Refereed papers

The use of information technology to enhance diabetes management in primary care: a literature review

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ABSTRACT

Background Evidence suggests that a more structured approach to diabetes care can lead to better health outcomes. We needed to develop an evidence-based conceptual framework for the Chronic Disease Management Network (CDM-Net) project which aims to use information technology (IT) to optimally support diabetes care in the Barwon region of Victoria, Australia.

Objective This review aims to demonstrate the benefits of IT in supporting a systematic approach to diabetes management in general practice and to increase our understanding of perceived barriers to and facilitators to the use of IT in this context.

Methods The literature review was based on articles extracted from relevant databases by using search terms related to type 2 diabetes and IT. Eligible papers were those based on original studies which evaluated some form of IT intervention in medical practice and were published after 1996 in the English language. Studies evaluating the use of telemedicine were excluded.

Findings IT has been used to provide support to patients, enhance changes in healthcare delivery and provide clinicians with access to expertise and timely, useful data about individual patients and populations. IT use has been associated with a corresponding improvement in measures of diabetes care including HbA1c, blood pressure and lipids, and in the frequency of eye and foot exams. Important barriers to using IT in diabetes care include confidentiality concerns, inadequate funding, workforce shortages, lack of time and anxiety about change. Adequate training and integration into the usual process of care are essential facilitators to implementing IT.

Conclusions IT can be used to improve diabetes care by promoting a productive and informative interaction between the patient and the care team.

Keywords computerised medical records systems; diabetes; information technology

Introduction

The national government in Australia has, since 1999, provided financial incentives to general practitioners (GPs) to use computers to support their clinical practices. These incentives were initially successful in encouraging a change from handwritten to computer-generated prescriptions. Financial incentives were then broadened through the Practice Incentives Program[1] to encourage GPs to undertake a more systematic approach to chronic disease management, including diabetes.[1–4] GPs are now able to claim fees from

Medicare (the Australian health insurance system) for developing 'care plans' for patients with diabetes and obtaining multidisciplinary input into these plans from allied health professionals and medical specialists. The clinical content of diabetes care plans is based on an 'annual cycle of care' which details the tasks to be completed within a 12-month cycle in accordance with evidence-based guidelines.[5]

Although there is some evidence that the use of care plans has improved diabetes management to a small extent,[3,6] it has been argued that these plans only partially address Wagner's chronic care model.[4] This model is widely used to support systems change in chronic disease management and places considerable emphasis on the use of information technology (IT).[7,8] The model identifies four organisational components that need development in order to promote a productive interaction between the consumer and the practice team. These components are:

- providing support and information for patients and carers to manage their own conditions
- changes in the design of healthcare delivery, for example through the use of proactive planning and nurse practitioners
- providing clinicians with access to expertise, for example via electronic clinical decision support tools
- clinical information systems which provide timely, useful data about individual patients and populations.

At present, care plans mainly address the linkages between the consumer and the practice-based team, especially the GP, without adequately considering the organisational changes which are required.[9] It is therefore not surprising that only 14% of patients with diabetes are currently given care plans and only 1% of them are tracked for adherence to these.[10] The use of IT may be able to increase the number of people on care plans, track them for achieving 'wellness' goals and make the interaction between patients and their care team more productive.

The CDM-Net project aims to use IT in a major supporting role in diabetes care. Specifically, CDM-Net uses an electronically created 'web based' care plan in which basic demographic and clinical data are extracted from a GP's computer database, supported by an off-site 'call centre' of nurses to help complete the plans. It also enables multidisciplinary input into these care plans from remote locations. This is a multidisciplinary project conducted in the Barwon Region of Victoria, Australia, which is south-west of Melbourne. The project's conceptual framework is based on the literature on the use of IT to support chronic disease management, especially that of diabetes.[10] Further details about the CDM-Net project will be published subsequently.

Aim of literature review

Based on Wagner's contention that IT has a significant role in supporting the management of chronic disease,[11] a literature review was undertaken to address key questions of relevance to using this model. These questions include:

- How is IT used to enhance diabetes management?
- What is the impact of IT on diabetes management?
- What are the barriers to and facilitators to using IT in this role?

