

The role of pharmacists in the management of type 2 diabetes: A literature review

Nitisha Khunti, Andrew Willis, Melanie Davies, Kamlesh Khunti

Diabetes is one of the primary causes of death and disability globally, affecting over 371 million people, which is said to rise to 552 million people by 2030 (International Diabetes Federation, 2012). Current estimates suggest that there are over 3 million people in England with diabetes, of whom roughly a quarter are undiagnosed (Holman et al, 2011). The prevalence of diabetes is higher in developed countries than in developing countries but as developing countries become more industrialised, the incidence of diabetes will also increase. In the UK, it is estimated that the cost of treating diabetes and its related complications is approximately £14 billion (around 85% of that being due to type 2 diabetes), accounting for around 10% of the total NHS expenditure for England and Wales (Kanavos et al, 2012). In 2012, around 4.8 million deaths resulted from the disease and its associated complications worldwide (International Diabetes Federation, 2012). Diabetes has been stated to be the underlying cause of 12% of all new cases of legal blindness, over one third of new cases of end-stage renal disease and approximately half of non-traumatic lower-extremity amputations. It has also been indicated that people with diabetes are two to four times more likely to die from heart disease or suffer a stroke (Powers, 2001).

Diabetes management is a life-long process and necessitates a large amount of effort on behalf of the person with the condition. This individual is arguably the most vital component of effective management of the condition. Inadequate diabetes management results in increased severity of complications. Adherence to medication is therefore extremely important; however, poor adherence has been an ongoing problem for both patients and healthcare workers (Nagasawa et al, 1990; Vermeire et al, 2001).

Appropriate glycaemic control is key when managing patients with type 2 diabetes mellitus. HbA_{1c} is now used as the monitoring test of choice for measuring glycaemic control in people with diabetes (Reynolds et al, 2006). A

high HbA_{1c} is a good indicator of poor glycaemic control over the past 3 months. Improved glycaemic control is essential for preventing the risk of diabetic complications. The United Kingdom Prospective Diabetes Study (UKPDS) established that for every 1% decrease in HbA_{1c}, a 21% reduction is seen in deaths related to diabetes, with a 37% reduction in microvascular complications (Stratton et al, 2000).

NICE suggests a target HbA_{1c} of 6.5% for people with type 2 diabetes requiring no medication and 7.5% for those on multiple therapies (Home et al, 2008). The specific HbA_{1c} level should be tailored for each individual and should be agreed in concordance with the person with the condition and his or her GP or nurse. HbA_{1c} targets of less than 6% are not

Citation: Nitisha Khunti, Andrew Willis, Melanie Davies, Kamlesh Khunti (2013) The role of pharmacists in the management of type 2 diabetes: A literature review. *Diabetes & Primary Care* 15: 131–40

Article points

1. In both the UK and US, the role of the pharmacist is of increasing importance in the management of chronic illnesses.
2. A literature review was conducted to explore the extent to which pharmacist-led interventions lead to improvements in glycaemic control evaluated by HbA_{1c}.
3. This review demonstrates the useful role pharmacists can play in helping people successfully control their diabetes.

Key words

- Glycaemic control
- Literature review
- Pharmacists

Authors

Nitisha Khunti is a Student, University of Central Lancashire, Preston. Andrew Willis is a Research Assistant, Melanie Davies is Professor of Diabetes Medicine and Kamlesh Khunti is Professor of Primary Care Diabetes and Vascular Medicine, Leicester Diabetes Centre and College of Medicine, Biological Sciences & Psychology, University of Leicester.

recommended owing to increased risk of severe hypoglycaemia and increased mortality (Mayor, 2008; Scherthner, 2010).

The pharmacist's role in diabetes management

In both the UK and US, the role of the pharmacist is of increasing importance in the management of chronic illnesses (Lindenmeyer et al, 2006). The community pharmacist is becoming considered as the first port of call in order for patients to obtain advice on managing their disease (Glasgow and Anderson, 1999). It is estimated that on average, a person with diabetes visits the pharmacy three to eight times more often than other patients (Pinto et al, 2006). Consequently, community pharmacists have the opportunity of playing a fundamental role in managing diabetes along with its complications by providing people who have diabetes with programmes for monitoring therapeutic interventions and improving medicine compliance, as well as counselling on lifestyle factors for improving their quality of life (Baran et al, 1999; Nichols-English et al, 2002).

