such access by virtue of being uninsured or underinsured. The protocol at the community health center reflects the need to manage those most vulnerable as a matter of first priority.

Clinical Information Systems Evolve in Context

Clinical information systems are evolving entities requiring constant attention to help them meet the local needs of practices and end-users, a point highlighted in the community health center exemplar where various iterations of care management processes and technologies were needed. In the end, the measure of the efficacy of a clinical information system is not only whether it performs the tasks of a registry in evidence-based practice, but whether it is also widely used by clinicians in day-to-day practice. This evolutionary nature of development should encourage practices to get started even with rudimentary systems.

Finally, these protocols must exist in a care delivery context that makes sense for the primary care team and the patient. In other words, registries cannot exist in isolation. In these exemplars, we see the registries work well because they exist in the context of a generalist model of integrated care that supports the primary care provider in more than just the one disease category. In the community health center exemplar, for example, the care management occurs in the context of a BHC program that provides same-day access to mental/behavioral care and that also includes a consulting psychiatry service. In the VA example, the registry exists in the context of a step-wise model that includes immediate evaluation and treatment planning as well as ready access to behavioral health specialists. This creates an environment where care management has a rationale and purpose that is reinforced naturally by day-to-day clinic processes. Otherwise, population-based care management can become a good idea with no home.

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An Electronic Medical Record-Derived Real-Time Assessment Scale for Hospital Readmission in the Elderly

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ABSTRACT

Objective: "Readmission risk score," a 20-point, 4-dimensional tool, is generated from the electronic medical record. This study was performed to evaluate the ability of the readmission risk score to predict 30-day readmissions among older hospitalized patients.

Methods: A retrospective study was conducted utilizing data from the electronic medical record. Using a cutoff value of 7, the readmission score sensitivity was 61%, specificity was 22%, positive predictive value 12%, negative predictive value 77%. The positive and negative likelihood ratios were 0.8 and 1.8, respectively.

Conclusion: The readmission risk score was associated with 30-day readmissions (median score of readmitted vs not readmitted patients was 8 vs 5; $P = 0.001$), and it may be better at identifying those who are not at risk for readmission.

BACKGROUND

Despite significant improvement in care, hospital readmission rates have not declined.[1] Approximately one-fifth of Medicare beneficiaries are readmitted within 30 days of discharge, costing $17.4 billion in 2004.[2] The discharge process is often complex. Older patients may experience multiple transfers after discharge from hospital; eg, from hospital to nursing home to home. Only 61% are limited to a single transfer after their hospital care.[3]

Risk factors for readmission[4-6] and strategies to reduce the risk are well known[7-9] (Table 1). Previous efforts to develop a tool using routine inpatient data have been moderately effective.[10,11] To our knowledge, there is no successful and reliable real-time tool developed to predict readmission at the bedside. It is important for health care workers to know patients at risk of rehospitalization to address the risk.

The Acute Care for Elders Tracker (ACE Tracker)[12] is a real-time report electronic resource that summarizes information from the electronic medical record (EMR) of patients 65 years and older. This report requires no additional evaluations of the patient by the health care team. (See Figure 1 for data queried.) This study was performed to test the effectiveness of the readmission risk score and to answer the question, "Can a real-time readmission risk score embedded in the EMR predict 30-day readmissions among patients 65 years and older"?

METHODS

The readmission risk score is generated real-time from the EMR. The score ranges from 0 to 20 based on the presence or absence of risk factors noted in Table 1. The variables were chosen based on previous research. An extensive literature search was performed that included all OVID databases (Medline and EBM reviews from 1950 to present), CINAHL, AgeInfo, Ageline, and Google Scholar. A team of clinicians including a physician, nurse, and social worker reviewed the quality of the papers and commented on the relevance of the variables. A number of evidence-based predictors were not captured in the EMR and could not be incorporated in the readmission risk score. The final variables were chosen based on availability in the EMR, previous research[13,14] and team clinical experience (Table 2). The readmission risk score is noted on the ACE Tracker (Figure 1).

Evaluation of the readmission risk score utilized data from the EMR (Cerner Corp, North Kansas City, Missouri). Ten of the 13 hospitals were included in this study due to availability of the ACE Tracker and the EMR at those hospitals. The size

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Table 1. Risk Factors for Hospital Readmissions

Socioeconomic factors

- Age
- Gender
- Self-reported Race/Ethnicity
- Self-reported Household Income
- Education
- Insurance Status
- Having a Regular Physician
- Activities of Daily Living Score
- Admit from Skilled Nursing Facility
- Lives Alone
- Education Barriers

Admitting Diagnoses

- Congestive Heart Failure
- Psychosis
- Other Vascular Surgeries
- Chronic Obstructive Pulmonary Disease
- Pneumonia
- Gastrointestinal Problems

Health Conditions

- Self-rated General Health
- Heart Disease
- Prior Stroke
- Cancer
- Diabetes
- Visual Impairment
- Congestive Heart Failure
- Chronic Obstructive Pulmonary Disease
- Diabetes Mellitus
- Chronic Skin Ulcers/Pressure Ulcers
- Cirrhosis
- Leukemia
- Peripheral Vascular Disease
- Metastatic Cancer
- Malnutrition
- Acute Respiratory Failure
- Rheumatoid Arthritis
- Chronic Kidney Disease
- End-of-Life Care
- Depression
- Polypharmacy
- Hypertension
- Rhematoid Arthritis
- Pulmonary Embolism

Health Care Utilization

- Number of Hospital Admissions
- Length of Stay of Current Hospital Admission

Table 2. Components of the Electronic Medical Record with Weighted Points Used to Compile the Rehospitalization Risk Score

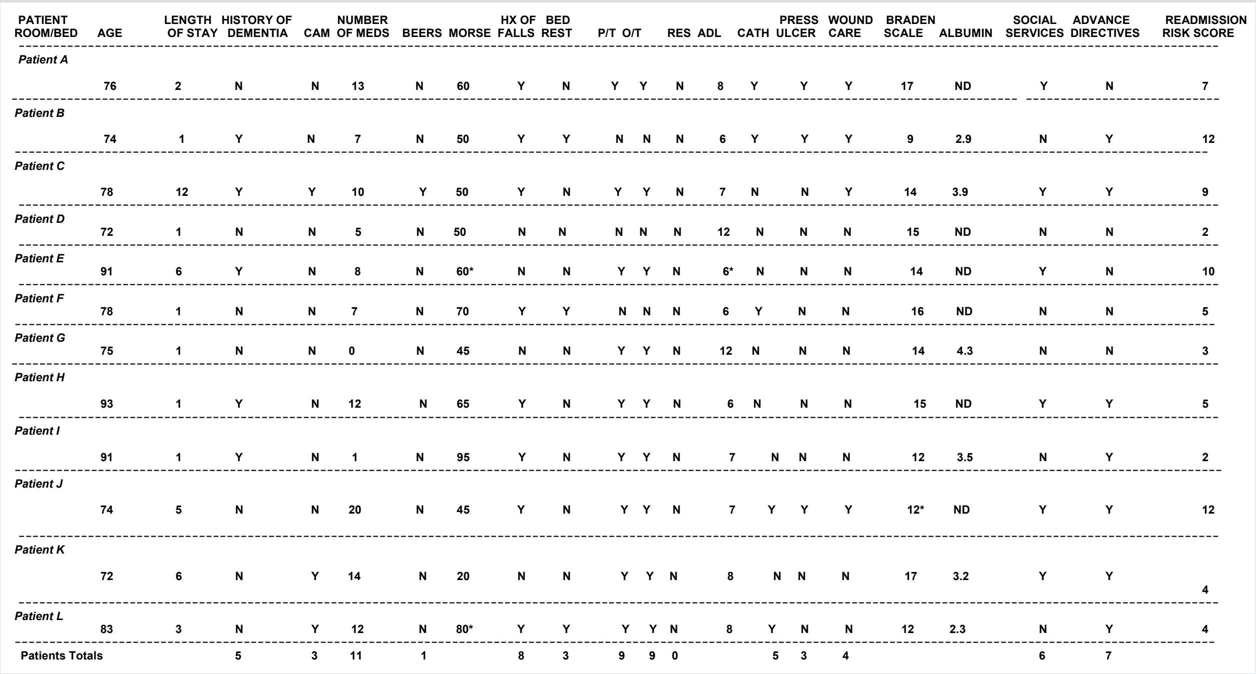
Admitting Diagnosis: Maximum Score	**5**
Congestive Heart Failure	5
Psychosis	5
Other Vascular Surgeries	3
Chronic Obstructive Pulmonary Disease	3
Pneumonia	1
Gastrointestinal Problems	1
Hospital Utilization: Maximum Score	**4**
One Hospital Admission in Prior 6 Months	1
Two or More Hospitalizations in Prior 6 Months	2
Current Length of Hospital Stay 6-9 Days	1
Current Length of Hospital Stay ≥10 Days	2
Comorbidities: Maximum Score	**6**
Congestive Heart Failure	1
Chronic Obstructive Pulmonary Disease	1
Diabetes Mellitus	1
Shortness of Breath	1
Chronic Skin Ulcers/Pressure Ulcers	1
Cirrhosis	1
Leukemia	1
Peripheral Vascular Disease	1
Stroke/Cerebrovascular Accident	1
Metastatic Cancer	1
Malnutrition	1
Acute Respiratory Failure	1
Rheumatoid Arthritis	1
Hypertension	1
Socioeconomic Factors: Maximum Score	**5**
Activities of Daily Living Score[18] ≤6 of 12	1
Medicaid Insurance	1
Admit from Skilled Nursing Facility	1
Lives Alone	1
Education Barriers	1

of the included hospitals varied from small to large tertiary care hospitals (5 hospitals were licensed to a capacity in the range of 65 to 100 beds; 4 hospitals had a bed capacity in the range of 101 to 400; and 1 hospital had a capacity of more than 400 beds).

Index hospitalization was defined as inpatients 65 years and older admitted to the hospital on the ACE Tracker on a single day, January 26, 2011. A single day was chosen as a uniform point in time of the assessment of older hospitalized patients. The validity of the EMR has been previously described.[12] To ensure that the tool was as close to "real life" as possible, patients were included regardless of admission to the intensive care unit, the presence or absence of psychiatric diagnosis, and discharge to inpatient rehabiliation. Patients were excluded if the index hospitalization was an observation stay or if death occurred in the hospital. The study was approved by the Aurora Institutional Review Board.

Primary Outcome

The primary outcome was readmission to any of the hospitals included in the study within 30 days of discharge from the index hospitalization. Admissions to rehabilitation units, transfers from 1 hospital to another hospital, inpatient



PATIENT ROOM/BED	AGE	LENGTH OF STAY	HISTORY OF DEMENTIA	CAM	NUMBER OF MEDS	BEERS	MORSE	HX OF FALLS	BED REST	P/T	O/T	RES	ADL	CATH	PRESS ULCER	WOUND CARE	BRADEN SCALE	ALBUMIN	SOCIAL SERVICES	ADVANCE DIRECTIVES	READMISSION RISK SCORE
Patient A	76	2	N	N	13	N	60	Y	N	Y	Y	N	8	Y	Y	Y	17	ND	Y	N	7
Patient B	74	1	Y	N	7	N	50	Y	Y	N	N	N	6	Y	Y	Y	9	2.9	N	Y	12
Patient C	78	12	Y	Y	10	Y	50	Y	N	Y	Y	N	7	N	N	Y	14	3.9	Y	Y	9
Patient D	72	1	N	N	5	N	50	N	N	N	N	N	12	N	N	N	15	ND	N	N	2
Patient E	91	6	Y	N	8	N	60*	N	N	Y	Y	N	6*	N	N	N	14	ND	Y	N	10
Patient F	78	1	N	N	7	N	70	Y	Y	N	N	N	6	Y	N	N	16	ND	N	N	5
Patient G	75	1	N	N	0	N	45	N	N	Y	Y	N	12	N	N	N	14	4.3	N	N	3
Patient H	93	1	Y	N	12	N	65	Y	N	Y	Y	N	6	N	N	N	15	ND	Y	Y	5
Patient I	91	1	Y	N	1	N	95	Y	N	Y	Y	N	7	N	N	N	12	3.5	N	Y	2
Patient J	74	5	N	N	20	N	45	Y	N	Y	Y	N	7	Y	Y	Y	12*	ND	Y	Y	12
Patient K	72	6	N	Y	14	N	20	N	N	Y	Y	N	8	N	N	N	17	3.2	Y	Y	4
Patient L	83	3	N	Y	12	N	80*	Y	Y	Y	Y	N	8	Y	N	N	12	2.3	N	Y	4
Patients Totals			5	3	11	1		8	3	9	9	0		5	3	4			6	7	

Figure 1. Components of the electronic medical record with weighted points used to compile the rehospitalization risk score.
Abbreviations: CAM, confusion assessment method; meds, medications; Beers, "beers" high-risk medications; Morse, Morse fall score; P/T, physical therapy; O/T, Occupational therapy; RES, restraints; ADL, activities of daily living; Cath, urinary catheter.
Asterisk represents a decline in morse score as compared to admission

Table 3: Readmission Risk Score Properties at Varying Cut-off Points

Readmission Risk Score	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Positive Likelihood Ratio	Negative Likelihood Ratio	30-day Readmission
≥4 points	97%	28%	19%	98%	1.4	0.1	19%
≥7 points	58%	63%	21%	90%	1.6	0.7	21%
≥9 points	42%	81%	27%	89%	2.2	0.7	27%

hospice and elective outpatient procedures were not considered readmissions.

