RCPE
Royal College of Physicians of Edinburgh

UK CONSENSUS CONFERENCE ON DIABETES

Royal College of Physicians of Edinburgh, 13–14 May 2010

in association with:

ABCD · Diabetes UK · PCDS Primary Care Diabetes Society · RCGP Royal College of General Practitioners Scotland

Supplement 17 to *The Journal of the Royal College of Physicians of Edinburgh*

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ACKNOWLEDGEMENTS

The Royal College of Physicians of Edinburgh, in association with the Royal College of General Practitioners (Scotland), Diabetes UK, the Association of British Clinical Diabetologists and the Primary Care Diabetes Society, would like to acknowledge grants received from:

Bristol-Myers Squibb and AstraZeneca 'Alliance'
Novo Nordisk Ltd
Takeda
GlaxoSmithKline
Lilly Diabetes

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Published by:
Royal College of Physicians of Edinburgh
9 Queen Street
Edinburgh EH2 1JQ

Foreword

Diabetes mellitus has never been more important. We are in an increasing epidemic of type 2 diabetes and in some parts of the world the incidence of type 1 diabetes has increased three-fold over the past four decades. While there are clear reasons for the former, the latter is more difficult to explain. Research into the pathogenesis of diabetes, its complications and optimal management has been distilled into a number of national and international guidelines. Against this background, the Royal College of Physicians of Edinburgh Consensus Conference committee convened a UK conference in Edinburgh in May 2010 to answer five pertinent questions relevant to those at risk of diabetes, those with diabetes and those caring for people with diabetes in the 21st century. Using a tested framework a concise statement has provided answers to the following:

- Who can prevent diabetes?
- What are the practical implications of developments in genetics?
- Which psychological interventions work?
- What after metformin?
- What are the best models of care for children and adolescents?

We expect the statement to be useful to many groups and individuals, both nationally and internationally. The answers are diverse: sometimes specific and definitive, and at other times more general. As perhaps expected, the statement calls for more evidence and research in all of the above areas and funding agencies will be able to use the statement when deciding allocation of research resources. We urge people, society and government and its institutions to take particular cognisance of the output in relation to the first question. The epidemic of type 2 diabetes must be reversed and our 'toxic and diabetogenic' environment transformed. If 12% of the urban Chinese population have diabetes the world is on the edge of a precipice.

We are most grateful to many people who have contributed to the statement. These include the organising committee, authors of the background papers, reviewers of the background papers, chairmen and speakers at the conference, poster presenters and sponsors. A particular vote of thanks goes to the chairman of the Consensus Panel, Professor Roland Jung, his vice-chair, Dr Andrew Elder, and the other 14 members who worked efficiently and constructively to produce the enclosed statement. In a Consensus Conference the audience at the conference are pivotal in shaping the draft statements and we grateful acknowledge the contributions of many individuals. Margaret Farquhar and Christine Berwick provided exceptional support to the organising committee and we wish to express our sincere thanks to them.

We sincerely hope that the statement, background papers, speaker and poster abstracts will be of value in our ongoing attempts to prevent or delay the onset of diabetes and effectively treat the condition once diagnosed, so as to limit its impact on all the lives that it effects.

Dr James Walker and Dr Alan Jaap
Co-chairs of the RCPE UK Consensus Conference on Diabetes, May 2010

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J R Coll Physicians Edinb 2010; 40(Suppl 17):2

RCPE UK Consensus Statement on Diabetes

Members of the Consensus Panel

The prevalence of diabetes is increasing rapidly around the world as the population ages and become more obese. It is a condition that demands much of patients and diabetic control is often poor, particularly in the young. Treatment and care must take account of patients' individual needs and preferences. The increasing incidence of this disease will require additional resources being committed to proven services and treatments that deliver value for money.

WHO CAN PREVENT DIABETES?

Two thirds of the UK adult population is overweight (body mass index, BMI>25 kg/m^2) and one quarter obese (BMI>30 kg/m^2), reflecting excess calorie intake and low levels of physical activity. Obesity is strongly associated with risk of developing type 2 diabetes, cardiovascular diseases and some cancers. A whole population approach to prevention is needed. This requires action by:

- **People and society**: Patients, their families and the community at large all have a role in preventing type 2 diabetes. This includes full participation of, and support for, those at highest risk, including some ethnic minority and economically deprived communities.
- **Government and its institutions**: Greater leadership is needed from Government to improve our obesogenic environment. The lessons from effective legislation on smoking should be used to promote healthier diets, increased physical activity and to inform transport and planning policy. The food and drink and catering industry should be more tightly regulated by legislation in the interests of public health. For example, restrictions on 'less healthy' food and drink advertising in children's television programmes should be extended to non-broadcast media and the wider marketing environment.
- **NHS**: The NHS has a crucial role to play in primary prevention and detection of diabetes through health promotion, advocacy, the training and education of its staff, community partnerships and opportunistic case finding among high-risk groups. There is insufficient evidence and too many uncertainties about the risks, practicalities, benefits and costs to support a national, population-based screening programme at this time. However, there is good evidence that lifestyle intervention in high-risk groups can prevent or delay the onset of type 2 diabetes, but translational research is required to define how to put these findings into everyday practice.

WHAT ARE THE PRACTICAL IMPLICATIONS OF DEVELOPMENTS IN GENETICS?

Current knowledge on the application of genetics suggests the following:

- There is no evidence that general population genetic screening for diabetes is beneficial and it is not recommended.
- Genetic testing of patients at increased clinical risk of diabetes provides little additional predictive value and is not recommended.
- As current clinical diagnostic criteria misclassify a small proportion of patients, there is a role for testing for monogenic diabetes in selected patients, as they may benefit from alternative treatment; for example, hyperglycaemia with onset before six months of age and young onset type 2 diabetes with a strong family history. This is an evolving field and it is difficult to define clear criteria in other groups of patients (see www.diabetesgenes.org).
- The resource implications of genetic profiling are not defined and require further research.

Research on genetic testing shows promise in elucidating disease mechanisms and developing new treatments.

WHICH PSYCHOLOGICAL INTERVENTIONS WORK?

- Improving diabetes health will only occur if the individual's health beliefs, health-related behaviours, knowledge and self-care skills and their personal circumstances are considered and supported.
- The organisation of diabetes healthcare in the UK inhibits sufficient focus on these issues.
- Previous work has demonstrated the theoretical principles of psychological interventions such as behaviour modification, motivational interviewing, cognitive behavioural therapy goal-setting and coping skills (e.g. SIGN 116). Robust, high-quality research to assess their generalisability, cultural suitability, applicability and their implementation across populations and between different disease groups is required.
- Appropriate psychosocial and educational services tailored to the individual's circumstances should be available and be offered by an appropriately trained healthcare provider.
- The training and continuing education of all those involved in the care of patients should be informed by applied psychology and include the need for a person-centred approach.

WHAT AFTER METFORMIN?

If agreed treatment goals cannot be attained on a combination of lifestyle modification and metformin, a review of the following should occur:

- The patient's ability to achieve suggested lifestyle modification and adherence to metformin treatment following appropriate reinforcement and support.
- The appropriateness of the treatment goal for the individual, taking into account their personal preferences, occupation, co-morbidities and likely ability to adhere to more complex treatment regimens.

Additional pharmacological treatment should then be considered if necessary. The consensus is to follow SIGN or NICE guidance. There are no randomised controlled trials to definitively determine the effect of combination therapy on clinically important outcomes. Individual clinician judgement and expertise should still be applied to the needs and circumstances of individual patients and should be documented and justified.

The selection of new drugs or new combination regimens should not be based on the HbA_{1c} level and weight change alone but also on other factors, including hypoglycaemia, quality of life and cardiovascular disease.

A range of research studies are required on long-term outcomes and late-onset adverse effects of pharmaceuticals on a population basis. Further research on patient concordance with medication and lifestyle interventions should be undertaken.

WHAT ARE THE BEST MODELS OF CARE FOR CHILDREN AND ADOLESCENTS?

There is no evidence that one model of care is better than any other. The best performing teams appear to have at their core person-centred attitudes and the ability to motivate the young person and their families and are teams that can be trusted to deliver at all times.

Care for this group of people is usually provided by specialists and should be provided by multidisciplinary teams, including physicians, specialist nurses, dieticians and psychological support workers. These teams should be resourced to provide the full range of services required – both technical (e.g. insulin pumps) and supportive.

Key elements of care, specifically tailored to the needs of young people, include:

- **Health system** – resources, integrated structures and planning, regional and local networks.
- **Delivery systems** – accessible service; multidisciplinary team, adequate frequency of consultations, audit and governance.
- **Decision support** – clinical care consistent with best evidence and patient preference, delivery of relevant information and planned transition to adult services.
- **Self-management support** – shared goals, sustained relationships, understanding of responsibilities, requisite skills and school support.
- **Clinical information systems** – databases, recall, audit and research.
- **A patient-focused, goal-led approach**, audited against robust quality standards.

The importance of social networking, peer support, family support and sustained rapport with professionals has been demonstrated in some settings and requires further research.

Who can prevent diabetes? Current issues in the prevention of type 2 diabetes

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ABSTRACT Research evidence supports the widely held view that much of the current and growing disease burden associated with diabetes in the UK is due to sedentary lifestyles and dietary trends and is therefore preventable in principle. However, prevention is dependent on the implementation of affordable and effective interventions that will encourage behaviour change, increasing physical activity levels and modifying low-fibre, calorie-dense diets. Both population-wide and individual-based intervention/prevention strategies may be feasible and cost-effective, but there are a number of key outstanding uncertainties that require both further research and economic modelling to resolve. The potential for harms to outweigh benefits when implementing preventive interventions, and for health inequalities to be exacerbated when promoting behaviour change, means that guidance must consider ethics as well as effectiveness. The nature and scale of the challenge faced means that societal as well as individual and community change will be required. There are synergies between diabetes prevention strategies and wider public health priorities in relation to both chronic disease prevention and global climate change, but strong advocacy and leadership from the health sector will be required if we are to seize the opportunity to reverse current trends.

DECLARATION OF INTERESTS No conflict of interests declared.

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doi:10.4997/JRCPE.2010.S01

INTRODUCTION

Diabetes prevention efforts to reduce the morbidity and mortality associated with the condition are an international public health concern. The need for urgent action has been highlighted by the International Diabetes Federation (IDF).[1,2] The increasing priority given to prevention in the UK was demonstrated in 2008 when the first Diabetes UK Frontiers in Diabetes conference focused on barriers to prevention. The recent Diabetes UK policy report focuses on prevention and prediabetes.[3]

There are a number of existing reviews in this field, most recently an evidence update completed by Simmons et al. for the IDF.[4] There are a number of areas where the potential for public health benefits might be significant, but where, in the absence of clear evidence for the effectiveness and cost-effectiveness of policies, current guidance is largely based on expert consensus.

The aim of this paper is to highlight some of the major issues raised by the question 'Who can prevent diabetes?', drawing on international evidence and framing the issues in a UK context, using recent national policy documents. It takes a broad public health definition of prevention, including both primary prevention and secondary prevention (screening and early detection). It aims to provide a starting point for debate about current priorities, the need for further research to support policy and practice and the role that could be played by healthcare professionals in achieving diabetes prevention at individual, community and population levels.

CURRENT NATIONAL POLICY DIRECTIONS

There is already evidence-based guidance on the prevention of obesity and overweight and the promotion of healthy lifestyle choices produced by both SIGN and NICE and a number of relevant Cochrane Collaboration reviews (see Table 1). In the past year both English and Scottish Departments of Health have published relevant policy and consultation documents. These address screening and intervention programmes for diabetes and cardiovascular risk but focus on different populations. The Scottish *Better Diabetes Care* consultation document clearly identifies a number of relevant ongoing programmes ('Keep Well' and 'Well North') which have targeted deprived communities and remote rural communities respectively. The English Department of Health is targeting families with its 'Change4Life' programme, developing 'LifeCheck', an online health service to help middle-aged individuals assess and manage their own health, and has recently introduced 'NHS Health Check', which offers five-yearly vascular risk assessments to all 40–74-year-olds in the population.[5]

Raising awareness of risk more widely in the general population has been pursued through national media

TABLE 1 Evidence-based guidance and systematic reviews

SIGN guidelines Adult obesity: http://www.sign.ac.uk/pdf/sign8.pdf Child obesity: http://www.sign.ac.uk/pdf/sign69.pdf CVD prevention: http://www.sign.ac.uk/pdf/sign97.pdf
NICE clinical guidelines Obesity: http://guidance.nice.org.uk/CG43
NICE public health guidance Physical activity guidance: PH2, PH8, PH13, PH17 Primary care: http://guidance.nice.org.uk/PH2 Physical activity/environment: http://guidance.nice.org.uk/PH28 Workplace: http://guidance.nice.org.uk/PH13 Young people: http://guidance.nice.org.uk/PH17 Behaviour change: http://guidance.nice.org.uk/PH6
Diabetes prevention in high-risk populations (guidance in preparation) http://guidance.nice.org.uk/PHG/Wave19/6 http://guidance.nice.org.uk/PHG/Wave19/62
Cochrane Collaboration Systematic Reviews (www.cochrane.org/reviews) • Dietary advice for prevention of type 2 diabetes • Zinc supplementation for the prevention of type 2 diabetes mellitus • Wholegrain foods for the prevention of type 2 diabetes mellitus • Alpha-glucosidase inhibitors for people with impaired glucose tolerance or impaired fasting blood glucose • Exercise or exercise and diet for preventing type 2 diabetes mellitus • Exercise for overweight or obesity • Long-term non-pharmacological weight loss interventions for adults with prediabetes • Long-term pharmacotherapy for obesity and overweight • Psychological interventions for overweight or obesity • Low glycaemic index or low glycaemic load diets for overweight and obesity
Health Technology Assessment (HTA) Programme: • Waugh N, Scotland G, McNamee P et al. Screening for type 2 diabetes: literature review and economic modelling. *Health Technol Assess* 2007; 11:1–144. • Gillett M, Royle P, Snaith A et al. Non-pharmacological interventions to reduce the risk of diabetes in people with impaired glucose regulation: systematic review and economic evaluation. (publication due June 2010)

campaigns, most directly through the Diabetes UK campaigns 'Measure Up' and 'Silent Assassin'. To date, the focus of policy initiatives and national campaigns has been on awareness raising, the identification of individuals at risk and on encouraging individual lifestyle change rather than wider societal, environmental or regulatory change. In order to better understand the impact of policy on relevant individual behaviours, there is a need to develop pragmatic policy options across a wide spectrum of potential fields, including both individual behavioural interventions and environmental interventions (such as the development of safe walking and cycling routes) and regulatory interventions (such as clearer food labelling) so that their impact can be evaluated in 'real-world' settings. Evidence that can inform policy, in relation to both population and individual level interventions, is discussed below.

CURRENT EVIDENCE FOR THE EFFECTIVENESS OF POPULATION-LEVEL INTERVENTIONS

There is little direct evidence for the impact of population-level interventions on reducing diabetes risk in UK populations. However, the modest changes in behaviour seen in prevention trials suggest that interventions to promote similar goals in the general population might be feasible.[6] The trends in body mass index (BMI) and sedentary lifestyles associated with an increasingly 'obesogenic' environment indicate that reversing current trends requires small but significant shifts in activity and dietary patterns – the 'small change' approach.[7,8] Therefore, more attention needs to be given to understanding the determinants of behaviours linked to chronic disease at the population level and on the evaluation of efforts to shift the entire distribution of behaviour.

Health-promotion programmes are increasingly using tools and techniques from social marketing – defined by the National Social Marketing Centre as 'the systematic application of marketing techniques and approaches to achieve specific behavioural goals, to improve health and reduce health inequalities'. Recent systematic reviews and policy reports have summarised the types of evidence available to date on physical activity and dietary change, which is promising but not conclusive.[9,10] There is also a growing interest in the development of interventions based on individual target-setting linked to financial incentives for achieving targets, linked in turn to physical activity or weight loss.[11–13]

As some ethnic minority, socio-economically deprived and specific 'hard-to-reach' communities (such as gypsy travellers) are known to be at increased risk of diabetes, there is a need to develop culturally appropriate interventions that facilitate behaviour change. Dietary habits and patterns of physical activity are recognised to be largely influenced by environmental, financial and cultural factors.[14] The feasibility and acceptability of both individual- and population-level diabetes prevention strategies should therefore be evaluated in specific communities and across a range of settings.[15] Both non-randomised pragmatic evaluations and qualitative studies of barriers to and facilitators of change are required to increase our understanding of 'what works, how, and for whom'.

CURRENT EVIDENCE FOR THE EFFECTIVENESS OF INDIVIDUAL-LEVEL INTERVENTIONS

Diabetes prevention research has largely focused on identifying individuals at high risk through screening and treating those with non-diabetic hyperglycaemia with intensive lifestyle or drug interventions.[2] There is clear evidence for the potential to prevent diabetes from

international trials in people with impaired glucose tolerance (IGT), and long-term results from these studies are promising.[16–18] The current challenge is that of translating trial findings into 'real-world' prevention programmes.[4] There has been some progress in the design and evaluation of more pragmatic diabetes prevention initiatives.[19–23] However, there remain many complex challenges for the real-world adaptation of diabetes prevention study[24] (DPS)-like or diabetes prevention programme[25] (DPP)-like interventions in the community. There is also a need to consider how we best balance ensuring the effectiveness of interventions with a minimisation of costs and improved sustainability when scaling up trial interventions.[26] In particular, there is concern about the effectiveness of interventions in high-risk populations outside the context of clinical trials since behaviour change and medication adherence is difficult to sustain without supportive physical, social and cultural environments.

Some of the uncertainties relating to screening for undiagnosed prevalent diabetes and the effectiveness of earlier intervention have been resolved since these were identified by the IDF consensus statement. The Anglo-Danish-Dutch study of intensive treatment of people with newly diagnosed diabetes in primary care (ADDITION) involves a screening phase to identify previously undiagnosed diabetes followed by a pragmatic open-label cluster randomised controlled trial comparing the effect on cardiovascular risk of intensive multi-factorial therapy with standard care.[27] Initial data from ADDITION suggest that people with diabetes detected by screening do have an adverse but modifiable cardiovascular risk profile at diagnosis.[28,29] One-year follow-up in the Cambridge and Dutch ADDITION arms found that cardiovascular disease risk factors had improved since diagnosis and were significantly lower among patients in the intensive treatment arm.[30,31]

A controlled trial examining the psychological impact of stepwise screening for diabetes (ADDITION-Cambridge) by comparing participants invited for screening with those not invited suggested that anxiety, depression, worry about diabetes and self-rated health were not significantly different between those invited for screening and controls. This is reassuring and suggests that step-wise screening with appropriately informed consent is associated with limited psychological harm.[32,33]

Although these results suggest that screening for diabetes and intensive modification of cardiovascular risk are both feasible, the main determinant of the effectiveness and cost-effectiveness of diabetes screening is the magnitude of cardiovascular risk reduction following early detection and intensive treatment, which remains uncertain.

In terms of the practicalities of screening programmes, it is still unclear how best to target screening invitations, how often to rescreen and how to tackle problems of uptake, particularly among individuals at high risk. The evaluation of the national pilot screening programme for type 2 diabetes in deprived areas of England identified a number of problems with implementing diabetes screening in high-risk communities.[34] Screening for diabetes inevitably finds many more people at increased risk than people with the disease, including many with impaired glucose regulation who we know would also benefit from behaviour change interventions. It remains unclear how to effectively intervene to reduce risk for these individuals when there are limited resources for individualised support. The English 'Health Checks' programme[5] will inevitably identify large numbers of people who might benefit from interventions to reduce their risk of cardiovascular disease and diabetes, and should provide opportunities to evaluate different risk identification and intervention strategies in a 'real-world' context.

ECONOMICS OF DIABETES PREVENTION: COST-EFFECTIVENESS AND AFFORDABILITY

Key uncertainties around the impact of population-level interventions and how to effectively deliver interventions in community settings are linked to uncertainties about the economics of diabetes prevention. There is concern about the benefits of relatively low-intensity interventions in less selected populations compared to the effectiveness in prevention trial participants, and the resources needed to sustain behavioural changes or medication adherence. Moreover, cost-effectiveness does not imply affordability and the significant up-front costs of prevention programmes impose a need to find more efficient ways of achieving benefits.