Although, at present, pharmacists do not diagnose diabetes, they can play an important role in helping the individual to maintain control of his or her condition. Owing to the rapid development of accessible medications to treat diabetes, the pharmacist's role in caring for people with diabetes has evolved. The pharmacist is able to educate individuals about the correct way of taking and using medication, identify drug interactions, explain monitoring devices and make recommendations for additional products and services (Palaian et al, 2005).

Medication adherence is also an essential part of effectively managing diabetes, and pharmacists are in an ideal position to positively influence this (Bogden et al, 1998). It has been acknowledged that owing to the difficulties in people complying with medication regimens for chronic diseases, "Pharmacists have an important role to play in health care, which is much more than selling medicines" (WHO, 2006). This includes the "seven-star concept", where a pharmacist has been described as a caregiver, communicator, decision-maker, teacher, life-long learner, leader and manager and is therefore ideally situated to carry out efficient interventions aimed at improving long-term health outcomes.

The 2005 Community Pharmacy Contract was aimed at implementing changes to pharmacists' roles by extending them to optimise public health. Pharmacists are becoming increasingly involved in clinical care in a number of ways, such as counselling, reviewing medication and independent prescribing. Type 2 diabetes has been recognised as a significant condition as part of the New Medicine Service

(NMS), which is provided by pharmacists to deliver support to individuals prescribed long-term therapies for the first time. Patients are also able to receive support and counselling for their medicines via the Medicines Use Review (MUR) service. Both these services can be utilised and extend how pharmacists can make a contribution to patient care in diabetes (Ali et al, 2012). As is mentioned above, an average person with diabetes is thought to visit the pharmacist approximately three to eight times more often than other patients, creating many opportunities for a community pharmacist to get involved and play an important role in the management of diabetes and its complications (Pinto et al, 2006).

Review method

Primary research question

The question we examined was: “To what extent do pharmacist-led interventions lead to improvements in glycaemic control evaluated by HbA_{1c}?”

Literature search

Studies on the role of the pharmacists in the management of type 2 diabetes were identified through a search of MEDLINE (1946–2012), PubMed, Scopus and Google search engines on the Internet. Search terms included in the searches were “type 2 diabetes mellitus”, “pharmacist interventions” and “HbA_{1c}”.

Criteria

Any studies that had taken place in the community, outpatient, primary care and hospital (secondary care) settings were included. Studies were considered suitable if they comprised people with type 2 diabetes and were designed to measure an improvement in HbA_{1c} following an intervention delivered by a pharmacist. Only papers available in English were considered.

Results

Study selection

This review focuses on 18 studies that were accessible in full text and recognised as suitable. Ten studies were carried out in the US (Jaber et al, 1996; Coast-Senior et al, 1998; Nowak et al, 2002; Cranor et al, 2003; Rothman et al, 2003; Leal et al, 2004; Choe et al, 2005; Kiel and McCord, 2005; Odegard et al, 2005; Scott et al, 2006). The remainder were studies based in the UK (Al Mazroui et al, 2009; Ali et al, 2012), Australia (Clifford et al, 2005; Taylor et al, 2005; Krass et al, 2007), Spain (Fornos et al, 2006), Malaysia (Lim and Lim, 2010) and Iran (Farsaei et al, 2011). *Table 1* gives an overview of the studies and the different interventions used.

Table 1. Study characteristics.