Statistical Analysis

Sensitivity, specificity, positive and negative predictive values of the risk score, and likelihood ratios were generated for all cut-off values. Median risk score of patients readmitted and not readmitted were compared using the Mann-Whitney test with the assistance of MINITAB software (Minitab, State College, Pennsylvania).

RESULTS

Two hundred seventy-two patients 65 years and older were admitted to 10 of 13 hospitals and 30 medical-surgical units on January 26, 2011. Forty-five were excluded because of observation status (30), inpatient death (3), and missing data (12); 227 patients were included in the study. Average age was 79 years (65 to 99 years); 57% were females; average length of stay 8 was days (1 to 56 days); average hospital stay on January 26, 2011, was 4 days (0 to 28 days). The overall 30-day readmission rate was 15%.

The distribution of readmission risk score among hospitalized patients is shown in Figure 2. Forty-one percent had a value score of 7 or more. At this cutoff value, sensitivity was 61%, specificity 22%, positive predictive value 12%, negative predictive value 77% (Table 3). The positive and negative likelihood ratios were 0.8 and 1.8. Higher readmission risk scores were correlated with readmission (median score of readmitted vs not readmitted patients 8 vs 5; $P = 0.001$).

Sensitivity, specificity, and positive and negative predictive values were calculated for all possible cut-off points. A few representative cut-off values are presented in Table 3.

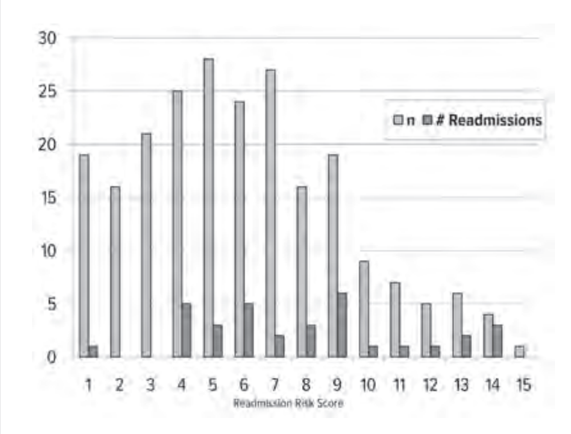


Figure 2. Distribution of readmission risk score and rate of readmission among 227 older patients at 10 Aurora hospitals.

DISCUSSION

Potential Implications

In a future with financial disincentives for readmissions[15] it will be important for hospitals to deploy models designed to reduce the rate of readmissions. Readmissions are a quality indicator available to the public.[16] At the individual patient level, unnecessary readmission is an inconvenience that may be avoidable.

Those at high risk for readmission could receive general and targeted interventions to mitigate their risk and to optimize the use of post-acute resources. The low positive predictive value and high negative predictive value of the readmission risk score may allow the health care team to safely identify patients who are at low risk for readmission. This may allow targeting of resources to create interventions for the high-risk patients. Low-risk patients may benefit from general interventions to help them manage their illness and coordinate care. Health systems may be able to safely exclude this group of patients from higher-cost interventions such as home nurse visits.

Limitations

This risk score may be generalizable only to patients cared for at hospitals with an EMR that captures variables specific to the hospitalized elderly; eg, activities of daily living score and education barriers. We may have underestimated readmission rates due to lack of data capture on patients readmitted to a different health care system. Most of the fields that we captured were on admission; any missing or new information did not have any effect on the risk score. Finally, the variables that determine the readmission risk score were determined based on prior research, clinical experience, and availability in EMR.

Future Direction

A recent systematic review[17] noted that currently available readmission risk prediction models perform poorly. Furthermore, models of patient-level factors (such as medical comorbidities, demographics and clinical variables) are better able to predict mortality than readmissions. Broader social and environmental factors may be better able to predict readmissions. The authors have an opportunity to improve the readmission risk score by further exploring patient care data that includes functional status, and social and environmental factors not included in prior studies. Future efforts will need to address the problems identified with the tool and will need to link the score to interventions to help mitigate the risk. A well-validated readmission risk score could be made available to providers outside of the hospital, the site where most of the effort occurs to prevent rehospitalization. Finally, studies will be needed to demonstrate that using a risk score could improve outcomes or reduce costs.

CONCLUSION

The readmission risk score correlates with 30-day readmission. The readmission risk score may be better at identifying those who are not at risk for readmission. Software tools automatically built into the EMR may help health care workers define populations who are and who are not at risk for hospital readmission.

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The Theory and Application of UW eHealth-PHINEX, A Clinical Electronic Health Record–Public Health Information Exchange

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ABSTRACT

Background: Electronic health records (EHRs) hold the promise of improving clinical quality and population health while reducing health care costs. However, it is not clear how these goals can be achieved in practice.

Methods: Clinician-led teams developed EHR data extracts to support chronic disease use cases. EHRs were linked with community-level data to describe disease prevalence and health care quality at the patient, health care system, and community risk factor levels. Software was developed and statistical modeling included multivariate, mixed-model, longitudinal, data mining, and geographic information system (GIS)/spatial regression approaches.

Results: A HIPAA-compliant limited data set was created on 192,201 patients seen in University of Wisconsin Family Medicine clinics throughout Wisconsin in 2007-2009. It was linked to a commercially available database of approximately 6000 variables describing community-level risk factors at the census block group. Areas of increased asthma and diabetes prevalence have been mapped, identified, and compared to economic hardship.

Conclusions: A comprehensive framework has been developed for clinical-public health data exchange to develop new evidence and apply it to clinical practice and health policy. EHR data at the neighborhood level can be used for future population studies and may enhance understanding of community-level patterns of illness and care.

INTRODUCTION

Effective clinical care and public health response greatly depend upon information. With the widespread adoption of electronic health records (EHRs), there is great potential to positively transform these 2 components of the health care system.[1,2] For example, EHRs have reduced clinical errors, improved chronic illness care,[1-3] and improved the completeness, accuracy, and timeliness of case reporting to public health.[4]

A bidirectional data exchange between clinical care and public health could revolutionize how these 2 disciplines interact. Through surveillance and epidemiologic analysis, public health provides situational awareness and improved health outcome prediction modeling for individuals in high-risk populations. Translating merged clinical and public health data into useful information on chronic disease and feeding this new information back to clinicians at the point of care could provide additional decision support.[1] In this way, the high volume and quality of exchanged EHR data could serve as a foundation to create a rapid learning health system, a process to rapidly develop new evidence, learn from it, and apply these findings to medical practice and health policy.[1,5,6]

Population data collected from EHRs has the potential to provide useful information to evaluate condition-specific clinical process metrics and outcomes, facilitate clinical decision support, enhance team-based population care outside the traditional face-to-face clinical encounter, and provide feedback on specific patient populations at the point of care. However, EHR databases must be representative of the populace and its communities if the analytic results are to be useful and meaningful.

The best prevalence estimates for diabetes, asthma, and other chronic conditions in Wisconsin comes from Wisconsin's

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Behavioral Risk Factor Surveillance System (BRFSS)[7] which is part of the nation's largest ongoing annual telephone health survey system tracking health conditions and risk behaviors in residents 18 years old and older. However, the BRFSS is designed only to estimate prevalence at the state level[8] and suffers from the biases of self-report and low response rate.[9] Based on increasing implementation of EHRs, it may be more efficient and less costly to study chronic disease from a public health viewpoint through de-identified clinical data rather than telephone survey systems and other currently available survey methods.

Constructing, reviewing, and reporting on summary quality measures is a very important and a necessary first step to improve health care delivery systems. However, it is not sufficient because the aggregated measures by themselves provide limited insight into what contributes to performance variation and what solutions or interventions might be proposed. Simply reducing clinical practice quality variation is insufficient to substantially improve the health of individuals and populations.

The multiple determinants that contribute to disease, risk, disparity, and performance of the health care system can be more completely described through an ecologic health systems model. This model reflects individual biologic factors and behaviors, clinical care elements, and social, family, environment, and community characteristics.[10-12] Furthermore, a multilevel, systems approach that examines diseases within their biological, psycho-socioeconomic, environmental, and community contexts is likely to provide a better understanding of disease disparities and clinical quality outcomes.

There has been broad bipartisan support for making universal EHR adoption a national priority. Beginning with a 2004 presidential directive, the Office of the National Coordinator for Health Information Technology (ONC) was established and charged with developing a nationwide health information network to improve health care quality, make health care safer and more efficient while also improving population health and reducing cost.[1] Building on ONC's activities, the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act was established, making substantial investments to stimulate widespread EHR adoption. Starting in 2011, HITECH offers eligible health care providers financial incentives for demonstrating meaningful use of EHRs. To receive incentives, providers must use certified EHR systems to electronically capture health information in a coded format, use it to track key clinical conditions, coordinate care, and initiate the reporting of clinical quality measures (CQMs) and public health information.[13,14]

We describe the University of Wisconsin Electronic Health Record – Public Health Information Exchange (UW eHealth-PHINEX) program which is designed to statistically represent the ecologic health systems model. In addition, this paper will describe the overall demographics of this clinic population and compare it to the broader Dane County and statewide populations. It is planned to serve as a resource for physicians and allied health professions for training, research, continuous health care quality and population health improvement, public health system improvement, and surveillance.

METHODS

Setting

This research was conducted at the University of Wisconsin-Madison School of Medicine and Public Health and the Wisconsin Division of Public Health. In January 2010, the Healthcare Information and Management Systems Society (HIMSS) recognized the University of Wisconsin Hospital and Clinics with the HIMSS Analytics Stage 7 Award for delivering care without the use of paper charts, sharing patient information securely with other providers of care, and using their vast database of clinical information to improve patient safety and outcomes.[15] Stage 7 indicates the most advanced use of EHRs. It is the pinnacle of an environment where paper charts are no longer used to deliver patient care.

The University of Wisconsin Department of Family Medicine (DFM)[16] operates 25 clinics throughout the state with 187 faculty, 100 residents, and nearly 700 employees. Together these organizations use the Epic EHR[17] to deliver care to nearly 200,000 patients who are seen in the DFM clinics.

The Division of Public Health (DPH) is responsible for providing public health services to the people of Wisconsin. The Office of Health Informatics operates the Public Health Information Network (PHIN), which includes a secure web portal that offers advanced statistical analysis, visualization, and reporting (AVR) services for surveillance and epidemiologic investigation.[18]

Project Design, Participants, and Procedures

The project was designed to transform current health information systems to an improved state that could then fully encompass the ecologic health systems model. It used the collaborative requirements development methodology[19] to develop information technology (IT) requirements and specifications. The Information Technology—Enterprise Performance Life Cycle (EPLC) was used as a guide for project management. The EPLC framework consisted of 10 life-cycle phases: initiation (identify business need), concept (identify high level requirements), planning (full project management plan), detailed requirements (what it must do), design, development (coding), testing, implementation, operations, and management.[19]

Focus groups developed system needs by first looking at how work is currently done (business process analysis), how the work could be done better (business process redesign), and how information systems could support the new processes (requirements development).[20] These teams developed requirements and specifications for data security, access, and analysis. Working from these requirements, clinician-led teams next developed detailed Epic data extract and analysis criteria for asthma and diabetes "use cases" (a use case defines the information needs for a health outcome or risk factor under investigation). Commercially available databases were identified to provide community-level information. Information technologists then developed the PHIN AVR Web Portal data systems based on these criteria. Patient data was exchanged if charges were generated during a 3-year period for any patient that had a clinical encounter in any of the 25 UW DFM clinics using the UW Health Link Epic EHR platform.