Which interventions are most likely to be cost-effective?

For individuals with impaired glucose tolerance, lifestyle intervention,[24,25,35–37] rosiglitazone,[38] metformin[25,35] and acarbose[39] have all been shown to prevent progression to diabetes. However, health economic studies suggest the most cost-effective interventions are likely to be intensive lifestyle interventions (and/or metformin) in high-risk groups.[2] Evidence suggests that lifestyle intervention is likely to be more effective than drug management in the long term. However, outside the context of a clinical trial, maintaining behaviour change may be difficult. The potential impact of side effects of drugs and issues of adherence in a community setting need to be a considered, as does the desirability of medicalising those with prediabetes. However, for some patients, switching to metformin may be a pragmatic approach and modelling suggests this could be a cost-effective strategy.[40]

Addressing uncertainty about longer-term benefits and effectiveness of 'real-world' community interventions

In the future we will have more data from long-term follow-up of participants in randomised controlled trials with robust outcome data. This will enable us to predict

with more certainty the long-term clinical and economic impacts of both diabetes prevention and screening programmes. The relative cost-effectiveness of upstream interventions at the population level will be harder to establish with any certainty. As personal behaviours take time to change and the health benefits can take even longer to establish,[41] the delayed effects of small lifestyle changes will be difficult to measure and it may not be possible to confidently attribute population-level secular trends to specific prevention measures. However, benefits can be modelled based on cohort study evidence that behaviour reliably predicts health outcomes, and assuming the observed relationships are causal.

Most economic studies lack long-term follow-up data (greater than 10 years) from DPS and rely on computer simulation modelling to predict the long-term clinical impact of DPPs and associated economic impact. Data from ongoing community-based studies are likely to be of shorter duration so models need to adopt conservative assumptions regarding sustained reductions in risk of diabetes and demonstrate the effect of using a much shorter time horizon model. Sufficient follow-up is required to show the effect of any 'maintenance' intervention. In the absence of such evidence, cost-effectiveness evaluations of community interventions will need to rely on reductions in risk of diabetes estimated through changes in glycaemia measures or other intermediate measures such as weight change and exercise.

Evidence gaps

There are some key issues that contribute to the uncertainty around the cost-effectiveness of the prevention of diabetes, some of which will be addressed by current trials, including ADDITION.[27] In particular, we lack evidence to model the natural history of diabetes from onset to clinical diabetes and the sustained effectiveness of both population-level and individual interventions.

It is important that the number of uncertain parameters in economic models does not lead to undue scepticism about their value. Probabilistic sensitivity analysis allows uncertainty around effectiveness and other model parameters to be taken account of, resulting in estimates of how likely interventions are to be cost-effective. Combined with sensitivity analyses that test the effect on results of altering key assumptions and time horizons, such analyses can help to inform decisions that inevitably involve uncertainty in the short term. Longer-term results from trials are still needed to confirm benefits predicted by models of intervention effects.

The cost-effectiveness of prevention is likely to change over time, since more effective management of glycaemia or related complications will reduce the marginal cost-effectiveness of earlier intervention. Equally, the cost-effectiveness of screening will be reduced if primary prevention policies are effective.

ETHICAL ISSUES

Since prevention – both primary (i.e. interventions in populations and individuals who do not have diabetes or who have non-diabetic hyperglycaemia) and secondary (i.e. screening to identify those with undiagnosed diabetes) – involves interventions that will have an impact on healthy individuals, not all of whom will directly benefit, there are specific ethical implications to consider. As well as weighing potential harms and benefits of prevention, there are trade-offs between respecting individual autonomy and the wider public health benefits of active intervention.

The Nuffield Bioethics Council's *Impacts on autonomy and personal freedom: a useful framework for considering public health interventions* is based on the extent to which interventions impact on personal freedom.[42] The intervention levels considered range from 'do nothing', 'provide information' and 'enable choice' through 'guide choice' and 'restrict choice' to 'eliminate choice'. Because there are a large variety of potential diabetes prevention interventions in the 'provide information' category (e.g. calorie counts on all restaurant menus, clearer food labelling) and 'enable choice' category (e.g. better facilities to encourage walking and cycling; free or cheap provision of fruit and vegetables) there may be an ethical argument that these are preferable to interventions which restrict choice (banning specific foods from shops or from school lunch-boxes). However, it is also possible that focusing on the provision of information, better facilities and more choice frequently benefits the better off – whose purchasing decisions may be more influenced by nutritional information than price, for example. So policy decisions must also take account of potential impacts on inequality and how these can be mitigated.

Informed consent for screening

Gaining fully informed consent for diabetes or pre-diabetes screening is a complex process, and the way in which screening is explained may have a direct impact on uptake and outcomes.[43] Data from a controlled trial of stepwise screening for diabetes are reassuring and suggest that there are limited psychological harms associated with the screening process.[32,33] Although there is growing evidence that screening does not result in significant 'false reassurance',[44] ideally if an individual has modifiable risk factors (particularly if they are overweight and have a sedentary lifestyle) they need effective support for making lifestyle changes, whatever their screening test result.

Unintended impacts on health inequalities

Behaviour change interventions, including screening and information provision/awareness raising, may be more effective in better-off populations and may actually exacerbate health inequalities. Guidance therefore needs to consider how to mitigate any potential adverse impact on inequalities.

IDENTIFYING SYNERGIES BETWEEN DIABETES PREVENTION AND OTHER POLICY PRIORITIES

Preventing diabetes or promoting healthy lifestyles?

A narrow focus on diabetes is likely to underestimate the true impact on population health of individual and collective interventions to promote change in key health behaviours such as diet and physical activity. Most effective diabetes prevention interventions are likely to help reduce cardiovascular disease and cancer risk, as well as improving mental health and social and emotional well-being.

The advantage of highlighting the wider and more immediate benefits of healthier lifestyles is that the message may be seen as more widely applicable and a positive message be viewed more effectively that a negative one (immediate health benefits rather than avoiding or delaying a hypothetical condition that might occur in the future). The advantage of a focus on diabetes prevention may be to focus and personalise the message for individuals and communities known to be at significantly increased risk of diabetes, such as specific ethnic minority communities.

Preventing diabetes, tackling climate change and achieving social inclusion goals

The recent Foresight report on obesity[45] took a broad view of the factors influencing current obesity trends and identified some important potential synergies in term of policies and actions that would reduce obesity while achieving other (non-health) major policy goals – specifically tackling climate change and tackling social exclusion – and the same is true of diabetes prevention policies. Many of the examples the report gives of relevant policy initiatives are directly applicable to diabetes prevention: designing sustainable communities and implementing sustainable food policies and active transport policies to increase walking and cycling. Similarly, there is a strong case for addressing socio-economic inequalities as an underlying driver of unhealthy behaviours.[46]

KEY POINTS

- There is already some relevant, evidence-based guidance in this field published by NICE, SIGN and Diabetes UK which, although not all specifically developed for those at increased risk of diabetes, addresses both population-level interventions to increase physical activity and change dietary habits and individual-level interventions for those already overweight or obese.
- Identifying individuals with impaired glucose tolerance and using intensive behaviour change interventions can reduce risk of diabetes in the context of randomised trials. Drugs – and surgery – to manage hyperglycaemia and obesity can also reduce risk of progression to diabetes in those unresponsive to behavioural interventions.
- There is less direct evidence that population-wide or community-level interventions or screening and individual-level intervention outside the context of trials are effective and cost-effective in reducing diabetes risk. In the context of these uncertainties, modelling potential costs and benefits may help identify an appropriate balance between individual and population-level interventions.
- Prevention programmes should take account of ethical considerations, including the impact on inequalities. Interventions should ideally be designed to mitigate the exacerbation of inequalities by investing in measures that target populations and individuals at risk of poorer health outcomes, ensuring interventions are both accessible and appropriate.
- There are potentially strong synergies between diabetes prevention strategies and other major and urgent public health priorities including climate change, socio-economic inequality, obesity prevention and reducing the burden of chronic diseases.

CONCLUSIONS

In considering 'Who can prevent diabetes?' the conclusions of the recent Foresight report on obesity are relevant:

> The evidence is very clear that policies aimed solely at individuals will be inadequate and that simply increasing the number or type of small scale interventions will not be sufficient to reverse this trend… a bold whole system approach is critical – from production and promotion of healthy diets to redesigning the built environment to promote walking, together with wider cultural changes to shift societal values around food and activity. This will require a broad set of integrated policies including both population and targeted measures and must necessarily include action not only by government, both central and local, but also action by industry, communities, families and society as a whole.[45]

Collectively, we will need to enlist all available evidence to develop and advocate evidence-based interventions that if implemented on a large enough scale will have a measurable impact on the population risk of diabetes and associated harms. There are synergies between diabetes prevention strategies and wider public health priorities in relation to both chronic disease prevention and global climate change, but strong advocacy and leadership from the health sector will be required if we are to seize the opportunity to reverse current trends.

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What are the practical implications of developments in genetics?

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ABSTRACT In recent years there has been a rapid increase in our understanding of the genetics of diabetes and the implication of genetics for clinical care. The major clinical breakthrough has been in identifying monogenic forms of diabetes. It has now been established that knowing the genetic aetiology alters treatment. This is seen for maturity onset diabetes of the young (MODY) caused by mutations in the *HNF1*α and HNF4α genes (extreme sensitivity to sulphonylureas); mutations in the *glucokinase* gene (no treatment required); and for mutations in the potassium channel genes encoding Kir6.2 and SUR1, where patients with neonatal diabetes can be transferred off insulin with high-dose sulphonylurea treatment. For the more common types of diabetes the clinical impact of genetics has yet to be realised, yet with the dramatic improvements in genotyping/sequencing technologies available it is probably just a matter of time before genetic profiling will be used to predict diabetes risk, or to tailor therapy for the individual.

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doi:10.4997/JRCPE.2010.S02

DECLARATION OF INTERESTS No conflict of interests declared.

For many years the classical division of diabetes mellitus into type 1 and type 2 diabetes has served clinicians well. Those, usually young people, with an acute presentation had type 1 diabetes and required insulin. Those, usually older obese people, that did not have type 1 diabetes had type 2 diabetes. There were a few rare forms of diabetes known about, but it made no difference to treatment so these were rarely looked for.

The recent developments in the genetics of diabetes have provided considerable insight into the heterogeneity of diabetes, as well as the biology of β-cell dysfunction and insulin action. Initial advances were seen in 'monogenic diabetes', in which a single genetic defect causes diabetes, and it is these forms where there has been direct impact on clinical care and establishing the need for genetic testing in the diabetes clinic. More recently, there has been exponential progress in teasing out the genetics of complex type 1 and 2 diabetes. While this has revealed previously unconsidered pathways associated with diabetes, the potential clinical use of these findings has yet to be established. Therefore this review will focus primarily on monogenic diabetes, with just a brief overview of the developments in common types of diabetes.

NEONATAL DIABETES

Diabetes that presents before the age of six months is unlikely to be type 1 diabetes.[1–2] Infants with neonatal diabetes mellitus (NDM) have low birth weight due to low fetal insulin secretion, and usually develop insulin requiring diabetes in the first three months of life. Presentation is often with severe hyperglycaemia or diabetic ketoacidosis. Clinically, neonatal diabetes can be divided into whether the diabetes persists (permanent, PNDM, 45%) or resolves (transient, TNDM, 45%).[3] This clinical classification has been dissected by recent genetic developments. Transient NDM can now be almost entirely explained either by imprinting anomalies on chromosomal region 6q24, with the remainder due to K_{ATP} gene mutations.[4] Approximately 60% of PNDM can be explained, primarily by mutations in the K_{ATP} genes, but also by mutations in the insulin gene and homozygous mutations in glucokinase.[5–7] This review will focus on the K_{ATP} channel. (For a review of all NDM please refer to Shield.[8])

K_{ATP} channel mutations

The pancreatic β-cell secretes insulin in response to a variety of nutrient and other stimuli. The ATP-sensitive potassium (K_{ATP}) channel is a key step in this process of stimulus-secretion coupling, and consists of four Kir6.2 subunits (encoded by the *KCNJ11* gene) and four SUR1 subunits (encoded by the *ABCC8* gene). Inactivating mutations cause the channel to be closed and thus the β-cells to over-secrete insulin, causing hyperinsulinaemic hypoglycaemia.[9] Activating mutations cause the β-cell to be unresponsive to glucose and therefore are a cause of NDM.[6,10–11]

Activating K_{ATP} channel mutations cause PNDM, TNDM and neurological features

The phenotype seen with mutations in SUR1 and Kir6.2 is very similar. Some mutations cause TNDM and the diabetes remits at 35 weeks (range 2–208 weeks) and then relapses at five years of age (range 1–16 years).[4] Different mutations cause PNDM. About 20% of Kir6.2 mutations are associated with neurological features due to the expression of the K_{ATP} channel in the brain, peripheral nerves and muscle. Approximately 5% have a neurological syndrome that is characterised by severe Developmental delay, Epilepsy and Neonatal Diabetes (DEND). About 15% have an intermediate phenotype

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(intermediate DEND or iDEND) with milder developmental delay and without epilepsy.[6] Due to the severity of presentation, often with diabetic ketoacidosis (DKA), and the fact that the majority have no detectable endogenous insulin secretion,[6,12] all patients with NDM, until recently, were initiated on insulin and those with PNDM remained insulin treated for life.

Insulin can be replaced by oral sulphonylureas in patients with NDM

The activating mutations in the K_{ATP} channel genes alter ATP sensitivity or gating of the channel, resulting in a lack of channel closure with a glucose stimulus.[6] Sulphonylureas are a drug class that has been used for more than 50 years to treat type 2 diabetes. These drugs act on the SUR1 subunit of the K_{ATP} channel to bring about channel closure. When three patients with Kir6.2 mutations were challenged with the intravenous sulphonylurea tolbutamide they produced measurable insulin secretion.[6] This paved the way to conversion off insulin to oral sulphonylurea therapy, first in one case[13] and then in a large series.[12] In this series, 90% of patients were able to transition from insulin to sulphonylurea, and every individual who did so improved their glycaemic control (Figure 1) (evidence level 2++).

Over and above the ability to transfer off insulin, what is striking about the glucose control in patients with PNDM treated with sulphonylureas is their near normoglycaemia and minimal hypoglycaemia. This reflects prandial regulation of insulin secretion, an effect that is mediated by sulphonylureas enabling the β-cell to respond to incretins.[12] For many patients who have successfully transferred to sulphonylureas, they have normal glycosylated haemoglobin (HbA_{1c}), can eat what they want, can do what they want and in essence are non-diabetic.

MATURITY ONSET DIABETES OF THE YOUNG

Maturity onset diabetes of the young (MODY) is non-insulin-requiring diabetes that presents in children or young adults and accounts for about 1–2% of diabetes. It has an autosomal dominant inheritance and hence there is often a strong family history of diabetes. Once again, genetics has divided a clinically defined condition into a number of aetiologically distinct subtypes. The most clinically relevant of these will be discussed. These are MODY due to mutations in the transcription factors hepatocyte nuclear factor (HNF) 1α, HNF4α and HNF1β; and the glycolytic enzyme glucokinase (reviewed in Stride and Hattersley[14]). The diabetes phenotype due to the transcription factor gene mutations is similar, with onset usually in adolescence or early adulthood, gradual progression requiring increasing treatment and ultimately insulin, and association with micro- and macrovascular complications. Glucokinase mutations, as will be discussed, cause stable, mild, non-progressive hyperglycaemia and are therefore quite distinct from the other MODY

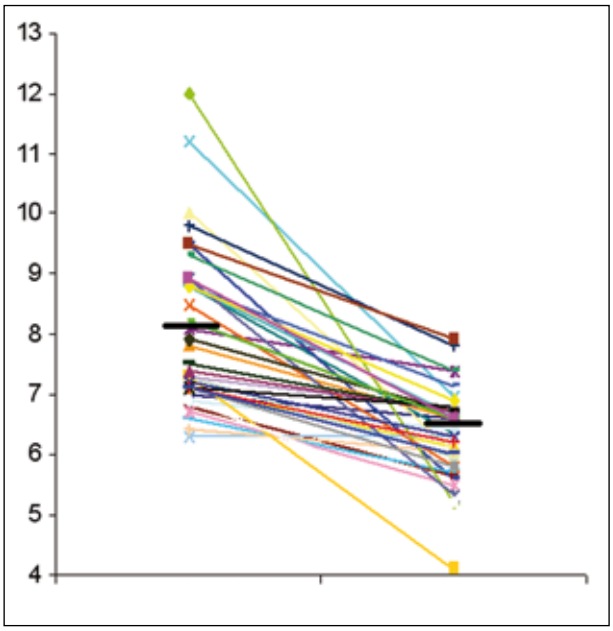

FIGURE 1 HbA_{1c} prior to and after successful transfer off insulin onto sulphonylureas in patients with neonatal diabetes due to Kir6.2 mutations.[12] (With kind permission of *The New England Journal of Medicine*.)

subtypes. Table 1 outlines the key features of the different MODY subtypes.

MODY due to HNF1α and HNF4α mutations are sensitive to sulphonylureas and can transfer off insulin

A series of case reports[15–17] prompted a randomised open-label crossover trial of metformin and sulphonylureas in patients with diabetes due to an HNF1α mutation and patients with type 2 diabetes matched for age and body mass index (BMI).[18] Treatment consisted of gliclazide for six weeks, followed by metformin for six weeks (or vice versa). The primary outcome was fasting glucose reduction from baseline. The results of this study showed dramatically greater response to sulphonylureas in patients with HNF1α mutations compared to their response to metformin and compared to response to gliclazide in patients with type 2 diabetes (Figure 2) (evidence level 1+). The mechanism for this sensitivity reflects the fact that sulphonylureas act downstream of the major defects seen with HNF1α mutations so a patient with an HNF1α mutation is essentially blind to glucose but sensitive to sulphonylureas. Although there are no such robust data for patients with HNF4α similar sulphonylurea sensitivity has been described[19] (evidence level 3).

Because of the marked sensitivity to sulphonylureas in HNF1α diabetes, patients who had been misdiagnosed as having type 1 diabetes and were insulin treated, but who subsequently were found to have an HNF1α mutation were trialled with sulphonylureas.[20] All 34 patients successfully transferred off insulin, some with

TABLE 1 Features of the MODY subtypes (adapted from Hattersley A et al.[39])

	Age of onset (range)	Diabetes characteristics	Other features
HNF1α (MODY 3)	14 (4–18)	• Progressive • Sulphonylurea sensitivity	• Low renal threshold for glucose • Normal birthweight
HNF4α (MODY 4)	17 (5–18)	• Progressive (like HNF1α) • Sulphonylurea sensitivity	• Hyperinsulinaemic hypoglycaemia • Macrosomia and increased birth weight
HNF1β (MODY 5)	26 (10–61)	• Diabetes only present in 50% of mutation carriers • Rapidly progresses to insulin • Insulin resistance as well as β-cell dysfunction	• Low birth weight • Renal cysts • Genital tract malformation • Hyperuricaemia • Elevated alanine aminotransferase • Pancreatic exocrine dysfunction • Absent pancreatic body and tail
GCK (MODY 2)	When tested (present from birth)	Stable non-progressive fasting hyperglycaemia	• Fasting glucose 5.5–8 mmol/l • Small increment at oral glucose tolerance test (2 hours increment <3.5 mmol/l)

over 30 years of being 'insulin-dependent' (evidence level 2+). However, 10 patients subsequently had insulin reintroduced. The 24 remaining off insulin remained off for between 17 and 90 months; of these 80% achieved an HbA_{1c} of <7.5% or a >1% reduction.[20]

The decision to be made clinically when treating non-type 1 diabetes is what oral agent to prescribe. In type 2 diabetes, metformin and sulphonylureas have similar efficacy,[21] but metformin is usually favoured because of its macrovascular benefit and weight neutrality. However, if a patient is known to have an HNF1α mutation, even if they are phenotypically indistinct from someone with type 2 diabetes, the randomised trial[18] would support the use of sulphonylureas as first-line agent in this patient group (A grade), as 62% responded at least two-fold better to gliclazide than they did to metformin. This contrasts with just 16% in those with type 2 diabetes. In addition, knowing someone has an HNF1α mutation should prompt an attempt at transfer off insulin to sulphonylureas in patients who have not previously failed on a sulphonylurea (C grade). This is the first robust evidence for genetics impacting on the clinical therapeutic management of diabetes.