Citation	Country	Title	Size (Population)	Type	Intervention
Controlled studies					
Al Mazroui et al, 2009	UK	"Influence of pharmaceutical care on health outcomes in patients with type 2 diabetes mellitus"	Total: n=240 Intervention: n=120 Control: n=120 (Type 2 diabetes)	Randomised controlled trial	A pharmaceutical care programme, which consisted of patient education along with medication adherence, metabolic control and lifestyle advice.
Ali et al, 2012	UK	"Impact of community pharmacy diabetes monitoring and education programme on diabetes management: a randomized controlled study"	Total: n=46 Intervention: n=23 Control: n=23 (Type 2 diabetes)	Randomised controlled trial	Patients were provided with a programme of education about diabetes, its treatment and associated cardiovascular risk factors. They were seen for monitoring/counselling by a community pharmacist on six occasions over a 12-month period.
Choe et al, 2005	USA	"Proactive case management of high risk patients with type 2 diabetes mellitus by a clinical pharmacist: a randomized controlled trial"	Total: n=65 Intervention: n=36 Control: n=29 (Type 2 diabetes)	Randomised controlled trial	Patients received evaluation and modification of pharmacotherapy, self-management diabetes education, and reinforcement of diabetes complications screening processes through clinic visits and telephone follow-up.
Clifford et al, 2005	Australia	"Effect of a pharmaceutical care program on vascular risk factors in type 2 diabetes"	Total: n=180 Intervention: n=92 Control: n=88 (Type 2 diabetes)	Randomised controlled trial	Patients had face-to-face medication and lifestyle counselling at baseline and at 6 and 12 months along with 6-weekly telephone assessments and were also provided with other educational material.
Farsaei et al, 2011	Iran	"Effect of pharmacist-led patient education on glycemic control of type 2 diabetes: a randomized controlled trial"	Total: n=172 Intervention: n=87 Control: n=87 (Type 2 diabetes)	Randomised controlled trial	Patients received an educational programme about oral antidiabetes medications, adherence, and a diabetes diary log and pill box usage. Patients' glycaemic control was monitored for 3 months via either telephone or face-to-face interviews with the pharmacist.
Fornos et al, 2006	Spain	"A pharmacotherapy follow-up program in patients with type 2 diabetes in community pharmacies in Spain"	Total: n=112 Intervention: n=56 Control: n=56 (Type 2 diabetes)	Randomised controlled trial	Pharmacists identified and resolved drug-related problems and provided education on diabetes complications, lifestyle changes, foot inspections, correct medication use and self-monitoring.
Jaber et al, 1996	USA	"Evaluation of a pharmaceutical care model on diabetes management"	Total: n=39 Intervention: n=17 Control: n=22 (Type 2 diabetes)	Randomised controlled trial	Patients in the intervention group received diabetes education, medication counselling, instructions on dietary regulation, exercise, and home blood-glucose monitoring, and evaluation and adjustment of their antidiabetes regimen.
Krass et al, 2007	Australia	"The Pharmacy Diabetes Care Program: assessment of a community pharmacy diabetes service model in Australia"	Total: n= 289 Intervention: n=149 Control: n=140 (Type 2 diabetes)	Randomised controlled trial	Patients were provided with a diabetes service that included detection of drug-related problems, management and review of disease, medications, and lifestyle, along with support for self-monitoring, adherence, and reminders of complications.
Odegard et al, 2005	USA	"Caring for poorly controlled diabetes mellitus: a randomized pharmacist intervention"	Total: n=77 Intervention: n=43 Control: n=34 (Type 2 diabetes)	Randomised controlled trial	The pharmacist intervention comprised development of a diabetes care plan, regular pharmacist-patient communication on diabetes care progress, and pharmacist-provider communication on the patient's diabetes care progress.
Scott et al, 2006	USA	"Outcomes of pharmacist-managed diabetes care services in a community health center"	Total: n=149 Intervention: n=76 Control: n=73 (Type 2 diabetes)	Randomised controlled trial	Patients in the intervention group were enrolled into a pharmacist-managed diabetes care programme.
Non-controlled studies					
Coast-Senior et al, 1998	USA	"Management of patients with type 2 diabetes by pharmacists in primary care clinics"	Total: n=23 (Type 2 diabetes)	Non-randomised prospective study	The pharmacist provided patients with diabetes education, medication counselling, monitoring, and insulin initiation and/or adjustments. Face-to-face interactions were provided for patients initially and after that patient-pharmacist interactions were either face-to-face or via telephone.
Cranor et al, 2003	USA	"The Asheville Project: long-term clinical and economic outcomes of a community pharmacy diabetes care program"	Total: n=85 (Majority had type 2 diabetes)	Quasi-experimental, longitudinal, pre-post cohort-with-comparison study	Pharmacists provided patients with a consultation and patients were then provided with the opportunity to meet with pharmacists in order to monitor treatment goals and to receive diabetes education, home glucose meter training, and information about adherence to their regimen. Pharmacists also referred patients to their physician or the diabetes education centre, as required.
Kiel and McCord, 2005	USA	"Pharmacist impact on clinical outcomes in a diabetes disease management program via collaborative practice"	Total: n=109 (Majority had type 2 diabetes)	Retrospective review	Patients were seen by a clinical pharmacist and also had the option of individual and/or group visits to nurses and dietitians, who were certified diabetes educators.
Leal et al, 2004	USA	"Improving quality of care in diabetes through a comprehensive pharmacist-based disease management program"	Total: n=199 (Majority had type 2 diabetes)	Observational prospective study	Patients received suitable diagnostic, educational, and therapeutic management services, including prescribing medication and ordering laboratory tests.
Lim and Lim, 2010	Malaysia	"Evaluation of a pharmacist-managed diabetes medication therapy adherence clinic"	Total: n=43 (Majority had type 2 diabetes)	Retrospective cross-sectional study	A pharmacist-managed diabetes medication therapy adherence clinic.
Nowak et al, 2002	USA	"Metabolic control and adherence to American Diabetes Association practice guidelines in pharmacist-managed diabetes clinic"	Total: n=57 Intervention: n=28 Control: n=29 (Type 2 diabetes)	Retrospective analysis	A pharmacist-managed diabetes clinic.
Rothman et al, 2003	USA	"Pharmacist led, primary care-based disease management improves hemoglobin A _{1c} in high-risk"	Total: n=138 (Type 2 diabetes)	Retrospective study	Patients received a management session on diabetes education, treatment recommendations and counselling and were provided medication management.
Taylor et al, 2005	Australia	"A cost-effectiveness analysis of a community pharmacist-initiated disease state management service for type 2 diabetes mellitus"	Total: n=99 Intervention: n=53 Control: n=46 (Type 2 diabetes)	Parallel-group design	Patients were educated about blood glucose monitoring and were given Medisense blood glucose monitors, which they were asked to use during the study. Patients were provided with six follow-up visits. Patients were also counselled on their lifestyle and self-care and the downloaded blood glucose monitoring data were printed out and discussed at each visit.