Mapping

Asthma and diabetes prevalence variation was mapped and identified. EHRs were geocoded by matching the patient address to its latitude-longitude coordinates. Once the latitude-longitude was obtained, the patient record was matched to the census block group (600- to 1500-person neighborhoods) and census tract (2500 and 8000 person county subdivision) where it was located. Ancillary to the geographic codes, the ICD-9 codes (473.xx for asthma and 250.xx for diabetes) were carried forward from the EHR to the geocoded points.

Using a geographic information system (GIS), the individual points were aggregated to the census tract, providing a count by census tract of the overall total number of patients as well as the total number of patients with either asthma or diabetes in order to determine the disease prevalence. Once the aggregation was complete, these data could be graphically represented to illustrate the prevalence of both asthma and diabetes within each census tract. The prevalence was reported in terms of the percent of the population with the specific condition being evaluated. The prevalence values were then associated with a 5-class grey shading scheme that allowed a visual depiction of the distribution of both asthma and diabetes prevalence in a map of Dane County, Wisconsin.

The social and economic conditions by census tract in the Dane County area were described using the economic hardship index.[21,22] The index is scored by combining 6 indicators: crowded housing (percent of housing units with more than 1 person per room), poverty (percent of households living below the federal poverty level), unemployment (percent of persons over the age of 16 years that are unemployed), education (percent of persons over the age of 25 years without a high school education), dependency (percent of population that is under age 18 or over age 64 years), and income level (median per capita). Data for these indicators were obtained from the 2010 US Census. Scores on the index can range from 1 to 100, with a higher index number representing a greater degree of economic hardship.

RESULTS

Logic Model

Figure 1 displays the logic model for the UW eHealth-PHINEX project. Funding, systems, staffing, data, and organizations were the inputs to carry out project activities. Implementation activities included developing specifications, performing disease prevalence and clinical quality statistical modeling, exchanging data, and creating the secure web portal. Some of the challenges included obtaining a data use agreement between UW and DPH, finding and hiring a skilled Epic programmer, and procuring Human Subjects Institutional Review Board approval.

Five focus groups were held. Three groups were with public health epidemiologists and data stewards (ie, public health data security, access, analytics) and 2 groups were with health care administrators and clinicians (ie, clinical data security and access; clinical-public health data integration [which also included public health epidemiologists and medical officers]). A physician, epidemiologist, and database analyst team met to develop the detailed EHR data extract specifications for asthma and diabetes use cases. Teams subsequently met biweekly to develop detailed disease analysis and modeling reports.

Statistical specifications went beyond current practices of simple descriptive statistics and included multivariate analyses, mixed-model multivariate analyses, data mining, and GIS/spatial regression.[23-26]

The principal project outputs are detailed demographic, clinic, and community-specific reports that identify the multiple determinants of disease prevalence, disparity, and health care quality. Over the short-term, we anticipate this approach will lead to improved insight into the determinants for each of these factors. This, in turn, can then serve as the foundation for multilevel intervention trials with the potential for reduction in disparity and disease risk factors, and improved clinical outcomes. The long-term goal is the achievement of the Institute for Healthcare Improvement's Triple Aim: improving population health, improving the patient experience including health care quality, and reducing per capita cost of care.[27]

Conceptual Model

Figure 2 provides a conceptual overview of the information systems environment and consists of a 3-step process to improve health care quality and population health: finding patterns in the data to gain insight, running comparative effectiveness trials to discover new methods of improving care and effective policies, and promoting the new, more effective method to be the standard of care while repeating the discovery process for

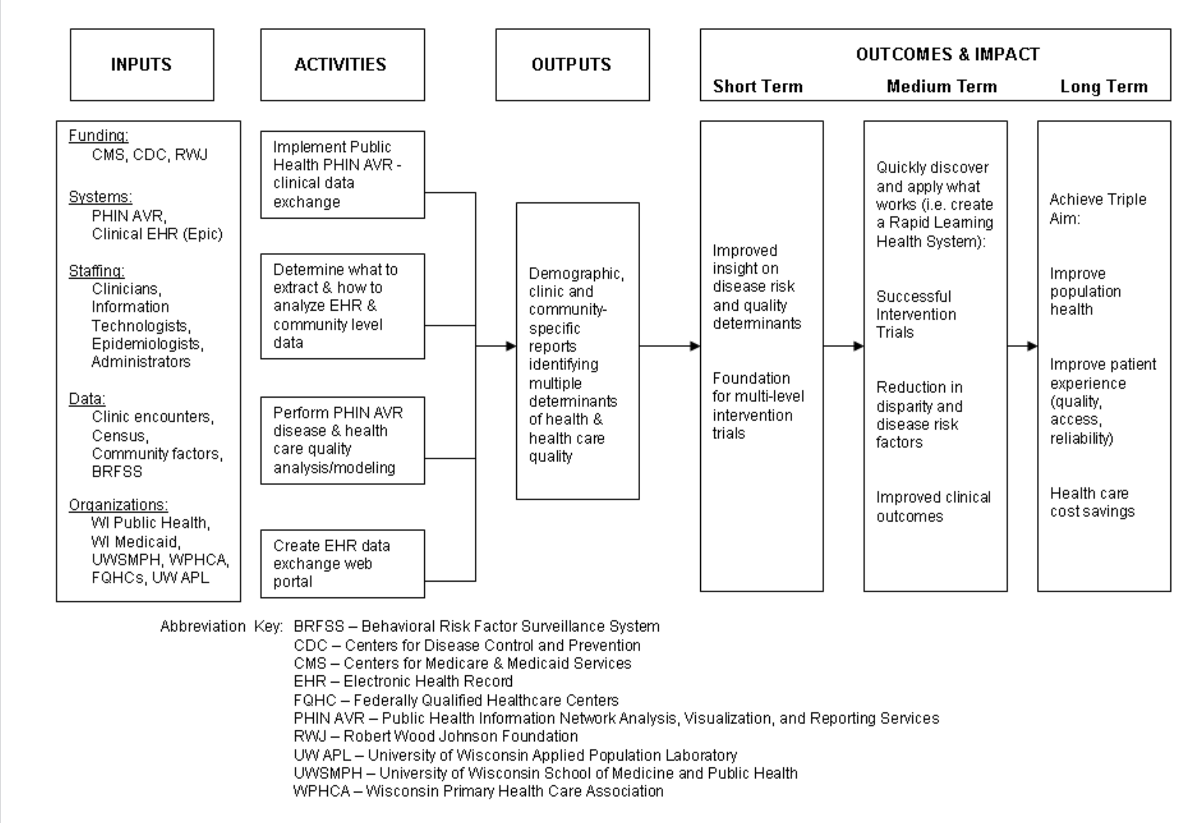


Figure 1. The logic model for the UW eHealth-PHINEX project.

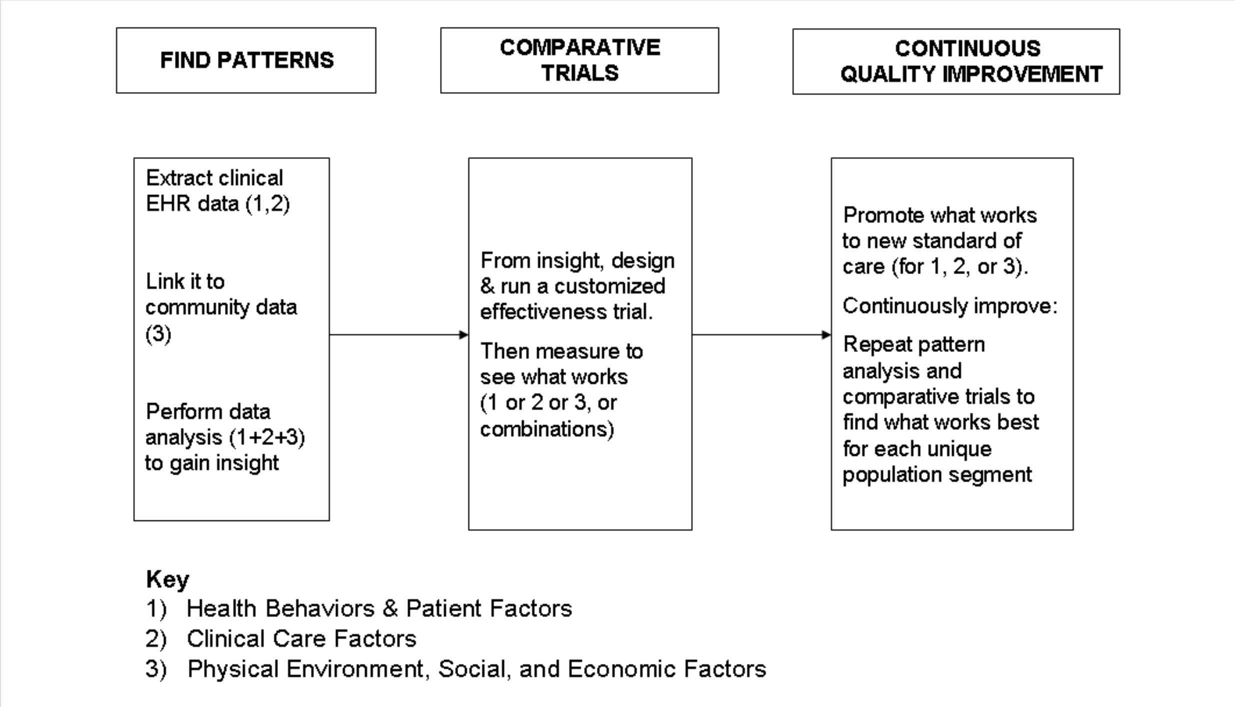
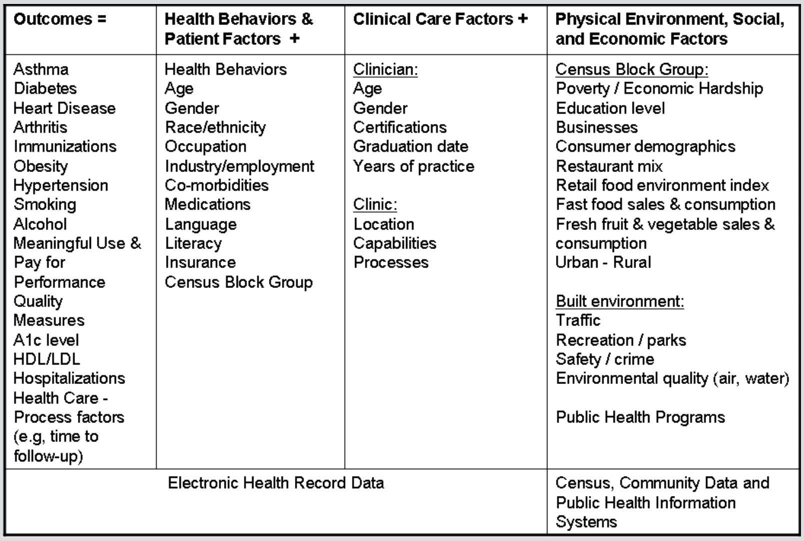


Figure 2. A conceptual overview of the information systems environment.



Outcomes =	Health Behaviors & Patient Factors +	Clinical Care Factors +	Physical Environment, Social, and Economic Factors
Asthma Diabetes Heart Disease Arthritis Immunizations Obesity Hypertension Smoking Alcohol Meaningful Use & Pay for Performance Quality Measures A1c level HDL/LDL Hospitalizations Health Care - Process factors (e.g, time to follow-up)	Health Behaviors Age Gender Race/ethnicity Occupation Industry/employment Co-morbidities Medications Language Literacy Insurance Census Block Group	Clinician: Age Gender Certifications Graduation date Years of practice Clinic: Location Capabilities Processes	Census Block Group: Poverty / Economic Hardship Education level Businesses Consumer demographics Restaurant mix Retail food environment index Fast food sales & consumption Fresh fruit & vegetable sales & consumption Urban - Rural Built environment: Traffic Recreation / parks Safety / crime Environmental quality (air, water) Public Health Programs
Electronic Health Record Data			Census, Community Data and Public Health Information Systems

Figure 3. Overview of the EHR extract linked to the community risk factor data set.