HNF4α mutations cause macrosomia and neonatal hyperinsulinaemic hypoglycaemia

Although the diabetes phenotype due to HNF4α mutations is similar to that due to HNF1α mutations, HNF4α mutations cause hyperinsulinaemia in utero, and in some this also manifests as hyperinsulinaemic hypoglycaemia in the neonatal period[22] (evidence level 2+). In the UK series, the affected offspring birth weight was 790 g heavier than the unaffected (no HNF4α mutation) offspring, and as a result there was greater extreme macrosomia (>5 kg birth weight) and two cases of Erb's palsy or shoulder dystocia.[22] Transient hypoglycaemia was reported in 8/54 infants with heterozygous HNF4α mutations, but was reported in none of 54 non-mutation carriers (p<0.003). There was documented hyperinsulinaemia in three cases. The hypoglycaemia was diazoxide responsive and resolved in all cases by one year of age. The mechanism for this paradoxical oversecretion in utero, and subsequent hypoinsulinaemia causing diabetes in later life has still to be explained. However, clinically, birth weight can be used to guide genetic testing (a birth weight >4.4 kg is 80% specific for an HNF4α mutation compared with an HNF1α mutation[23]) and neonates with hyperinsulinaemia and a family history of diabetes should be tested for an HNF4α mutation (D grade).

Glucokinase mutations are a common cause of incidental hyperglycaemia, and do not require treatment

Glucokinase catalyses the first step in glycolysis and is rate limiting. The kinetics of this enzyme make it able to alter flux through glycolysis according to the glucose

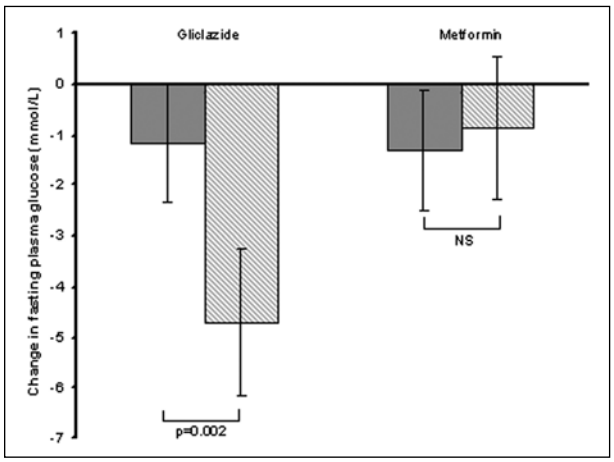

FIGURE 2 Fasting glucose reduction achieved by gliclazide and metformin in patients with HNF1α mutations and patients with type 2 diabetes.[18] Diagonal shaded bars represent HNF1α patients; solid bars are type 2 diabetic patients. (With kind permission of *The Lancet*.)

concentration, and thus it acts as the pancreatic glucose sensor. Heterozygous inactivating mutations in glucokinase cause a shift in the glucose response curve, resulting in patients having a raised fasting glucose. However, given sufficient stimulus, the β-cell will maximally secrete insulin, and thus the post-prandial glucose rise is small. So classically patients with MODY due to a glucokinase mutation will have a high fasting glucose (>5.5 mmol/l) but a small increment at 2 hours after a 75 g oral glucose challenge (<3.5 mmol/l) (evidence level 2+).[24] As a result of this ability to respond to meals, the HbA_{1c} in patients with glucokinase mutations is usually normal or only slightly elevated, and hence the risk of microvascular disease is low.[25] Treatment is not indicated, and in fact the use of insulin or oral agents has little impact on glycaemia.

In a Czech study of 60 paediatric patients referred to secondary care with asymptomatic hyperglycaemia who had persistent hyperglycaemia on retesting, 35 (68%) were found to have glucokinase mutations, two had an HNF1α mutation, one had an HNF4α mutation and one a Kir6.2 mutation. Eleven had type 1 diabetes[26] (evidence level 2+). This study contrasts with a study in an older population, aged 30–70 years, with an increased diabetes risk and with fasting hyperglycaemia (5.5–7.7 mmol/l), where the prevalence of glucokinase mutations was just 5/658 patients.[27] Thus in this paediatric population, where the prior probability of finding a monogenic cause is high, there is a higher prevalence of glucokinase mutations, whereas in the older population where type 2 diabetes is much more likely, fasting hyperglycaemia or a small increment at oral glucose tolerance testing are not discriminatory.

TYPE 1 AND TYPE 2 DIABETES

After many years with little progress, the acceleration in affordable genotyping technology and advances in our understanding of genetic architecture have prompted a flurry of exciting publications. These report in excess of 20 robustly replicated loci for type 2 diabetes[28] (evidence level 1++) and 18 for type 1 diabetes[29] (evidence level 1++). The main output of these discoveries has been that novel pathways have been identified for diabetes, and that there is a considerable overlap between different diseases (e.g. type 2 diabetes and prostate cancer,[30] type 1 diabetes, coeliac disease and rheumatoid arthritis[31]. A full discussion of this is beyond the scope of this review).

Considerable effort is under way to translate these genetic findings into an understanding of the biological mechanism. It is likely that the greatest clinical benefit of genetics of common diabetes will be in the development of novel therapies. However, what remains uncertain is the direct clinical utility of genetics of type 1 and 2 diabetes. While a number of groups have shown that combining all the known type 2 diabetes genes can be used to predict disease, this is of little added value to traditional risk factors such as BMI, age and family history. To assess predictive utility a receiving operating curve (ROC) is usually plotted, where the area under the ROC (AUROC) is a measure of predictive ability (50% being random, 80–85% the level thought to be clinical useful to predict disease). In a study of two populations (the Botnia study and the Malmö Preventive Project) where longitudinal data was available on the development of diabetes, the AUROC for phenotype alone was 0.74, and this was only increased to 0.75 ($p=1*10^{-4}$) by the inclusion of genotype at 16 polymorphisms.[32] Even in type 1 diabetes where the sibling relative risk (λ_s) is much greater than in type 2 diabetes (15 vs 3), the utility of genetic testing has still to be established.[33] One problem is that all the loci identified only add up to a small fraction of the heritability of type 1 or type 2 diabetes. The current hope is that this 'missing heritability' consists of multiple rare variants with large effect, and identifying these may enhance prediction.

Another area of hope where genetics might deliver is in pharmacogenetics of type 2 diabetes, a field that also is accelerating fast.[34] However, once again, although the discoveries help unravel drug mechanism, they lack clinical utility due to small effect sizes. In a recent study, 6% of the population who carry two loss-of-function polymorphisms in *CYP2C9*, encoding the key enzyme that metabolises sulphonylureas, were 3.4 times less likely to achieve a treatment HbA_{1c} of <7%.[35] This is the largest pharmacogenetic effect described to date for diabetes drugs, yet the added predictive value of genotype was minimal, and there remains considerable unexplained variation in individual response to diabetes drugs – an area where rare variant discovery might contribute. The field where pharmacogenetics is impacting on clinical medicine is in its utility to predict very rare but extremely severe adverse drug reactions, with the paradigm being that of HLA-B*5701 and abacavir hypersensitivity.[36] In diabetes there are not such severe adverse reactions, but the ability to predict metformin intolerance, thiazolidinedione-induced oedema or hypoglycaemia with sulphonylureas is an area where genetics may begin to play a role in the clinic.

PRACTICAL IMPLICATIONS

Neonatal diabetes

As 60% of permanent neonatal diabetes and 26% of transient neonatal diabetes are due to K_{ATP} channel mutations and 90% of these are able to be treated with sulphonylureas with near normoglycaemia, then:

- All infants, children or adults who develop(ed) diabetes before six months of age should have genetic testing (grade B);
- All infants who have a K_{ATP} channel gene mutation should be trialled with high-dose sulphonylurea (grade B).

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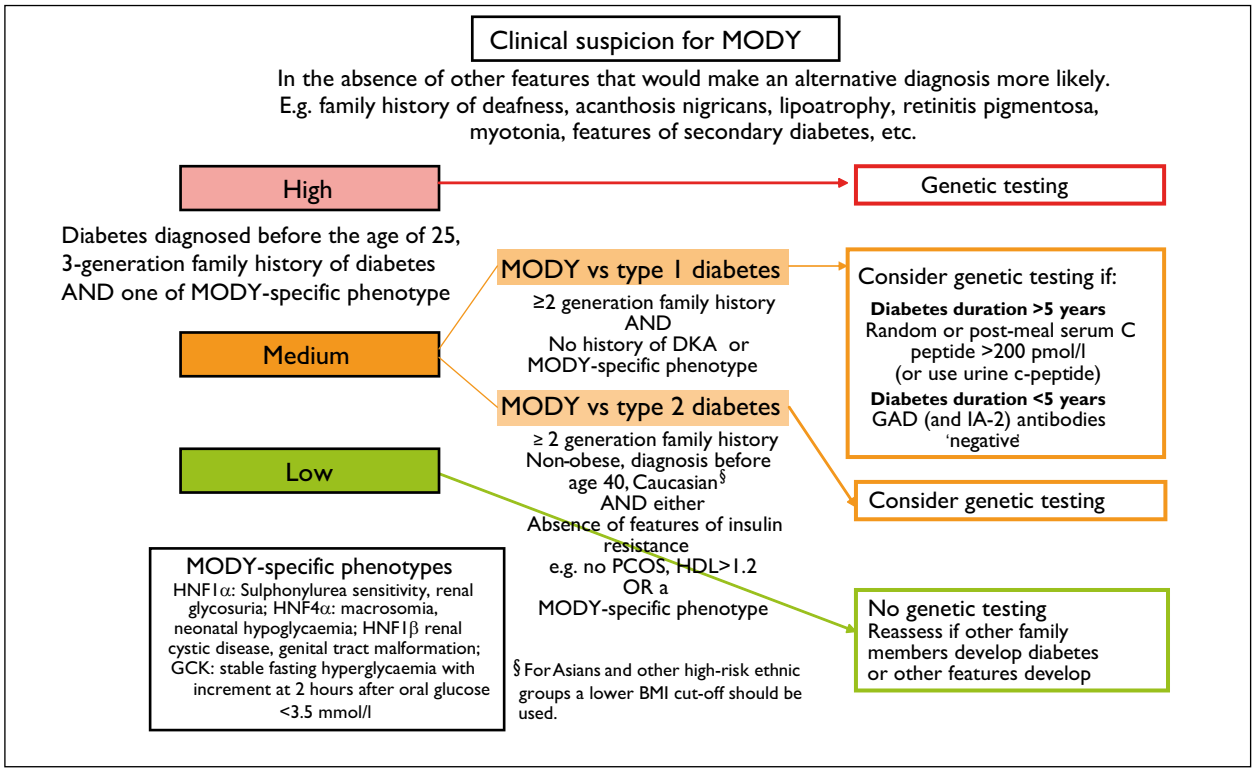

FIGURE 3 A flow chart depicting an approach to deciding whether to screen for MODY, either by direct genetic testing or by testing C-peptide and pancreatic autoantibodies.

Genetic testing should be carried out before considering a trial of sulphonylureas as high doses of sulphonylurea are often required (doses up to five times the maximal adult dose/kg have been used), and knowing that an individual has a K_{ATP} channel mutation will provide confidence in progressing up to such doses before seeing an insulin reduction. Genetic testing for neonatal diabetes is currently free of charge (www.diabetesgenes.org.uk).

Since awareness of neonatal diabetes as a distinct entity has increased, the estimated prevalence has risen and is now estimated at one in 200,000 to 260,000 live births,[37] suggesting there should be about 15–20 cases in Scotland, and about 200–250 in the UK as a whole. A relative lack of adults currently diagnosed suggests that the adult population is a considerable source of undiagnosed neonatal diabetes, and as adults with K_{ATP} channel mutations can still successfully transfer off insulin, efforts should be made by adult diabetologists to identify these people within the 'type 1' patients in secondary care (grade D).

There is increasing, albeit anecdotal, evidence[38] that treating early with glibenclamide can reverse or even prevent the neurological features of iDEND, and therefore all children with a confirmed K_{ATP} channel mutation should be started on a sulphonylurea as soon as possible, and genetic testing should not be delayed (grade D).

Identifying MODY

The classical defining MODY criteria are of a three-generation family history, an age of onset in one family member before 25 and non-insulin-requiring diabetes. Sequencing MODY genes should be considered in families who fulfil these criteria, with specific features being used to guide the gene to be sequenced (see Table 1). For example:

- Increased birth weight – HNF4α
- Renal glycosuria – HNF1α
- Renal cysts – HNF1β

For further information, please refer to the 'Best practice guidelines for the molecular genetic diagnosis of maturity-onset diabetes of the young'[23] or the International Society for Pediatric and Adolescent Diabetes (ISPAD) guidelines for diagnosis and management of monogenic diabetes.[39]

Recommendation: Sequence MODY genes in families that fulfil classic MODY criteria (grade D).

Additional clinical criteria may also suggest MODY in patients who do not fulfil the above criteria. Testing pancreatic autoantibodies and C-peptide can be helpful. A suggested approach to identify MODY in the diabetes clinic is shown in Figure 3.

Pancreatic autoantibodies

Type 1 diabetes is defined by the presence of autoimmune destruction of the β-cells, and this is characterised by

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detectable pancreatic autoantibodies at diagnosis. A number of autoantibodies can be measured, and if four antibodies are measured (to glutamate decarboxylase, [GAD-65], islet antigen 2 [IA-2], insulin and ZnT8A), only 2–4% of patients are autoantibody-negative.[40] Currently both IA-2 and GAD antibody testing is sensitive and specific, although only GAD antibody testing is routinely available.[41] Where possible, both IA-2 and GAD antibodies should be tested in all individuals presenting with presumed type 1 diabetes, if only to confirm clinical diagnosis. If these antibodies are present in low titre (negative), an alternative diagnosis such as MODY should be considered, although, particularly if only GAD antibodies were tested, type 1 diabetes cannot be excluded. It should be emphasised that whatever the ultimate diagnosis, a clinical presentation with ketosis and severe hyperglycaemia requires insulin treatment to reverse the metabolic abnormalities.

Recommendations:

- Reconsider a diagnosis of type 1 diabetes if GAD (and IA-2) antibodies are negative (grade D);
- If in doubt, treat with insulin initially as this is safe and effective. Insulin treatment can be withdrawn once a diagnosis is made (grade D).

C-peptide

The C-peptide is cleaved in proinsulin processing, and is co-secreted with insulin. It is thus a marker of endogenous insulin secretion and is particularly useful when a patient is insulin treated, as the serum insulin assay cannot be used. Five years after diagnosis of type 1 diabetes in the Diabetes Control and Complications Trial, 0% of adolescents and only 11% of adults had measurable C-peptide (evidence level 2+).[42] So if MODY is queried more than five years after diagnosis of 'type 1 diabetes', the persistence of C-peptide makes a diagnosis of type 1 diabetes unlikely and other causes should be considered. C-peptide needs to reach the laboratory within one hour and thus is not suitable for primary care; however, urinary C-peptide is stable and the urinary C-peptide–creatinine ratio may prove to be useful[43] but is not yet routinely available.

Recommendation: In patients where non-type 1 diabetes is suspected over five years from diagnosis, measure C-peptide (when glucose >8 mmol/l). Persistence of C-peptide after five years of diabetes makes type 1 diabetes unlikely (grade D).

Incidental hyperglycaemia

As highlighted above, 68% of children selected purely on persistent asymptomatic hyperglycaemia had a glucokinase mutation, yet family history of diabetes was not an inclusion criterion for glucokinase sequencing.

Recommendation: Asymptomatic hyperglycaemia that does not progress in children and young adults should prompt sequencing for glucokinase mutations (grade C).

Treatment choice

Recommendations:

- Patients with an HNF1α mutation should be treated with a low-dose sulphonylurea first line (grade A);
- Patients with and HNF4α mutation should be treated with a low-dose sulphonylurea first line (grade D);
- Patients with a glucokinase mutation do not require treatment (grade D).

Prevalence of MODY and availability of testing

There is considerable variation in the number of MODY patients by region in the UK. All data that follow are provided by the Exeter referral lab (Shields, Hattersley, Ellard; personal communication). The highest number of MODY patients is seen in the southwest of England, with a prevalence of 49 per million population. This is likely to reflect the strong research and clinical interest in MODY based in Exeter. Beyond this there is a clear difference in number by country, with Scotland having the highest number of MODY patients per population (27 per million). England has 20 per million, Wales 13 per million and Northern Ireland 5 per million (evidence level 3). There are two probable explanations for this. Firstly, in an initiative set up by the Exeter team, 18 diabetes specialist nurses received additional training on genetic forms of diabetes with an aim to increase and update the knowledge of the local diabetes teams. These Genetic Diabetes Nurses were originally funded within England and Scotland but not in Wales or Northern Ireland. Another barrier to referral for genetic testing is cost and specifically which budget is used to meet these costs. Some primary care trusts have not agreed to meet these costs in England. In Scotland, with the highest referral rate and highest number of MODY patients identified, the cost for genetic testing is met centrally.

Recommendation: Increased awareness and reduced barriers to genetic testing increase detection of MODY. All patients should have similar access to genetic testing irrespective of their geographical location in the UK (grade D).

SUMMARY

In the past five years there have been considerable developments in diabetes genetics. In type 1 and type 2 diabetes the exciting new discoveries are shedding new light on biological mechanisms of disease, but have yet to impact directly on clinical care. In monogenic diabetes the progress has been in translating the genetic discoveries into clinical care, and establishing that knowing the genetic aetiology of diabetes determines the treatment choice. With this established, the critical next step is to fully incorporate genetic testing into routine care.

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Which psychological interventions work?

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ABSTRACT It is the daily behaviour of people with diabetes that most influences shorter-term and longer-term health outcomes. Consequently, health professionals involved in diabetes care provision are routinely trying to make sense of, and change, health-related behaviour. The aims of this article were to: a) identify whether or not psychological interventions can lead to improved health outcomes in adults and children, and b) if so, what was the nature of the psychological interventions that worked best. Overall, the literature on young people with types 1 diabetes and adults with types 1 and 2 diabetes indicates that psychological interventions are effective in improving glycaemic control in the short term. However, there was insufficient evidence to conclude which psychological interventions were most effective. The literature on psychological interventions in diabetes is relatively underdeveloped and therefore has many limitations.

DECLARATION OF INTERESTS No conflict of interests declared.

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doi:10.4997/JRCPE.2010.S03

INTRODUCTION

Helping adults and children with diabetes to avoid short- and longer-term complications is the primary aim of diabetes services. Unfortunately, just under half of people with diabetes do not attain good control.[1] There is a general consensus that reducing diabetes-related complications can only occur by improving the ability of people with diabetes to self-care.[1–3] This is because it is the day-to-day health-related behaviours that are the most important determinant of the outcomes of care, rather than the average of three or so hours per year contact with health professionals that occurs in the UK.[3] We know that simply telling adults and young people (and their families) what they should do often does not work, and that there is little relationship between knowledge and behaviour.[4] Therefore, in theory at least, diabetes services are in the business of trying to understand and change health-related behaviours.

There are a range of health-related behaviours which are of interest to diabetes services. These include those behaviours associated with average blood glucose levels, the occurrence of hypoglycaemic and hyperglycaemic episodes, high blood pressure, smoking and obesity.[2,5] Typically, the behaviours that influence these important clinical indicators are complex and reflect aspects of lifestyle that are long-standing. Furthermore, the relationships among the clinical indicators and behaviours of interest can be bi-directional so establishing, for example, causality can be extremely problematic, especially where glycaemic control and self-care behaviours are concerned. The underlying reasons for peoples' difficulties managing effectively their condition vary. Many of the significant barriers to improved control relate to beliefs that people with diabetes have about themselves and their condition, and relate to emotional well-being.[6]

Psychological theories and models have a long history of informing attempts to change behaviour and improve emotional well-being. Over recent years many clinical guidelines in the UK by the National Institute for Health and Clinical Excellence (NICE) and the Scottish Intercollegiate Guidelines Network (SIGN) have included recommendations for psychological interventions. Evidence-based recommendations have been made not only for the treatment of mental health problems such as depression and anxiety[7,8] but also for physical health conditions such as low back pain[9] and obesity[10] and changing behaviour related to public health issues.[11] The aim of this paper is to try to establish whether psychological interventions are effective in improving the short- and longer-term health outcomes of children and adults with diabetes, and if so which specific types of interventions work best.

