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The ADKnowl: identifying knowledge deficits in diabetes care.

J Speight and C Bradley

Correspondence to:
Ms Jane Speight
Health Psychology Research, Dept of Psychology,
Royal Holloway, University of London,
Egham, Surrey,
TW20 0EX, UK.
Tel: 01784 443718
Fax: 01783 434347
E-mail: j.speight@rhul.ac.uk.

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Abstract

Aims To present the ADKnowl measure of diabetes-related knowledge and evaluate its use in identifying the nature and extent of patient and health professional knowledge deficits.

Method The ADKnowl was used in a large-scale study of 789 patients (451 treated with insulin and 338 treated with tablets and/or diet) attending for annual review at one of two hospital outpatient diabetes clinics

Results Knowledge deficits were apparent in the patients. For example, 57% did not recognise the inaccuracy of the statement "fresh fruit can be eaten freely with little effect on blood glucose levels". Seventy-five percent of patients did not know that it is advisable to trim toenails to the shape of the toe. Knowledge deficits were identified for many other areas of diabetes management, e.g. prevention of hypoglycaemia, avoidance of ketoacidosis. Sixteen health professionals at the clinics answered the same items. Contrary to recommendations, 25% of health professionals thought that fresh fruit could be eaten freely. Seventy-five percent of health professionals did not know the current recommendations for trimming toenails. As expected, $HbA_{1(c)}$ did correlate with scores from 2 specific items while $HbA_{1(c)}$ did not correlate with summed ADKnowl score.

Conclusions Patient knowledge deficits were identified. Some specific knowledge deficits among health professionals may be the cause of some patient knowledge deficits. The ADKnowl is a useful tool in assessing both patient and health professional knowledge deficits and is available for use in a context of continuing evaluation.

Keywords diabetes, knowledge, measures, health professionals, patients.

Abbreviations DM, diabetes mellitus; DSN, Diabetes Specialist Nurse; QoL, quality of life

Introduction

The past decade has seen great improvements in our understanding of diabetes and its management, with the DCCT (1993) (1) and the UKPDS (1998) (2) providing considerable evidence to indicate how complications can be prevented or delayed. The Audit Commission's report on diabetes (3) has indicated that "education is crucial so that individuals can manage this complex disease effectively themselves". The report goes on to highlight the features of high quality patient education which include "continuous assessment and a programme for established patients according to individual needs ... [and] ... built-in evaluation via assessment of each patient's knowledge"(3).

Whilst it is generally acknowledged that self-care is an important aspect of diabetes management, recognition of the role of patient knowledge and its promotion have become unfashionable in recent years and superceded by a growing interest in attitudes and health beliefs (4, 5, 6) due to disappointment in many studies that were unable to identify any direct relationship between knowledge and glycaemic control (7, 8, 9, 10). As concern about the apparent failure of knowledge to predict outcomes (the so-called 'knowledge-behaviour gap') has become more widespread, the perceived importance of measuring knowledge appears to be diminishing (11). With continuing changes in treatment, technology and advice, many of the knowledge measures first developed in the 1980s are now out of date (12, 13, 14) despite updates in the early 1990s (15).

Consequently, when knowledge has been measured, the instruments used have often been inadequate for the task and, as a result, studies have failed to show any relationship between knowledge and behaviour, thus widening any 'knowledge-behaviour gap'. In reality, the gap in question has, more often, been a gap between generalised knowledge and specific biomedical indices, such as HbA_{1c} levels. Many important aspects of knowledge will not logically or sensibly relate to HbA_{1c} levels, but will relate to other clinical and behavioural outcomes, which may be more difficult to measure.

The failure of many studies to find an association between knowledge and biomedical outcomes has largely been due to one or more of the following factors (11):

1. Investigators have often used total knowledge scores when attempting to correlate knowledge with biomedical outcomes. However, it is not reasonable to expect that improved knowledge of particular aspects of care, e.g. footcare, would have any bearing on an outcome such as metabolic control, although incidence of foot problems may well be reduced with improved footcare knowledge. Despite this, answers to footcare items have often formed a part of total scores which investigators have tried, usually unsuccessfully, to relate to blood glucose control.
2. Published knowledge studies often omit details of the instrument used to measure knowledge and important characteristics of their data, e.g. possible floor and ceiling effects.
3. People often learn about a problem after it develops and proves difficult to deal with, such that prospective measurement of knowledge is essential in determining causal relationships between knowledge and outcomes.
4. Particular aspects of knowledge may only be relevant in certain circumstances, e.g. knowledge of how to adjust insulin when sick and not eating is important in preventing diabetic ketoacidosis (DKA) during concurrent illness, but will not have such consequences in the absence of illness.

Thus, many efforts to relate patients' total knowledge scores to metabolic control have failed due to ill-judged summing of scores across different items of knowledge, inappropriate cross-sectional study designs and lack of recognition of the importance of context. Knowledge

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needs to be measured item-by-item and the benefits of improved knowledge assessed with respect to specific, relevant outcomes if the role of knowledge in improving outcomes is to be demonstrated.