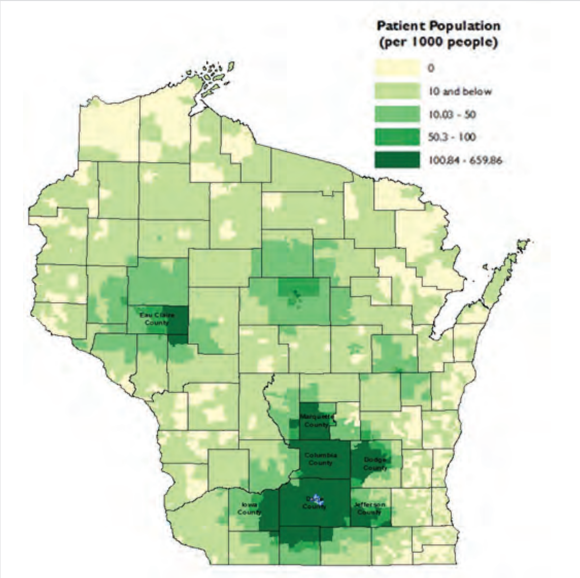


Figure 4. The geographic distribution of 192,201 patients seen at 25 UW Department of Family Medicine clinics by census block group (2007-2009).

population segments that did not benefit from the intervention. This data exchange project is currently at the first step of finding patterns.

The ecologic health systems model, like the county health rankings model,[28] recognizes that health behaviors, clinical care, social and economic factors, and the physical environment may determine if someone stays healthy or not. Examples include the following: (1) health behaviors–activities to maintain health such as smoking avoidance, moderate alcohol consumption, regular exercise, and appropriate body weight for height; (2) clinical care–quality metrics that define if a health care system is meeting a standard of care (eg, HbA1c <7 for patients with diabetes). Evaluation of the quality metric performance varies by patient and community-level risk factors; and (3) social and economic factors, and physical environment–determining if individuals have an adequate income to afford health-promoting foods and evaluating if an individual's neighborhood supports safe exercise outdoors, provides access to fresh fruits and vegetables, and offers a wide variety of restaurants rather than only fast food.

From the data exchange, one can begin to find patterns in these factors. First, the HIPAA-limited EHR data set was extracted (eg, diagnoses, lab results, demographics, vital signs, body mass index, and smoking history). The data set was linked to community-level data [eg, economic hardship, employment, fresh fruit and vegetable consumption] at the census block group or census tract level.

Disease prevalence and health care quality was assessed by various statistical approaches, including multivariate analyses and data mining. The areas of health behaviors, clinical care, and community factors were modeled to gain insight on what variables predict health, disease, and health care quality, which would then contribute to designing comparative-effectiveness trials. The success of interventions could in part be measured through information contained within the EHR. Furthermore, characteristics of individuals who had success could be compared to individuals who did not. The advantage of using the EHR is that the results may be more generalizable to a clinic population, the trial may suffer less subject dropout, and the patient burden of clinical trial visits may be reduced. Clinicians and investigators may benefit by learning which interventions are effective or not.

Community Level Data (Social, Economic, and Environmental Factors)

The Esri Business Analyst (BA) Premium product[29] has approximately 6000 variables at the census block group level, on community demographics, socioeconomic segmentation, consumer spending, business locations and type, street data, and market potential.[29] Census block groups are the smallest geographical unit for which the US Census Bureau publishes sample data.

BA data was acquired and linked to the EHR at the census block group.

Clinical EHR Data Model

There were 111 variables extracted from the Epic Clarity database, including encounter and problem list diagnoses, social history/patient demographics, laboratory test orders and results, procedures, vital signs, and medications. This extract included data from patients seen during the years 2007-2009 in 25 UW DFM clinics. This encompasses 192,201 patients, 2.54 million encounters, 3.1 million diagnoses, and 1.54 million laboratory results. These data complied with the HIPAA privacy rule for limited data sets. In this limited data set, all protected health information was removed except date of encounter, birth month and year, ZIP code, and census block group of the patient's address. Random accession numbers were created for patient, primary care provider, and clinic. This allowed for analysis on these factors while keeping patient, provider, and clinic identities anonymous. Results can then be fed back to the UW DFM to decode identities internally and reveal individual patient, provider, and clinic quality performance characteristics and inform practice.

Ecologic Health Systems Modeling

Figure 3 provides an overview of the EHR extract linked to the community risk factor data set. Outcomes (asthma and diabetes prevalence, meaningful use quality measures, etc) can be modeled as a function of health behaviors and patient factors (smoking, age, gender, race/ethnicity, comorbidities), clinical care factors, and social, economic and physical environment community factors (eg, poverty, economic hardship, built environment, fresh fruit and vegetable consumption, etc).

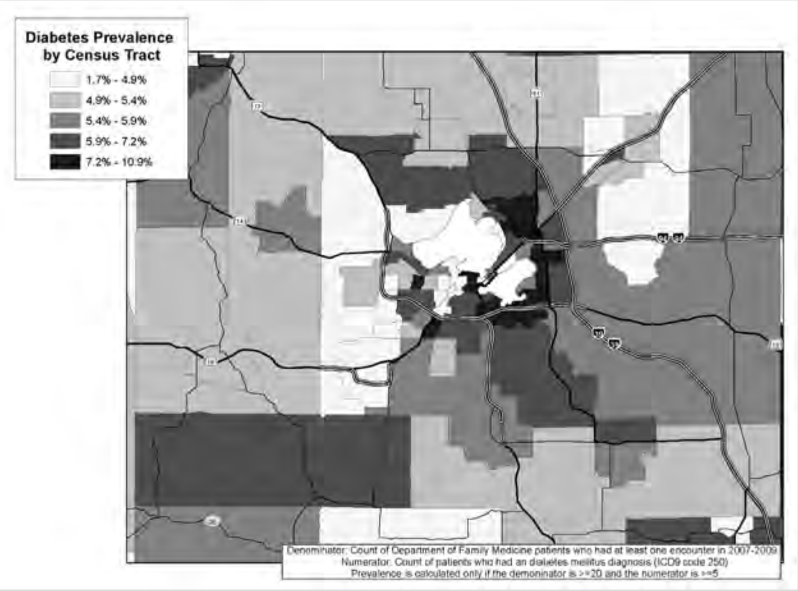


Figure 5. Diabetes Prevalence by Census Tract, Dane County (2007-2009).

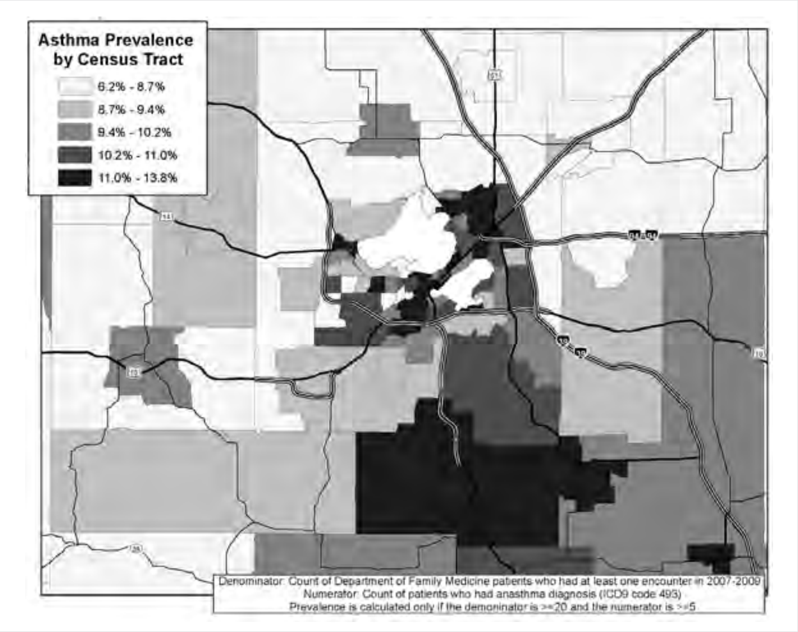


Figure 6. Asthma Prevalence by Census Tract, Dane County (2007-2009).

Population Demographics

Figure 4 shows the geographic distribution of patients seen at UW DFM clinics. While most patients cluster in and around Dane County and surrounding counties (Sauk, Columbia, Dodge, Jefferson, Iowa, Rock, Green, and Marquette), there was still a widely dispersed sampling of patients throughout the rest of the state because of patients seen at the Eau Claire, Augusta, Wausau, and Appleton DFM clinics.

The DFM clinic sample contained 40,320 children and 151,881 adults. A statewide comparison of census and UW eHealth-PHINEX demographics showed that the UW eHealth-PHINEX population is fairly representative of the Wisconsin

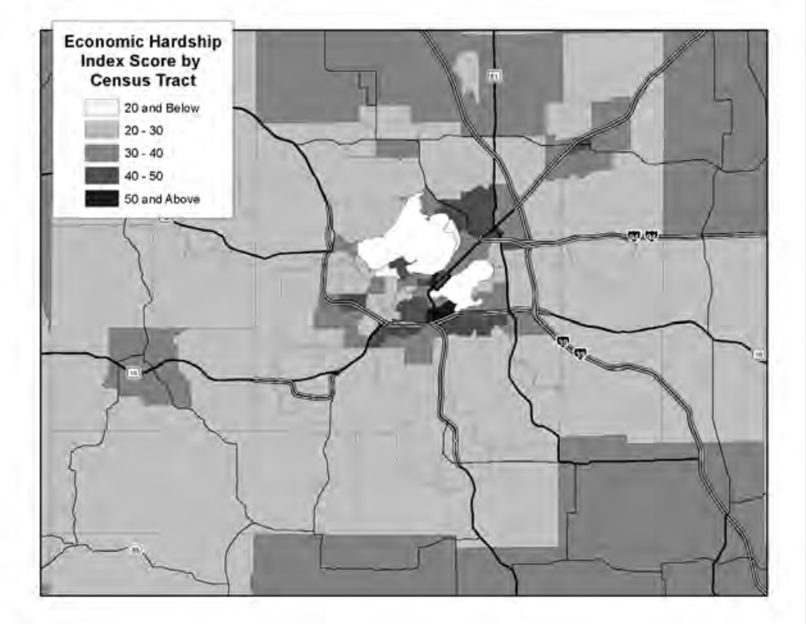


Figure 7. Economic Hardship Index by Census Tract (2010).

statewide census population (Table 1) with the following exception. There was a smaller percentage of adults 65 years or older in the UW eHealth-PHINEX population (9.34%) compared to the state population (13.31%).

Because the majority of the DFM clinic patient population resides in Dane County, we also made a demographic comparison to this area (Table 2). Within Dane County, the UW eHealth-PHINEX population slightly over-represents non-Hispanic Blacks (5.70% vs 4.95%) but has a similar representation of Hispanics (4.79% vs 4.99%).

The map of diabetes prevalence of the UW eHealth-PHINEX population in Dane County reveals considerable variation in diabetes prevalence. It ranges from 1.7%-4.9% (lowest quintile) to 7.2%-10.9% (highest quintile) (Figure 5). The map shows neighborhoods in the northeast, east and the southeast have the highest diabetes prevalence (Figure 5). The map of asthma prevalence also indicates a substantial range of prevalence (6.2%-8.7% [lowest quintile] to 11.0%-13.8% [highest quintile]) (Figure 6). It shows neighborhoods in the northeast and the south have the highest asthma prevalence.

Use Case Studies: Asthma, Diabetes, Economic Hardship Index

Areas of increased asthma and diabetes prevalence have been mapped and identified in Dane County (Figures 5 and 6) and compared to the economic hardship index (Figure 7). Economic hardship appears to correlate with diabetes risk and to a lesser extent with asthma. Formal testing of this association is planned. Data mining is under way to examine the multiple predictors of asthma. Multivariate modeling is being performed to describe asthma and diabetes disease prevalence, and the determinants of pediatric obesity. These results are being compared to traditional public health data systems, such as the BRFSS telephone survey. Finally, clinical quality measures also are being studied for these conditions. Using predictive analytics, poor HbA1c control is being examined by patient demographic and community-level risk factors. Detailed reports on all of these findings are being prepared and will be published at a later date.