CHILDREN AND ADOLESCENTS WITH TYPE 1 DIABETES

There have been a small number of high-quality systematic reviews of the effectiveness of psychological interventions in young people with type 1 diabetes. An extensive review on behalf of the National Institute for Health Research's Health Technology Assessment programme (NIHR HTA) was published nearly a decade ago.[12] This review, which contained a mixture of psychological and educational intervention studies, included 25 randomised controlled trials (RCTs) of which 12 contained sufficient details to allow effect size calculations of changes in glycosylated haemoglobin (HbA_{1c}). The mean effect size resulting from the psychological interventions was 0.33, which translates to a reduction of about 0.6% in HbA_{1c}. Eight RCTs contained sufficient data to calculate the mean effect size for psychosocial outcomes, which was 0.37.

J R Coll Physicians Edinb 2010; 40(Suppl 17):20–4

The authors highlighted a number of weaknesses in the literature. For example, most studies were underpowered to identify the levels of change highlighted above; follow-up was over a relatively brief period in view of the fact that diabetes is a lifelong condition; most studies were conducted in the USA and most interventions were not theoretically grounded (which generally are less effective than theoretically derived interventions). The reviewers also referred to more clinically relevant issues for example, they could identify no studies which had varied the intervention depending on the actual specific circumstances of participating subjects. In addition, because of small sample sizes, the review was unable to reach any conclusions about the effectiveness of psychological interventions to help those young people with poor control.

Several years later, this systematic review was updated, again including psychological and educational interventions.[13] Compared with the earlier review,[12] the authors noted an increased proportion of RCTs (54% compared with 40%); an increased mean number of subjects per study (79.7 vs 53.8) but no meaningful increase in theoretically based interventions. Nine RCTs published since the 2001 review were used to calculate the mean effect size, which was 0.11. This substantially lower figure is largely due to three intervention studies (two of which were based on cognitive behavioural therapy principles) resulting in poorer control (negative effect sizes of –0.20, –0.11 and –0.31). The median effects size on HbA_{1c} was similar to the earlier review (0.17 vs 0.18), as were the mean and median effect sizes for psychosocial outcomes (0.35 vs 0.36 and 0.38 vs 0.37, respectively). The authors noted that no particular theoretical approach to the design and implementation of psychological interventions appeared to be superior to others. There remained a number of significant limitations in the literature; for example, it was not possible to separate the intervention from the interventionist. That is, it was unclear if similar results would be obtained by others delivering the interventions studied.

A systematic review published in 2005 specifically explored the effectiveness of family-based interventions.[14] The authors identified 19 RCTs which contained a mixture of psychological and educational interventions. Of these, 12 studies concerned children or adolescents with the pooled effect on HbA_{1c} of 0.6%. The fact that both this review and that of the NIHR HTA[12] several years earlier shared three studies within their analysis cannot account fully for the strikingly similar results. The authors highlighted that the heterogeneity of interventions studied and psychosocial outcome measures used were important weaknesses within the existing literature.

There has been one systematic review of RCTs which included only psychological interventions, rather than those which included both psychological and educational components.[15] An educational intervention within this review was defined as being specifically designed to increase diabetes-related knowledge and skills, to improve self-management. There is typically an educational component within psychological interventions. However, in this case its purpose is usually to develop psychological sophistication in line with the underlying theory from which the intervention is derived, and then to apply this to defined clinical problems. This review reported a pooled effect size of 0.35, which is equivalent to a reduction of 0.48% in HbA_{1c}. Of the 10 RCTs included in this calculation, six were included in the 2001 review.[12] The authors further noted an improvement in psychosocial outcomes of mean effect size to 0.46. Moreover, they highlighted the fact that the quality of studies was poor to moderate, and that most interventions were based broadly on cognitive behavioural principles. Comparison therefore between different types of psychological interventions was not possible.

ADULTS WITH TYPE 1 DIABETES

There are fewer systematic reviews of psychological interventions used with adults than with young people. However, we do have one high-quality, relatively recent systematic review and meta-analysis which helpfully excluded educational interventions.[15] This review identified 11 RCTs and these were used to calculate the standardised mean effect size of 0.17. Of these 11 studies, eight resulted in improved glycaemic control and three in poorer control. The mean effect size for improvement in psychological distress was 0.35. Although most of the studies reviewed were informed by cognitive behavioural principles they were certainly not homogeneous. For example, one RCT evaluated the effect of two 15-minute individual exploratory discussions about well-being with diabetes specialist nurses against standard care in the Netherlands.[16] Another RCT compared the effectiveness of cognitive behavioural techniques against blood glucose awareness training, with both interventions delivered in six two-hour sessions to groups of subjects.[17] Yet another compared the effect of an intensive in-patient progressive muscle relaxation programme against treatment, as usual in the USA.[18]

An RCT published subsequently to the above review is worthy of note. A relatively large RCT in the UK compared the effects of about four hours of motivational enhancement therapy over two months versus four hours of motivational enhancement therapy plus eight hours of cognitive behavioural therapy (CBT) over six months versus usual care.[19] Unusually, each arm of this study had more than 100 subjects. Twelve months later, the motivational enhancement therapy plus CBT group had a mean HbA_{1c} of nearly 0.5% lower than subjects who had received usual care. Arguably the only potential difficulty with this study is the training of the nurses who delivered the interventions. The authors detail that they

sensibly continually assessed nurses' skills during the training period, allowing them to deliver the study intervention only when deemed sufficiently competent. However, the training period was only three months, and this is significantly shorter (by at least six months) than even those training courses designed for delivery of low-intensity interventions based on CBT (generally guided self-help), and we certainly know that outcomes are linked to therapists' skill levels in CBT.[7]

ADULTS WITH TYPE 2 DIABETES

As far as the author is aware, there has been one systematic review of psychological interventions to improve glycaemic control among adults with type 2 diabetes. A review published in 2004[20] identified 12 RCTs, of which nine resulted in better control and three in poorer control. The standardised mean effect size was 0.32 in favour of psychological interventions, which the authors indicate equates to a decrease of 0.76% in HbA_{1c}. Removing two studies wherein the control groups received less intensive psychological interventions resulted in an increased effect size of 0.44 and a corresponding drop in HbA_{1c} of 1.06%. Five RCTs could be used to calculate the mean effect size for improvement in psychological distress, which was 0.58. It is important to note that psychological difficulties (such as depression, anxiety and binge eating) were explicitly a target for the interventions.

It is clear from this review that the target groups have been relatively dissimilar. For example, some studies specifically targeted people with type 2 diabetes who also had clinical depression, a binge eating problem or suboptimal control or were obese. These are very different groups and certainly within a cognitive behavioural paradigm would require dissimilar management and treatments. The authors highlighted the fact that most interventions (10 of the 12) used were based on based on cognitive behavioural theory and interventions. It is extremely difficult to find terms to encompass the nature of the psychological interventions that have been used in studies in diabetes, because of their diversity. It is unlikely, however, that many within the cognitive behavioural therapy community would consider 16 Qigong relaxation training sessions by a Qigong doctor as an example of their work. This is not meant to be a criticism of the review, rather a comment to emphasise the fact that we need to be mindful of the homogeneity of the interventions and interventionists.

Subsequent to the 2004 review,[20] there had been one RCT worth highlighting. A US study[21] compared a standard seven-hour education programme provided to newly diagnosed low socioeconomic status adults with type 2 diabetes (n=38), and a four-hour condensed version of the educational programme plus three hours of a psychological intervention (n=43). The intervention was based on an approach called acceptance and commitment therapy (ACT). Acceptance and commitment therapy is part of the so-called third wave of psychological treatments. It emphasises the development of mindfulness (trying to live in, and focus on, the present moment), acceptance (including the fact that difficulties are inevitable) and value-based living (so you try to live an interesting and meaningful life, even in the face of difficulties).

There were a number of significant results between the groups across the pre-treatment to follow-up point three months later. The mean HbA_{1c} in the control group fell from 8.21% to 8.07%, while in the ACT group it decreased from 8.17% to 7.47%, significantly favouring the latter group. Similarly, in the control group the number of subjects whose HbA_{1c} was below 7% decreased slightly from 10/38 to 9/38 between pre-treatment and follow-up. In the ACT group over the same period there was an increase from 11/43 to 21/43. Again the difference between the two groups was significant. The main weaknesses of this study are that the number of subjects is relatively small, the follow-up period short and the ACT intervention was delivered by a single interventionist.

DISCUSSION

It is clear that the existing evidence suggests that psychological interventions are effective in improving the short-term glycaemic control of children and adults with type 1 diabetes and adults with type 2 diabetes. The extent to which this is the case is less clear, and we have no evidence of whether gains are maintained over longer periods. Expecting an improvement in the region of about 0.5% in HbA_{1c} would appear to be realistic. There is no substantial evidence to help inform us which of the many possible psychological interventions available are most effective overall and also where specific sub-groups are concerned. For example, we currently have little to guide us on what is the most effective psychological intervention for younger children, adolescents, those with type 1 diabetes, those with type 2 diabetes, those with especially poor control, and so on.

The existing literature is beset with limitations. However, it is worth reflecting on the fact that a recent update of a UK national clinical guideline on the management of depression using psychological interventions resulted in the identification of 139 RCTs, which in total included data on nearly 13,000 subjects.[7] This current review highlights the difficulty of systematically evaluating literature on a topic in its infancy. In short, in the area of diabetes we have relatively little data typically provided from small-scale studies wherein the psychological interventions are relatively idiosyncratic, the extent and nature of the educational components are often unclear and inclusion criteria is broad. The latter point profoundly influences effect size calculations and may in part account for the considerably lower effect size values for psychosocial outcomes when compared to the mental health literature (which is typically in the region of 0.75).

Unfortunately, understanding exactly what is being described by the term 'psychological intervention' is not easy, particularly for those with no training in professional psychology. There are myriad psychological theories and models which can be used to inform the design and delivery of interventions. Some are clearly dissimilar. For example, psychoanalysis is typically a long-term exploratory approach which seeks to resolve unconscious conflicts, and CBT is a time-limited, problem-orientated approach that seeks to help change unhelpful ways of thinking and behaving. However, even CBT is a broad church which encompasses many somewhat different approaches.[22] This means that almost all studies are not evaluating a specific approach (such as CBT), rather more usually a small number of affiliated techniques. This in turn results in the heterogeneity highlighted in the section on type 1 diabetes in adults.

In view of the problems ascertaining exactly what is being delivered in studies using psychological interventions (and their apparent idiosyncratic nature) it is unsurprising that there is heterogeneity in the psychosocial outcome measures employed. Few studies used the same psychosocial outcome measure and this makes direct comparison problematic, which is especially unhelpful when these variables are hypothesised to act as mediating factors of blood glucose control. For example, it might be the case that researchers hypothesise that aspects of family functioning influence the glycaemic control of children with type 1 diabetes. However, if all studies investigating this used dissimilar psychosocial measures then comparisons of results are difficult. Indeed, one review[13] noted that 40 different psychosocial measures were used in the studies they included, with only five being used in more than one RCT. Likewise, the dissimilar terms used to describe interventions which may share many features, such as behavioural family systems therapy,[23] family therapy[24] and multisystemic therapy,[25] do not easily allow replication or clarification of what was actually delivered. Although there have been attempts to dissect psychological interventions into discrete components,[26] this level of analysis is largely absent within the wider literature on psychological interventions and definitely within the diabetes literature.

An especially difficult issue in the current literature is that we do not know the relative contribution of the intervention itself (the content) and the interventionist to results. This is a commonly occurring theme in the general literature on psychological therapy and behavioural change. Certainly it is the case that there is good evidence that some psychological therapists obtain significantly better or poorer outcomes than others, and these differences can be larger than the effects of using different types of intervention.[27] This is called the therapist effect.

Another, related, issue highlighted by one systematic review[13] is that RCTs had typically compared interventions to routine care and therefore it was not possible to separate the influence of increased contact with a diabetes professional per se. This again is a long-standing topic of discussion and exploration, and cannot be easily disentangled from the so-called therapist effects highlighted above because personal characteristics that facilitate relationship-building are associated with better outcomes.[28] Overall, the empirical literature indicates that psychological interventions are superior to placebo control conditions, which are in turn superior to doing nothing.[27] To explore both therapist effects and the influence of actual increased contact time would require considerably more sophisticated (and expensive) research designs than have been conducted up to this point.

Finally, it is worth noting that the RCTs conducted over the past couple of decades do not reflect standard clinical practice in the UK. For example, the subjects in the literature on young people are not representative of those who would usually receive formal psychological interventions and the interventions themselves are also dissimilar. Generally, studies have used broad inclusion criteria so the young people were often neither clinically distressed nor poorly controlled. However, dedicated psychology provision to diabetes services is limited, if present at all.[29,30] Therefore, as psychologists are a precious resource, diabetes teams tend to refer the neediest young people, usually those with clinically significant psychological problems and the poorest control. Consequently, little psychology time is dedicated specifically to improving the glycaemic control of the general diabetes population.[29]

Those young people with diabetes referred to psychologists in the UK would ordinarily receive an individual assessment which would inform the exact nature of the psychological intervention. That is, all young people with diabetes referred to local NHS psychology services would not routinely receive the same intervention, even if seen by the same psychologist. The situation is similar in psychology service provision to adults with diabetes, with the additional difficulty that there is considerably less of it and the number of patients is vastly increased.[29]

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The best model of care for children and young people with diabetes

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ABSTRACT The health service is challenged with finding the best way of caring for increasing numbers of children and young people with diabetes with an increasingly intensive approach to their condition. Drawing on studies comparing outcomes across paediatric diabetes centres across the world, this paper examines what works best. Using the framework of the chronic care model, a theoretical best model of care is constructed from a combination of effective structures and processes of care. The model consists of patient-focused, goal-based care provided by a multidisciplinary team of skilled professionals. These local teams should be able to provide all aspects of diabetes care, from social and mental health care to the provision of accepted modern technologies, such as insulin pumps. Robust audit data need to be available from fully supported IT systems measuring structures, processes and outcomes of care. A central organisation such as a managed clinical network should exist to co-ordinate and supervise the delivery of this model in order to ensure equal delivery of high quality care for all.

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doi:10.4997/JRCPE.2010.S04

DECLARATION OF INTERESTS No conflict of interests declared.

INTRODUCTION

The incidence of diabetes in childhood has been rising by 3.9% each year in Europe in recent years.[1] This has been higher in the pre-school age group, where the incidence is predicted to double by 2020 from its 2005 figure.[1] Young people (defined as individuals between the ages of 11 and 18 years[2]) with diabetes struggle to attain the standards for glycaemic control set for them.[3,4] They have a high mortality,[5] develop long-term complications at a relatively early age[6] and have high rates of mental health problems.[7] These factors challenge health services to find the best way of caring for increasing numbers of children and young people with diabetes, so the best model of care needs to be clearly defined. This paper summarises the available evidence and expert opinion on the factors that may contribute to the best model of care for children and young people with diabetes.

What is a 'model of care'?

A clear definition of 'model of care' is hard to find in the medical literature. Examples include: 'an overarching design for the provision of a particular type of health care service that is shaped by a theoretical basis, evidence based practice and defined standards'[8] and 'a multifaceted concept, which broadly defines the way health services are delivered'.[9] The main theme of these definitions is the provision, or delivery, of healthcare. Delivery of healthcare has three components: structure, process and outcome.[10] Structural data are characteristics of personnel and hospitals or clinics. With these a framework is created from which to deliver the process. Process data are the components of the encounter between a doctor or another healthcare professional and a patient (e.g. teaching carbohydrate counting or using a particular insulin regime). The process is intended to create a beneficial effect on outcomes. Outcome data refer to the patient's subsequent health status (e.g. glycosylated haemoglobin, HbA_{1c}, or frequency of hypoglycaemia).

A simple definition of the term 'model of care' would therefore be: 'The structures of healthcare and the processes they deliver.'

What models of care are used for childhood diabetes?

In the UK, children with diabetes in the most part have their care delivered by specific professionals based within secondary care.[11] This has been directed by consensus agreements such as the St Vincent declaration and the recommendations of the British Paediatric Association in 1990,[12,13] but it relies on the structures underpinning the secondary healthcare services, which are not specifically designed for chronic care so may have a number of shortcomings. Models of care for childhood diabetes have evolved slowly from this by adopting novel 'processes' into slowly adapting structures (e.g. implementing intensive insulin therapy, then slowly increasing the numbers of nursing staff available to deliver it), rather than making radical changes to structures to enable the most efficient delivery of the process. We therefore do not find radically different models of care for childhood diabetes within the UK and across the world.

Which factors contribute to better care?

Several studies have compared cohorts of children in different diabetes centres over time and have attempted to speculate on which aspects of the most successful

centres could contribute to a best model of care. They have used HbA_{1c} as the outcome measure as it is the best known predictor of long-term complications as outlined in the Diabetes Control and Complications Trial (DCCT)[14] and so is assumed to be a measure of successful delivery of care in the real world (as opposed to that within a clinical trial).

The Hvidøre study group studied a cohort of 2,873 children with type 1 diabetes in 22 centres in 18 countries across Europe, Japan and North America in 1995 and found that average HbA_{1c} varied significantly between centres from 7.6 to 10.2%.[15] The centres were reassessed three years later. Although many had adopted an intensive insulin regime after the first analysis, significant differences in HbA_{1c} still existed. These differences were not accounted for by differences in genetics, ethnicity, insulin regime or rates of hypoglycaemia, suggesting that it was the delivery of care in some centres which was better than others. The authors concluded that diabetes education, management from the onset of the disease, different attitudes within diabetes teams and different levels of patient empowerment were the factors explaining the differences.[16]

Likewise, the Diabaud 2 study found significant differences in HbA_{1c} between 18 Scottish paediatric diabetes centres, also suggesting that care in some centres was better than others.[17] Deployment of resources, organisation of the clinic and strategies of medical care were suggested as possible reasons for the differences, but these factors could not be quantified by the study. Cultural factors have also been suggested as a significant factor affecting outcomes between centres. A comparison of a centre in Scotland (Dundee) and a centre in Italy (Chietti) found significant differences in their mean HbA_{1c} (9.1% vs 7.6%), and the authors investigated possible cultural reasons for the differences by analysing interviews with children and young people.[18] The cultural factors influencing glycaemic control appear to be communication, reciprocal support between young people and professionals, and family structure.

A cohort in Western Australia of 1,335 children prospectively followed up for 10 years from 1992 showed a significant improvement in overall HbA_{1c}.[19] The authors speculated that the improvement may partly have been due to increased skills in the clinicians and caregivers, implying that the overall quality of care had improved during this time. A recent study of 2,705 children in the 19 diabetes centres in Denmark reported a significant decrease in HbA_{1c} levels from 1996 to 2006 as well as a significant difference in HbA_{1c} levels between centres. The reduction in HbA_{1c} was related to increased self-monitoring of blood glucose, although there was no association with the number or type of insulin injections.[20] The authors speculated that an increased focus on treatment goals, treatment regimens, glucose monitoring and optimal care may have contributed to the improvement.

TABLE 1 Facets of diabetes care delivery thought to affect outcomes in children and young people[16–20,22,23]

Focus on education
Management from the onset of the disease
Attitudes of clinic personnel
Patient empowerment
Organisation of the clinic
Strategies of medical care
Communication
Reciprocal support between young people and professionals
Increased skills in clinicians and caregivers
Treatment goals
Focus on treatment regimes
Glucose monitoring
Frequent clinic visits and frequent telephone contact

These five studies have suggested some 'real world' evidence of factors within some centres that contribute to better outcomes. This is not strong evidence and many of these factors are vague and not well defined. However, each study has powerfully highlighted that it is not the treatments per se which make a difference to children in the real world, but other factors relating to healthcare delivery. As Ed Wagner of the MacColl Institute states:

> Improvements in the quality of chronic illness care require more than evidence about efficacious tests and treatments. They also require evidence about the system changes that produce better care and quality improvement methods to implement such changes.[21]

Facets of diabetes care delivery thought to affect outcomes in children and young people are listed in Table 1.