Effect of pharmacist interventions on HbA_{1c}

For all 18 studies, the primary outcome measure was change in HbA_{1c}. All the studies found that the interventions had been successful in significantly reducing HbA_{1c} in people with type 2 diabetes (see *Table 2*). The largest reduction in HbA_{1c} was 26 mmol/mol (2.4%), from 89 to 63 mmol/mol (10.3% to 7.9%; Jaber et al, 1996). Taylor et al, (2005) found the smallest reduction in HbA_{1c}, from 62.4 to 57.4 mmol/mol (7.86% to 7.40%), resulting in a decrease in HbA_{1c} of 5.0 mmol/mol (0.46%).

Discussion

This paper examines the evidence of the effectiveness of pharmacist interventions on reducing HbA_{1c}. The studies reviewed reported that interventions by a pharmacist were successful in significantly reducing HbA_{1c} in people with type 2 diabetes. They suggest that a pharmacist intervention in people with type 2 diabetes could potentially reduce diabetic complications, mortality rates and associated treatment costs.

Overall, studies in which patients had a higher baseline HbA_{1c} level presented a greater reduction over the course of the pharmacist intervention. From the studies, it can be seen that the pharmacist interventions included many different aspects such as counselling on medications, strategies to improve adherence and self-monitoring, and lifestyle advice. It is not possible to categorically state which components of the included interventions resulted in improvements of HbA_{1c}. However, it is noteworthy that two of the studies displaying large reductions in HbA_{1c} (Jaber et al, 1996; Farsaei et al, 2011) included equipment to allow self-monitoring of blood glucose in addition to advice on self-monitoring. This has been shown by a recent systematic review and meta-analysis to be effective in reducing HbA_{1c} (Farmer et al, 2012). However, as we did not conduct any statistical analysis of interventional effects based on intervention type, any hypothesis on effects of individual aspect of interventions could not be substantiated. It could therefore be assumed that the amalgamation of these interventions together resulted in a synergistic improvement in glycaemic control. The Australian Fremantle Diabetes Study (Clifford et al, 2005) demonstrated that HbA_{1c} can be reduced significantly independent of pharmacotherapeutic changes, which shows the improvements in HbA_{1c} were most likely due to improved adherence and lifestyle modifications. Pharmacist interventions that include pharmacotherapeutic changes could thus further improve glycaemic control.

Compared with other type 2 diabetes interventions, by other healthcare professionals, this review suggests that pharmacist interventions can lead to relatively greater improvements in glycaemic control. A past Cochrane review looked at the

Table 2. Association between pharmacist interventions and HbA_{1c} results.