To the authors' knowledge, no new measures of diabetes-related knowledge have been developed to the point of publication in the UK in recent years. In the USA in 1998, Fitzgerald and colleagues published a validation of the "Diabetes Knowledge Test" (DKT) (16) which could be adapted for use in the UK. However, the DKT uses a multiple-choice format which does not offer a 'don't know' option and includes wrong answers which are closely worded but inaccurate versions of the correct responses, designed to 'catch out' respondents who are guessing. The design of the ADKnowl (described below) offers several advantages over multiple-choice formats, better allows for selective use of subsets of items for particular purposes, and facilitates updating of items.

The aim of the present study is to present a new measure of knowledge, designed to overcome the many problems associated with previous measures and to identify the nature and extent of diabetes-specific knowledge deficits which are likely to impair biomedical and/or psychological outcomes.

Design of the ADKnowl

The ADKnowl - Audit of Diabetes Knowledge (© Bradley, 1993 latest revision 1998 used in the present work) builds on the DKN and Charing Cross instruments (12, 13) and was designed to measure essential knowledge of diabetes and its management. It is suitable for use by patients with Type 1 and Type 2 DM and offers the following advantages over previous measures. The ADKnowl:

- targets knowledge deficits which can be related to measurable outcomes
- makes use of both correct and incorrect responses
- 'false' statements are those that are known to be common and/or serious misconceptions; these are only included if it is thought that people may still consider the statement to be true despite evidence now available to the contrary. 'False' statements are not included if their only purpose would be to 'catch people out'.
- a 'don't know' option is provided to discourage guessing and aid interpretation of responses

The questionnaire has been several years in its development, informed by interviews with health professionals, including doctors, dietitians, chiropodists, and DSNs. The interviews generated an over-inclusive set of statements which encompassed essential diabetes knowledge and common / serious misconceptions. Members of the British Diabetic Association's Diabetes Information Management and Audit Group (DIMAG) and their diabetes care teams completed and gave detailed comments on items in the pilot questionnaire. Extensive consultation with DIMAG and associated diabetes care team members resulted in revisions to the ADKnowl. A series of pilot studies in several contexts led to further minor revisions and the version of the ADKnowl here used.

The ADKnowl includes 23 item-sets (104 items) relating to treatment, sick days, hypoglycaemia, effects of physical activity, reducing complication risks, smoking / alcohol effects, footcare, and diet & food. Respondents are asked to shade circles to indicate whether a given statement is true or false. Use of a 'don't know' response option is encouraged in preference to guessing. Two item-sets (7 items) are to be answered only by those using insulin and 2 item-sets (9 items) are to be answered only by those who treat their diabetes with tablets.

Patients and Methods

The ADKnowl was included in the questionnaire package for the DIABQoL+ Programme (17), a large-scale study of patients (diagnosed for at least one year) attending the outpatient diabetes clinic of a Teaching Hospital or a District General Hospital for annual review. During the period 1st November 1997 - 30th April 1998, 2045 patients were eligible for annual review (Teaching Hospital = 1192; District General Hospital = 850; unknown = 3), all of whom were either given a questionnaire package by the DSN when attending their appointment or were posted the questionnaires in the event of not attending or being missed by the DSN. A pre-paid envelope was provided for return of questionnaires to Royal Holloway. The diabetes teams at each clinic (22 health professionals at the District General Hospital; 15 at the Teaching Hospital[1]) were also asked to complete the ADKnowl before seeing patients' results. HbA1c (at the Teaching Hospital) and HbA1 (at the District General Hospital) were measured routinely for the purposes of annual review using Affinity Chromatographic Technique (HbA1c: Primus Corporations reference range 4.2-6.2%; HbA1: Drew GHb100 Analyser reference range 3.0-6.0%).

Provision of patient education at the clinics

At the Teaching Hospital, all newly diagnosed patients were invited to attend a class. Classes were run weekly by DSNs, chiropodists and dietitians. These classes were followed-up by one-to-one education as required. At the District General Hospital, newly diagnosed people with Type 2 DM were offered two group education sessions while people with Type 1 DM were predominantly offered one-to-one teaching. No formal provision was made in either clinic for checking the knowledge of, or educating, newly referred patients. At the Teaching Hospital, re-education was offered to all patients, with opportunities to re-visit DSNs, dietitians and chiropodists as appropriate, but uptake was not high. At the District General Hospital, 'update' sessions had been offered to patients on two separate occasions but had resulted in such low uptake that the practice had been abandoned; re-education, therefore, was provided on an adhoc basis.

Statistical Methods

Statistical analysis was performed using SPSS 9.0 for Windows. The Mann-Whitney U test was used to identify differences between the participating clinics in terms of demographic characteristics. It was also used to detect differences by treatment for total knowledge score (i.e. percentage of correct items). Partial correlations were used to control for treatment type when correlating total knowledge score with age and with BMI. Kendal's Tau was used to correlate total knowledge score with age at leaving full-time education, duration of DM, duration of current treatment, years attending clinic and $HbA_{1(c)}$ levels. Differences in $HbA_{1(c)}$ levels with regard to responses to specific items (which might be expected to be related to $HbA_{1(c)}$ levels) were also explored using Mann-Whitney U tests, comparing those giving correct with those giving incorrect responses. The cross-tabulation procedure (using chi-square) (18) was used to determine differences in knowledge on individual items between treatment groups and clinics and in terms of duration of diabetes (splitting on the median duration of 11.5 years). In order to control the familywise error rate for these chi-square analyses, a more conservative significance level was determined: using the Bonferroni correction (18) (alpha level/no. of tests), a significance level of $p<0.00016$ (i.e. 0.05/312) was adopted; p-values between 0.05 and 0.00017 are regarded as trends only.