THE CHRONIC CARE MODEL

The MacColl Institute for Healthcare Innovation is a US think-tank which has developed a validated, evidence-based model of care for chronic disease.[24] It has identified six key elements of its chronic care model (CCM) (see Table 2).[21]

By considering all these elements, many centres in other fields of medicine have improved the quality of their healthcare[25] and the model has been adapted for use

TABLE 2 The key elements of the chronic care model[21]

1. Delivery system redesign
2. Decision support
3. Self-management support
4. Healthcare organisation
5. Community resources
6. Clinical information systems

internationally by the World Health Organization.[26] To create the best model of care for childhood diabetes we should consider what evidence there is for the structures and processes we use in each of these six elements. The aforementioned cohort studies have given useful suggestions. Additional evidence for best practice in childhood and adolescent diabetes has been summarised in several recent evidence-based reports on the subject from Australia,[27] the US (American Diabetes Association recommendations),[28] the UK (National Institute for Health and Clinical Excellence, NICE,[2] and Scottish Intercollegiate Guidelines Network, SIGN,[29] guidelines), Canada (Canadian Diabetes Association recommendations)[30] and the International Society for Paediatric and Adolescent Diabetes (ISPAD)[22] consensus guidelines. These guidelines have been produced to give a comprehensive evaluation of the evidence for diabetes treatments and provide a basis for national standards. The recommendations from these guidelines can therefore be placed within the context of the CCM to help us to construct the best model of care for childhood diabetes.

DELIVERY SYSTEM REDESIGN

This element of the CCM concerns the delivery of effective and efficient clinical care.

Team structure and centre size

Since the St Vincent Declaration[12] and the British Paediatric Association recommendations in 1990[13] it has been accepted that children with diabetes should have their care provided by a local multidisciplinary team. All of the consensus guidelines specify that an integrated package of care should be delivered by a multidisciplinary team, appropriately trained and comprising of a consultant paediatrician or paediatric endocrinologist with an interest and expertise in diabetes, a specialist nurse, a dietician and a psychologist or social worker.[2,22,23,27–30]

From the guidelines and the available evidence it is difficult to define exactly how many patients an individual team should be responsible for, and how many professionals there should be in each team. There is evidence from the UK that children attending larger clinics with more specialised consultants receive better care,[31,32] although a comparison of 207 paediatric diabetes centres in Germany and Austria did not reveal an effect of centre size on HbA_{1c} when comparing centres with less than 50 patients to those with more than 50 patients.[33] Within the UK, the Royal College of Nursing (RCN) recommends a ratio of diabetes specialist nurse to patient of one to no more than 70 children or young people based on their responsibilities and workload.[34]

Although specific recommendations for the ratio of dieticians and psychologists to patients are not available, it is clear from the consensus statements that these professionals are an essential component of each multidisciplinary team. Given the amount of evidence which exists on the effect of psychosocial factors on a child's diabetes control, the UK NICE guidelines recommend that all children and young people and their families have easy access to mental health workers.[2] Likewise, with increasing use of intensive insulin therapy and insulin pumps in children comes an increasing need for access to expert dietetic advice. Given the complexity of the advice required, specialist paediatric dieticians with experience in childhood diabetes should be part of each team and available at each clinic.[32,35]

It is also recommended that advice from the team should be accessible 24 hours a day, by telephone.[2,22,30] The structure of care delivery should allow any child suspected of having diabetes to be referred without delay to the team.[2]

Ambulatory care

All six consensus guidelines suggest that, if appropriately resourced, a diabetes team should be able to offer home-based care from diagnosis if the child is well,[2,22,23,27–30] although evidence supporting one of these processes over the other is inconclusive.[36]

Facilities should be in place to test HbA_{1c} levels two to four times per year and this should be available in the clinic.[2,27]

How often does a child need to be seen?

Children who are irregular in attendance are more likely to have acute complications of their diabetes and poor glycaemic control.[37] Frequent clinic visits (3–4 per year) appear to be beneficial and predictive of improved clinical outcome.[38] A trial which included measures to increase children's attendance at clinic found that by increasing attendance (mean of 7.1 visits in 24 months compared to control group of 5.2 visits), HbA_{1c} and acute complications were reduced.[39] The DCCT also showed similar improvements in the patients in the intensive therapy arm, who were reviewed on a monthly basis, as well as having frequent telephone contact.[14] This degree of follow-up contact is not found in the consensus recommendations. Quarterly clinic visits are the recommendation within the NICE[2] and ISPAD[22] guidelines.

DECISION SUPPORT

This element of the CCM concerns the promotion of clinical care that is consistent with scientific evidence and patient preferences.

Using evidence-based guidelines

Patients should be aware of the team's use of standards and evidence-based guidelines. Literature is available from guideline publishers specifically for the public so they will have an expectation of the standards that the team is working towards.[40]

Screening for complications and associated conditions

Screening should take place for long-term complications (retinopathy, nephropathy, foot exam) and associated conditions (coeliac disease, thyroid disease) as per the nationally accepted guidelines. Resources should be allocated to enable full implementation of screening guidelines. There are minor variations in the recommended screening frequency and age of testing across the world.[2,22,23,27–30] However, whichever guideline is accepted, the delivery of that process should be monitored carefully. The national diabetes audit in England and Wales is an example of a means of monitoring how good centres are at meeting the recommendations for screening by NICE.[4] The diabetes team should have easy access to podiatry and ophthalmology services when required.

Delivery of education

The 2004 NICE guidelines stress the importance of the diabetes team delivering educational interventions which are structured and help the child or young person and parent develop their ability to decide on aspects of their own care.[2] They also stress the importance of offering specific support strategies, such as mentoring and self-monitoring of blood glucose levels supported by problem solving, to improve their self-esteem and glycaemic control. The evidence for this is still evolving. The five-day dose adjustment for normal eating (DAFNE) course teaches adults the principles of carbohydrate counting and dose adjustments. Evaluation revealed improved HbA_{1c} and quality of life.[41] Similar results have been reported from other standalone courses.[42,43] Evidence for the use of such a course in children and young people is lacking, although in the UK the current KICk-OFF (Kids In Control OF Food) trial aims to provide this.[44]

As children become young people and then young adults, they should be motivated to maintain a healthy lifestyle, being informed about contraception, alcohol, drugs and smoking. Professionals in the team should be aware of the changing nature of children's educational needs as they grow older and should be skilled enough to adjust the level of the delivery of this appropriately. Specific training in adolescent medicine and resources on the subject are readily available in the UK, so teams should be equipped to provide the necessary education to young people who are progressing towards adulthood.[45]

Insulin regimens

An analysis of the different types of insulin available is not the aim of this review, but all consensus guidelines recommend that intensive insulin treatment, including pump therapy, should be provided by all centres treating children and young people, based on evidence extrapolated from the DCCT.[14] This can only be provided effectively if the model of care can also deliver intensive education and communication support.

Transition

Transition is a 'purposeful, planned process that addresses the medical, psychosocial and educational/vocational needs of adolescents and young adults with chronic physical and medical conditions as they move from child-centred to adult-oriented health care systems'.[46]

All the consensus guidelines stress the importance of transition and make a number of recommendations for delivery of care at this stage. Guidance documents specifically focused on transition have been produced by the Royal College of Physicians of Edinburgh[45] and the Department of Health.[47] The essence of these is that a smooth planned transition is necessary, with enough time for the young person to familiarise themselves with the practicalities of the move from paediatric towards adult services. The paediatric and adult teams should work together to provide seamless transition as it reduces the number of young people who are lost to follow-up.

Transition should occur at a time of relative stability in the individual's health and should be at a time agreed by the patient. At this stage in a young person's life glycaemic control deteriorates[3] so it is important to ensure that they are engaged and actively involved in the transition process. The emphasis on transition has come about from the realisation that young people with diabetes are often unsatisfied with the care they receive from the diabetes care teams around the time they reach young adulthood. They express this by not attending clinics and not engaging with the services.[48,49] Patient preference becomes a particularly important part of the model of care for young people at this stage.

Innovative strategies that depart from traditional methods of consultation, such as motivational interviewing (see below), may be more useful in this age group to maintain their engagement. Although there is now an increased effort to improve the transition process, there is little evidence to support what models work best at this time of life. An assumption that trying to improve clinic attendance will improve outcomes may not actually be true, and alternative options need to be examined.[50]

SELF-MANAGEMENT SUPPORT

This element of the CCM covers empowering and preparing patients to manage their health and healthcare.

Collaborative management in chronic illness

The consensus guidelines stress the need for diabetes teams to consider the child or young person and their parents as members of the team. This derives from the concept of collaborative management. Collaborative management occurs when patients and care providers have shared goals, a sustained working relationship, mutual understanding of roles and responsibilities and requisite skills for carrying out their roles.[51] This means a move away

from consultations in which the professional defines the problem, prescribes a treatment and expects the patient to comply, towards the problem being defined by the patient and specific targets and goals set to aim for. This way of management does not assume that the patient will go away and sort out their problems themselves; rather it assumes a high level of contact with the patient, which may be by telephone, email or scheduled return visits.

A particular form of counselling which involves these processes is motivational interviewing.[52] This has been trialled with promising results in a study in young people with diabetes in Wales.[53] Counselling happened outside the clinic setting and did not specifically focus on diabetes targets, but recipients benefited, with improved HbA_{1c} and improved quality of life. It appears likely that incorporating this style of interviewing into the diabetes consultation will have a beneficial effect on the quality of care and may be more likely to lead to behaviour change. The current DEPICTED study from Cardiff University will provide more evidence of this in the near future. Recently the study group reported that among paediatric diabetes professionals significant deficiencies exist in training and experience in communication skills.[54] This suggests that children and young people's psychosocial issues are not being attended to and this may significantly impair their ability to manage their own diabetes. Clearly this is an aspect of paediatric diabetes care that now needs to be the focus of more attention. The team psychologist should be in a position to co-ordinate the team's management of psychosocial issues with education and training of the team as well as the recommended role in screening for mental health issues.[2,29]

Collaboration not only in the decision-making process about their diabetes care but also in the design of their diabetes service is now recognised as being very important for young people in order to keep them engaged and reduce their high rates of long-term complications.[5,6,45,47]

Telephone support and new technologies

To be effective, educational and motivational interventions need to be ongoing, with frequent telephone contact, and both face-to-face care and telephone availability have been demonstrated to improve HbA_{1c} and to decrease hospitalisation rates for acute diabetes complications.[22,23] Another variation in communication which has been proven to be beneficial is text messaging as a motivational tool.[55] As more and more people make regular use of the internet it makes sense to explore this modality as a means of communicating with patients. A pilot study of a virtual diabetes clinic has been carried out in Warwick, UK.[56] The participants were all adults with insulin pumps. Although there were no significant changes to HbA_{1c}, the clinic was well accepted. Young people have shown positive attitudes to this type of clinic.[57] Future research in this area is expected.

COMMUNITY RESOURCES

This element of the CCM covers the mobilisation of community resources to meet the needs of patients.

Charities and patient support groups

There are a number of community organisations which exist to support children and their families with diabetes, such as Diabetes UK and the Juvenile Diabetes Research Foundation. There is sparse evidence of effect in this area in childhood diabetes, although interestingly an audit of diabetes care and outcomes in Northern Ireland among children and young people found that membership of Diabetes UK was associated with lower HbA_{1c} levels.[58] Diabetes teams should be aware of the local and national community resources that exist to support families, as they may fill gaps in support provided by the health service. One example is diabetes camps, which are a recommended part of a child's experience, according to the Australian guidelines.[27] This service may only be provided by charitable organisations in some countries.

School support

Children and young people spend most of their waking lives in school so it makes sense that personnel there should be trained to provide or supervise all diabetes care prescribed by the diabetes team. The local diabetes team should be responsible for establishing this.[2,22,27,59]

HEALTHCARE ORGANISATION

This element of the CCM covers support from all levels of the organisation and includes strategies for comprehensive system change.

Healthcare systems for childhood diabetes require support and backing from government and senior management. In the UK, government directives are in place which local healthcare organisations are expected to implement. These are the National Service Frameworks (NSFs).[60–63] The main roles of NSFs are to set clear quality requirements for care based on the best available evidence, and to offer strategies and support to help health organisations achieve these standards.[64]

The NSFs for diabetes incorporate standards which are based on the SIGN guidelines (Scotland)[29] and NICE guidelines (England and Wales)[2]. As with any government directive, the ability of the NSFs to improve the quality of care relies on them being implemented efficiently and monitored. The national diabetes audit is used in England and Wales to monitor several processes of care for the NSF, but less than 40% of centres in England submit data for this due to lack of time and resources.[4] Despite the standard-setting exercises of the NSFs in the UK, there remain obstacles to achieving them. The five-year report on the NSF in England has revealed deficiencies.[65] A recent survey of nursing practice in the UK found that

although numbers of specialist nurses had increased, the mean ratio of nurses to patients was 1:109,[66] well below the recommendation of 1:70,[34] and a survey of services in 2002 in the UK found that most clinics had very limited access to psychology services and inadequate dietetic resources.[32] These findings suggest that without strong incentives or increased financial resources, local health services will not automatically implement these standards in the UK.

The answer to this problem may lie in the creation of regional managed clinical networks. This has been proposed in England by the Department of Health working group responsible for the recent document *Making every young person with diabetes matter*.[67] The proposal suggests that regional networks would support strategic development, would be responsible for quality assurance and audit, and would support local services in their provision of aspects such as pump services, education or out-of-hours support. In Scotland the equivalent would be a national managed clinical network (MCN) for children's diabetes services. With these powers a single MCN would be best placed to ensure that consistent high-quality care is delivered with equity of resources and equal care across the nation.

CLINICAL INFORMATION SYSTEMS

This element covers organising patient and population data to facilitate efficient and effective care.

Evaluating healthcare

Clearly we need to assess the way healthcare is delivered for children with diabetes to add to the many experimental studies of their treatments. Treatments are usually assessed by their effect on outcomes. However, to assess the quality of healthcare we should look mainly at processes;[68] that is, if a standard is set for the process, such as 'all children over 12 years should be screened for retinopathy annually', then is that actually being carried out? If it is not, then we cannot expect the outcomes to improve. A change in the structure (e.g. an increase in clinic personnel) may be necessary to allow the process to happen.

The CCM is designed to allow healthcare providers to consider in detail the structural factors and how they affect the process, and to focus on them as a means to improve their model of care. Arguably, audit then becomes the most important aspect of the CCM because it underpins the whole process of improvement. If good quality audit and monitoring is in place, then robust data on structures, processes and outcomes will be available and the model of care can improve using feedback on its own performance. The importance of audit and monitoring outcomes in patients with diabetes was established in 1989 after a meeting of the World Health Organization and International Diabetes Federation in Italy (the St Vincent declaration).[12] National audits of children's diabetes services and outcomes have revealed important data in the past, but in Scotland this has not been an ongoing audit.[3,17] To be fully effective it should be carried out continuously, be co-ordinated by a national body (for example, Paediatric Diabetes MCN) and be fully supported financially by the government.

IT systems and databases

Clinical databases are a necessity for effective audit and should be used in the care of children with diabetes, both at local and regional or national levels. Their use for quality improvement purposes has been described in Denmark[20,69] and Germany.[33] In England and Wales there is not a universal database for the monitoring of standards nationally and this means the national diabetes audit is incomplete.[4] The national diabetes framework in Scotland aims to implement the Scottish Care Information – Diabetes Collaboration computer database nationally.[70] As yet, this system has not produced any robust data on childhood diabetes care in Scotland, but it has the potential for this.

FUTURE WORK AIMED AT FINDING THE BEST MODEL OF CARE

The international SWEET project attempts to follow on from the Hvidøre group to investigate the factors that in practice allow some centres to have better outcomes than others. This is an international European study which aims to define centres of reference for paediatric and adolescent diabetes in order to produce recommendations for minimum treatment and care, patient education programmes and training programmes for health professionals.[71] It is likely to be several years before results are available.

The Diabetes Attitudes, Wishes and Needs (DAWN) youth project is an initiative by Novo Nordisk, ISPAD and the International Diabetes Federation. It has five key goals: improved communication between patients and healthcare professionals, improved team care and collaboration between professionals, improved support for self-management, overcoming psychosocial barriers to the use of effective therapies and providing psychological support. It recognises that these factors have a significant effect on the outcomes of children with diabetes and aims to address the deficiencies through research, education and training.[72]

CONCLUSION

The best model of care for children and young people has at its centre a well-resourced multidisciplinary team which is able to have frequent clinical contact with its patients and is available for them 24 hours a day. It is able to carry out screening and educational interventions and to co-ordinate transition to the nationally set standards. The team continually evaluates its performance in

carrying out evidence-based processes, and strives towards improved outcomes. It has access to and uses IT facilities to help it achieve this. The team is aware of the resources available for its patients in the wider community and helps them use these. Underpinning all of these factors is the team's approach to the child and parents; the team accepts the child and parents they are caring for as part of the team and aims to help them care for themselves with motivational tools and education, focusing on treatment goals and good communication. In order to ensure that all children and young people across the country can have access to the same high-quality care, the local service must be resourced and supervised by a central organisation such as a specific managed clinical network.

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The organisation of diabetes care

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ABSTRACT The evidence base for the most effective and an efficient approach to organising the delivery of more complex care for people with type 2 diabetes is weak. This paper reviews some principles of care delivery, some observational studies of care delivery systems and some national audit data of comparative performance. It concludes that important characteristics of better systems are: structured patient education; reliable identification whether during routine ongoing care or at the time of an intercurrent event of people who could benefit from treatment escalation followed by prompt appropriate interventions; recognition, understanding and application of evidence-based glucose control treatment guidelines by all diabetes care providers; negotiated care planning between patients and the most appropriate care provider when treatment escalation is required; and an integrated system of care that delivers all of these in a collaborative, co-ordinated way by generalist and specialist nurses and doctors throughout a health economy.

DECLARATION OF INTERESTS No conflict of interests declared.

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doi:10.4997/JRCPE.2010.S05

INTRODUCTION

The lifetime trajectory of 'an episode of diabetes' is concisely but comprehensively illustrated by the 'tadpole diagram' of the English National Service Framework for diabetes (Figure 1).[1] Even cursory review makes it clear that someone with diabetes is likely to need a wide variety of services during their lifetime with the disorder, particularly if they develop it in early or middle life. Indeed, a huge variety of support services for people with diabetes have emerged although, it is firmly acknowledged,[2] the best outcomes arise when they are combined with good self-management skills.

The resultant multiplicity and diversity of services that have to be navigated by a person with diabetes is often and understandably perplexing (Figure 2). User confusion is intensified by the potential for multiple configurations of these components resulting in the emergence of many different 'models of care', each with their staunch advocates.

In contrast to the solid evidence base for the components of care that should be delivered along the lifetime pathway of care,[3,4] evidence for the significant superiority of any particular configuration of care providers over alternative arrangements is not strong (see below). Using 'After metformin – what next' as the trigger, this paper will endeavour to explore the complexity of the multiple interrelationships and the consequent impossibility of neatly isolating one component of the lifetime care pathway from the rest; what is known about the effectiveness of different care models; how decision-making might occur within the care models; and the current effectiveness of UK Diabetes Care Systems in respect of achieving target (low risk) glucose control.

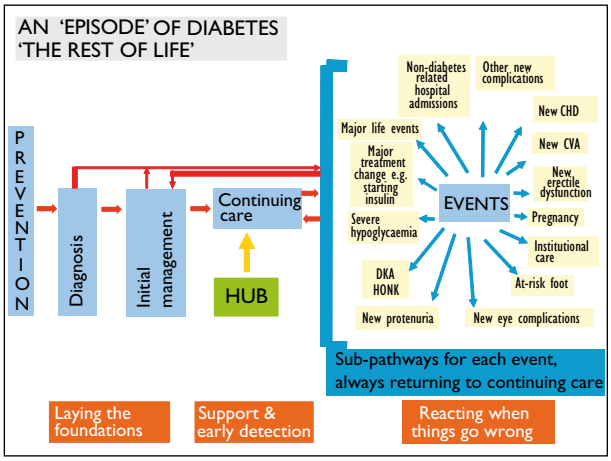

FIGURE 1 The 'tadpole' diagram.