DISCUSSION

The UW eHealth-PHINEX project is an information system platform to statistically represent the ecologic health systems model. The study demonstrates that data from a network of family medicine clinics from a multispecialty practice within an academic center is able to reasonably approximate the populations of its surrounding county and state. EHR databases also may offer better availability of data by subpopulations such as children, elderly, certain racial and ethnic groups, disabled persons, and/or a particular gender compared to traditional survey data. As clinical systems become more accountable by producing quality indicators for meaningful use and pay-for-performance, combining EHR and census block group data becomes fundamental to creating accurate comparisons and understanding the multiple predictors of clinical quality and public health system performance. It then provides the basis for designing and testing a spectrum of potentially effective interventions at the patient, health behavior, clinical care, and community levels (social, economic, and physical environment).[29-31] These insights can then be used to develop tailored interventions optimized for specific segments of our patient populations and their communities. In this way, more personalized care can be offered to increase the likelihood of individual response and increase the probability that these efforts will improve their health. The UW eHealth-PHINEX is a roadmap for this approach.

The creation of quality metrics is a necessary first step for improving any system, but it is only the beginning. Simple, aggregate health care quality measures have limited utility.[32] Instead it also is necessary to understand the multiple determinants that drive variations in quality (such as health behaviors, poverty, or the physical environment). UW eHealth-PHINEX provides a platform to accomplish this task. In the future, it will be possible to feed back the merged clinical and community data and use this information to inform individual patient treatment and engagement at the point of care. Local public health jurisdictions could collaborate with clinical care systems on the community-level interventions and monitor clinical outcomes. New standards of community-level care could be promoted and populations at risk identified for further interventions.

It is estimated that clinical care accounts for only 20% of health outcomes, while 30% is related to health behaviors, another 40% is attributable to social and economic factors, and the remaining 10% is related to the physical environment.[28-33] Thus, if comparative effectiveness research's full potential for improving the population's health is to be realized, such comparisons must go beyond those differences found between 2 medications or devices. These comparisons must be made along with behavioral interventions, either alone or in conjunction with other approaches.[34,35] By modeling the interplay of the multiple determinants of disease, the UW eHeath-PHINEX platform can pinpoint health disparity and related environmental features at the local level to suggest interventions and areas to focus limited public health resources.

An EHR-public health data exchange such as the one described in this study can provide superior public health surveillance information on chronic conditions such as asthma and diabetes. When these data are used to map patterns of disease, they can identify neighborhoods with high prevalence of chronic disease such as diabetes (Figure 5) and asthma (Figure 6) and compare these risks to community factors such as increased economic hardship (Figure 7). This type of exchange has the potential to improve surveillance, and better inform local public health community health improvement plans,[36,37] accreditation and quality improvement,[38] and nonprofit hospital community health needs assessments.[37] For example, the county health rankings is an invaluable methodology to support local public health community assessments and evaluations, and while it is

Table 1. Wisconsin Statewide Comparison of Census and UW eHealth-PHINEX Clinic Demographics (2007-2009).

	Wisconsin Census Data 2007-2009[a]		Wisconsin UW eHealth-PHINEX Patients 2007-2009	
	N	**Percent (95% CI)**	**N[b]**	**Percent (95% CI)**
Overall	5,627,985		192,201	
Sex				
Male	2,795,161	49.67 (49.61 – 49.72)	88,485	46.04 (45.74 – 46.34)
Female	2,832,824	50.33 (50.28 – 50.39)	103,710	53.96 (53.63 – 54.29)
Age Group				
0-4	361,847	6.43 (6.41 – 6.45)	12,914	6.72 (6.60 – 6.83)
5-11	496,694	8.83 (8.80 – 8.85)	12,898	6.71 (6.59 – 6.83)
12-17	458,426	8.15 (8.12 – 8.17)	14,508	7.55 (7.43 – 7.67)
18-34	1,284,712	22.83 (22.79 – 22.87)	51,647	26.87 (26.64 – 27.10)
35-64	2,277,326	40.46 (40.41 – 40.52)	82,275	42.81 (42.51 – 43.10)
65+	748,981	13.31 (13.28 – 13.34)	17,959	9.34 (9.21 – 9.48)
Race/Ethnicity				
White, Non-Hispanic	4,809,406	85.46 (85.38 – 85.53)	161,042	87.99 (87.56 – 88.42)
Black, Non-Hispanic	352,101	6.26 (6.24 – 6.28)	7,456	4.07 (3.98 – 4.16)
Other, Non-Hispanic	178,549	3.17 (3.16 – 3.19)	6,672	3.65 (3.56 – 3.74)
Hispanic	287,930	5.12 (5.10 – 5.13)	7,858	4.29 (4.20 – 4.38)

[a]Average of 3 years of estimates (2007-2009), based on the 2000 US Census
[b]Due to missing data within each variable, stratified counts may not sum to overall N

Table 2. Dane County, Wisconsin, Comparison of Census and UW eHealth-PHINEX Clinic Demographics (2007-2009).

	Wisconsin Census Data 2007-2009[a]		Wisconsin UW eHealth-PHINEX Patients 2007-2009	
	N	**Percent (95% CI)**	**N[b]**	**Percent (95% CI)**
Overall	483,639		117,486	
Sex				
Male	240,048	49.63 (49.44 – 49.83)	54,699	46.56 (46.17 – 46.95)
Female	243,591	50.37 (50.17 – 50.57)	62,786	53.44 (53.02 – 53.86)
Age Group				
0-4	30,567	6.32 (6.25 – 6.39)	8,279	7.05 (6.90 – 7.20)
5-11	38,313	7.92 (7.84 – 8.00)	8,248	7.02 (6.87 – 7.17)
12-17	32,567	6.73 (6.66 – 6.81)	8,814	7.50 (7.35 – 7.66)
18-34	148,049	30.61 (30.46 – 30.77)	31,238	26.59 (26.29 – 26.88)
35-64	187,096	38.69 (38.51 – 38.86)	51,443	43.79 (43.41 – 44.16)
65+	47,047	9.73 (9.64 – 9.82)	9,464	8.06 (7.89 – 8.22)
Race/Ethnicity				
White,Non-Hispanic	410,496	84.88 (84.62 – 85.14)	97,097	85.60 (85.06 – 86.14)
Black, Non-Hispanic	23,927	4.95 (4.88 – 5.01)	6,467	5.70 (5.56 – 5.84)
Other, Non-Hispanic	25,088	5.19 (5.12 – 5.25)	4,437	3.91 (3.79 – 4.03)
Hispanic	24,127	4.99 (4.93 – 5.05)	5,434	4.79 (4.66 – 4.92)

[a]Average of 3 years of estimates (2007-2009), based on the 2000 US Census
[b]Due to missing data within each variable, stratified counts may not sum to overall N

extremely important to compare disease prevalence and disparity among local jurisdictions by ranking them, it is equally if not more important to understand disparities within the local jurisdiction itself. Consider Dane County, a community with a high health ranking. It is 11th out of 72 Wisconsin counties,[38] yet the UW eHealth-PHINEX was able to pinpoint substantial variation in asthma and diabetes burden, along with economic hardship within the county itself. These within-health jurisdiction analyses are vitally important to a comprehensive understanding of population health risks and the efficient targeting of limited public health resources.

The Institute of Medicine recently issued its report *Primary Care and Public Health: Exploring Integration to Improve Population Health*[39] and it called for greater integration between the 2 disciplines. This report suggests that a collaboration between primary care and public health will result in achievement of each organization's individual goals and have an overall greater impact on population health than each organization working alone. Each group brings unique knowledge, resources, and skills to analyze clinical data in ways that can promote the health of individual patients and communities.[39] The UW eHealth-PHINEX program has anticipated these IOM recommendations by creating a robust clinical data exchange platform with the potential to improve health care quality and the health of Wisconsin's citizens and communities. Future plans include expansion of the dataset to incorporate data from UW Pediatric and Internal Medicine primary care clinics. This work has implications beyond our local exchange and could serve as a model for future statewide and national EHR-public health data sharing.

Limitations

This project is limited to a component, UW DFM, of 1 integrated health care system; within that health system, patients may receive care in other health systems where data may not be readily accessible for exchange. Furthermore, patients are not randomly sampled from all areas of Wisconsin. These patients come to the UW clinic for care and most have insurance. Therefore, our data may underestimate the magnitude of disparities in asthma and diabetes prevalence by racial and ethnic categories that are available in greater numbers in larger Wisconsin cities. Prevalence estimation and quality predictors could be substantially improved if all of Wisconsin's EHR data were similarly combined and analyzed using the emerging statewide EHR data exchange, the Wisconsin Statewide Health Information Network (WISHIN).[40] WISHIN support of the data exchange functions demonstrated here should be considered as it evolves and matures.[5]

CONCLUSIONS

A comprehensive framework has been developed and demonstrated for clinical-public health data exchange. It supports a rapid learning health system to better appreciate the multiple determinants of disease disparity and health care quality, and can serve as an information platform for continuous quality improvement of clinical care and population health. Health information technology and, more specifically, EHR data exchange, have the potential to provide the critical information we need to better understand both our individual patients and populations we serve.

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Disclaimer: The mention of commercial products does not imply endorsement.

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Improving a Regional Outreach Program in a Large Health System Using Geographic Information Systems

John P. Gabbert, MS; Robert M. Trine, MBA; Marilu Bintz, MD

ABSTRACT

As government-insured populations grow, commercially insured populations decrease, and declining insurance reimbursements pressure cost and revenue. Health systems must strive to improve quality while lowering costs. Large medical centers with rural sites must understand their geography and how distances impede access to services, thereby affecting patient health. Without relevant data, which can be provided through the use of geographic information systems (GIS) technology, improvement is often delayed. Gundersen Lutheran Health System, a large multi-specialty system with urban and rural sites in 3 states, is developing an evaluative outreach GIS to facilitate understanding of, and response to, rural health needs. Investing in GIS technology furthers the health system's ability to deliver superior, affordable care.

BACKGROUND

Large regional medical centers must manage multiple geographic information factors to answer operational questions of who, what, where, when, why, and how care should be delivered. In population health terms, these factors include patient locations and densities, clinical service lines, hospitals, clinics, employers, insurance coverage, demographics, medical transportation, and referral patterns. Such overlapping complexity could be better understood by using visual technology.

Gundersen Lutheran Health System is a large multi-specialty integrated health system in western Wisconsin whose focus is on quality and safety, exceptional patient experience, culture that embodies care and ownership, affordable care, and growth. This focus drives the health system toward self-aware critique that stems in part from its 3-state geography, hill-and-dale topography, and urban/rural demography. In that regard, the organization recognized the need to provide leaders and analysts with readily available patient data and maps constructed from those data. Recently, the Geographic Information System (GIS) function shifted from paper maps toward dynamic intranet mapping with exportable data tables.

As government-insured populations grow (baby boomers to Medicare recipients), commercial insurance program populations decrease, and declining insurance reimbursements pressure cost and revenue, greater regional awareness must strive to improve quality while lowering costs. Clinical information technologies—electronic health records, data-rich analysis, telemedicine, and GIS—may help the organization succeed. Information technologies augment the value a tertiary medical center can offer to smaller regional hospitals, benefitting rural patients in their own communities via their own physicians and providers. This article describes a GIS system designed to support these missions and its transition from design to production.

METHODS

The health system's service area is comprised of 19 counties in 3 states: western Wisconsin, southeastern Minnesota, and northeastern Iowa. Two decades ago, outreach representatives and regional leaders segmented service areas surrounding local (typically critical access) hospitals into sets of contiguous US Postal Service ZIP codes.

In 2011, a decision was made to develop a prototype into a full GIS project addressing 3 key questions to assist with regional decision-making: (1) What is the viability of a current outreach location? (2) Where does an opportunity exist for new outreach? and (3) Where are there new potential clinic locations or service sites?