[1] Including consultants, SHOs, Registrars, DSNs, dietitians, chiropodists and clinic managers but not including nursing auxilliaries or receptionists.

Results

Completed questionnaires were returned by 789 (39%) patients (Teaching Hospital = 30%; District General Hospital = 51%; unknown = 33%); 451 insulin treated and 338 tablet and/or diet treated patients. A further 238 (12%) declined to participate in the study and 63 (3%) packages were returned by the Royal Mail, undeliverable. Frequencies of patients by treatment regimen, complications, gender and ethnicity are given by clinic in Table 1. The Teaching Hospital sample was younger than the District General Hospital sample (U=54491.5; n=329 & 419 respectively; p<0.0001) although older at leaving full-time education (U=43264.5; n=285 & 396 respectively; p<0.0001) and included more patients from ethnic minority groups (U=49088.5; n=312 & 400 respectively; p<0.0001). There were no other significant differences between the two clinics. $HbA_{1(c)}$ levels were not comparable because different assays were used in each clinic.

Sixteen health professionals (43%) returned completed questionnaires; some identified their profession on the questionnaire but many did not. Consequently, it was not possible to analyse responses by profession, as this would have breached anonymity in this select sample.

Knowledge scores were higher in insulin-treated than in non-insulin-treated patients (U=34875.0; n=422 & 323 respectively; p<0.0001), as has been found elsewhere (18). Expected small but significant positive associations were found between total knowledge score and age at leaving full-time education (T=0.234, n=677, p<0.0001), duration of diabetes (T=0.217, n=726, p<0.0001), duration of current form of treatment (T=0.194, n=671, p<0.0001) and years attending clinic (T=0.145, n=706, p<0.0001). Controlling for treatment type, a negative association was identified between total knowledge score and age (r=-0.276, n=742, p<0.0001) but not between total knowledge score and BMI. Little if any association was expected between overall knowledge scores and $HbA_{1(c)}$ levels and none reached significance (HbA_{1c}: T=0.071, n=336, p=0.057; HbA_1: T=0.036, n=340, p=0.328).

It was hypothesised that people giving correct answers to selected knowledge items, which might be expected to be associated with $HbA_{1(c)}$ levels, would have lower $HbA_{1(c)}$ levels than those giving incorrect responses. Precise wording of each ADKnowl item, together with the percentage of patients responding correctly is given in Table 2. Correct, incorrect and 'don't know' responses are shown for all patients; correct responses only are shown by treatment type and clinic. Lower $HbA_{1(c)}$ levels were identified for people giving correct responses than for those giving incorrect responses to item 1b ("a little glucose in the urine is a good thing") for patients from the District General Hospital (U=3669.50, n=171 correct & 51 incorrect responses, p=0.043) where there were more incorrect response to this item than at the Teaching Hospital (n=182 correct and 30 incorrect responses). Lower $HbA_{1(c)}$ levels were also associated with correct responses for item 2d ("tablets ... can be stopped if urine tests show no glucose") for tablet-treated patients from the Teaching Hospital (U=246.50, n=68 correct & 11 incorrect responses, p=0.036) where there were more incorrect responses than at the District General Hospital (n=101 correct & 7 incorrect). Two dietary items concerning he effects of fresh fruit (11h) and fresh fruit juice (11i) on blood glucose levels were also investigated for significant differences in $HbA_{1(c)}$ levels but none were found.

Those with a greater duration of diabetes (>11.5yrs) tended to give correct responses more frequently than those who had had diabetes for fewer years (82/104 items: 79%). Using the Bonferroni correction, this difference was significant for 26 (25%) items (p<0.00016). For 16 items (15%), patients with a greater duration of diabetes had less knowledge: the main topics here being diet & food, and footcare.

Knowledge deficits were apparent for many patients: the mean percentage of patients responding correctly to each of the 104 item statements was 66.5% (range: 14.6% - 95.6%).

The mean percentage of missing responses per item was 8.25% (range: 2.3% - 15.0%) and the mean percentage of "don't know" responses per item was 12.6% (range: 0.5% - 41.1%).

For all patients, knowledge deficits were most apparent for:

- diet and food, e.g. items 11e, 11f and 11h.
- the effects of alcoholic drinks, e.g. item 16a (especially in tablet- / diet-treated patients).
- footcare, e.g. items 18b, 19a, 19b, 20b and 22a.

For insulin-treated patients, knowledge deficits were most apparent for:

- mistaking common symptoms of hyperglycaemia for hypoglycaemia (items 6b and 6f).
- taking less insulin with the same amount of food when increasing physical activity (item 9a).