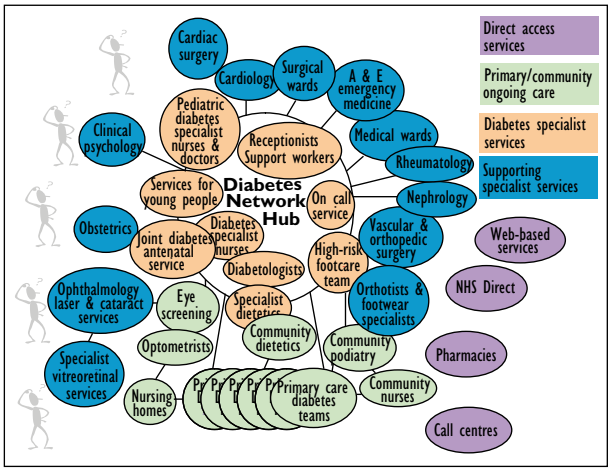

FIGURE 2 Components of an 'integrated' diabetes care service.

B Young

THE COMPLETE CARE PACKAGE: COMPONENTS OF CARE

The topic for one of the strands of this consensus conference is 'After metformin – what next?', implying that it is principally concerned about the approach to the care for people with type 2 diabetes at the point when they have evolved beyond the very earliest stages of their progressive disorder. However, this phase in the progression of diabetes cannot be dissociated from the preceding and potentially succeeding components of the lifetime diabetes care pathway as illustrated by the 'tadpole'.

The first year after diagnosis (tail of the 'tadpole')

This is the period when the foundations of diabetes care need to be laid. The success or failure of treatment for all of the remainder of the course of a person's diabetes is probably predicated on the success of this period. The person with new diabetes needs to be guided through the dismay and the dejection that commonly accompanies diagnosis towards a radical re-evaluation of their lifestyle. They need to be equipped with the knowledge and skills to self-manage their condition effectively in partnership with their professional advisors. Structured education[4] is now recognised to be essential to the success of this phase of management.

The hub – continuing care (the body of the 'tadpole')

During the first year after diagnosis, in addition to laying the self-care foundations, it is necessary to establish continuing or ongoing care. This is the hub of the lifetime care for everyone with diabetes. It is a regular cycle of recall, review, renegotiation of an agreed care plan and goal setting. As a minimum it comprises the now familiar set of assessments – a review of glucose control, cardiovascular risk and lifestyle as well as screening for early detection of eye, kidney and lower limb complications.

Events – reacting when things go wrong (head of the 'tadpole')

Most people who live for more than a few years with diabetes will encounter events that require additional, usually specialist, management. These 'events' range from physiological changes such as pregnancy through non-diabetes-related hospital admission to acute metabolic decompensation, new long-term complications of diabetes and long-term care for disability. All of these events need to be dealt with competently if the adverse impact of the event itself and its interaction with diabetes is to be minimised so that normal or near-normal function resumed. Once stability has been re-established, continuing care needs to be resumed.

MODELS OF CARE

Recognising the complexity (multiple functions, care providers and care locations) and interdependencies within the lifetime pathway of diabetes care, groups of providers that share a 'whole systems view' have sought to yield improvements (effectiveness, efficiency, safety, access, equity, satisfaction) by integrating organisational arrangements. The characteristics of these arrangements have been subject to some observational scrutiny.

The evidence for integrated care models

Combined insurer and provider

The NHS combines the roles of insurer and provider, but fragments the provider function. Outside the UK this is the health maintenance organisation (HMO) model, as epitomised by Kaiser Permanente in the USA. Kaiser HMO delivers both inpatient and outpatient care using a multidisciplinary approach across all relevant boundaries. It focuses on chronic disease pathways supporting prevention, self-management, disease management and care management. Key supports of the system include clinical leadership, training and a strong focus on information technology and communication systems.[5] Although widely admired, the evidence that such systems deliver healthcare benefits is limited. In summary, they appear to improve partnerships, contribute to increased but unquantified capacity, possibly reduce admissions and lengths of stay and have an uncertain impact on costs.

Integrated providers but separate commissioners

There have been systematic reviews of the effectiveness of care programmes that integrate providers rather than commissioners.[6] The common elements of the systems evaluated include self-management support and patient education, clinical follow-up, case management, multidisciplinary patient care teams, multidisciplinary care pathways and feedback reminders and education for professionals. In general, the reviews identify improved staff adherence to guidelines, reduced hospitalisation, reduced cost and improved patient health, quality of life and satisfaction. However, evidence for any change in health outcomes is minimal and similarly evidence on patient experience or cost-effectiveness is poorly documented. Things that were key enablers of integration that the reviewers deemed successful included supportive shared clinical information systems, the presence of specialised clinics, agreement about the nature of integration between personnel involved, leaders with a clear vision of integrated care, finance for implementation and maintenance, management commitment and support, a culture of quality improvement and patients capable of and motivated for self-management.

Managed clinical networks

Managed clinical networks aim to provide virtual integration rather than structural integration. An approach in Scotland was evaluated.[6] It involved patients, sharing information, mapping patient pathways and constructing protocols, standards and guidelines, all of which seem to be viewed positively. A small number of significant improvements in care provision were reported,

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but although there were significant set-up and maintenance costs, no benefits could be demonstrated in respect of improved resource use.

On the basis of this rather flimsy evidence but a groundswell of intuitive consensus, borne out of the summative experience of many healthcare professionals and patients, the Royal College of Physicians of London has come down firmly in favour of integrated care in its report *Teams without walls*:

> For patients to really benefit from this new approach, hospital and community teams need to merge to ensure that the patient sees the right person, at the right time, in the right setting.[7]

So whereas it is not possible to garner a solid 'evidence base' for virtual or structural provider integration combined with or separated from insurer/commissioner responsibilities, it does seem to this author that the common sense approach to making the elements of a diabetes care service patient friendly and fit to deliver the 'tadpole' care pathway is some sort of formal integrated working arrangements. These include clinical leadership, shared guidelines (between care professionals, across organisational boundaries/care settings), patient engagement, shared clinical information systems and constructive provider/commissioner dialogue. I further suspect that it will never be a case of 'one size fits all', but rather that such principles will always have to be adapted and progressively re-adapted to local geographical, socio-economic and resource (human and financial) constraints.

DECISION-MAKING WITHIN THE 'MODEL OF CARE': MANAGING GLUCOSE CONTROL

The UK Prospective Diabetes Study (UKPDS) confirmed beyond all doubt that type 2 diabetes is a progressive disorder in which if hyperglycaemia is to be minimised, escalating management is required over time. There is now abundant evidence that minimisation of hyperglycaemia reduces the risks of both the specific (microvascular) complications of diabetes and also the enhanced risk of macrovascular disease. Accordingly, effective glucose control in type 2 diabetes confers substantial healthcare and cost benefits.[8] The question 'After metformin – what next?' implies that following lifestyle optimisation, training in self-care and initiation of the foundation pharmacological intervention, metformin, there are more difficult choices about how to manage the remaining course of type 2 diabetes.

I would argue that unless at that point there has already been investment in 'the first year after diagnosis', particularly psychological support and structured education, then the game may already be at least partly lost because the opportunity to intervene at a time of maximum 'readiness to change'[9] (i.e. immediately after diagnosis) will have passed. For any intervention to be successful the person with diabetes needs to understand the need for and be ready to engage with one of the next possible steps. The need to consider the next step will often be identified during a routine continuing care review, when the success of the subsequent decision-making will be heavily dependent on the enabling preparation of information and education. Ideally this will have established a framework of understanding about type 2 diabetes progression, the stepwise evolution of care interventions and so on. Alternatively, the need to escalate care might be identified during an 'event' ('head of the 'tadpole') when the psychological impact of an unwelcome change in health circumstances may facilitate a new period of 'readiness to change'.

Among the approaches to consider 'after metformin' is a plethora of potential pharmacological interventions. Various agencies such as the National Institute for Health and Clinical Excellence (NICE) and the Scottish Intercollegiate Network (SIGN) have endeavoured to summarise the evidence for each and they have put recommended sequences of drug use into algorithms,[2,3] which can be customised by local services (Figure 3). Such algorithms help summarise the evidence and the options, but ultimately patients and their healthcare advisors need to agree a treatment goal, an approach to achieving the goal, responsibilities for the actions that comprise the approach and a time within which the approach will be deemed effective (to be continued) or ineffective (to be discontinued and another plan devised). This is the essence of 'care planning'[10] or an 'N of 1' trial[11].

So to optimise the management of glucose control in a person with type 2 diabetes who no longer has low-risk glucose control on treatment with lifestyle optimisation and metformin one needs, as a minimum:

1. Educated, informed and engaged patients;
2. Effective continuing care in which people needing treatment escalation are promptly and accurately identified;
3. Recognition at the time of diabetes 'events' of patients with high-risk glucose control;
4. Recognition and understanding of evidence-based glucose control treatment guidelines by all diabetes care providers;
5. Care planning between patients and the most appropriate care provider (General practitioner? Practice nurse? Diabetes specialist nurse? Diabetologist?) when treatment escalation is required;
6. An integrated system of care that ensures 1–5 above are delivered in a collaborative, co-ordinated way across a health economy.

B Young

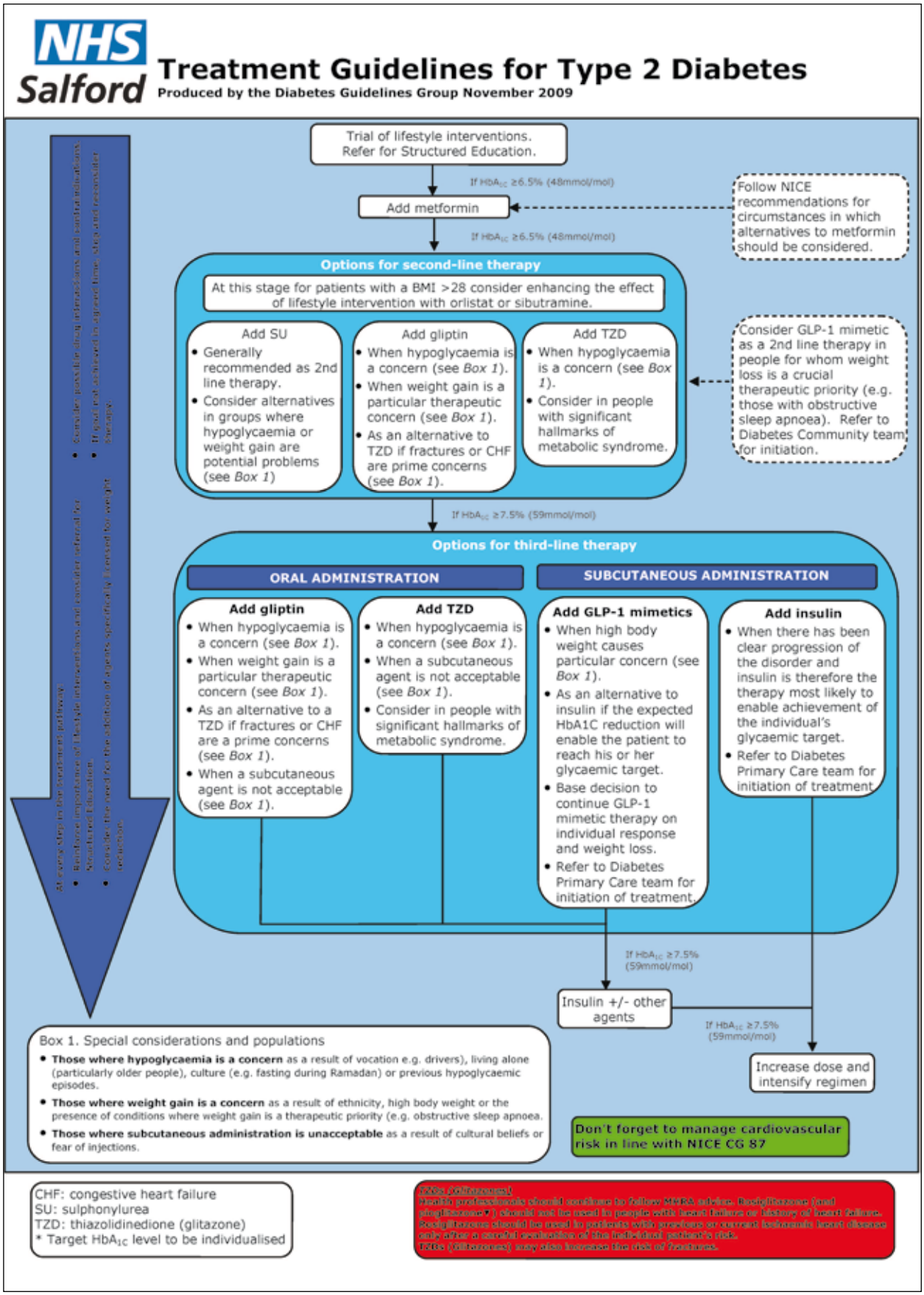

FIGURE 3 NICE guidance for the management of hyperglycaemia in type 2 diabetes summarised into a local algorithm for one health economy.

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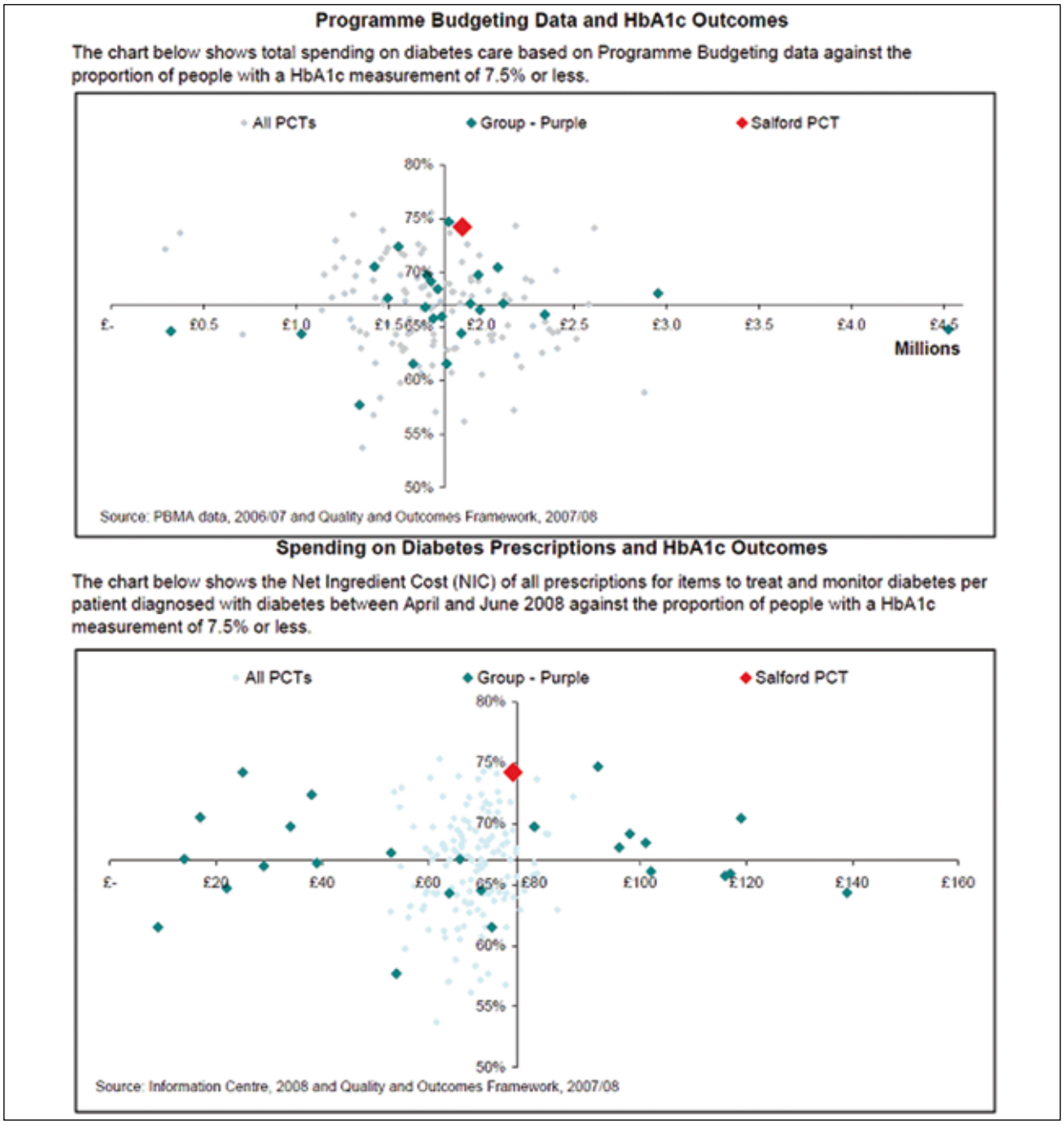


FIGURE 4 Diabetes programme budgeting and spending in NHS Salford.

WHAT ARE CURRENT 'MODELS OF CARE' ACHIEVING?

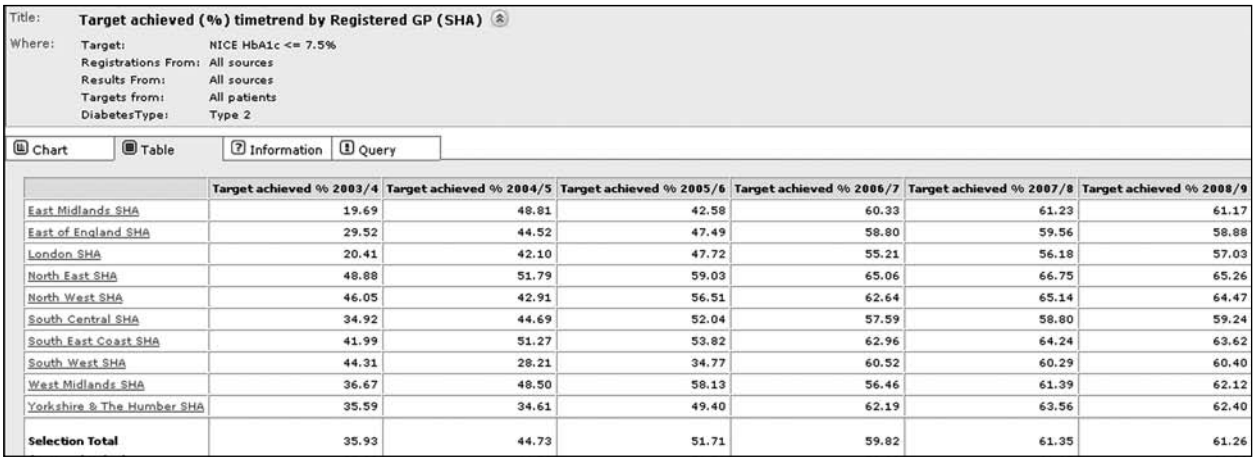
Since the inception of the Diabetes National Service Framework more than five years of national audit data in England testify both to improvements overall and to considerable residual variation. It is clear that, in England at least, the question 'After metformin, what next?' seems to be answered more often correctly but still very inconsistently.

Cost-effectiveness

Across health economies the cost-effectiveness of deploying the numerous alternative treatments for type 2 diabetes varies widely as shown in data from the Yorkshire & Humber Public Health Organisation Diabetes Health Intelligence Unit (Figure 4). The data highlight the performance of Salford as compared with all English health economies (the 'group – purple' are those in the same Diabetes Area Classification as Salford in respect of age distribution, ethnic mix, obesity and socio-economic deprivation).

