Detection and remediation of medically urgent situations using telemedicine case management for older patients with diabetes mellitus

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Introduction: Detection and response to medically urgent situations in patients with diabetes mellitus can improve the process and outcomes of care and potentially decrease morbidity and mortality. We examined the detection and remediation of medically urgent situations among older patients receiving telemedicine case management for diabetes.

Methods: In the setting of a randomized trial, 338 patients in the intervention group and living in upstate New York received a home telemedicine unit to transmit blood glucose and blood pressure values to a nurse case manager, videoconference with a nurse or dietitian every 4–6 weeks and access educational websites. The educators met with a supervising endocrinologist 4–5 times weekly and clinical recommendations were proposed to the primary care providers via mail, fax, or phone.

Results: Over a 36 month period, 67 medically urgent situations were identified and addressed (1.9 events/month). Some of these situations were potentially life-threatening, including major drug contraindications (N = 24), other medically urgent situations (N = 19), and medical urgent conditions (ie, unstable angina) (N = 24).

Conclusion: The interaction via telemedicine in rural upstate New York between patients with diabetes mellitus, a diabetes care team, and primary care providers can successfully identify and remediate medically urgent situations.

Keywords: telemedicine, diabetes mellitus, medically urgent situations

Introduction

The management of diabetes has been hindered by difficult access to comprehensive diabetes education and care programs. In rural areas, access to face-to-face care may be impeded by geographic distance, weather, lack of transportation, and provider shortages. In urban inner cities, with predominantly minority populations, obstacles to access include language, culture, low educational attainment, disempowerment, lack of support for health-related behaviors and activities, and provider shortages (Shea et al 2002). Telemedicine has the potential to overcome these barriers, improve access, and reduce disparities among sociodemographic groups. It may also improve quality of care, health outcomes, and health status (DHHS 2000). We have previously demonstrated that diabetes tele-education was as effective as face-to-face diabetes education in improving glycemic control and diabetes-related stress (Izquierdo et al 2003).

The Informatics for Diabetes Education and Telemedicine (IDEATel) project is a demonstration project evaluating the feasibility, acceptability, effectiveness, and cost-effectiveness of advanced computer and telecommunication technology to manage the care of Medicare beneficiaries with diabetes living in federally designated underserved areas (Shea et al 2002; Starren et al 2002). There is an urban component managed by Columbia University in New York City, NY and a rural component managed by SUNY Upstate Medical University in Syracuse, NY (Shea et al 2002). The main goal of the

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IDEATel study was to improve glycemic and blood pressure control, and lipid levels (Shea et al 2006). In this analysis another potential benefit was explored, namely detection and remediation of medically urgent situations.

The Institute of Medicine (1999) has stressed that preventable medical errors in hospitals exceed attributable deaths to motor-vehicle accidents, breast cancer, and AIDS. It recommended that patient safety be addressed in order to provide high quality medical care (IOM 2001). Other studies have demonstrated that medical errors are common in the elderly and in patients with diabetes and these are often preventable (Gurwitz et al 2003; Forster et al 2004).

Many medical errors stem from preventable adverse drug events. Studies have shown that more than 90% of persons aged 65 years and older take a least one medication per week. More than 40% take five or different medications per week (Gurwitz et al 2003). Gurwitz and associates (2003) reported that of 1523 adverse drug events, 6.8% were related to hypoglycemic agents in an elderly ambulatory population. They observed that 10.9% of 421 preventable adverse drug events were related to hypoglycemic medications. Others (Forster et al 2003) have noted that preventable medical errors were often due to therapeutic errors. Forster and associates (2003) defined therapeutic errors as the simultaneous use of medications known to interact adversely, the use of a therapy known to be contraindicated in a specific condition, and the failure to adequately monitor a treatment. This group concluded that interventions to decrease adverse medical events could include improved communication between patient and primary care provider, better coordinated home-care services when patients are discharged from the hospital, and frequent phone contact. They note that many elderly patients are frail and lack the ability to attend follow-up clinic appointments. Telemedicine is an intervention that could improve monitoring of these patients, enhance communication between patient and their primary care provider, and provide access to medical care.

Methods

Study design

The IDEATel project's research methods, rationale, design, and technical implementation have been previously described (Shea et al 2002; Starren et al 2002). Medicare beneficiaries with diabetes were recruited through their primary care physicians and were offered participation if they were ≥55 years of age, resided in federally-designated Medically Underserved Areas or Health Professional Shortage Areas in New York State, and fluent in either English or Spanish. All participants signed informed consent. Exclusion criteria were moderate or severe cognitive, visual, or physical impairment, or the presence of severe comorbid disease. Subjects were randomized to receive the telemedicine intervention or usual care.