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To answer these questions, the organization needs to know how well it serves rural patients in proximity to their homes. The performance of a clinical care outreach program is measured in volume of visits, procedures, and charges. (See Figure 1 with visit/trend detail; Figure 2 demonstrates average patient drive times in a rugged area for patients who see particular outreach specialists. Figure 3 displays ZIP code and patient populations.) Any numeric data (cancer severity, for example) from de-identified patient encounters can be mapped in aggregate for a specific area with demographic data, such as average household income, average highest level of education, etc.

The completed GIS will suggest potential outreach locations from state data (by diagnoses set/specialty) in areas that need specialists, ie, finding gaps in services. The issue of new clinic locations or service sites will come from initial recommendations based on patient locations and drive times, and on measured proximity to existing services, and the prospective sites' potential for service and effect on existing clinics.

At Gundersen Lutheran currently, paper maps still provide graphic information to service areas via individual clinical care programs. Data flows through corporate research analysts who conduct tabular and trend analysis of regional activities. Data specialists write programs extracting stored information; analysts add state data and refine results into aggregated tables and graphs. Finally, the cartographer maps some elements for presentations. A lower-cost, faster, automated self-service map and data system holds the promise to improve the planning of services and care for populations who receive care from the system.

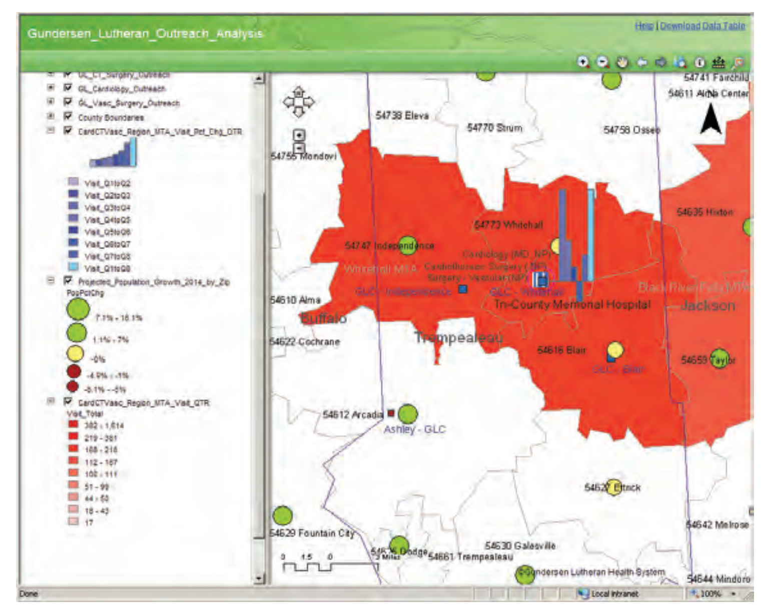

Figure 1. Cardiology/Cardiothoracic Surgery/Vascular Surgery outreach visit activity with quarter-to-quarter percent change, overall period (12-quarter) visit volume, and population growth symbolized in a 2 ZIP code regional hospital service area.

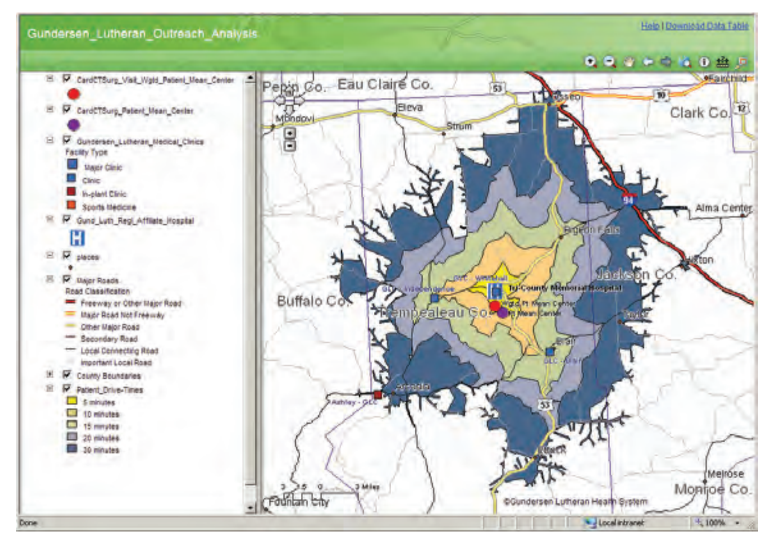

Figure 2. Website representation of Whitehall, Wisconsin, patient average drive-time rings to the Gundersen Lutheran clinic, with Cardiology/Cardiothoracic (CT) Surgery outreach visit count-weighted patient mean residence center, and Cardiology/Cardiothoracic (CT) outreach patient mean residence center, for 149 patients. Note the extended average drive times vs short distances in this topographically steep area.

The Process

The project uses ArcGIS tools, including ArcMap, ArcGIS Server (ArcSDE), and ArcGIS Business Analyst, by Esri, a leading GIS software vendor,[1] with installations in all levels of government, science, and industry worldwide. These tools are compatible with open source (non-copyrighted system) databases as well as major commercial databases (eg, Oracle, DB2, SQL Server)[2] and fit well in health care information systems departments. A number of E911 and computer-aided dispatch emergency medical transportation solutions, such as RescueNet

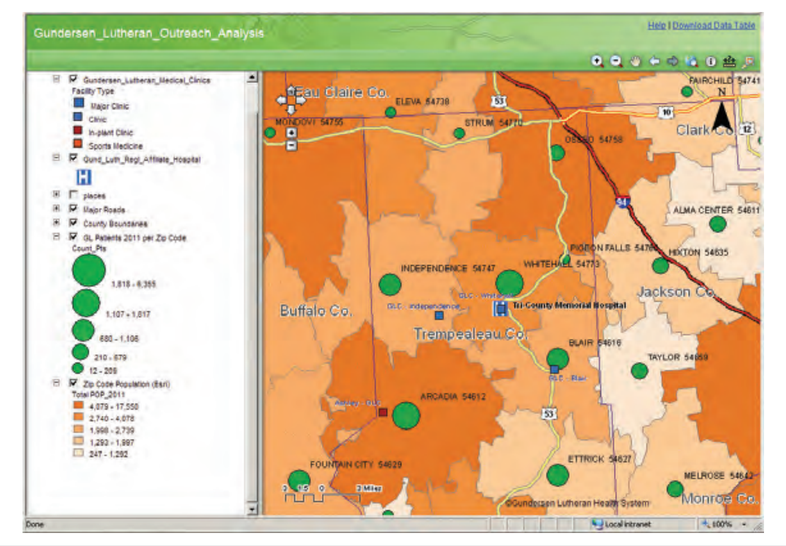

Figure 3. Website representation of Whitehall, Wisconsin area 2011 (Esri) ZIP code total population with Gundersen Lutheran total patient population 2011 per ZIP code.

Dispatch by Zoll Medical Corporation,[3] are built on the Esri ArcGIS platform.

The description of a GIS, "a relational database with a sense of space," summarizes these software tools' capabilities for organizing, processing, analyzing, and symbolizing spatially related data. Thus, 'geo-' processing operations bind the aggregated de-identified patient data to the specific areas under analysis and make that data available for symbolizing and interpretation in the online map.

The immediate audience for these geographic tools includes research analysts, clinical care program directors, department chairs, marketing leaders and analysts, regional leaders, and system leadership. This team identifies optimal local relationships that support integrated (clinic-hospital) care, efficient resource deployment, affordable costs, and foremost, improve patient health.

State, county, city, and postal code boundaries with demographic data, and transportation and water features underpin the application. Other important data include health system locations—the medical center, outpatient surgical centers, regional hospitals, affiliated nursing homes, and clinics. These data appear as differentiated points defining a clinician's home location. Outreach providers (including telemedicine) will appear at appropriate clinics and appear by specialty and frequency.

Visit volume and trend by outreach location and clinical care program comprise layers in rolling 12-quarter total periods. All de-identified patient visits, either inpatient or outpatient, in a service area (regardless of patient residence), procedures and aggregated total charges, with trended volumes, and trended changes in volume, are applied to the service area. In addition, visits volume per quarter (visits trend), with quarter-to-quarter percent change, are symbolized by small bar graphs (Figure 1).

Employers by type, location, and employee count, with insurance coverage source for large employers, and health maintenance organization coverage areas by county are also important. Any relevant numeric data of interest can be symbolized geographically, gated by importance, availability, cost, and time. Map interface and legend will vary by key question, displaying relevant layers and symbology.

Three primary data sources support the project. First is the system's data warehouse of de-identified patient data narrowed to age, gender, ZIP code, provider, relevant diagnosis group (specialty), visit location, procedure location, and total charges. Second is state data via Wisconsin Hospital Association[4] with Minnesota Hospital Association[5] data-sharing for eastern border and metropolitan counties, and Iowa Hospital Association [6] via Thomson Healthcare.[7] Third, standard map layers via Esri anchor known reference points, features, and boundaries.

Use of the GIS System

This application, when complete, will provide decision makers, research analysts, clinical care program leaders, and regional leaders access to data and maps in a self-service mode. Present development primarily supports current outreach viability. De-identified patient encounters as visits, procedures, and charges in a 12-quarter span will flow from the data warehouse, and state data will flow from the hospital associations via the data vendor, into an intranet website whose map interface and legend are determined by the user. Accompanying standard format downloadable data tables will speed statistical and graphical analysis and will directly address expected data skeptics' questions. Choices on how to allocate resources to better serve patients still may involve lively debate but will be better informed by facts.

DISCUSSION

Health systems considering the use of GIS programs to complement existing operational performance research efforts require investment in someone trained in GIS from a geography or computer science background. In addition to GIS desktop and server software and dedicated server hardware, a successful GIS program requires support from information systems and operational leadership.

Without relevant data, or where there is geographic uncertainty, skepticism and historical anecdotes reign and improvement is often delayed.[8] In essence, GIS visual data enhances the decision process that bears directly on patient care. To do so requires leadership confidence in the quality and value of the information.

As Gundersen Lutheran invests more in geographic information technology, the system should provide insight that simplifies and augments understanding of complex outreach data. One of the system's most notable strengths stands as its ability to deliver superior care to an increasingly Medicare-funded patient base at affordable cost. The GIS clinical information tool will help manage this present day rural health care challenge for patient well-being.

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Digital Ischemia as a Paraneoplastic Consequence of Squamous Cell Lung Carcinoma

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Jeffrey M. Resnick, MD; Jessica Engel, MSN, AOCNP

ABSTRACT

We report the case of a 40-year-old man who presented with digital ischemia and squamous cell lung carcinoma. Based on review of the literature, to our knowledge this case represents the youngest patient with lung carcinoma associated with digital ischemia and the only one with this type of tumor. The patient's digital ischemia symptoms improved rapidly with systemic chemotherapy; however, he did eventually lose the distal portion of 1 finger to dry gangrene and mummification.

INTRODUCTION

Digital ischemia as a paraneoplastic syndrome of lung carcinoma is an unusual finding. It may be a complication of its own or may be associated with paraneoplastic Raynaud's phenomenon. Only 13 cases of digital ischemia, or paraneoplastic Raynaud's phenomenon accompanied by digital ischemia, in association with lung carcinoma were found during a review of the literature utilizing PubMed and OVID and the search terms "lung carcinoma," "Raynaud's phenomenon," "digital ischemia," and "paraneoplastic." We report a patient who, based on the literature review, is the youngest patient to date with digital ischemia associated with lung carcinoma and the only one with a squamous cell differentiation tumor type.

CASE REPORT

A 40-year-old white man with a 20-pack-per-year history of smoking initially presented with cough, fatigue, and decreased appetite. He was diagnosed with pneumonia by chest radiograph and treated with antibiotics without improvement. Two weeks later, the distal phalanxes of the fourth and fifth fingers of his left hand became bluish-colored with dyesthesia and pain (Figure 1). The temperature of these fingers was normal and peripheral pulses were palpable. There was no sign or history of arterial trauma and no known family or patient history of Raynaud's phenomenon. A venous Doppler ultrasound of the left arm was negative for deep vein thrombosis. No other sites of superficial ischemia were observed. His symptoms persisted, even with pain management with acetaminophen and hydrocodone (Vicodin) prescribed as needed. Three weeks after initial presentation, a computed tomography (CT) chest scan showed a 4.5-centimeter right-sided bronchial mass, complete obstruction of the bronchus, and collapse of the right upper lobe with bilateral hilar and mediastinal lymphadenopathy. Two days later, bronchoscopy with biopsy and brochioaveolar lavage was performed. The specimen, while demonstrating non-small cell carcinoma, did not allow for more precise classification of the tumor. Subsequently, sputum cytology was collected, reviewed by a cytopathologist, and ultimately revealed a squamous cell carcinoma (Figure 2). Positron emission tomography/CT (PET/CT) scan 1 week later showed a right lung mass (standardized uptake value [SUV] >10) extending into the mediastinum and mildly increased activity in dorsal and lumbar vertebral bodies and the pelvis (SUV 3.5).