Organisational effectiveness – National Diabetes Audit

If one looks at achievement of the NICE guideline[2] in terms of haemoglobin A_{1c} less than 7.5%, or indeed less than 6.5% or 10%, there have been steady improvements



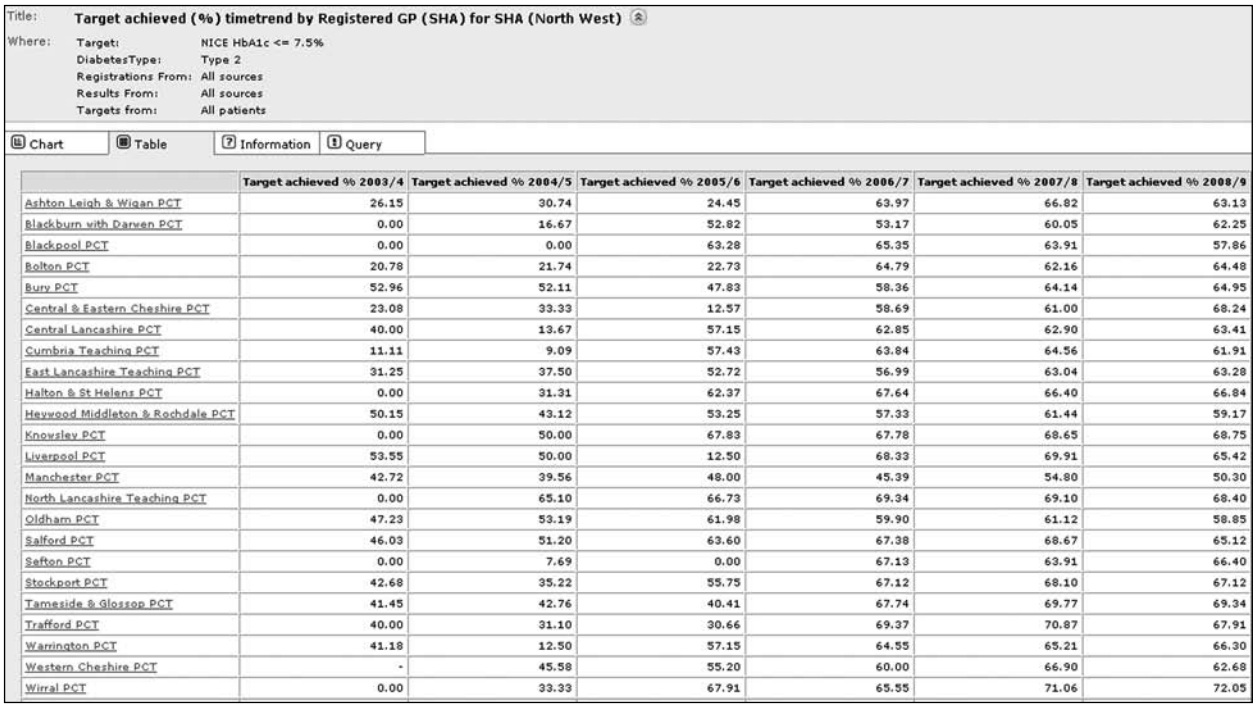
Title: **Target achieved (%) timetrend by Registered GP (SHA)**

Where:
Target: NICE HbA1c <= 7.5%
Registrations From: All sources
Results From: All sources
Targets from: All patients
DiabetesType: Type 2

Chart | Table | Information | Query

	Target achieved % 2003/4	Target achieved % 2004/5	Target achieved % 2005/6	Target achieved % 2006/7	Target achieved % 2007/8	Target achieved % 2008/9
East Midlands SHA	19.69	48.81	42.58	60.33	61.23	61.17
East of England SHA	29.52	44.52	47.49	58.80	59.56	58.88
London SHA	20.41	42.10	47.72	55.21	56.18	57.03
North East SHA	48.88	51.79	59.03	65.06	66.75	65.26
North West SHA	46.05	42.91	56.51	62.64	65.14	64.47
South Central SHA	34.92	44.69	52.04	57.59	58.80	59.24
South East Coast SHA	41.99	51.27	53.82	62.96	64.24	63.62
South West SHA	44.31	28.21	34.77	60.52	60.29	60.40
West Midlands SHA	36.67	48.50	58.13	56.46	61.39	62.12
Yorkshire & The Humber SHA	35.59	34.61	49.40	62.19	63.56	62.40
Selection Total	35.93	44.73	51.71	59.82	61.35	61.26

FIGURE 5 English National Diabetes Audit (NDA): % HbA_{1c} <7.5%, regions 2004–09, mean 61.3%, range 58.9–65.3%.



Title: **Target achieved (%) timetrend by Registered GP (SHA) for SHA (North West)**

Where:
Target: NICE HbA1c <= 7.5%
DiabetesType: Type 2
Registrations From: All sources
Results From: All sources
Targets from: All patients

Chart | Table | Information | Query

	Target achieved % 2003/4	Target achieved % 2004/5	Target achieved % 2005/6	Target achieved % 2006/7	Target achieved % 2007/8	Target achieved % 2008/9
Ashton Leigh & Wigan PCT	26.15	30.74	24.45	63.97	66.82	63.13
Blackburn with Darwen PCT	0.00	16.67	52.82	53.17	60.05	62.25
Blackpool PCT	0.00	0.00	63.28	65.35	63.91	57.86
Bolton PCT	20.78	21.74	22.73	64.79	62.16	64.48
Bury PCT	52.96	52.11	47.83	58.36	64.14	64.95
Central & Eastern Cheshire PCT	23.08	33.33	12.57	58.69	61.00	68.24
Central Lancashire PCT	40.00	13.67	57.15	62.85	62.90	63.41
Cumbria Teaching PCT	11.11	9.09	57.43	63.84	64.56	61.91
East Lancashire Teaching PCT	31.25	37.50	52.72	56.99	63.04	63.28
Halton & St Helens PCT	0.00	31.31	62.37	67.64	66.40	66.84
Heywood Middleton & Rochdale PCT	50.15	43.12	53.25	57.33	61.44	59.17
Knowsley PCT	0.00	50.00	67.83	67.78	68.65	68.75
Liverpool PCT	53.55	50.00	12.50	68.33	69.91	65.42
Manchester PCT	42.72	39.56	48.00	45.39	54.80	50.30
North Lancashire Teaching PCT	0.00	65.10	66.73	69.34	69.10	68.40
Oldham PCT	47.23	53.19	61.98	59.90	61.12	58.85
Salford PCT	46.03	51.20	63.60	67.38	68.67	65.12
Sefton PCT	0.00	7.69	0.00	67.13	63.91	66.40
Stockport PCT	42.68	35.22	55.75	67.12	68.10	67.12
Tameside & Glossop PCT	41.45	42.76	40.41	67.74	69.77	69.34
Trafford PCT	40.00	31.10	30.66	69.37	70.87	67.91
Warrington PCT	41.18	12.50	57.15	64.55	65.21	66.30
Western Cheshire PCT	-	45.58	55.20	60.00	66.90	62.68
Wirral PCT	0.00	33.33	67.91	65.55	71.06	72.05

FIGURE 6 English NDA: % HbA_{1c} <7.5%, north-west PCTs 2004–2009, number of people recorded with type 2 diabetes 191,494, mean 64.5%, range 50.3–72.1%.

during the six years of the National Diabetes Audit when judged at regional level (Figure 5). Improvement has occurred generally across all primary care trusts as well (Figure 6), but at this level of organisation more variability is apparent as shown for the north-west region. The pattern among health boards in Scotland is similar (Figure 7).[12] When one gets down to individual general practices, yet again the overall trend is towards improvement, but variation is much more pronounced.

Although it is known that age, duration of diabetes, ethnicity and deprivation all influence overall target achievement rates, and this is reconfirmed in the National Diabetes Audit data, the Yorkshire and Humber Public Health Observatory Diabetes Health Intelligence reports, which allow comparison of health economies that have similar population characteristics (diabetes area classification), make clear that that these factors alone do not account for the residual variation. So at local health economy and individual general practice levels there is good evidence that the amalgam of factors thought to characterise optimal diabetes care delivery is not being deployed consistently.

CONCLUSIONS

What we are left with, then, is a strong evidence base for effective glucose control interventions in diabetes care; a general acceptance that the totality of these interventions is only practicable as a result of successful collaboration

NHS Board	HbA1c < 7.5	
Ayrshire & Arran	9,655	66.6%
Borders	2,724	63.0%
Dumfries & Galloway	3,936	65.9%
Fife	9,386	69.3%
Forth Valley	6,771	63.5%
Grampian	10,722	59.4%
Greater Glasgow & Clyde	23,756	61.2%
Highland	6,296	60.2%
Lanark	13,551	64.8%
Lothian	16,139	66.8%
Orkney	474	66.3%
Shetland	512	70.8%
Tayside	9,805	64.0%
Western Isles	553	61.0%
Scotland	**114,280**	**63.8%**

FIGURE 7 Scottish Diabetes Survey 2009: % HbA_{1c} <7.5% NHS Boards, number of people recorded with type 2 diabetes 199,262, mean 63.8%, range 59.4–70.8%.

between multiple care providers; good evidence that in many health economies and certainly at national level there has been significant overall improvement in the attainment of evidence-based glucose control goals; but balancing evidence that this overall improvement conceals appreciable variations in performance at the health economy and even more at the primary care organisation level.

Perhaps it is time to investigate the provenance of these variations. Do they reflect failures to adhere to the principles of effective integrated care identified by observational studies to date? Or are there as yet unrecognised factors that determine whether people with type 2 diabetes and their care providers will more consistently be able to answer the question 'After metformin – what next?' in ways that improve achievement of low-risk glucose control?

Almost certainly, when looking to improve treatment target achievement rates, there is a need to review critically the local organisation of care arrangements as rigorously as adherence to treatment guidelines or algorithms. Systems of diabetes care are inherently complex so that the classical randomised controlled trial is unlikely ever to be a practicable mechanism with which to improve the evidence base for the effectiveness and efficiency of the different care models. But as outlined above, health service researchers have identified key characteristics of the prevalent care models. So, now that there are large-scale annual audits throughout the UK, if each health economy added some of these characteristics to their submissions an observational study would instantly be established.

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SCREEN OR NOT TO SCREEN?

Professor Kamlesh Khunti, Leicester

The prevalence of type 2 diabetes mellitus (T2DM) and pre-diabetes is increasing globally and many cases remain undiagnosed. Modelling studies have suggested that screening for T2DM and impaired glucose regulation followed by interventions is cost-effective. Although intervention studies have demonstrated the efficacy of lifestyle behaviour change programmes at slowing the progression to T2DM in high-risk populations, there are important gaps in the evidence when it comes to translating diabetes prevention research into practice.

A number of criteria need to be justified prior to implementation of a programme to prevent a disease. One key element of a screening programme is that a safe, acceptable and predictive test should be available to detect the pre-disease state. For every person with diabetes, there will be three to four people who will be at risk of diabetes. A good response rate is necessary for a screening programme to achieve a high diagnostic yield. To avoid unnecessary costs and inconvenience, it is important to identify high-risk people more likely to benefit from a screening programme. Non-invasive pre-screening tools are more cost-effective than an initial blood test. Simple self-assessment or practice-based computer strategies are most cost-efficient at identifying those with T2DM and those with impaired glucose regulation. The gold standard method of detecting undiagnosed T2DM and impaired glucose regulation is an oral glucose tolerance test (OGTT). This test is resource-intensive and appears to have limited use in a routine healthcare setting. Currently there are moves to simplify the diagnosis of diabetes and impaired glucose regulation using haemoglobin (HbA_{1c}), which will have an impact on any screening programme being implemented. However, there are still uncertainties, including how often people with a normal test or with impaired glucose regulation should be rescreened.

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LIFESTYLE CHANGE: WHO CAN MAKE IT WORK?

Professor Raj Bhopal, Edinburgh

Lifestyle change is, arguably, the vital ingredient in both the prevention and control of type 2 diabetes mellitus (T2DM). Lifestyle changes that prevent or control adiposity and maintain a modest amount of regular physical activity would dramatically reduce the incidence of new T2DM and improve its control in those already afflicted.

Two surprising, fundamental and opposing insights have emerged in research on lifestyle change in the past 50 years. The first is that, contrary to common sense, members of the public, mostly, do not act on lifestyle advice given by health professionals, even when they accept the case is sound. We need to reflect deeply on why this is so. The second is that if lifestyle advice is acted upon, the benefits for diabetes prevention are spectacular.

This presentation will start with a brief scan of diabetes prevention trials, and the rationale for the Prevention of Diabetes and Obesity in South Asians (PODOSA) trial. In particular, I will explain why a 15-session, family-orientated, home-based intervention was chosen, despite its high cost.

From there, I will tackle the question in the title on first principles. The answer will echo one of the earliest UK public health strategies, and state that lifestyle change is 'everybody's business'. Lifestyle change that relies on interactions between the public, patients and health professionals (including, of course, health promoters) is expensive but both feasible and cost-effective. However, it is probably not sustainable, especially in financially tough times. Making lifestyle change work in a sustainable way, it appears, requires a redesign of our style of life. It will require a reduction in personal choice and ostensibly radical actions, for example dramatic rises in the price of high-calorie, low-nutrition foods and for personal transport and paying for services such as a lift or escalator (excepting the disabled). Rather than counting calories, we need to make calories count in terms of nutritional value. Rather than seeing labour-saving devices as beneficial, we need to see each opportunity to take exercise as a boon. Pending such social and environmental changes that need political leadership, doctors, nurses, dietitians and other health promoters will need to battle against the consequences of obesity and physical inactivity.

J R Coll Physicians Edinb 2010; 40(Suppl 17):40–6

BARIATRIC SURGERY: WHO BENEFITS MOST?

Mr David Galloway, Glasgow

The recent steady increase in the prominence of bariatric surgery has given rise to a range of observations which relate to both the metabolic effects of weight reduction and the incidence and effects of numerous co-morbid conditions. One result has been the recognition of the specific metabolic consequences of certain gastrointestinal reconfigurations and hence the definition and development of 'metabolic surgery'.

The prevalence of obesity in the adult population of most Western countries has risen inexorably over the past three decades. The figures for Scotland[1] indicate that for 2008 the prevalence of a body mass index (BMI) in excess of 25 kg/m^2 had reached 66.3% for men and 59.6% for women aged 16–64. More alarming still is the prediction that while obesity (BMI in excess of 30 kg/m^2) affects slightly more than one in four adults that figure is expected to rise to 40% in the next 20 years.[1]

Bariatric surgery is now established as an effective treatment for selected, severely obese patients and the effects on weight control, quality of life, mortality and related conditions such as type 2 diabetes mellitus (T2DM) are well known.[2,3] There is a developing consensus with respect to the most appropriate indications for surgery in this group.

The effect of both restrictive and mixed restrictive and malabsorptive procedures in effectively reversing the metabolic sequelae of T2DM have also been consistently described. There is a great deal of active research interest in seeking to understand and exploit the mechanisms of this effect. The various roles of incretins and other signalling hormones are not only inter-related but are both diverse and complex.

It seems likely that new, minimally invasive (endoscopic and not necessarily surgical) procedures will become real options with a predominant indication for managing T2DM in a definitive and durable manner. The additional benefit to those who can benefit from weight reduction will be an added advantage. As the relative characteristics of the benefit from the several procedure-related approaches to T2DM management become clear there is little doubt that many patients with weight-related metabolic problems can expect much more effective management.

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ARE WE GENOTYPING ENOUGH?

Dr Anna L Gloyn, Oxford

An estimated 2% of diabetes in the UK is caused by monogenic disorders of the β-cell (maturity onset diabetes of the young, MODY). The two most common subtypes of MODY seen in clinical practice are caused by mutations in the genes encoding hepatocyte nuclear factor 1-alpha (HNF1α) and glucokinase (GCK). The assignment of the correct molecular diagnosis is important for informed decisions regarding both treatment and prognosis. The use of low-dose sulphonylureas should be the first-line treatment in MODY due to HNF1α mutations (HNF1α-MODY), while patients with MODY due to GCK mutations (GCK-MODY) can often be managed by diet alone. Despite these clear advantages, individuals with MODY are frequently misdiagnosed as either having type 1 or type 2 diabetes or, even when MODY is suspected, do not undergo molecular genetic testing.

The hurdles that need to be overcome before systematic diagnostics for monogenic diabetes are in place include the development of improved protocols for case identification, increasing the awareness of monogenic diabetes among clinicians and reducing the cost of genetic testing. At present, the prevalence of monogenic diabetes varies greatly across the UK, reflecting differences in referral rates from different centres. Currently, patients are typically selected for molecular genetic testing on the basis of non-specific clinical features (age of onset, parental history of diabetes) and/or a clinical presentation, which is otherwise atypical for the assumed aetiology. There is a genuine need for both novel biochemical screening tools to identify and direct efficient genetic analysis in those for whom a probably monogenic diagnosis of diabetes exists and for prospective studies to evaluate the use of extended clinical and biochemical criteria for diagnostic referrals. With the advent of new sequencing technologies, which will decrease the cost of genetic testing, health economics should support increased molecular diagnostic referrals.

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USING GENETICS TO MANAGE THE DIABETES EPIDEMIC

Professor Tim Frayling, University of Exeter

There have been major advances in understanding the genetic component to type 2 diabetes over the past three years. Advances in technology have allowed researchers to test the majority of common variation in the human genome in large numbers of patients and non-diabetic controls. These genome-wide association studies (GWAS) have identified more than 30 gene variants associated with type 2 diabetes. Many more variants are associated with related traits, including obesity, lipid levels and glucose levels.

Two main conclusions have emerged from these findings. First, the effects of the known genetic variants are too small to offer useful predictive value. Even when combining information from all variants, there is currently limited clinical value in testing these variants. This may change as we move to sequencing the whole genome in patients and identify a fuller spectrum of variation involved in the condition. Second, the GWAS findings have provided many important insights into the aetiology of diabetes. These insights include:

a) the implication of novel mechanisms involved in diabetes risk – most of the associated variants are not near obvious candidate genes;
b) the prominence of reduced β-cell function ahead of increased insulin resistance as a primary cause of diabetes in today's environment;
c) a difference between physiological and patho-physiological glucose levels – the gene variants influencing fasting glucose levels in the non-diabetic population are often different to those predisposing to type 2 diabetes;
d) a link between circadian rhythm and diabetes – most notably variants in the melatonin receptor gene influence insulin secretion;
e) a genetic link between prostate cancer and type 2 diabetes;
f) an aetiological link between reduced circulating sex hormone-binding globulin (SHBG) and increased risk of type 2 diabetes – an association previously thought to be secondary to insulin resistance;
g) a genetic link between growth in utero and type 2 diabetes.

These findings offer a chance to make real progress in understanding why many obese and overweight people do not get type 2 diabetes, while many non-obese individuals do get the condition. Understanding the biology behind the disease will eventually lead to improved management for patients.

THE IMPORTANCE OF HEALTH BELIEFS IN PEOPLE WITH DIABETES

Dr John Harvey, Wales College of Medicine

Effective management of diabetes requires advice from professionals but also a significant input from the patient in terms of self-management. We ask our patients to undertake a large amount of self-care, probably more than in any other chronic disease. The degree to which they achieve the goals we set has a major influence on the glycaemic control and outcome achieved. Historically we have relied on 'education' to influence patients' behaviour but with only modest success. More important than knowledge are patients' beliefs about diabetes, their own 'personal models' of the condition.[1] We have shown the impact these have on behaviours such as clinic attendance.[2] Patients' personal models do relate to glycaemic control. The development of personal models in the newly diagnosed is related to aspects of the way in which education is delivered to patients and to personality.[3] The perceptions generated mediate the approach patients take in dealing with their diabetes.[4]

Psychological factors are a major influence on patient self-care behaviour and hence glycaemic control, medical outcome and quality of life. In the majority of patients this is not psychiatric disease but the influences on normal behaviour. This analysis suggests an approach in which we assess health beliefs at the individual level and try to influence those which are unhelpful. In the future, clinical practice in diabetes will need to make more use of this body of psychological theory.

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WHAT PSYCHOLOGICAL INTERVENTIONS SHOULD BE USED AND WHEN?

Dr Vivien Swanson, Stirling

Health professionals cannot fail to appreciate the 'psychological burden' of diabetes.[1] People with diabetes are required to constantly manage health behaviours, including medication adherence and lifestyle factors in the context of day-to-day demands and stressors, which can lead to psychological distress, anxiety or depression. Clinical standards and guidelines for diabetes care are unanimous in their conclusions that tackling psychological issues are key to good clinical and self-management (for example, the American Diabetes Association guidelines[2]). However, a recent Scottish Intercollegiate Guidelines Network (SIGN) update for diabetes lifestyle factors suggested that 'research on the efficacy of psychological interventions in diabetes is in its infancy'.[3] Where interventions have been shown to be effective, adequate mechanisms for integrating psychological approaches as part of day-to-day diabetes care are not always in place, and health professionals may lack information as to 'which approaches are most appropriate for what types of improvement, in what settings'.[4]

This presentation will summarise some of the psychological challenges facing people with type 1 and type 2 diabetes, including behavioural issues, depression and anxiety and relate these to diabetes self-management. The evidence for the efficacy of different psychosocial interventions to improve diabetes self-management, including behaviour change, goal setting, patient empowerment, motivational interviewing, cognitive behaviour therapy and coping skills, will also be evaluated based on the recent SIGN guideline update.[3]

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WHAT PSYCHOLOGICAL SUPPORT I NEEDED

Susan Morrow, Edinburgh

I have had type 1 diabetes since 1986. Since then I have received no formal psychological support. During my talk I will discuss what kind of support I have needed and at what points during my life support would have been useful. I will explore if my life and diabetic control would be any different if I had been offered support.