Intervention

The telemedicine intervention subjects received a home telemedicine unit (HTU), which consisted of a web-enabled computer with modem connection to an existing telephone line. The HTU had four capabilities: (1) a video camera and microphone that allowed for videoconferencing with a nurse case manager and dietitian; (2) a home glucose monitoring device and a blood pressure (BP) monitoring device with connections to the HTU for uploading home fingerstick glucose and blood pressure readings; (3) access to patients' own clinical data through graphic and other data displays; and (4) access to educational websites created for participants in the project. Subjects were trained individually on the use of the HTU.

The nurse case managers were also trained in diabetes management (most were certified diabetes educators) and in the use of computer-based case management tools to facilitate interactions through videoconferencing with patients. Case managers interacted with patients using the home telemedicine unit and case management software (Version 2b of the Veterans Health Administration Clinical Practice Guidelines for the Management of Diabetes Mellitus in the Primary Care Setting [VHA 2000]). Televisits were scheduled every 4–6 weeks. The primary care physicians of the intervention patients retained full responsibility and control over their patients' care. The case managers met daily with an endocrinologist to discuss the management of these patients. The record of each visit included the patients' medications, BP and glucose readings, and clinical recommendations for change in management if needed. These notes were forwarded to the primary care provider by mail, fax, or phone. For clinical recommendations that the team felt were particularly important and urgent, the primary care provider was called by telephone. For recommendations that were important but not urgent, a directed interactive letter was faxed. This letter offered the option for the primary care provider to fax back a response. This analysis includes study participants in the upstate New York region only.

Medically urgent events

For subjects in the Upstate region, we recorded events that were classified as medically urgent. These events were

categorized into six groups: (1) identification of inappropriate medications or medication dose; (2) identification of inappropriate timing of insulin or other glycemic control medications which could result in significant hypoglycemia or hyperglycemia; (3) identification of contraindication to current medication, which included use of metformin when the creatinine was greater than 1.4 mg/dl in females and 1.5 mg/dl in males, and use of thiazolidinediones (TZD) in American Heart Association class III and IV congestive heart failure; (4) identification of adverse events related to medications, which included medical events such as decompensation of congestive heart failure when a TZD was added; (5) identification of acute medical conditions requiring immediate treatment, such as chest pain and sudden onset of dyspnea; and (6) identification and treatment of serious hypoglycemia, defined as a fingerstick glucose less than 60 mg/dl that was undetected by the patient or requiring the assistance of another person.

These medically urgent events were identified during the patient-nurse home televisit by one of three diabetes educators, and discussed during the daily medical conferences between the three diabetes educators and supervising endocrinologist or upon review of the completed office visit note by the endocrinologist prior to transmission to the primary care provider. The endocrinologist and case managers had access to patient laboratory data, such as serum creatinine and liver function tests. Incorrect doses, time of medications, adverse effects, and contraindications of medications were defined by comparing patient's current medication information found in the Physician Desk Reference, VHA Clinical Practice Guidelines (VHA 2000) and Consensus Statements of American Diabetes Association (ADA 2005). Miscommunication errors between patient and the primary care providers were identified and corroborated with the primary care provider. The diabetes team (board certified endocrinologist, two diabetes nurse educators, and a dietician) determined whether a specific event met the criteria for one of the described six categories discussed above and whether it was considered to be medically urgent or the intervention to be potentially life saving.

Medically urgent situations were brought to the attention of the primary care medical provider by phone if immediate action was necessary or by faxed letter detailing the event and requesting a response. Approximately 50% of the primary care providers gave written permission for the diabetes team to adjust doses of insulin and other glycemic control medications directly. Such actions were followed by faxing this information to the patient's primary care providers for immediate review.

Results

The rural upstate New York cohort of IDEATel consisted of elderly individuals (mean age 71 years) who were 57% female. The majority had an annual household income of < $20,000 and at least some high school education. The mean A_1C was 7.0% at baseline and 28% used insulin. Only 154 out of the 338 subjects had A_1Cs >7% (Table 1).