For tablet- or diet-treated patients, knowledge deficits were most apparent for:

- importance of regular examinations (item 13d).
- the meaning of the $HbA_{1(c)}$ assay (items 23a, b, c and d).

Knowledge of footcare, hypoglycaemia, and diet & food were the most problematic topic areas, with patients achieving mean scores of 59.5%, 62.4% and 64.5% respectively for these topics. Patients exhibited greatest knowledge about reducing the risk of complications (including the importance of check-ups) - a mean score of 81%.

Figure 1 shows the percentage of patients and health professionals giving correct responses to selected items, for which knowledge deficits may have serious short-term consequences. For example, only 63% of patients knew that hypoglycaemia can be caused by an increase in physical activity[2] (item 5c) and only 37% patients knew that alcoholic drinks lower blood glucose levels after a few hours (item 16a).

Figure 2 shows the percentage of patients and health professionals giving correct responses to selected items, for which knowledge deficits may impair long-term biomedical and/or psychological outcomes. In particular, only 25% of patients and health professionals were aware of the most up-to-date advice regarding the cutting of toenails (item 19b), i.e. to the shape of the toe (not straight across).

Health professionals' knowledge was, as expected, generally far greater than patient knowledge, but some deficits were apparent. Consensus was achieved for topics such as hypoglycaemia, complications and treatment (mean scores 95.6%, 95.0% and 94.9% respectively). However, knowledge deficits were somewhat more frequent for diet & food (mean=88.5%) and footcare (mean=80.3%), areas of care often provided by non-medical specialists.

[2] When people treated by tablets or diet only (i.e. those individuals considered by many health professionals to experience fewer hypos) are excluded, this figure rises to 85.6%. However, this is still unsatisfactory as, in this sample of 451 insulin-treated people, 67 are at risk of experiencing a hypo when they increase their physical activity.

Discussion

The present study is limited by the low response rate, which may have been influenced by two factors. First, the ADKnowl was administered as part of a large questionnaire package (26 pages) to be completed at two time points one year apart. The size of the questionnaire package and commitment over time clearly deterred some people who may have been more inclined to participate if there were fewer questionnaires and the possibility of direct personal benefits. Secondly, the particularly low response rate at the Teaching Hospital (30%) is perhaps indicative that this cohort is over-researched, as suggested by non-participants' anecdotal comments. Thus, the sample was self-selected with possible consequences for the levels of diabetes-specific knowledge displayed. It is unclear in which direction knowledge levels would turn given a more complete sample, but it is, perhaps, more likely that non-respondents would display lower rather than higher levels of knowledge than respondents. Another limitation of this study lies in the number of statistical tests performed. However, many differences remained highly significant despite use of a conservative alpha level ($p<0.00016$).

Despite these limitations, the data suggest that substantial numbers of patients are not equipped with essential information about diabetes and its management. Furthermore, where only small percentages of patients have knowledge deficits, it is the severity of possible consequences and the sample size that make it important that 100% of patients have accurate knowledge. The possible exception to this ideal is where patients do not engage in a particular activity and do not need to have that knowledge. For example, there may be less need to correct knowledge of the effects of smoking on risk of complications in non-smokers than there is for smokers whose behaviour may be changed by that knowledge. The role of behaviour in increasing the predictive value of knowledge will be examined in follow-up data where, for the first time, a measure of relevant behaviours is included alongside the ADKnowl.

There was an expected small but significant positive association between knowledge and duration of diabetes, which is not surprising given that diabetes education is likely to be a cumulative process. However, those specific topics for which greater duration was unusually associated with lesser knowledge may be of some concern. Many patients were unaware of the most recent guidance on cutting toenails, and those who were aware had been recently diagnosed, suggesting that new developments and changes in important educational messages had not reached those who had had diabetes the longest. This interpretation makes sense given the lack of any formal arrangements for re-educating patients in the two participating clinics.

The importance of measuring knowledge and the success of patient education interventions have, in the past, mostly been assessed in relation to metabolic control and relationships have proved difficult to find. The present study indicates that demonstrating a clear relationship between knowledge and metabolic control is, indeed, a complex process; only 2 of the 4 specific items that were particularly expected to relate to metabolic control showed any significance. These 2 significantly-associated items are relatively 'pure' knowledge items, as the relationship between these aspects of knowledge and $HbA_{1(c)}$ would be less influenced by behaviour than it would be for the other two items. Thus, for some aspects of knowledge, more information is needed regarding the mediating effects of behaviour upon outcomes (e.g. drinking fruit juice and/or eating fruit freely, interacting with lack of knowledge of potential effects on blood glucose levels). Such information is available from follow-up data.

It is widely accepted that patients need educating to reduce the risk of short- and long-term biomedical consequences. Less well recognised is the potential importance of knowledge in reducing the negative impact of diabetes on quality of life (QoL). Clearly, more accurate knowledge of complications and dietary restrictions may play some part in reducing QoL (e.g. increasing worries about the future and decreasing dietary freedom) but, it is also possible

that increased knowledge may liberate the person with diabetes; knowledge is power! In the short-term, if QoL is compromised by a lack of knowledge that imposes unnecessarily strict regimens, people with diabetes are unlikely to maintain optimal self-care (19). In the long-term, any complications that may develop will certainly impact negatively on QoL (20).