Methods

Search strategy

The following databases were searched: the Medical Literature Analysis and Retrieval System Online (Medline), the American Psychological Association Online database (PsycINFO), the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and the Cochrane Evidence Based Medicine (EBM) reviews (all via Ovid). A search was also conducted through Google Scholar. Relevant references from extracted articles were identified to increase the literature search yield. Search terms using the Medical Subject Headings (MeSH) thesaurus comprised: diabetes mellitus, type 2/or diabetes mellitus AND medical record systems, computerized/or information systems/or computers/or internet. Keywords used were information technology.multi-purpose (mp) and web based. multi-purpose (mp).

Inclusion criteria

Only original studies which evaluated the use of IT interventions (web based programs, electronic medical records, messaging systems) for diabetes management in medical practice and which were published after 1996 in English were reviewed. These included studies using randomised controlled trials or observational (non-randomised controlled trials, pre-post studies, and post-intervention studies) or qualitative methods.

Exclusion criteria

Studies evaluating the use of IT for other chronic diseases, review papers which described other studies and opinion pieces were excluded. In addition, studies evaluating the use of telemedicine (videoconferencing

and telephone based consultations between patients and physicians) were excluded because telemedicine has less relevance to the CDM-Net project which is focusing on the use of broadband technologies for chronic disease management. These broadband technologies, such as linkage to an electronic medical record through the internet, enable single point access to a host of different services.

Data abstraction

The titles and abstracts were independently reviewed by the first two authors and, if found eligible, the full articles were then obtained for review. Where there was disagreement between the two authors about the eligibility of an article, conflicts were adjudicated by the third author.

Results

A total of 444 articles were identified using the above search strategies but only 25 articles satisfied the inclusion/exclusion criteria. Four additional articles were found from the articles' references. The 29 articles included the use of both quantitative and qualitative methodologies. One-third of them used a randomised controlled trial design to measure the impact of IT. A summary of the key features of the papers is shown in Table 1. The majority (22) of the studies were conducted in the USA. Other countries in which studies were conducted included South Korea (2), the UK (1), the Netherlands (1), Finland (1), Taiwan (1) and Spain (1). No Australian studies were found.

The complexity of the IT systems used in the studies varied considerably, ranging from the use of web based

Table 1 Summary of relevant articles

Author/year	Methods	Intervention	Patient studied	Doctor studied	Location
McMahon GT (2005)	RCT[a]	Web based care management program	Yes	No	USA
East J (2003)	Pretest–post-test non-equivalent group design + PDSA[b]	Computerised diabetes registry and clinical guidelines	No	Yes	USA
Meigs JB (2003)	RCT	Web based program	No	Yes	USA
Pagliari C (2003)	Mixed methods	Web based program	No	Yes	UK
Grant RW (2006)	Descriptive	Web based program	Yes	Yes	USA
Sequesit TD (2005)	RCT	EMR[c]	No	Yes	USA
Chima C (2005)	Audit	Computer systems	No	Yes	USA
O'Connor P (2005)	Longitudinal study with group comparison	EMR	No	Yes	USA
Levetan CS (2002)	RCT	Computer	Yes	No	USA
McKay HG (2001)	RCT	Web based program	Yes	No	USA
Goldberg HI (2003)	Case studies	Web based tool linked to EMR	Yes	No	USA
Hassol A (2004)	Survey and focus groups	Web based tool linked to EMR	Yes	Yes	USA

Table 1 Continued

Author/year	Methods	Intervention	Patient studied	Doctor studied	Location
Raiston JD (2004)	Qualitative	Web based tool linked to EMR	Yes	No	USA
Branger PJ (1999)	Group comparison	EMR–electronic data interchange	No	Yes	Netherlands
Montori, VM (2002)	Before–after study design	Planned care +/– EMR	No	Yes	USA
Smith SA (1998)	Retrospective study	EMR	No	Yes	USA
Glasgow RE (2003)	RCT	Web based	Yes	No	USA
Crosson JC (2007)	Audit	EMR	No	Yes	USA
Hess R (20070	Mixed methods	PHR[d]–Web based tools linked to EMR	Yes	No	USA
Lee TI (2007)	Quasi experimental pretest–post-test	Web based	Yes	No	Taiwan
Orzano AJ (2007)	Cross-sectional analysis	EMR	No	Yes	USA
Bond GE (2007)	RCT	Web based	Yes	No	USA
Bond GE (2007)	RCT	Web based	Yes	No	USA
Kim CJ (2006)	RCT	Web based	Yes	No	South Korea
Harno K (2006)	RCT	Web based	Yes	No	Finland
Simon SR (2005)	Time series analysis	Internet	No	Yes	USA
Smith KE	Prospective feasibility study	Web based	Yes	No	USA
Kwon HS (2004)	Before and after study	Web based and short messaging system	Yes	No	South Korea
Ferrer-Roca (2004)	User analysis with questionnaire	Web based	Yes	No	Spain