Over a 36 month period, 67 medically urgent events were identified and addressed (Table 2). The interaction between the participant and the diabetes care team, and then with the primary care provider, led to intervention for these potentially life-threatening medical conditions at an average rate of 1.9

Table 1 Baseline demographic and clinical characteristics of participants in the upstate IDEATel cohort (percentages are given except for Hemoglobin A1c)

Characteristic	Upstate New York
Age at randomization (years)	
55–64	13.1
65–69	30.6
70–74	25.7
75–79	17.4
>79	13.1
Sex	
Male	43.0
Female	57.0
Race/Ethnicity	
African-American (non-Hispanic)	7.1
Hispanic	1.3
White (non-Hispanic)	91.5
Other	0.1
Education (years)	
0	0.1
1–11	36.6
12	37.9
>13	25.4
Data missing	0.0
Annual household income (dollars)	
<5,000	2.9
5,001–10,000	16.7
10,001–20,000	33.1
20,001–30,000	20.6
30,001–40,000	7.5
>40,000	9.7
Data missing	9.4
Diabetes treatment	
Pills alone	66.4
Insulin alone	14.0
Insulin and pills	13.8
Diet alone	5.5
Data missing	0.2
Hemoglobin A1c (%)	7.0%
% in subgroup with A1c ≥7% at baseline	45.5%

Table 2 Potential adverse events requiring clinical intervention in the Upstate New York Cohort of IDEATel over a 36-month period

Corrected inappropriate medication dose	8
Corrected inappropriate timing of insulin or antidiabetes medication	11
Identified contraindication to current medication	24
Identified new diabetes or medication complication	2
Identified acute medical condition immediate treatment	15
Serious hypoglycemia identified and treated	7
Total	67

interventions per month. In 11 participants, errors were corrected in the timing of the dose of insulin or oral glycemic control medication. For example, in 10 participants, the nurses found that short-acting lispro or regular insulin was being administered significantly after the meal instead of before or with the meal, thus leading to desynchronization of the peak insulin action with peak glycemia and creating the potential for hypoglycemia.

Contraindications to a currently used medication were identified in 24 participants. Most of these consisted of the use of metformin when the patient's creatinine was greater than 1.5 mg/dl in males or greater than 1.4 mg/dl in females. The use of metformin in individuals with significant renal impairment places them at increase risk for the development lactic acidosis, a rare but serious complication of metformin therapy. Eight of the 24 subjects taking contraindicated medications involved the administration of TZDs in patients with congestive heart failure. TZDs are contraindicated in patients with class III and IV heart failure. Several of these patients had multiple admissions for congestive heart failure, which did not recur after the TZD was discontinued per the recommendations of our intervention team.

In two patients we identified adverse events related to medications. One subject had significantly elevated liver enzymes (ALT and AST) while taking pioglitazone, atorvastatin, and fenofibrate. The second patient, who was insulin-requiring, was having frequent, serious hypoglycemia. This subject had hypoglycemia unawareness, a condition in which the patient does not have the typical warning signs of hypoglycemia and so was at risk for the more serious complications of hypoglycemia, such as seizure or syncope. By adjusting the insulin doses, hypoglycemia did not recur and the patient regained his hypoglycemic awareness (Cryer 2004).

In 15 participants we identified an acute medical condition requiring immediate treatment. During one televisit, the nurse educator noted serious acute gastrointestinal complaints and called the primary care provider (the subject was not planning to call for help). Further evaluation revealed that patient had severe gastrointestinal bleeding, requiring admission to an intensive care unit. She recovered and was able to return home. Another participant reported chest pain and dyspnea during a televisit. Subsequent evaluation through the primary care physician revealed unstable angina and the patient underwent emergent cardiac catherization with angioplasty and stenting.

In seven patients, serious, recurrent hypoglycemic episodes were identified and treated. In three patients, significant psychosocial issues were identified. One patient could not afford to purchase his medications. In another case, the patient did not have enough money to purchase food and was experiencing hypoglycemia from not eating. For both individuals, appropriate social services were arranged. A third case consisted of a referral to public health services for a patient who was nonadherent to his medical regimen because of previously undiagnosed depression and alcohol abuse.

There was no evidence that the diabetes team contributed to adverse events or medical errors, either through wrong advice or communication failures.

Discussion

In this study, home televisits with a nurse case manager and dietitian at the Joslin Diabetes Center at SUNY Upstate Medical University in Syracuse were conducted with patients residing over a 30,000 square mile area. The diabetes case management delivered using telemedicine was able to identify, and in collaboration with the primary care provider, correct or treat a significant number of potentially life-threatening medical errors and conditions. The video component of the telemedicine visit was important in identifying and assessing the acuity of specific medical decompensation, which may not be evident by phone contact alone.

Many patients with diabetes are unable to attend comprehensive diabetes education and management programs and have a limited number of interactions with their health care providers because of poor access. The primary care providers have only 10–15 minutes on average with each patient at each visit. The majority of our patients have at least three chronic diseases and multiple complaints, making it difficult to address all their diabetes needs in a single short follow-up visit. With the proliferation of new medications for the comprehensive treatment of diabetes and its complications, it is also difficult to remain current with all recommendations and potential drug interactions and contraindications.