Health professionals also gave 'incorrect' responses in the present study. In some cases, these were true knowledge deficits but in other cases health professionals were in disagreement when they had very specific experiences that provided exceptions to more generally accepted rules. Where health professionals exhibit true knowledge deficits, patient knowledge deficits may follow. Dissemination of new developments or evidence can take up to ten years to be implemented clinically (21) and patients cannot be expected to know and follow the most up-to-date advice if their health professionals are unaware of it themselves. Continuing education for health professionals and constant revision of the body of diabetes-specific knowledge, to ensure consensus on what patients are to be taught, is vital to the process of providing quality patient education. The ADKnowl has an important role to play in alerting health professionals to changes in expert views and, thereby, facilitating continuing education.

Inherent in the provision of a knowledge measure is the constant need to ensure that items are up-to-date and in accordance with the very latest recommendations. It was suggested by two referees that item 10c was incorrect, i.e. that high-fibre foods do not help to keep blood glucose levels steady. Evidently, the American Diabetes Association Clinical Practice Recommendations had changed with the 1995 publication (22). However, 77.5% of patients and 100% of health professionals believed, like the authors, that high-fibre foods do help to keep blood glucose levels steady. Their view is supported by European guidelines (23) and recent research (24). This is a clear instance of expert groups differing in their views of the evidence and points to the need for a systematic review and, perhaps, to further research.

Future studies need to be precise in their expectations of the associations between specific aspects of knowledge and specific biomedical and psychological outcomes. Well-designed prospective intervention studies will yield the most valuable evidence of the ADKnowl's sensitivity to change and predictive validity. Knowledge alone may not be sufficient to predict outcomes, but it is a pre-requisite of good diabetes management. The ADKnowl is here shown to be a valuable tool for up-to-date assessment of health professional and patient knowledge deficits, which present a major threat to good diabetes outcomes. Assessment of knowledge deficits by means of the ADKnowl provides a useful starting point for individualised continuing education for health professionals and patients and allows educational resources to be targeted appropriately.

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Copyright

The ADKnowl is available in 'Teleform' format suitable for scanning directly into an SPSS datafile, which can also be scored manually.

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Table 1 Demographic and other patient characteristics giving the significance of differences between the two hospital clinics (numerical discrepancies reflect missing values)

	District Gen'l Hospital n = 436	Teaching Hospital n = 352	Sig. level (2-tailed)
Diabetes Treatment regimen			
• Insulin & Diet n (%)	248 (57%)	200 (57%)	
• Tablet & Diet n (%)	163 (37%)	120 (34%)	ns
• Diet only n (%)	24 (6%)	31 (9%)	
Any complications of diabetes			
• Without n (%)	277 (64%)	225 (64%)	ns
• With n (%)	128 (29%)	106 (30%)	
Sex			
• Male n (%)	235 (54%)	186 (53%)	ns
• Female n (%)	198 (45%)	163 (46%)	
Ethnicity			
• White n (%)	383 (88%)	233 (66%)	****
• Other n (%)	16 (4%)	79 (22%)	
Age (years)			
• Mean	59.7	54.8	
• Median	62.0	58.0	****
• 95th percentile	79.0	75.8	
Age at leaving full-time education (years)			
• Mean	16.4	18.1	
• Median	15.8	16.0	****
• 95th percentile	21.8	25.0	
Duration of diabetes (years)			
• Mean	14.2	14.5	
• Median	10.9	12.0	ns
• 95th percentile	39.0	36.9	
Duration of current treatment (years)			
• Mean	11.1	11.9	
• Median	6.6	8.0	ns
• 95th percentile	38.8	35.4	
Years attending clinic			
• Mean	9.6	10.2	
• Median	6.3	7.0	ns
• 95th percentile	30.0	26.0	
BMI			
• Mean	27.3	26.9	
• Median	26.1	25.9	ns
• 95th percentile	37.0	36.6	
HbA_1 (DGH) and HbA_1c (Teaching Hospital)			different assays used in each clinic
• Mean	8.6	8.0	
• Median	8.4	7.8	
• 95th percentile	12.4	10.7	

**** $p<0.0001$

Table 2 Patient knowledge for each ADKnowl item - %age 'correct', 'incorrect' and 'don't know' responses for all patients; %age correct responses by treatment type and by clinic.