Citation	HbA _{1c} results		Statistically significant	HbA _{1c} (%)										
	Mean baseline	Mean final		1	2	3	4	5	6	7	8	9	10	11
Controlled studies														
Al Mazroui et al, 2009	69 mmol/mol (8.5%)	52 mmol/mol (6.9%)	Yes											
Ali et al, 2012	66 mmol/mol (8.2%)	49 mmol/mol (6.6%)	Yes											
Choe et al, 2005	87 mmol/mol (10.1%)	64 mmol/mol (8%)	Yes											
Clifford et al, 2005	58 mmol/mol (7.5%)	53 mmol/mol (7%)	Yes											
Farsaei et al, 2011	78 mmol/mol (9.3%)	58 mmol/mol (7.5%)	Yes											
Fornos et al, 2006	68 mmol/mol (8.4%)	63 mmol/mol (7.9%)	Yes											
Jaber et al, 1996	102 mmol/mol (11.5%)	77 mmol/mol (9.2%)	Yes											
Krass et al, 2007	74 mmol/mol (8.9%)	63 mmol/mol (7.9%)	Yes											
Odegard et al, 2005	88 mmol/mol (10.2%)	66 mmol/mol (8.2%)	Yes											
Scott et al, 2006	72.7 mmol/mol (8.80%)	53.9 mmol/mol (7.08%)	Yes											
Non-controlled studies														
Coast-Senior et al, 1998	98 mmol/mol (11.1%)	74 mmol/mol (8.9%)	Yes											
Cranor et al, 2003	63 mmol/mol (7.9%)	51 mmol/mol (6.8%)	Yes											
Kiel and McCord, 2005	75.2 mmol/mol (9.03%)	57.7 mmol/mol (7.43%)	Yes											
Leal et al, 2004	81 mmol/mol (9.6%)	60 mmol/mol (7.6%)	Yes											
Lim and Lim, 2010	94.8 mmol/mol (10.82%)	75.8 mmol/mol (9.09%)	Yes											
Nowak et al, 2002	89 mmol/mol (10.3%)	63 mmol/mol (7.9%)	Yes											
Rothman et al, 2003	95 mmol/mol (10.8%)	74 mmol/mol (8.9%)	Yes											
Taylor et al, 2005	62.4 mmol/mol (7.86%)	57.4 mmol/mol (7.40%)	Yes											

specialist nurse interventions in diabetes. No conclusive evidence was found to show that specialist nurses aided in the reduction of HbA_{1c} (Loveman et al, 2003), although this does not imply that there is actually a lack of effect.

A report on the 2009–2010 National Diabetes Audit (NHS Information Centre, 2011) suggested that a large number of people with diabetes in England and Wales are not receiving the expected standard of diabetes care. This demonstrates how the roles of the community pharmacist can be extended, especially in the management of long-term conditions and public health. From this review, it can be seen that pharmacist intervention can improve HbA_{1c}. This could lead to further extending the pharmacists' role in diabetes to early detection. Around 1.6 million people visit the community pharmacy in the UK every day (National Pharmacy Association, 2010). Screening for diabetes in the pharmacy environment offers a chance for this to be obtained by people who do not visit their GPs.

Limitations

This review has several limitations. Firstly, not all of the studies reviewed were randomised

controlled trials. Some of the pieces of research were non-controlled studies, meaning that the decrease in HbA_{1c} in these trials may not have been due to the pharmacist intervention. In addition, the long-term effects of pharmacist interventions in type 2 diabetes is unknown. The longest study reviewed was that of Choe et al (2005), which had follow-up out to 24 months. There is scope for future research on how pharmacists can continue interventions to assist in the long-term treatment of people with type 2 diabetes. Regardless of the stated limitations, these results are considered to be important and indicate comprehensive evidence in support of the important role of pharmacists in diabetes management.

Other considerations

The review shows how pharmacists are ideally situated to educate people with diabetes on the importance of medication adherence. By using their knowledge and drug expertise a personal relationship of trust between the pharmacist and the patient can be formed, which can be utilised to improve diabetes care and outcomes. Involving pharmacists with long-

term chronic conditions has proved effective in other conditions beyond diabetes. A review and meta-analysis of pharmacist interventions to enhance blood pressure control and adherence to antihypertensive therapy found that from 2619 patients in eight studies, pharmacist interventions significantly reduced both systolic blood pressure and diastolic blood pressure (Morgado et al, 2011).