Gurwitz and colleagues (2003) found that adverse drug events are common among older persons in the ambulatory clinical setting and more than a quarter were preventable. The more serious adverse drug events were more likely to be preventable. Errors involving glycemic control medications especially insulin are especially common (Gurwitz et al 2003). The Institute of Medicine (1999) has pointed to studies that have shown that 44,000 to 98,000 Americans died each year from medical errors. Types of medical errors include diagnostic errors (error or delay in diagnosis), treatment errors (error in the dose or method of using a drug, inappropriate care), preventive errors (failure to provide prophylactic treatment, inadequate monitoring or follow-up of treatment), and other types of errors (failure of communication). The report recommended a four-tiered approach to achieving a better safety record. One of the tiers described included the implementation of safety systems in healthcare organizations to ensure safe practices at the delivery level. Diabetes case management via telemedicine has the ability to contribute to this goal by improving communication between primary care providers and their patients, improving adherence through patient education and empowerment, and by improving access to timely diabetes care for patients in medically underserved areas.

Our study had several limitations. Although this was a randomized study, we did not have a reliable mechanism to identify medically urgent situations in the usual care (control) group. In addition, the majority of our patients had satisfactory glycemic control and did not require insulin therapy. Insulin therapy would be expected to be associated with higher rates of errors. Another limitation was that we had one group of observers who classified and categorized these events.

It is important to note that the study involved over 200 unaffiliated primary care providers, most of who use paper medical records. Electronic collection of prescription data was not possible. Some medical errors may have been prevented if all the primary care providers used electronic medical record systems. The medication contraindications detected by our group were primarily due to lack of awareness by the primary care physicians. Many, for example, were unaware that TZDs can worsen congestive heart failure. A significant percentage of the errors in the dosing of medications or inappropriate timing of insulin were due to lack of diabetes education or understanding by the patients, which was ameliorated by the diabetes nurse case managers.

We conclude that telemedicine that provides access to a trained and experienced diabetes care team to patients who do not routinely have such access can be helpful in detecting medically urgent situations in the elderly with diabetes. This finding has significant implications for the management of diabetes in high risk individuals who lack adequate access to comprehensive diabetes services. Further investigations are needed to better evaluate the use of new technologies to improve the quality of medical care in individuals with diabetes as well as other chronic diseases.

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References

[ADA] American Diabetes Association 2005. Clinical practice recommendations 2005. *Diabetes Care*, Suppl 1.

[ADA] American Diabetes Association. 2005. National diabetes fact sheet [online]. Accessed January 20, 2006. URL: http://www.diabetes.org/diabetes-statistics/prevalence.jsp.

Cryer PE. 2004. Current concepts: diverse causes of hypoglycemia-associated autonomic failure in diabetes mellitus. *N Engl J Med*, 350:2272–9.

[VHA] Department of Veterans Health Affairs. 2000. Veterans Health Administration Diabetes Program. VHA clinical practice guidelines for the management of diabetes mellitus in the primary care setting, updated May 2000 [online]. Accessed January 20, 2006. URL: http://www.humanitas.com/vha/dm/index.htm.

Forster AJ, Clark HD, Menard A, et al. 2004. Adverse events among medical patients after discharge from hospital. *CMAJ*, 170:345–9.

Gurwitz J, Field T, Harrold L, et al. 2003. Incidence and preventability of adverse drug events among older persons in the ambulatory setting. *JAMA*, 289:1107–16.

[IOM] Institute of Medicine. 1999. To err is human: Building a safer health system [online]. Accessed January 20, 2006. URL: http://www.nap.edu/books/0309068371/html.

Izquierdo R, Knudson PE, Meyer S, et al. 2003. A comparison of diabetes education administered through telemedicine versus in-person. *Diabetes Care*, 26:1002–7.

Shea S, Starren J, Weinstock RS, et al. 2002. Columbia University's Informatics for Diabetes Education and Telemedicine (IDEATel) Project: Rationale and design. *J Am Med Inform Assoc*, 9:49–62.

Shea S, Weinstock RS, Starren J, et al. 2006. A randomized trial comparing telemedicine case management with usual care in older, ethnically diverse, medically underserved patients with diabetes mellitus. *J Am Med Inform Assoc*, 13:40–51.

Starren J, Hripcsak G, Sengupta S, et al. 2002. Columbia University's Informatics for Diabetes Education and Telemedicine (IDEATel) Project: Technical Implementation. *J Am Med Inform Assoc*, 9:25–36.

[IOM] Institute of Medicine. 2001. Crossing the quality chasm: a new health system for the 21st century. Washington: NAP, p 345.

[DHHS] US Department of Health and Human Services. 2000. Healthy People 2010. Washington, DC: US Govt PO.