[a] RCT: randomised controlled trial; [b] PDSA: Plan–Do–Study–Act; [c] EMR: electronic medical record; [d] PHR: personal health record (patient held medical record)

interventions to the use of an electronic medical record (EMR) without being connected to the internet. Some of the interventions used clinical guidelines, patient registries (a register of patients with diabetes including key demographic and clinical data) and email systems. Only one study, conducted in the USA, described the use of a diabetes care plan for patient management.[12] This did not include the use of financial incentives for

GPs, which have been a core feature of care plan development in Australia.

Uses of IT to support diabetes care

Information technology has been used to provide clinicians with access to expertise and timely, useful data about individual patients and populations, to enhance changes in healthcare delivery and to support patients in self-management. IT has been used as a decision support tool based on clinical reminders and alerts that are linked to patient-specific information, with the advice given to GPs founded on evidence based guidelines.[13–15] A valuable adaptation of IT-enabled clinical decision support is the use of a cardiovascular risk calculator to assist GPs in identifying patients that are more likely to develop cardiovascular disease, which is a common complication in patients with diabetes.[16]

The advances in IT have created new opportunities for changes in the design of healthcare delivery. IT has also been used as an information storage system to create diabetes registries[16,17] which can assist GPs to conduct clinical audits. Patients can now upload their blood glucose and blood pressure readings onto their computers and share these with their GP via the internet.[18–20] The internet allows for email communication between patients, their GPs and other healthcare providers, thereby enhancing interactive feedback based on the uploaded results.[19,21–23]

Self-management strategies were a major component of studies targeting patients.[12,21,24–29] Web based programs were used to provide diabetes education, and access to online coaches and peer support groups[26,30] in addition to providing web links to internet sites of support agencies.[16] IT has also been used to provide physical activity programs tailored to the patient's specific needs.[18,30] Attempts have been made to enable patients to view parts of their EMR to facilitate self-management.[29] The parts shown to the patient contain key biochemical indicators and a medication regimen in a format that makes sense to them.

Impact of IT in diabetes care

Both process and outcome measures can be used to determine the impact of IT on diabetes care (see Tables 2 and 3). Process measures indicate how care was delivered and what was done for the patient diagnostically or therapeutically, while outcome measures refer to the status of the patient at the end of the episode of care. Process measures involving biochemical parameters such as HbA1c and lipids have shown significant improvement as demonstrated by increased test ordering.[13–15,31] Other improved process measures include significantly increased numbers of foot[32] and eye[15] check ups for patients with diabetes, increased numbers of immunisations carried out,[31] and increased prescription of medications (statins and ACE inhibitors).[15]

Outcome measures using HbA1c and lipids have showed mixed results. Some studies indicate no improvements in HbA1c[14,26] and LDL-cholesterol.[14,21] However, the use of web based interventions was associated with statistically significant improvements in HbA1c and lipid parameters,[18,19,33,34] although the improvement in HbA1c may be reduced by the presence of co-morbidities.[35]

Barriers and facilitators to using IT in diabetes care

Although the sustainability of an IT system depends on the identification of barriers and facilitators to its use in the context in which the system is being implemented, only one study pursued this as a research objective.[16] This study reported that lack of time, poor access to equipment and training, fear of computers and anxiety towards change were barriers identified by participants (GPs, nurses and administrators). The factors that facilitated IT implementation included receiving adequate training, the integration of the system into the usual process of care and the involvement of participants with experience in using IT.[16] Unfortunately, patients as participants in the system were not reported on in this paper. However, other researchers have reported on patient-specific barriers including confidentiality concerns,[29] lost or unknown passwords,[22] slow responses from doctors,[22] lack of time[20] and difficulty fitting the system around the patient's daily activities.[25] Other identified barriers to the sustainability of IT systems include lack of adequate funding and workforce shortages.[21]

Discussion

For diabetic 'care plans' to be successfully supported by IT in general practice, their use should be embedded in the chronic care model as previously described. This literature review has identified the uses of, impacts on, and barriers and facilitators to applying IT to the chronic care model for diabetes management. It has shown that IT can be successfully used to support various components of the chronic care model leading to some improvements in diabetes care, especially for process outcomes. However, there were mixed results for biological outcome measures such as HbA1c,