A UK study involving a cross-sectional questionnaire survey in order to learn the attitudes of community pharmacists regarding services for people with type 2 diabetes reported that over 80% of returned questionnaires reported that pharmacists saw people with diabetes “very often” or “often” when they picked up their prescriptions, but around three-quarters stated that they “never/rarely” or only “sometimes” counselled patients on what to expect from their medication (Abduelkarem et al, 2003). More than 90% of the pharmacists considered a healthy lifestyle to be important; however, most “never/rarely” or were only “sometimes” involved in its promotion. The study demonstrated that the advice and services provided by community pharmacists was inadequate and did not reach the standards and objectives set out in the National Service Framework for Diabetes. An American study found that pharmacists’ attitudes were significantly positive regarding the requirement for specific diabetes care education, the significance of tight glycaemic control, the team approach to care, and providing people with diabetes education in an outpatient setting (Younis et al, 2001).

A UK study reviewed patient perceptions of the current and future roles of the community pharmacist in type 2 diabetes management (Twigg et al, 2012). People who had had diabetes for a long period of time and who felt they had not received adequate care from the medical practice acknowledged pharmacist care more. Individuals who already had a good relationship with their GP or nurse and who had well-controlled diabetes did not see a place for a pharmacist in their care outside medicines supply. Nevertheless, this still draws attention to the fact that for people with poorly controlled

diabetes or who do not receive their information from the medical practice, the pharmacy can be an alternative place for obtaining information from a qualified health professional in a suitable and reachable location.

Weitzman et al (2009) found from a survey of 468 patients, 94.9% would feel comfortable talking to their pharmacist about their diabetes and more than 70% would see their pharmacist on a regular basis to have their glucose levels checked. Sixty-six per cent of individuals were not aware that pharmacists are able carry out blood glucose testing. The majority of responders (97.9%) trusted their pharmacists’ advice on medications. However, despite this, more than 35% of patients do not go to the pharmacists for medicines advice. The patients’ lack of awareness of pharmacists’ abilities is highlighted in this study along with the communication gap between patients and pharmacists.

Conclusion

Tight glycaemic control is extremely important when managing people with type 2 diabetes and this review demonstrates the useful role pharmacists can play in helping people successfully control their diabetes. We believe that pharmacists are in a perfect position to aid in managing people with diabetes, through intervening and helping them with medication adherence. Although there is a limited number of studies used in the review, they highlight the clear benefit that pharmacist interventions could provide in order to improve therapeutic adherence in diabetes.

In order for people with diabetes to take advantage of the pharmacy services, they must be aware that these facilities are offered. It has been acknowledged that not all patients confide in their pharmacists about their medicines and other health issues. Pharmacists are medicine specialists, are educated on a varied range of health issues, and are easily accessed by patients. As a result of this, it is unclear why there is a communication gap between pharmacists and patients.

Community pharmacists can educate and counsel patients which, as seen, can result in significant improvements in glycaemic control,

Page points

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2. The authors believe that pharmacists are in a perfect position to aid in managing people with diabetes, through intervening and helping them with medication adherence.
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ultimately leading to a decrease in risk of strokes, cardiovascular events and mortality. These interventions will also improve the quality of life of people with diabetes. Owing to the current NHS changes and the rising incidence and cost of diabetes, it is becoming more and more vital to consider the pharmacist as an important healthcare provider who can efficiently aid in managing the diabetes crisis. ■

Acknowledgements

This work was conducted as part of Nitisha Khunti's placement at the University of Leicester through the Wellcome Studentship.

This work was supported by the National Institute for Health Research Leicester–Loughborough Diet, Lifestyle and Physical Activity Biomedical Research Unit and the National Institute for Health Research Collaboration for Leadership in Applied Health Research and Care – Leicestershire, Northamptonshire and Rutland (NIHR CLAHRC – LNR).

Abduelkarem A, Sackville M, Morgan R et al (2003) Views and practices of community pharmacists regarding services for people with type 2 diabetes. *Int J Pharm Pract* **11**: 161–8

Al Mazroui N, Kamal M, Ghabash N et al (2009) Influence of pharmaceutical care on health outcomes in patients with type 2 diabetes mellitus. *Br J Clin Pharmacol* **67**: 547–57

Ali M, Schifano F, Robinson P et al (2012) Impact of community pharmacy diabetes monitoring and education programme on diabetes management: a randomized controlled study. *Diabet Med* **29**: e326–33

Baran R, Crumlish K, Patterson H et al (1999) Improving outcomes of community dwelling older patients with diabetes through pharmacist counselling. *Am J Health Syst Pharm* **56**: 1535–9