AFTER METFORMIN: WHO DECIDES?

Dr Amanda Adler

Metformin, or glucophage ('glucose eater'), is the drug of choice as first-line treatment for type 2 diabetes in all but the most hyperglycaemic patients. Its attributes include its price (cheap), relatively infrequent hypoglycaemia and weight neutrality, and it remains the only drug in diabetes shown in clinical trials to lower the risk of myocardial infarction. As such, metformin firmly holds place as first-line treatment. Yet, metformin rarely succeeds in controlling glycaemia as monotherapy. For treatment options after metformin, a number of choices exist at the second- and third-line. These include sulphonylureas, DPP-4 inhibitors, acarbose, incretins, thiazolidinediones and insulin, among others.

This talk will discuss the role of the regulator, the payer, patient, carer and manufacturer in the choice of these subsequent therapies, as well as the role of increasingly pragmatic ongoing trials, notably those designed to address cardiovascular safety. The development of both guidelines and quality standards strive to achieve quality, uniform, cost-effective care. This talk will highlight important gaps in the evidence required by those who make decisions about reimbursement of anti-diabetic therapies and the importance of valuing health-related quality of life, specifically those associated with hypoglycaemia and weight gain.

LESSONS FROM SCOTLAND

Dr Stephen Greene, Dundee

A 'model of care' is a multifaceted concept, broadly defining how health services are delivered. However, the definition of 'success' is problematic, particularly in a condition such as type 1 diabetes (T1D) that is predominantly self-managed. The service may be delivered effectively, but the primary health outcome is not achieved.

NHS Scotland appears to deliver a successful health service for young people with T1D and their families. In a part of the world with a high incidence, which is likely to rise significantly in the next 20 years, all children are referred to and managed by a multidisciplinary team of health professionals that delivers treatment at onset, early education and support, continuing education and immediate care of diabetes emergencies, some of which require hospital therapy. The service is underpinned by peer-reviewed guidelines and quality control through clinical networks. A 'standard' clinic system has been established with children and their families being offered outpatient appointments three to four times per year, supported by local parents' and patients' organisations and national support groups. Children appear to be well integrated into society, with the vast majority growing and developing appropriately, attending school and higher education normally and gaining employment.

Disappointingly, however, despite this effort, the outcome of the self-management of diabetes in Scotland continues to remain unacceptable by medical standards. The majority of children and adolescents have poor metabolic control, mostly related to difficulties in adherence to the intensive management regimens; this predicts poor long-term health for adults with diabetes, with a high risk of vascular disease and early mortality from heart attacks, stroke and renal failure.

New approaches to the models of care are required to support and motivate young people and their families with T1D. Recent evidence suggests prospective studies of social networks and increased 'social capital' predict health outcome. What is needed is a network that improves for individuals and their families 'diabetes social capital'. A radical rethink on the components of Scottish models of care is required.

LESSONS FROM ITALY

Roberto Trevisan, Ospedali Riuniti di Bergamo, Italy

The transition to adult care is inevitable for children and adolescents with diabetes. This transition occurs in differing care settings, and there is no age when transition is smoothest. This transition is difficult for many youths, and lack of consistent care may follow transition in 30–40% of patients. Even in those who remain in care, reports of metabolic control in the two years after transition vary. Several guidelines indicate that a planned transition to adult diabetes care improves outcomes and there is some evidence that a combined adolescent/adult clinic with both paediatric and adult diabetes specialists may be the optimal model of transition to adult care. We aim to present a different care model where there is no transition to adult care, since children and adolescents with diabetes are followed up by the same diabetes specialist team from the diabetes onset throughout all diabetes duration.

In Bergamo's hospital, the Paediatric Unit is deeply involved in oncology and organ transplantation. This is the reason why ten years ago it was agreed to implement a specific new approach for the care of children with type 1 diabetes. At diabetes onset, children and adolescents are admitted in the Paediatric Unit, where the diabetes team together with paediatricians treat acidosis and dehydration. During this admission, which is as short as possible, the diabetes team provides proper education for patients and their families.

After this initial period of diagnosis and education (when frequent contact is required), the child is regularly reviewed throughout the year in the diabetic clinic on a specific day. This is to allow families to meet and discuss common problems related to diabetes. This occurs no less than three or four times per year, including one major annual review (paying particular attention to the review of regular growth data, blood pressure, puberty, associated conditions, nutrition and complications) with a multidisciplinary team (including a psychologist). Continuous subcutaneous insulin infusion and continuous glucose monitoring are also provided to those children with special needs or difficulties in getting a good metabolic control. As a result of this model, transition to adult care is absent in our care setting.

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LESSONS FROM LIVING WITH DIABETES

Maggie Smith, Edinburgh

Brief histology I have been a diabetic for 37 years. I was diagnosed eventually, after 18 months of investigations and being on antibiotics for urinary infections on and off, in April 1973, aged 3¾ years, following an abortive episode of measles. I was given x 2 injections daily of isophane. Urine testing was socially challenging and not very accurate. I was on a set amount of exchanges at each meal time.

Transition In 1981, aged 12 years, I was put onto pork insulin. By 1983, aged 14 years, I had been to the hospital to learn how to do my own injections and got my first blood glucose testing machine. It was a very difficult period in my life and took a lot of adjusting to. I fell pregnant when I was 35 years old. Due to it being unplanned I needed to take control almost immediately. This I did with great enthusiasm and dedication.

How accessible/didactic diabetes care is I believe that diabetes care is fairly accessible for those patients living in the UK. There are numerous websites for people willing to access information online and Balance is a good source of information.

D-day + histology This year, on 18 February, my son was diagnosed with type I diabetes. He will be five years old on 27 May. It is still very raw for me, as I know what he will have to go through in life being a diabetic. We were out for family meal (pizza) and he went to the toilet four times. Once home, I checked his blood glucose and it was 32.5. It rose to >33.3 mmol/l an hour later so I phoned the Royal Hospital for Sick Children (RHSC) and took him in. By 11pm I was being told my son had type I diabetes.

Comparisons of models of care What I've done here is to look at my son's diagnosis in 2010 and what happened with him in regards to the care he has received and is receiving from the RHSC and compare it with the care I received back in 1973.

Suggestions for better models of care I have put forward suggestions for how, as a parent of a newly diagnosed diabetic child, I envisage this model of care could change and become more in tune with a patient's needs and requirements, thus improving the overall service that the NHS provides.

MY LIFE WITH DIABETES

Ross Finnie, Glasgow

I have been a type I diabetic for 45 years. My wife, Phyl, has developed an almost telepathic understanding of my condition and it is doubtful if I would have survived without her support. A few key friends in my personal, professional and public life have also provided essential support. On the medical front, only three excellent diabetic consultants and three GPs have provided a remarkable continuity of outstanding medical support.

I qualified as a chartered accountant and moved into corporate finance, specialising in mergers, acquisitions and reconstructions of small to medium-sized companies. These type of transactions involve long and irregular hours, not wholly consonant with diabetes. I played rugby football until I was 30 and have always enjoyed a very active social life.

I was first elected as a local councillor in 1977 and managed to juggle council meetings and my professional career for the next 22 years until I stood down in 1999. I was then elected to the first Scottish Parliament and was re-elected in 2003 and 2007. I was appointed as a Cabinet Minister in the Liberal Democrat/Labour coalition government and served throughout the first eight years with the environment and rural development portfolio. I am currently my party's Shadow Secretary for Health and Wellbeing.

My first insulin regime was on single-dose lente and that lasted for 19 years. I was moved on to a three-dose regime of Human Actrapid and Human Ultratard and now Humalog and Lantus. My only prolonged period of poor balance and control was followed by diabetic retinopathy requiring laser treatment in 1980. I had to take three months off in 2004 for a double heart bypass operation, but I returned to full cabinet duties and have not looked back.

I am very far from being a perfect diabetic patient, but I have lived my life to the full and I have no regrets.

Speaker abstracts

ACHIEVING CONSENSUS

Dr Ken McHardy, NHS Grampian

The Royal College of Physicians of Edinburgh has hosted a number of consensus conferences since 1995. Each conference has been constructed around a broadly common basic methodology, whereby contemporary issues in clinical practice are presented by invited experts, then considered and discussed by a mixed, and substantially voluntary, gathering of interested parties. A second group of invited experts sit as a consensus panel considering the presented evidence and audience reaction to it, leading to the production of an agreed draft or 'consensus' statement. All participants have a further opportunity to comment on, and potentially amend, this statement before it is finalised at the end of the conference.

Previous conferences have covered issues ranging from management of long-term clinical conditions (e.g. chronic obstructive pulmonary disease and chronic kidney disease), through service reconfiguration (e.g. stroke management, epilepsy services and the emergence of acute medicine) to rationalisation of established treatments (e.g. lipid-lowering drugs and hormone replacement therapy).

The principle behind these conferences and their attempts to achieve consensus are noble in that they aim to involve partnership working with a sizeable group of interested professionals, who are empowered to contribute their opinions in an attempt to achieve inclusive agreement on actions or change promoted by the group. However, while much of the currency of the interaction is centred on relevant knowledge and measured evidence, one may legitimately ask about the completeness with which the recommendations of the so-called consensus will be adopted by those who 'consented', let alone by their wider professional peer groups beyond.

As diabetes now makes its debut under the RCPE Consensus Conference spotlight, this presentation will take a light-hearted look at how the attitudes, values and beliefs of experienced practitioners (and patients!) may challenge the idealised view that consensus can ever be truly achieved or wholeheartedly implemented.

J R Coll Physicians Edinb 2010; 40 (Suppl 17):40–6

AUDIT: MANAGEMENT OF DIABETES IN A RURAL PRIMARY CARE SETTING (THURSO, SCOTLAND)

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Objective: To examine the degree to which targets for diabetes control including haemoglobin (HbA_{1c}), blood pressure, body mass index (BMI) and annual ophthalmology reviews are achieved in a rural general practice.

Methods: A retrospective medical record audit was conducted among 274 diabetic patients registered under the practice.

Participants: Type 1 and type 2 diabetes mellitus patients.

Results: A total of 274 patients (124 female, 149 male) with a mean age of 61.68 years old were studied in this audit. Of those, 84.9% of the patients had type 2 diabetes mellitus, while 15.1% had type 1 diabetes mellitus. A total of 19.7% of patients met the SIGN guidelines criteria for HbA_{1c} levels (<6.5%), while 88.9% of patients met the SIGN guidelines criteria for blood pressure control (<140/85 mmHg). A total of 91% of diabetic patients received annual ophthalmology reviews and 84% were found to have a BMI of 25 and above. This audit revealed a significant correlation between the types of medications taken and the HbA_{1c} control in diabetic patients ($p < 0.001$). Patients taking oral hypoglycaemic agents have lower HbA_{1c} levels compared with patients on insulin injections.

Conclusion: The results of this audit in a rural practice show that HbA_{1c} levels among patients are still very low, although blood pressure control and the percentage of patients receiving annual ophthalmology reviews are quite good. Interventions to improve HbA_{1c} levels in rural areas should be implemented to enhance the care for diabetes in the rural community.

PREVENTION OF TYPE II DIABETES MELLITUS IN RURAL SETTINGS

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Introduction: The incidence of type 2 diabetes mellitus has been rising during the past decade, even though this is an entirely preventable condition. A number of factors may have contributed to this increase, including obesity and unhealthy dietary lifestyles.

Aims: To assess healthcare workers' views regarding:
i) the strategies that can be used to increase awareness about the prevention of type 2 diabetes mellitus; and
ii) the reasons why lifestyle interventions fail in rural settings.
Limited research has been published regarding these parameters.

Methods: An anonymous survey of all healthcare workers employed at Princes Street and Riverbank surgeries in Thurso, between 8–19 February 2010.

Results: Of the 30 healthcare workers, 26 (87%) returned the questionnaire. Verbal information (19%) and posters in surgery (19%) were thought to be the most effective strategies, followed by local advertisements (15%) and patient leaflets (12%). Regarding the reasons why lifestyle interventions fail, the majority of healthcare workers thought that an inability to adapt personal lifestyle to changes (38%) was the most important factor. This was followed by lack of self-control (35%) and motivation (35%). A general consensus was that patient education, in different forms, can be the single most effective way of preventing this condition.

Discussion: The results of this survey showed that a variety of strategies can be employed to increase patients' awareness in rural settings. These methods can also be used at a national level. Finally, further research should be devoted to this field of medicine.

Poster abstracts

CAN PODIATRISTS IMPACT ON SELF-MANAGEMENT FOR PEOPLE WITH TYPE 2 DIABETES? PROPOSAL FOR A RANDOMISED CONTROLLED TRIAL

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Background: Type 2 diabetes has reached epidemic levels in the UK. Effective management of the condition inevitably means good self-management by people living with diabetes on a daily basis. Dietary changes to improve blood glucose (HbA_{1c}) control provide ongoing challenges for both patients and healthcare professionals. Podiatrists are well placed to implement long-term support of self-management strategies based on a valid theoretical framework.

Aims: This research aims to assess the effectiveness of podiatrists implementing cognitive behavioural strategies with diabetic patients, and to promote the use of collaborative person-centred consultations in daily healthcare practice.

Methods: Podiatrists, recruited from diabetic clinics in Scotland, will complete cognitive behavioural intervention training delivered by a psychologist and a dietician. Over 12 months, they will implement interventions with diabetic patients to improve self-efficacy and dietary changes. Mixed methodologies will be used to ensure the effectiveness of the intervention is evaluated in its entirety. The biomedical outcome (HbA_{1c}) will be monitored as part of usual care. Diabetes Quality of Life and Diabetes Treatment Satisfaction Questionnaires will be used at the baseline and completion points. Process evaluation through interviews and focus groups will provide a picture of the way in which the interventions were used and experienced by both patients and podiatrists.

PRAGMATIC EXPERIENCE OF LIAISON PSYCHIATRY WITHIN THE DIABETIC OUTPATIENT DEPARTMENT

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Psychological provision for diabetes patients is very patchy nationwide, despite evidence that there is a high level of distress and psychiatric co-morbidity within this population, often underdiagnosed and undertreated. Furthermore, there is good evidence that patients show poorer control, higher rates of complications and greater mortality when psychiatric disorders such as depression coexist with diabetes. There is growing recognition that effective psychological interventions may be delivered within diabetes departments, and numerous studies have shown the benefit of such strategies to various sub-groups of the diabetic population. Such research evidence is often difficult to transfer to everyday clinical practice. This may be due to a number of factors, including limited time to develop local strategies and difficulties in identifying where to begin.

I set up a trial service in the Diabetic Outpatient Department in the Royal Infirmary of Edinburgh. This was a six-month pilot service, one session per week, providing direct liaison for difficult to manage patients; a weekly clinic within the diabetic department; and training for the clinical staff on psychological matters.

Combining a standard psychiatric assessment with a comprehensive diabetic history allowed both the diagnosis of psychiatric disorders and a formulation of the patient's problems, which could inform the most appropriate treatment approach.

After consultation with diabetes staff across Lothian, we are developing a stepped protocol, including simple interventions that can be delivered by diabetes specialist nurses with ongoing supervision and input.

J R Coll Physicians Edinb 2010; 40 (Suppl 17):47–50

EXENATIDE WITH INSULIN: IS IT SAFE?

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Aim: Exenatide, an incretin mimetic, is a new class of medication which has been approved by the National Institute for Health and Clinical Excellence (NICE) for use in type 2 diabetes, in conjunction with oral hypoglycaemic agents. It is not yet licensed to be used with insulin. NICE recommends exenatide if the body mass index (BMI) is >35, if there is inadequate glucose control (HbA_{1c} >7.5%) or specific psychological, physical or biochemical problems arising from weight gain.

Method: We carried out a retrospective evaluation of 31 patients on exenatide and insulin. The case notes were reviewed and their medications, BMI and HbA_{1c} documented before and after starting on exenatide.

Results: Of the 31 patients, 53% were male and 48% female. A total of 72% were started on exenatide due to a BMI >35 and 59% due to both raised BMI and poor glycaemic control. The age range was 50–70 years. A total of 37% of the patients were on BD insulin, 47% on a basal bolus regime and 16% on once-a-day insulin. Body mass index and HbA_{1c} improved in 71% and 52% of patients respectively; however, in 29% of patients there was no change in the BMI and HbA_{1c}. More importantly, the addition of exenatide with insulin did not cause an increase in the BMI of any patients or cause hypoglycaemic events.

Discussion: Exenatide lowers blood glucose through an enhancement of glucose-dependent insulin secretion, the suppression of excess glucagon secretion, reduction of food intake and slowing of gastric emptying. In our audit exenatide improved glycaemic control and BMI in the majority of the patients and its combination with insulin did not produce any side effects. Moreover, our patients did not require additional monitoring.

PREGNANCY OUTCOMES IN A COHORT OF TYPE 1 AND TYPE 2 DIABETICS IN AN URBAN POPULATION

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Background: Diabetes is the fastest-growing global epidemic. Younger women are increasingly affected and therefore the numbers of pregnant women with diabetes are rising at alarming rates. It is recognised that women with diabetes are a high-risk group who experience significantly more intervention during pregnancy than the general maternity population: induction rates are reported as around 39%, Caesarean section rates at 67% and the spontaneous pre-term delivery rate is twice that in the general maternity population (CEMACH, 2005). As clinicians we are challenged to look at ways of providing high-quality care and to optimise pregnancy outcomes in this growing population of women.

Methods: This retrospective analysis looked at pregnancy outcomes including gestation at delivery, rate of pre-eclampsia, pre-term delivery and rate of neonatal admission of babies of all women with pre-existing diabetes from 2007 to 2008 in an urban population. Data were collected from routine antenatal and diabetes records.

Results and conclusion: These data provide us with the largest contemporary UK cohort of women with type 1 and type 2 diabetes. The methods, timing and success of induction of labour were compared between type 1 and type 2 diabetes. Almost 80% were delivered by Caesarean section. We discuss the contribution of early induction of labour as a potential cause of this high Caesarean section rate. The birthweights and outcomes of babies born to women were also compared.

Poster abstracts

PREVENTING TYPE 2 DIABETES MELLITUS: A STUDY OF WAIST CIRCUMFERENCE AND INFLAMMATORY STATUS IN PRE- AND POST-MENOPAUSAL INDO-MAURITIAN WOMEN

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Effective prevention of type 2 diabetes mellitus (T2DM) relies on risk assessment, which has remained elusive. The metabolic syndrome (MS) identifies a risk state with unknown aetiology and its clinical usefulness thus remains controversial. Central obesity has been strongly implicated in the aetiology of MS. The risk associated with a particular waist circumference (WC) is believed to be country- and ethnic-specific, and the establishment of cut-off points for a particular ethnic group may depend on their country of residence.

This preliminary cross-sectional study was carried out on pre- and post-menopausal, healthy Mauritian women of Indian origin to shed light on the relationship of central obesity with inflammation, which has also been strongly implicated in the aetiology of MS, using existing cut-off values for WC. Overweight subjects (body mass index, BMI=25–29.9) were recruited in the age group 41–55 years to fall in three WC categories: low: <80 cm; high: 80–88 cm; and very high: >88 cm.

Pro-inflammatory molecules were found to be significantly higher in subjects with central obesity (WC ≥80 cm), as was the erythrocyte sedimentation rate, whereas adiponectin, an anti-inflammatory molecule, was significantly lower. Differences were more marked in post-menopausal women across WC categories. Both BMI and WC correlated positively with all inflammatory markers studied and negatively with adiponectin. In the high WC category, interrelationships were conflicting, suggesting that inflammatory changes due to central obesity may start to occur in that category with interpersonal variations.

Our data show that central obesity is associated with a pro-inflammatory status, implicated in T2DM pathogenesis. This study contributes to the generation of worldwide ethnic-specific data required to provide global evidence for the establishment of central obesity as a metabolic risk for T2DM and the consideration of anti-inflammatory therapy along with lifestyle interventions and other pharmacological therapy in the prevention of T2DM.

J R Coll Physicians Edinb 2010; 40 (Suppl 17):47–50