Table 2 Impact on process measures relevant to diabetes 'care plans'

Process measures	CDS[a]	CIS[b]	DSD[c]	SMS[d]
Foot check	Meigs JB (2003)↑↑[e]	East J (2003)↑↑		
		Montori VM (2002)↑↑		
		Smith SA (1998)↑↑		
Eye check	Meigs JB (2003)↑[f] Sequist TD (2005)†[g]	Montori VM (2002)↑↑	Branger PJ (1999)↑	
Immunisations		East J (2003)↑↑,†		
		Montori VM (2002)↑↑		
Nutrition advice and changes		Montori VM (2002)↑↑		Glasgow RE (2003)↑↑
Smoking cessation advice		Montori VM (2002)↑↑		Glasgow RE (2003)↑↑
Physical activity advice	Kim CJ (2006)↑↑	Montori VM (2002)↑↑		McKay HG (2001)↑ Kim CJ (2006)↑↑
Medications	Sequist TD (2005)↑,†			

[a] CDS: clinical decision support (providing clinicians with access to expertise); [b] CIS: clinical information systems (provide timely, useful data about individual patients and populations); [c] DSD: delivery systems design (changes in the design of healthcare delivery); [d] SMS: self-management support (providing support and information for patients and carers to manage their own condition); [e] ↑↑: statistically significant improvements; [f] ↑: non-statistically significant improvements; [g] †: no improvement

HDL-cholesterol and LDL-cholesterol. These findings are consistent with other reviews on the use of IT to improve diabetes management.[36]

It is important to identify the facilitators and barriers to implementing IT in clinical practice. In general, these include patient factors (e.g. confidentiality concerns), organisational factors (e.g. funding, workforce shortages) and factors related to the GP (e.g. lack of time, anxiety towards change). Attention to these factors will augment both the implementation process and the sustainability of the IT system. In particular, there is a need to engage consistently with the recipients of the new technology (GP, patients and allied health professionals) in order to ensure that the system is properly aligned with the usual process of care.

There are several limitations to this literature review which might affect the conclusions which are drawn from it. First, there is considerable variability in the methods used in the studies which have been identified. Second, the majority of the studies were implemented in the USA which could limit the generalisation of the findings. In particular, we did not come across research

which examined the use of IT to support diabetic care plans in Australia. Third, the studies have not been scrutinised for methodological quality, given the variation in study designs and subject matter. Fourth, the scope was limited and did not, for example, look at telemedical services. However, the review did identify web based programs which are the latest application of IT for chronic disease management. Finally, a systematic review was not undertaken as the variety of study designs made such an approach unrealistic. Our literature review has however been useful in the design of the CDM-Net project.

The findings suggest that IT can improve patient self-management in diabetes, enhance the way in which diabetes care is delivered, support clinical information systems and provide clinical decision support with a corresponding improvement in process and outcome measures. This information has assisted in the development of the CDM-Net project. However, further investigation is still required to increase our understanding of how, why and when IT can improve the care of patients with diabetes. This includes a cost–benefit analysis of

Table 3 Impact on outcome measures relevant to diabetes 'care plans'

Outcome measures	CDS[a]	CIS[b]	DSD[c]	SMS[d]
HbA1c	Smith KE (2004)↑↑[e] Meigs JB (2003)↑ O'Connor PJ (2005)†[g] Levetan CS (2002)↑↑	Kim CJ (2006)↑[f]	McMahon GT (2005)↑↑ Branger PJ (1999)↑↑ Smith KE (2005)↑↑	McMahon GT (2005)↑↑ Glasgow RE (2003)† Lee TI (2007) ↑↑ Bond GE (2007) ↑↑ Kwon HS (2004)↑↑ Kim CJ (2006)↑ Harno K (2006)↑↑ Smith KE (2005)↑↑
LDL-cholesterol	Meigs JB (2003)↑↑ O'Connor PJ (2005)†		McMahon GT (2005)†	McMahon GT (2005)† Glasgow RE (2003)↑↑ Harno K (2006)↑↑
HDL-cholesterol			McMahon GT (2005)↑↑	McMahon GT (2005)↑↑ Glasgow RE (2003)↑ Bond GE (2007)↑↑ Kwon HS (2004)↑↑
T-cholesterol				Glasgow RE (2003)↑↑ Lee TI (2007)↑↑ Bond GE (2007)↑↑ Harno K (2006)↑↑
Triglycerides			McMahon GT (2005)↑↑	McMahon GT (2005)↑↑ Glasgow RE (2003)↑↑ Kwon HS (2004)↑↑ Harno K (2006)↑↑
Blood pressure	Meigs JB (2003)↑		McMahon GT (2005)↑↑	McMahon GT (2005)↑↑ Bond GE (2007)↑↑ Harno K (2006)↑↑
Body weight				Bond GE (2007)↑↑
Blood glucose	Lee TI (2007)↑↑	Kim CJ (2006)↑		Lee TI (2007)↑↑ Kim CJ (2006)↑