Bogden P, Abbott R, Williamson P et al (1998) Comparing standard care with a physician and pharmacist team approach for uncontrolled hypertension. *J Gen Intern Med* **13**: 740–5

Choe H, Mitrovich S, Dubay D et al (2005) Proactive case management of high-risk patients with type 2 diabetes mellitus by a clinical pharmacist: a randomized controlled trial. *Am J Manag Care* **11**: 253–60

Clifford R, Davis W, Batty K, Davis T (2005) Effect of a pharmaceutical care program on vascular risk factors in Type 2 diabetes. *Diabetes Care* **28**: 771–6

Coast-Senior E, Kroner B, Kelley C et al (1998) Management of patients with type 2 diabetes by pharmacists in primary care clinics. *Ann Pharmacother* **32**: 636–41

Cranor C, Bunting B, Christensen D (2003) The Asheville Project: long-term clinical and economic outcomes of a community pharmacy diabetes care program. *J Am Pharm Assoc* **43**: 173–84

Farmer AJ, Perera R, Ward A et al (2012) Meta-analysis of individual patient data in randomised trials of self-monitoring of blood glucose in people with non-insulin treated type 2 diabetes. *Br Med J* **344**: e486

Farsaei S, Sabzghabae A, Zargarzadeh A et al (2011) Effect of pharmacist-led patient education on glycemic control of type 2 diabetics: a randomized controlled trial. *J Res Med Sci* **16**: 43–9

Fornos J, Andres N, Andres J et al (2006) A pharmacotherapy follow-up program in patients with type-2 diabetes in community pharmacies in Spain. *Pharm World Sci* **28**: 65–72

Glasgow R, Anderson R (1999) In diabetes care, moving from compliance to adherence is not enough. Something entirely different is needed. *Diabetes Care* **22**: 2090–2

Gray A, Raikou M, McGuire A et al (2000) Cost effectiveness of an intensive blood glucose control policy in patients with type 2 diabetes: Economic analysis alongside Randomised Controlled Trial (UKPDS 41). *Br Med J* **320**: 1373–8

Holman N, Forouhi NG, Goyder E, Wild SH (2011) The Association of Public Health Observatories (APHO) Diabetes Prevalence Model: estimates of total diabetes prevalence for England, 2010-2030. *Diabet Med* **28**: 575–82

Home P, Mant J, Diaz J, Turner C (2008) Management of type 2 diabetes: summary of updated NICE guidance. *Br Med J* **336**: 1306–8

International Diabetes Federation (2012) *International Diabetes Federation Diabetes Atlas Update 2012*. IDF, Brussels, Belgium. Available from: <http://www.idf.org/diabetesatlas/5e/Update2012> (accessed 03.06.13)

Jaber L, Halapy H, Fernet M et al (1996) Evaluation of a pharmaceutical care model on diabetes management. *Ann Pharmacother* **30**: 238–43

Kanavos P, van den Aardweg S, Schurer W (2012) *Diabetes expenditure, burden of disease and management in 5 EU countries*. University of Leicester, Leicester. Available from: <http://bit.ly/13g6dt1> (accessed 03.06.13)

Kiel P, McCord A (2005) Pharmacist impact on clinical outcomes in a diabetes disease management program via collaborative practice. *Ann Pharmacother* **39**: 1828–32

Krass I, Armour C, Mitchell B et al (2007) The Pharmacy Diabetes Care Program: assessment of a community pharmacy diabetes service model in Australia. *Diabet Med* **24**: 677–83

Leal S, Glover J, Herrier R, Felix A (2004) Improving quality of care in diabetes through a comprehensive pharmacist-based disease management program. *Diabetes Care* **27**: 2983–4

Lim P, Lim K (2010) Evaluation of a pharmacist-managed diabetes medication therapy adherence clinic. *Pharmacy Practice* **8**: 250–4

Lindenmeyer A, Hearnshaw H, Vermeire E et al (2006) Interventions to improve adherence to treatment in people with type 2 diabetes mellitus: the role of pharmacists. *J Clin Pharm Ther* **31**: 409–19

Loveman E, Royle P, Waugh N (2003) Specialist nurses in diabetes mellitus. *Cochrane Database Syst Rev* **2**: CD003286

Mayor S (2008) Intensive glucose lowering arm of diabetes trial is stopped after excess deaths. *Br Med J* **336**: 407