All responses are given as % of correct responses.	CORRECT RESPONSE	ALL RESPONSES n = 789			CORRECT RESPONSES						
					TREATMENT TYPE				CLINIC[§]		
		Correct	Incorrect	Don't know	Insulin n=451	Tablet n=283	Diet n=55	X^2 sig. for treatment differences	District General Hospital n=436	Teaching Hospital n=352	X^2 sig. for clinic differences
1. Please consider each of the following statements about diabetes:											
a) Diabetes can be controlled with treatment	TRUE	95.5	1.3	0.5	96.5	96.1	94.5		96.6	96.0	
b) A little glucose in the urine is a good thing	FALSE	50.8	12.6	31.4	57.9	41.3	47.3	***B	49.5	53.4	*
c) Diabetes is likely to go away after a while	FALSE	88.9	2.6	4.0	94.0	84.5	80.0	***B	92.0	86.9	
d) Stressful experiences can affect blood glucose levels	TRUE	81.3	1.5	12.8	89.4	71.0	76.4	***B	85.6	77.6	**
e) Exercise can help you improve or maintain blood glucose control	TRUE	80.9	4.0	10.2	86.0	75.6	74.5	***B	82.3	80.7	
f) Achieving your ideal weight helps control diabetes	TRUE	88.4	2.4	4.5	87.8	90.1	94.5		90.1	88.1	
g) Blood glucose levels do not affect your chances of developing complications	FALSE	68.1	6.9	19.0	79.2	53.4	60.0	***B	71.3	65.3	
(This item only for people who take tablets to treat their diabetes) % excludes N/As											
2. Tablets for the treatment of diabetes ...											
a) help lower the amount of glucose in the blood	TRUE	89.4	2.1	4.2	-	89.4	-		95.6	89.5	*
b) need not be taken if a meal has been missed	FALSE	65.0	10.6	18.4	-	65.0	-		72.9	63.7	
c) do not need to be taken every day	FALSE	85.2	4.9	5.3	-	85.2	-		94.3	81.6	**
d) can be stopped if urine tests show no glucose	FALSE	71.0	6.4	17.3	-	71.0	-		82.9	63.4	***
e) can sometimes be the cause of too low a blood glucose level	TRUE	39.9	16.6	38.2	-	39.9	-		46.2	36.8	

(This item only for people who take tablets to treat their diabetes) % excludes N/As										
3. If you are ill and not eating, it is advisable to ...										
a) test glucose levels	TRUE	83.7	1.8	8.8	-	83.7	-		87.9	89.3
b) continue taking your tablets	TRUE	72.8	6.7	14.8	-	72.8	-		80.4	72.4
c) stop taking your tablets	FALSE	65.7	6.4	19.4	-	65.7	-		75.2	67.0
d) contact a doctor if you cannot keep fluids down	TRUE	87.3	0.7	7.1	-	87.3	-		92.3	90.4
(This item only for people who use insulin) % excludes N/As										
4. If you are ill and not eating, it is advisable to ...										
a) take less insulin	FALSE	49.4	27.5	9.3	49.4	-	-		57.8	56.7
b) take the same or more insulin	TRUE	55.9	25.9	7.1	55.9	-	-		65.3	59.8
c) test for glucose and ketones frequently	TRUE	87.1	0.2	6.0	87.1	-	-		92.2	94.7
d) contact a doctor if you cannot keep fluids down	TRUE	90.7	0.2	4.0	90.7	-	-		96.2	94.7
5. Please consider each of the following statements about hypoglycaemia ('hypos'):										
a) There is too little glucose in the blood	TRUE	72.6	6.0	12.7	86.7	54.1	60.0	***B	73.6	72.7
b) There is too much glucose in the blood	FALSE	56.2	14.3	14.5	71.0	37.5	38.2	***B	57.8	55.4
c) Hypos can be caused by an increase in physical activity	TRUE	63.3	7.0	20.4	85.6	34.6	34.5	***B	67.0	59.9
6. Please consider which of the following symptoms are commonly associated with 'hypos':										
a) Slurred speech	TRUE	59.1	5.9	22.6	73.2	41.7	40.00	***B	59.2	60.2
b) Feeling very thirsty	FALSE	36.0	32.3	18.2	55.2	10.2	14.5	***B	32.6	40.9
c) Sweating	TRUE	73.2	3.0	14.7	88.5	54.1	54.5	***B	74.8	72.7

d) Dizziness	TRUE	74.2	2.6	13.6	83.6	63.3	61.8	***B	74.1	75.9	
e) Confused thinking	TRUE	68.9	2.9	17.9	84.9	48.8	49.1	***B	71.1	67.6	
f) Passing more urine than usual	FALSE	38.6	22.8	25.3	58.1	13.4	12.7	***B	37.8	40.3	
7. If you get the symptoms of a hypo, it is advisable to ...											
a) take some insulin or tablets immediately	FALSE	59.5	7.8	18.1	80.7	33.6	25.5	***B	72.0	59.1	
b) eat or drink something which has sugar in it	TRUE	84.2	1.4	7.0	95.1	71.7	67.3	***B	85.8	83.8	
c) rest for 10-15 minutes	TRUE	63.4	5.5	17.2	74.7	50.9	41.8	***B	65.1	62.5	*
d) test blood glucose level straight away	TRUE	66.0	7.0	15.2	77.2	53.7	45.5	***B	65.6	67.9	
e) eat less food for the next meal	FALSE	58.1	4.7	23.9	74.5	36.4	41.8	***B	58.7	58.5	
8. The usual effect of physical activity is to ...											
a) lower blood glucose levels	TRUE	69.4	4.3	16.9	82.9	51.9	56.4	***B	70.6	69.3	
b) raise blood glucose levels	FALSE	64.7	3.3	18.4	78.3	46.6	52.7	***B	64.4	66.2	
c) increase glucose levels in urine	FALSE	49.8	3.9	31.9	63.0	31.1	43.6	***B	48.4	52.6	
d) leave blood glucose levels unchanged	FALSE	51.1	6.9	26.7	67.8	26.9	43.6	***B	49.5	54.0	
e) improve the control of diabetes	TRUE	67.5	5.8	17.6	72.7	63.3	54.5	***B	66.1	70.7	
(This item only for people who use insulin) % excludes N/As											
9. If you increase your physical activity, it is advisable to take ...											
a) less insulin with the same amount of food	TRUE	40.8	35.5	13.3	40.8	-	-		38.9	53.6	**
b) the same amount of insulin with more food	TRUE	65.0	18.4	8.4	65.0	-	-		77.7	62.2	***
c) more insulin with less food	FALSE	75.6	1.6	10.2	75.6	-	-		85.6	87.7	