a CDS: clinical decision support (providing clinicians with access to expertise); [b] CIS: clinical information systems (provide timely, useful data about individual patients and populations); [c] DSD: delivery systems design (changes in the design of healthcare delivery); [d] SMS: self-management support (providing support and information for patients and carers to manage their own condition); [e] ↑↑: Statistically significant improvements; [f] ↑: non-statistically significant improvements; [g] †: no improvements

using IT and the long-term sustainability of patient outcomes.

REFERENCES

1 Australian Government. *Review of Practice Incentives Program and Enhanced Primary Care Medicare items.* Canberra, Australia: Department of Health and Ageing, 2004. Available from www.health.gov.au/internet/wcms/publishing.nsf/Content/90ED4697EF1E2A15CA256F50001ABCD5/$File/rdp1104.pdf (accessed March 2008).

2 Blakeman TM, Zwar NA and Harris MF. Evaluating general practitioners' views on the enhanced primary care items for care planning and case conferencing. *Australian Family Physician* 2002;31:582–5.

3 Zwar NA, Hermiz O, Comino EJ, Shortus T, Burns J and Harris M. Do multidisciplinary care plans result in better care for patients with type 2 diabetes? *Australian Family Physician* 2007;36:85–9.

4 Harris MF and Zwar NA. Care of patients with chronic disease: the challenge of general practice. *Medical Journal of Australia* 2007;187:104–7.

5 Diabetes Australia and Royal Australian College of General Practitioners. *Diabetes Management in General Practice: guidelines for type 2 diabetes.* Gorokan, NSW: Diabetes Australia Publication, 2007.

6 Vagholkar S, Hermiz O, Zwar NA, Shortus T, Comino EJ and Harris M. Multidisciplinary care plans for diabetic patients: what do they contain? *Australian Family Physician* 2007;36:279–82.

7 Warm EJ. Diabetes and the chronic care model: a review. *Current Diabetes Reviews* 2007;3:219–25.

8 Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J and Bonomi A. Improving chronic illness care: translating evidence into action. *Health Affairs* 2001;20:64–78.

9 Beilby JJ. Primary care reform using a layered approach to the Medicare Benefits Scheme: unpredictable and unmeasured. *Medical Journal of Australia* 2007;187:69–71.

10 Georgeff M. *E-health and the Transformation of Healthcare.* Melbourne: Australian Centre for Health Research, 2007. Available from www.achr.com.au/pdfs/ehealth%20and%20the%20transofrmation%200f%20healthcare.pdf (accessed March 2008).

11 Wagner EH, Austin BT and Von Korff M. Organizing care for patients with chronic illness. *Milbank Quarterly* 1996;74:511–44.

12 Grant RW, Wald JS, Poon EG *et al.* Design and implementation of a web-based patient portal linked to an ambulatory care electronic health record: patient gateway for diabetes collaborative care. *Diabetes Technology and Therapeutics* 2006;8:576–86.

13 Chima CS, Farmer-Dziak N, Cardwell P and Snow S. Use of technology to track program outcomes in a diabetes self-management program. *Journal of the American Dietetic Association* 2005;105:1933–8.

14 O'Connor PJ, Crain AL, Rush WA, Sperl-Hillen JM, Gutenkauf JJ and Duncan JE. Impact of an electronic medical record on diabetes quality of care. *Annals of Family Medicine* 2005;3(4):300–6.

15 Sequist TD, Gandhi TK, Karson AS *et al.* A randomized trial of electronic clinical reminders to improve quality of care for diabetes and coronary artery disease. *Journal of the American Medical Informatics Association* 2005;12:431–7.

16 Pagliari C, Clark D, Hunter K *et al.* DARTS 2000 online diabetes management system: formative evaluation in clinical practice. *Journal of Evaluation in Clinical Practice* 2003;9:391–400.