Morgado M, Morgado S, Mendes L et al (2011) Pharmacists interventions to enhance blood pressure control and adherence to antihypertensive therapy: Review and meta-analysis. *Am J Health Syst Pharm* **68**: 241–53

Nagasawa N, Smith M, Barnes J, Fincham J (1990) Meta-analysis of correlates of diabetes patients' compliance with prescribed medications. *The Diabetes Educator* **16**: 192–200

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- NHS Information Centre (2011) *National Diabetes Audit Executive Summary: Key findings about the quality of care for people with diabetes in England and Wales*. NHS Information Centre, Leeds. Available from: <http://bit.ly/16DCajL> (accessed 03.06.13)
- National Pharmacy Association (2010) *Community Pharmacy Delivering Public Health on the Frontline: Report of the Pharmacy and Public Health Round Table*. NPA, St Albans. Available from: <http://bit.ly/10LHFbq> (accessed 03.06.13)
- Nichols-English G, Provost M, Koopalum D et al (2002) Strategies for pharmacists in the implementation of diabetes mellitus management programs – new roles in primary and collaborative care. *Disease Management and Health Outcomes* **10**: 783–803
- Nowak S, Singh R, Clarke A et al (2002) Metabolic control and adherence to American diabetes association practice guidelines in a pharmacist-managed diabetes clinic. *Diabetes Care* **25**: 1479
- Odegard PS, Goo A, Hummel J et al (2005) Caring for poorly controlled diabetes mellitus: a randomized pharmacist intervention. *Ann Pharmacother* **39**: 433–40
- Palaian S, Chhetri A, Prabhu M et al (2005) Role of pharmacist in counseling diabetes patients. *The Internet Journal of Pharmacology* **4**: 1–13
- Pinto S, Lively B, Siganga W et al (2006) Using the Health Belief Model to test factors affecting patient retention in diabetes-related pharmaceutical care services. *Res Social Adm Pharm* **2**: 38–58
- Powers A (2001) Diabetes mellitus. In: Braunwald E, Fauci AS, Kasper DL et al (eds). *Harrison's principles of internal medicine* (15th edition). McGraw-Hill, New York, NY, USA, 2109–37
- Reynolds T, Smellie S, Twomey P (2006) Glycated haemoglobin (HbA_{1c}) monitoring. *Br Med J* **333**: 586–8
- Rothman R, Malone R, Bryant B et al (2003) Pharmacist-led, primary care-based disease management improves hemoglobin A_{1c} in high-risk patients with diabetes. *Am J Med Qual* **18**: 51–8
- Scherthner G (2010) Diabetes and cardiovascular disease: Is intensive glucose control beneficial or deadly? Lessons from ACCORD, ADVANCE, VADT, UKPDS, PROactive, and NICE-SUGAR. *Wien Med Wochenschr* **160**: 8–19
- Scott D, Boyd S, Stephan M et al (2006) Outcomes of pharmacist-managed diabetes care services in a community health center. *Am J Health Syst Pharm* **63**: 2116–22
- Stratton M, Adler A, Neil H et al (2000) Epidemiological association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35). *Br Med J* **321**: 405–12
- Taylor S, Milanova T, Hourihan F et al (2005) A cost-effectiveness of a community pharmacist-initiated disease state management service for type 2 diabetes mellitus. *Int J Pharm Pract* **13**: 33–40
- Twigg M, Poland F, Bhattacharya D et al (2012) Patients' perceptions of the current and future roles of the community pharmacist in type 2 diabetes care. *Int J Pharm Pract* **20**: 5–15
- Vermeire E, Hearnshaw H, Royen V, Denekens J (2001) Patient adherence to treatment: three decades of research. A comprehensive review. *J Clin Pharm Ther* **26**: 331–42
- Weitzman A, McDowell K, Elswick B, Blommel M (2009) Letter: Consumer perception of pharmacist's role in diabetes: Results of Operation Diabetes Initiative. *J Am Pharm Assoc* **49**: 716–21
- World Health Organization (2006) *New tool to enhance role of pharmacists in health care*. WHO, Geneva, Switzerland. Available from: <http://bit.ly/CXEbm> (accessed 03.06.13)
- Younis W, Campbell S, Slack M (2001) Pharmacists' attitudes toward diabetes and their involvement in diabetes education. *Ann Pharmacother* **35**: 841–5