10. Please consider each of the following statements about diet:											
a) People with diabetes can eat foods containing sugar as part of a high-fibre diet	TRUE	33.5	47.8	10.7	42.6	20.5	29.1	***B	32.8	34.9	
b) Sugary foods will have no effect on blood glucose levels	FALSE	85.7	3.8	1.9	91.4	79.2	81.8	**	87.6	84.9	
c) High-fibre foods help to keep blood glucose levels steady	TRUE †	77.5	3.4	9.2	79.6	76.7	72.7		81.4	74.1	**
d) High-fat foods can increase the risk of complications	TRUE	74.1	8.7	7.3	75.2	72.8	80.0		74.8	74.7	
e) Special diabetic products can be eaten freely without leading to weight gain	FALSE	70.2	10.2	11.3	77.8	59.4	70.9	***B	75.9	64.5	***B
11. Please consider each of the following statements about food:											
a) The same sized portion of fish and white meat such as chicken contain less fat than red meat such as beef or pork	TRUE	81.5	5.8	5.8	81.6	81.3	90.9		84.6	79.3	*
b) It is not possible to eat too much protein	FALSE	48.9	13.2	26.7	53.4	43.8	43.6	*	52.3	45.7	
c) Fried foods are usually high in fat	TRUE	87.9	3.6	1.4	91.1	83.7	92.7	*	89.2	88.1	
d) Pastry and cakes are high in fat	TRUE	87.7	2.6	2.6	90.0	84.8	92.7		90.4	86.1	
e) Cheese and biscuits are usually less fattening than puddings	FALSE	38.4	41.9	13.5	39.5	36.0	45.5		37.8	39.8	
f) All margarines and spreads have fewer calories than butter	FALSE	37.0	43.0	12.3	40.4	31.4	41.8	**	39.7	34.4	
g) Restricting use of salt can help to reduce high blood pressure	TRUE	84.8	2.8	4.9	85.6	84.8	87.3		85.6	85.5	
h) Fresh fruit can be eaten freely with little effect on blood glucose levels	FALSE	43.5	44.3	4.8	53.7	30.4	32.7	***B	47.2	39.8	
i) Fresh, unsweetened fruit juice can be drunk freely with little effect on blood glucose levels	FALSE	52.2	33.6	6.5	61.4	40.3	43.6	***B	47.7	58.8	**
12. Keeping diabetes well controlled over the years can lower your risk of damage to ...											
a) nerves in your feet	TRUE	89.8	0.9	3.8	92.2	86.9	94.5		91.5	89.5	
b) your kidneys	TRUE	86.7	2.1	5.2	91.4	81.6	83.6	**	86.7	88.4	
c) your eyes	TRUE	92.6	0.6	1.9	95.1	89.4	98.2		93.8	92.9	

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13. Regular examinations are recommended to check ...											
a) for nerve damage to your feet	TRUE	89.8	1.1	3.6	93.8	85.5	89.1	**	92.2	88.6	
b) your blood pressure	TRUE	92.6	0.6	1.9	94.7	90.1	98.2		94.3	92.3	
c) your eyes	TRUE	94.6	0.0	0.6	96.7	92.6	98.2	**	96.8	94.3	
d) only things you have been having problems with	FALSE	64.0	16.5	8.6	71.0	54.4	63.6	**	64.9	64.2	
14. Eye examination with an ophthalmoscope (special torch for looking at the back of the eye) ...											
a) does not need doing every year if the back of the eye has been found to be healthy	FALSE	69.4	14.5	9.1	73.6	63.6	72.7	*	69.5	70.7	
b) is needed even if diabetes is well controlled	TRUE	87.2	3.5	2.9	89.4	86.2	83.6		89.7	85.8	
c) is not needed for people with diabetes treated by diet alone	FALSE	62.0	6.5	23.1	60.3	62.9	78.2	**	64.4	60.2	
d) is recommended because early treatment of damage to the back of the eye can prevent blindness	TRUE	90.2	0.5	3.5	92.2	88.3	92.7	**	92.4	89.2	*
15. If someone with diabetes smokes ...											
a) the risk of serious foot problems leading to amputation is increased	TRUE	67.2	2.8	22.4	70.3	63.6	67.3		73.2	61.1	**
b) the risk of heart disease is increased	TRUE	87.8	0.5	4.7	91.6	83.0	90.9		90.6	86.1	*
c) the risk of a stroke is increased	TRUE	81.9	1.1	9.4	83.1	81.3	83.6		83.9	81.0	
d) it is no worse than for a person without diabetes	FALSE	63.5	11.4	15.6	67.4	56.9	72.7		66.1	61.6	
e) it can be a good way of keeping their weight down	FALSE	67.9	11.6	11.6	73.8	59.0	72.7	**	70.0	66.8	
16. Alcoholic drinks generally ...											
a) lower blood glucose levels after a few hours	TRUE	37.2	28.4	25.9	52.1	19.1	12.7	***B	36.7	38.6	
b) raise blood glucose levels initially	TRUE	48.6	14.0	29.7	48.3	49.8	49.1	**	54.1	42.6	*
c) have no calories	FALSE	71.9	5.2	15.0	76.5	65.4	76.4	**	75.5	69.0	