17 Smith SA, Murphy ME, Huschka TR *et al.* Impact of a diabetes electronic management system on the care of patients seen in a subspecialty diabetes clinic. *Diabetes Care* 1998;21:972–6.

18 Kwon HS, Cho JH, Kim HS *et al.* Development of web-based diabetic patient management system using short message service. *Diabetes Research and Clinical Practice* 2004;66:S133–7.

19 Smith KE, Levine BA, Clement SC, Hu MJ, Alaoui A and Mun SK. Impact of MyCareTeam for poorly controlled diabetes mellitus. *Diabetes Technology and Therapeutics.* 2004;6:828–35.

20 Ferrer-Roca O, Franco-Burbano K, Cardenas A, Pulido P and Diaz-Cardama A. Web-based diabetes control. *Journal of Telemedicine and Telecare.* 2004;10:277–81.

21 McMahon GT, Gomes HE, Hohne SH, Hu TM, Levine BA and Conlin PR. Web-based care management in patients with poorly controlled diabetes mellitus. *Diabetes Care* 2005;28:1624–9.

22 Hess R, Bryce CL, Paone S *et al.* Exploring challenges and potentials of personal health records in diabetes self-management: implementation and initial assessment. *Telemedicine Journal and E-Health* 2007;13:509–17.

23 Branger PJ, van't Hooft A, van der Wouden JC, Moorman PW and van Bemmel JH. Shared care for diabetes: supporting communication between primary and secondary care. *International Journal of Medical Informatics* 1999;53:133–42.

24 Glasgow RE, Nutting PA, King DK *et al.* Randomized effectiveness trial of a computer assisted intervention to improve diabetes care. *Diabetes Care* 2005;28:33–9.

25 Ralston JD, Revere D, Robins LS and Goldberg HI. Patients' experience with a diabetes support programme based on an interactive electronic medical record: qualitative study. *British Medical Journal* 2004;328:1159–63.

26 Glasgow RE, Boles SM, McKay HG, Feil EG and Barrera M. The D-Net diabetes self-management program: long-term implementation, outcomes, and generalization results. *Preventive Medicine* 2003;36:410–19.

27 Goldberg HI, Lessler DI, Mertens K, Eytan TA and Cheadle AD. Self management support in a web based

medical record: a pilot randomized controlled trial. *Joint Commission Journal on Quality and Safety* 2004;30:629–35.

28 Goldberg HI, Ralston JD, Hirsch IB, Hoath JI and Ahmed KI. Using an internet co-management module to improve the quality of chronic disease care. *Joint Commission Journal on Quality and Safety* 2003;29:443–51.

29 Hassol A, Walker JM, Kidder D *et al.* Patient experiences and attitudes about access to a patient electronic health record and linked web messaging. *Journal of the American Medical Informatics Association* 2004;11:505–13.

30 McKay HG, King D, Eakin EG, Seeley JR and Glasgow RE. The diabetes network internet-based physical activity intervention. *Diabetes Care* 2001;24:1328–34.

31 East J, Krishnamurthy P, Freed B and Nosovitski G. Impact of a diabetes electronic management system on patient care in a community clinic. *American Journal of Medical Quality* 2003;18:150–4.

32 Meigs JB, Cagliero E, Dubey A *et al.* A controlled trial of web-based diabetes disease management. *Diabetes Care* 2003;26:750–7.

33 Harno K, Kauppinen-Makelin R andSyrjalainen J. Managing diabetes care using an integrated regional e-health approach. *Journal of Telemedicine and Telecare* 2006;12:13–15.

34 Bond GE, Burr R, Wolf FM, Price M, McCurry SM and Teri L. The effects of a web-based intervention on the physical outcomes associated with diabetes among adults age 60 and older: a randomized trial. *Diabetes Technology and Therapeutics* 2007;9:52–9.

35 Bond GE, Burr R, Wolf FM, Price M, McCurry SM and Teri L. Preliminary findings of the effects of co-morbidities on a web based intervention on self reported blood sugar readings among adults age 60 and older with diabetes. *Telemedicine Journal and E-Health* 2006;12:707–10.

36 Jackson CL, Bolen S, Brancati FL, Batts-Turner ML and Gary TL. A systematic review of interactive computer-assisted technology in diabetes care. *Journal of General Internal Medicine.* 2006;21:105–10.

CONFLICTS OF INTEREST

None.

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