The patient presented for an oncology consult the next day. Based on the PET/CT, which indicated bone metastases, he was diagnosed with stage IV non-small cell lung carcinoma (NSCLC). A thrombophilia workup to determine hypercoagulability state was performed. Tests for cryoglobulin, antiphospholipid antibody, antinuclear antibody, anticardiolipin antibody, and lupus anticoagulant all were negative, and homo-

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CME available. See page 142 for more information.

cysteine level was normal. However, erythrocyte sedimentation rate was elevated at 29 mm/hr (range 0-13 mm/hr).

Based on the diagnosis of stage IV NSCLC, the bluish discoloration, dyesthesia, and pain in the patient's fourth and fifth fingers of his left hand were determined to be most likely due to paraneoplastic digital ischemia localized to those fingers of the left hand. There have been reports in other patients with paraneoplastic digital ischemia that the ischemia often improves with initiation of treatment for the associated malignancy.[1-7] The patient began chemotherapy without any additional conventional treatment for digital ischemia, such as calcium channel blockers, aspirin, steroids, or anticoagulation. Since the initial bronchoscopy biopsy specimen did not allow for typing of the malignancy as either squamous or adenocarcinoma, and based on review of the literature indicating that NSCLC digital ischemia has been reported only in association with adenocarcinoma, the patient initially was treated with a chemotherapeutic regimen for stage IV lung adenocarcinoma with bone metastases.

The patient received his first cycle of systemic chemotherapy consisting of carboplatin, paclitaxel, and bevacizumab 1 week after biopsy and 1 day after the oncology consult. Within 2 days of receiving chemotherapy, he reported improvement in his symptoms as well as in the appearance of his fingers (Figure 3). A bone scan performed 5 days after the oncology consult was negative for metastatic disease.

The patient received a total of 4 cycles of chemotherapy consisting of paclitaxel (175 mg/m^2), carboplatin (AUC of 6), and bevacizumab (15 mg/kg) every 3 weeks. He had near complete remission, and the discrepancy between the PET/CT scan and bone scan was judged in favor of the negative bone scan, especially since he had never had any bone pain. At this point, his staging was revised to IIIB, and he subsequently had additional therapy with paclitaxel (45 mg/m^2) and carboplatin (AUC of 2) weekly, concurrent with radiation therapy (63 Gray cumulative dose, 35 total fractions) to the right lung tumor region and regional lymph nodes for 6 weeks. He had complete or near complete resolution of the right upper lobe lung mass.

Five months later, a follow-up CT of the chest, abdomen, and pelvis unfortunately showed recurrence of the right upper lobe mass. He began chemotherapy with docetaxel (75 mg/m^2) and carboplatin (AUC of 6) to be given every 3 weeks for a total of 3 cycles. An examination of his left hand after the first chemotherapy cycle revealed that the fifth finger had recovered completely; however, he eventually lost the distal portion of the fourth finger to dry gangrene and mummification (Figure 4).

A CT chest scan following the 3 cycles of docetaxel and carboplatin showed progression of the lung carcinoma. He began chemotherapy with pemetrexed (500 mg/m^2) with gemcitabine (1000 mg/m^2) and bevacizumab (15 mg/kg) for 3 cycles. Another CT chest scan showed further progression of the lung carcinoma, so he was given oral erlotinib (150 mg daily) for 7 weeks. Follow-up CT chest scan revealed continued progression of the lung carcinoma, so the patient chose palliative hospice care. No recurrence of digital ischemia or paraneoplastic Raynaud's phenomenon occurred. Unfortunately, the patient died 2 months later.

Figure 1. Appearance of the fourth and fifth fingers of the left hand during initial exam.

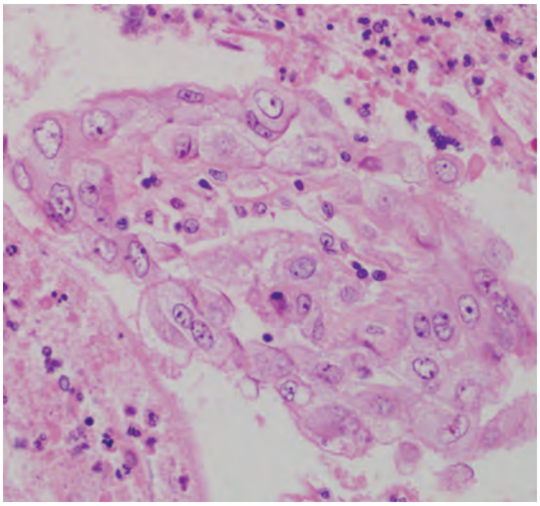

Figure 2. The sputum cytology specimen reveals cohesive groups of atypical cells with squamoid features, indicative of squamous cell carcinoma (hematoxylin and eosin, high magnification).

DISCUSSION

Paraneoplastic findings such as syndrome of inappropriate antidiuretic hormone secretion, Eaton-Lambert myasthe-

Figure 3. Improvement in the appearance of the fourth and fifth fingers of the left hand two days after initiation of chemotherapy.

Figure 4. Eventual loss of the distal portion of the fourth finger of the left hand; the fifth finger recovered completely.

nia syndrome, thrombosis, dermatomyositis, eosinophilia, and hypercalcemia are not uncommon in lung carcinoma.[8] However, digital ischemia in association with lung carcinoma remains an unusual and rare paraneoplastic manifestation, as it has since first reported in 1884 by O'Connor.[6,7,9] Also, when associated with a malignancy, digital ischemia may be a complication of its own, or it may be associated with a form of Raynaud's phenomenon.

Classic Raynaud's phenomenon is characterized by recurrent, reversible episodes of vasospasm that causes symmetrical cold-induced pallor and/or cyanosis of the distal portions of the fingers and toes.[4,7,10] It is relatively common, with a prevalence of 3% to 5% in the general population, yet it predominantly affects young women.[4,7,11] In approximately 87% of cases, it is an isolated phenomenon and rarely progresses to necrosis.[4,7] For the initial appearance of vasospasm, cold-induced pallor, and/or cyanosis, the first line of treatment should limit the use of vasoconstrictor drugs and have the patient avoid smoking and keep their hands and feet warm. If these symptoms persist and/or worsen, non-pharmacological treatments such as acupuncture, biofeedback therapy, botulinum toxin A injections, and low-level laser therapy also may be useful. The most common pharmacological treatment is calcium channel blockers, with other vasodilator drugs used in patients who do not respond well to these. The use of both pharmacological treatment and interventional techniques (eg, sympathectomy) is recommended in patients with ischemic conditions.

Paraneoplastic Raynaud's phenomenon is another form of Raynaud's phenomenon that is associated with malignant conditions. It differs from classic Raynaud's phenomenon and is a more rare condition. The average age of occurrence is 53 years, and it affects both sexes, although with an increased incidence in males (30%).[7,11] The onset of paraneoplastic Raynaud's phenomenon occurs over a short time period, and there are no reports of it being associated with the presence of antinuclear and antiphospholipid antibodies.[5,7,10] Asymmetrical involvement of the digits is a common occurrence, and more than 80% of the time it progresses to ischemia, necrosis, pulp atrophy, and gangrene.[7] Fortunately, many cases of paraneoplastic Raynaud's phenomenon will resolve following treatment of the malignancy with chemotherapy, radiotherapy, and/or surgery.[5,11]

The possible pathophysiologic mechanisms of digital ischemia, paraneoplastic Raynaud's phenomenon, and even classic Raynaud's phenomenon are not completely understood, with some postulated mechanisms remaining controversial.[3,4,7,10] Some possible mechanisms may include cryoglobulinemia, vasospasm with predominant vasoconstriction, arteritis and/or vasculitis, and hypercoagulability (eg, thrombocytosis, platelet aggregation, elevated fibrin products),[2-4,6-10,12] and multiple mechanisms could be involved in a single case.[11] These mechanisms could be induced by an increase in circulating blood proteins (eg, cryoglobulins), the deposit of tumor antigen-antibody complexes causing complement activation, tumor secretion of hormones, peptides, cytokines, or membrane phospholipids, and cross-reactivity between tumor and nonmalignant tissues.[3,7-10,12]

Among cases of lung carcinoma, most paraneoplastic syndromes are reported in relation to small cell lung carcinoma (SCLC) histology, while paraneoplastic Raynaud's phenomenon with or without digital ischemia, when reported, is more often a consequence of NSCLC.[1,3,4,6,8,13,14] Of 13 reported cases of digital ischemia and/or paraneoplastic Raynaud's phenomenon associated with lung carcinoma found in the literature, plus our patient's case, 10 of 14 (72%) had NSCLC, and 3 of 14 (21%) had SCLC, with 1 of 14 (7%) unknown.[1-7,13-17] The male to female ratio was 2.5:1, and the age range in males was 40 to 78 years, while the female range spanned 52 to 65 years of age. Most of the reported cases (72%), including our patient, presented with digital ischemia (or paraneoplastic Raynaud's phenomenon) prior to diagnosis of lung carcinoma, with a range of 15 days to 1 year.[1-3,5-7,13,16,17] There were 3 patients (21%) who presented with paraneoplastic Raynaud's phenomenon and/or digital ischemia after the diagnosis, with a range of 2 to 6 months.[4,9,15] There was no dating in one of the cases.[14]

Most of the cases had extensive laboratory and radiological evaluation for digital ischemia. Positive but nonspecific findings included elevated antinuclear antibodies, erythrocyte sedimentation rate, C-reactive protein, abnormal cryoglobulin, and direct Coomb's test, suggesting an autoimmune etiology. Ischemic symptoms improved as the underlying malignancy was treated.[1-7] Other treatments, such as calcium channel blockers, aspirin, steroids, vasodilators, heparin, and prostacyclins[1,4,6,7,9,13] seemed less effective, and most patients with favorable outcomes started responding significantly only after the underlying malignancy had been treated with antineoplastic agents or radiotherapy. The 2 patients who did not receive the appropriate therapy for their malignancy progressed to digital gangrene.[13,14]

Compared to the 13 other cases of paraneoplastic Raynaud's phenomenon and/or digital ischemia in association with lung carcinoma reported in the literature, our patient is the youngest and the only one with squamous differentiation.[1-7,13-17] The exact mechanism that produced his digital ischemia may never be explained, however, it most likely was due to the lung carcinoma. The nearly continual use of chemotherapy may explain why there was no recurrence of digital ischemia.

In conclusion, we believe evaluation for malignancy should be considered in smokers, elderly patients, or individuals with constitutional symptoms with unexplained or sudden onset of digital ischemia (and/or paraneoplastic Raynaud's phenomenon). Also, prompt treatment for such malignancy may prevent digital malady.

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Quiz: A Case Report of Digital Ischemia as a Paraneoplastic Consequence of Squamous Cell Lung Carcinoma

EDUCATIONAL OBJECTIVES

1. Understand the differences in presentation of classic in contrast to paraneoplastic Raynaud's phenomenon.
2. Describe the treatment modalities that have been employed for paraneoplastic Raynaud's and which are more likely to be effective.
3. Recognize when paraneoplastic Raynaud's phenomenon should be considered in a patient who presents with digital ischemia.

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QUESTIONS

1. Classic Raynaud's phenomenon differs from paraneoplastic Raynaud's by the following features:
   - ☐ a. Classic Raynaud's often appears in younger individuals, often women, while the paraneoplastic variety appears in older individuals, often male.
   - ☐ b. the classic form often progresses to digital necrosis.
   - ☐ c. both varieties often respond well to calcium channel blockers.
   - ☐ d. a and c only
   - ☐ e. a, b, and c.

2. Paraneoplastic Raynaud's is often insidious and usually is diagnosed after the neoplasm has been diagnosed.
   - ☐ true
   - ☐ false

3. With lung carcinoma, while most paraneoplastic syndromes (eg, inappropriate syndrome of antidiuretic hormone, hypercalcemia, Eaton-Lambert myasthenia gravis) are associated with small cell carcinoma histology, paraneoplastic Raynaud's phenomenon is more often a consequence of non-small cell lung carcinoma.
   - ☐ true
   - ☐ false

4. The most favorable outcomes for paraneoplastic Raynaud's phenomenon appear to be treatment of the underlying malignancy with antineoplastic agents or radiotherapy.
   - ☐ true
   - ☐ false

• • •

You may earn CME credit by reading the designated article in this issue and successfully completing the quiz (75% correct). Return completed quiz to *WMJ* CME, 330 E Lakeside St, Madison, WI 53715 or fax to 608.442.3802. You must include your name, address, telephone number, and e-mail address.

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Joy R. Tapper, MPH

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Milwaukee Health Care Partnership improves coverage, access, and care coordination for underserved

Joy R. Tapper, MPH, and Joseph E. Kerschner, MD

The important job of improving health care for the most vulnerable populations in Milwaukee County has engendered collaboration among area health care providers. The Medical College of Wisconsin is a proud member of the Milwaukee Health Care Partnership (Partnership), which comprises all 5 health systems in Milwaukee County, 4 federally qualified health centers (FQHCs), multiple public agencies, and collaborating organizations.

This level of commitment, modeled by the active leadership of each organization's most senior executive and coalescing around the complex and costly responsibility of caring for the uninsured and underserved, is uncommon if not unprecedented in the nation. Established in 2006, the Partnership endeavors to improve coverage, access and care coordination for medically underserved Milwaukee County residents. This population is defined as those covered by government insurance programs and uninsured individuals with incomes below 200% of the federal poverty level. Currently, 45% of county residents are vulnerable by these standards.

Our work, consequently, has been urgent and ongoing. Among the more significant actions taken thus far, the Partnership has helped subsidize the FQHCs and supported a network of more than 30 other safety net clinics. In collaboration with the state of Wisconsin Department of Health Services (DHS), it has assisted in the design and growth of Medicaid programs for low income children, families, and childless adults, representing a 20% expansion of coverage since 2008.

The Partnership has conducted multiple studies that have led to community-wide plans and tangible improvements. In response to a primary care access study, Milwaukee's FQHCs increased their capacity by increasing hours of operation, recruiting new providers, and expanding scope of services, yielding more than a 9% increase in utilization. A community-wide study of the county adult mental health system led to expanded behavioral health access to private hospitals, representing more than 4000 patient transfers annually. A medication access needs assessment led to acquisition of grant funding that provided more than 3500 low-income patients with free prescriptions.

> Collaborators have developed a host of innovative initiatives … to manage the complicated issues faced by underserved patients and providers seeking to address their needs.

Members of the Partnership have made major financial investments as well. They have secured more than $12 million in new funding, 80% of which has been contributed by the health systems. This is remarkable, considering that these systems already collectively provide $424 million annually in charity care, community investments, and Medicaid shortfalls.

Collaborators have developed a host of innovative initiatives within the Partnership to manage the complicated issues faced by underserved patients and providers seeking to address their needs. By way of example, the Specialty Access for Uninsured Program (SAUP) and Emergency Department Care Coordination Initiative are particularly unique approaches to critical problems in our communities.

• • •

Ms Tapper is executive director of the Milwaukee Health Care Partnership; Dr Kerschner is dean of the medical school and executive vice president of the Medical College of Wisconsin.

Access to specialty care is considered one of the most intractable issues in caring for the underserved. Low-income, uninsured adults often delay care or seek specialty care through emergency departments (EDs) because of the barriers they face. Safety net primary care clinicians often must negotiate with individual specialists and hospitals to get the consults, tests, and procedures they need.

Currently in pilot phase, SAUP is designed to ensure timely, clinically appropriate, and managed care that is equitably distributed among specialists and health systems. Participation requires a patient to be established at a FQHC or member primary care safety net clinic. Each clinic is matched to one or more partner hospitals to equalize workload and financial burden while affording increased communication, improved efficiency, and enhanced clinical care coordination. The hospitals are working to develop a network of specialists to serve the SAUP patients, and customary, non-elective treatment is covered.

Standardization of referral, registration, and accounting processes maintain consistency across partners, and thorough outcomes measurement and program evaluation will determine the long-range direction of the program.

The Emergency Department Care Coordination Initiative (Initiative) exists to decrease avoidable ED visits and related hospitalizations, reduce duplicative tests and procedures, and connect high-risk individuals with medical homes. In 2010, 46% of emergency department visits in Milwaukee County were classified as non-emergencies, and Medicaid and uninsured patients accounted for 68% of those visits.[1]

To make a difference, the Initiative created an "ED to Medical Home" process used among 9 Milwaukee County EDs and the 4 FQHCs. Physicians and case managers in the EDs identify patients, educate them regarding proper ED use, schedule primary care appointments, and make referrals to medical homes while the FQHCs reinforce these messages. The Initiative also utilizes the Wisconsin Health Information Exchange, which provides a secure way to access patient encounter history at the point of care to enhance clinical decision making.

Promising results have followed. In 2011, Milwaukee EDs scheduled more than 7600 appointments with area safety net clinics for qualifying patients. Of those patients, 42% attended their initial appointment while 45% returned for a second appointment within 6 months. If we can continue to reduce unnecessary ED utilization while increasing primacy care access, we will have relieved the local health care system of large burdens while improving overall public health.

All evidence indicates the Milwaukee Health Care Partnership is creating a winning environment for patients and clinicians. As Milwaukee continues to look for solutions to a more effective urban health care platform, we must continue these efforts as partners in the quest for a greater good.

In addition to the Medical College of Wisconsin, Partnership members include Aurora Health Care, Children's Hospital & Health System, Inc., Columbia St. Mary's, Froedtert Health, Wheaton Franciscan Healthcare, Milwaukee Health Services, Inc., Outreach Community Health Centers, Progressive Community Health Centers, Sixteenth Street Community Health Center, City of Milwaukee Health Department, Milwaukee County Department of Health & Human Services, Wisconsin Department of Health Services, Medical Society of Milwaukee County, Milwaukee Free Clinic Collaborative, Wisconsin Collaborative for Healthcare Quality, Wisconsin Health Information Exchange, Wisconsin Hospital Association, and Wisconsin Primary Health Care Association.

Reference

1. Emergency Department Care Coordination Report. Milwaukee, Wis: Center for Urban Population Health. March 2012.

MetaStar Aids Physicians in Adoption and Use of EHRs for Quality Improvement

Jay A. Gold, MD, JD, MPH

Electronic health records (EHRs) have multiple advantages, including the potential for higher quality care, improved health outcomes, and increased efficiencies. EHRs can make it easier for patients to access their health care information and for discrete health care organizations to coordinate care. To capture and share patient data efficiently, physicians need an EHR that stores data in a structured format. Structured data allow patient information to easily be retrieved and transferred so that physicians can use the information to benefit the patient. EHRs also can make reporting easier than when using a paper tool, which potentially can support greater population health.

Recognizing that EHR technology is a key tool in health care transformation, MetaStar is working in several areas to assist Wisconsin physicians with adopting and using this technology for quality improvement in their practices. A number of MetaStar's current projects are aimed at supporting physicians in the adoption and full use of EHRs.

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Doctor Gold is senior vice president and chief medical officer for MetaStar, Inc. This material was prepared by MetaStar, the Medicare Quality Improvement Organization for Wisconsin, under contract with the Centers for Medicare & Medicaid Services (CMS), an agency of the U.S. Department of Health and Human Services. The contents presented do not necessarily reflect CMS policy.

WHITEC

The Wisconsin Health Information Technology Extension Center (WHITEC) is a division of MetaStar. One of 62 Health Information Technology Regional Extension Centers in the country funded through a cooperative agreement with the Office of the National Coordinator for Health Information Technology, WHITEC provides subsidized services to primary care physicians, community health centers, and rural hospitals in Wisconsin. The WHITEC team of health IT specialists offers education, outreach, and technical assistance to assist providers in selecting, successfully implementing, and achieving meaningful use of certified EHR products.

For eligible professionals and hospitals who meet meaningful use requirements, the Centers for Medicare & Medicaid Services (CMS) is making available up to $27 billion in EHR incentive payments. Medicare-eligible professionals who do not meet the requirements for meaningful use by 2015 are subject to payment adjustments to their Medicare reimbursements that start at 1% per year, up to a maximum 5% annual adjustment. Because of this provision, it is ever more critical for providers to start working toward meaningful use now – earning incentives instead of assuming penalties.

WHITEC currently is working with nearly 1900 primary care providers in Wisconsin to help them adopt EHR technology and to achieve meaningful use Stage 1. The objectives in Stage 1 entail capturing patient data and sharing the data either with the patient or with other health care professionals. But this is the first of 3 stages, and the Stage 2 Notice of Proposed Rulemaking was released in late February of 2012. As set forth, Stage 2 builds upon the criteria of the first stage, increasing the threshold for performance of existing measures, and increasing requirements for patient engagement and health information exchange. WHITEC is working on the development of additional paid services for specialists, for those looking to achieve Stage 2 meaningful use, and for others.

Immunization Information Systems Innovation Pilot Project

MetaStar was one of two quality improvement organizations in the country selected by CMS for this pilot project, which offers free technical assistance for practices that wish to electronically report adult immunization data to the Wisconsin Immunization Registry (WIR).

WIR, operated by the Wisconsin Department of Health Services (DHS) and funded in part by the Centers for Disease Control and Prevention, collects immunization data from public and private health care providers to create complete records for individuals in the state. Providers can access and update vaccination information for their patients; they also can use this information to notify patients who are due or past due for vaccination. Public access can reduce the number of requests to providers for immunization records from their patients and can allow for better coordination of care. DHS recommends that providers offer this service to their patients and participate in efforts to eliminate vaccine-preventable diseases in Wisconsin. Adult vaccinations are particularly important because immunity can begin to fade over time, newer vaccines have been introduced over the years, age can make individuals more susceptible to serious diseases caused by infections, and some adults were never vaccinated as children.

MetaStar staff are providing free technical assistance and working with organizations' EHR vendors to set up interfaces between their EHRs and WIR and can help them establish electronic batch submissions. With well over 200 sites already recruited, MetaStar is committed to recruiting 400 sites by the end of September 2012. The processes developed in this project are expected to be spread to other states through guidance documents and to be incorporated into future work plans for other organizations across the country, with the goals of increasing efficiency, raising adult immunization rates, and supporting meaningful use of EHRs.

Quality Improvement Using HIT in Physician Offices

A major goal of the US Department of Health and Human Services' National Quality Strategy is better health for people and communities. One step toward achieving this goal is the best possible prevention and treatment of the leading causes of mortality. Health information technology (HIT) can assist physicians in this endeavor. Consistent with CMS's quality improvement priorities, MetaStar is partnering with physicians, patients, and the community to improve rates of immunizations and cancer screenings and to improve outpatient cardiovascular care.

The focus is on helping health care professionals use their EHRs to assist them with identifying and monitoring who needs to receive vaccinations or treatment interventions. MetaStar offers educational programming, best practices, peer-to-peer review, and intervention tools to assist in using an EHR to improve the use of preventive services and to help patients avoid preventable health care conditions. For example, interventions that include health information technology have the potential to improve immunization or mammography rates through timely notification of providers and patients when preventive care should be scheduled. EHRs can assist with monitoring and managing risk factors for cardiovascular disease such as hypertension or smoking status.

For physician practices with EHRs, MetaStar is assisting with activities related to the Physician Quality Reporting System (PQRS) and improving the use of EHR for care management. Such assistance is intended to promote effective use of health information technology in clinical practice and to help align PQRS reporting requirements with EHR incentives related to meaningful use.

Many of MetaStar's services are available to Wisconsin physician offices at no cost and are coordinated with the efforts of other organizations and initiatives, such as the national Million Hearts Campaign, to minimize demands on health care professionals' time and resources. MetaStar's charter for change incorporates bold goals for improving care, and we believe that EHRs can be a powerful mechanism in the hands of physicians and other providers in achieving these goals.

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