17. Because you have diabetes, your feet need to be checked for discolourations, infections, corns or injuries of any type ...										
a) by you or someone else once a day	TRUE	63.9	17.2	10.2	67.2	60.8	60.0		67.0	61.4
b) while 'wearing in' new shoes	TRUE	53.0	23.3	13.8	57.9	49.1	38.2	**	56.9	49.1
c) whenever you are aware of discomfort	TRUE	79.4	6.8	5.3	84.5	73.9	74.5	***B	82.3	77.3 *
d) only if you have had foot problems before	FALSE	70.2	12.8	7.5	76.3	62.9	65.5	***B	73.6	67.3
18. Please consider each of the following statements about footcare:										
a) It is best to wear shoes which are a size larger than usual	FALSE	61.9	17.4	13.2	70.5	50.2	58.2	***B	64.7	59.7
b) Soaking your feet is good for them	FALSE	18.2	47.4	27.2	22.8	12.0	14.5	***B	20.2	16.2 *
c) You may injure your feet but not feel it	TRUE	73.6	9.4	9.4	78.7	67.8	69.1	***	76.4	71.6 **
d) Foot injuries can take longer to heal than if you didn't have diabetes	TRUE	75.8	9.3	7.3	78.9	74.6	65.5	*	77.5	75.3
e) Wounds are likely to become infected if they are not looked after properly	TRUE	93.1	0.5	1.6	94.0	92.9	96.4		93.8	94.0
19. It is advisable to cut or file your toe nails ...										
a) straight across	FALSE	14.6	66.3	11.6	14.9	15.2	10.9		14.4	15.1
b) to the shape of your toe	TRUE	24.5	54.3	9.4	22.8	28.3	21.8		22.7	27.3 *
20. Foot problems such as blisters, corns, tough nails, can safely be treated by ...										
a) a state-registered chiropodist	TRUE	89.8	1.0	3.4	92.0	88.0	90.9		90.1	91.2
b) any chiropodist	FALSE	36.1	35.2	16.0	38.4	35.7	23.6		36.0	36.9
c) yourself	FALSE	57.7	21.9	9.4	57.0	60.4	56.4		58.9	57.4
d) anyone	FALSE	77.1	2.9	7.0	77.8	76.7	81.8		77.5	78.1

21. Types of shoes recommended for a person with diabetes include:											
a) lace-up shoes	TRUE	77.6	3.6	13.0	83.1	72.1	69.1	***	80.5	75.6	
b) trainers	TRUE	41.8	21.3	26.2	49.0	32.2	36.4	***	41.5	42.9	
c) high heels	FALSE	63.3	2.5	21.1	64.5	61.8	67.3		66.3	60.8	
d) open-toed shoes	FALSE	50.7	15.2	23.4	53.9	46.3	52.7	*	53.9	47.7	
e) no shoes at all	FALSE	69.9	4.0	14.6	74.9	63.3	70.9	**	70.6	70.5	
22. People with diabetes tend with age to have dry skin on their feet. It is therefore advisable to ...											
a) rub feet	FALSE	30.4	30.7	27.5	34.1	27.2	20.0		29.8	31.8	
b) rub handcream on feet	TRUE	63.9	10.7	18.2	65.6	64.7	52.7		66.5	61.9	
c) do nothing	FALSE	69.4	2.6	14.3	73.4	65.4	65.5		72.0	67.6	
d) wear socks	TRUE	56.2	11.3	20.1	57.6	55.5	54.5		58.3	54.8	
e) see a state-registered chiropodist	TRUE	76.5	2.6	9.6	78.7	73.9	80.0		78.0	76.1	
(Please consider the following items about $HbA_1(c)$ measures)											
23. The $HbA_1(c)$ level in the blood ...											
a) can show if you are getting hypos	FALSE	22.5	25.2	41.1	33.7	8.5	5.5	***B	20.9	25.0	
b) reflects the average blood glucose over the past 6-8 weeks	TRUE	49.4	6.3	33.5	64.3	31.1	27.3	***B	42.9	58.5	***B
c) reflects the average blood glucose over the past 6-8 days	FALSE	36.0	12.2	38.5	49.7	19.8	10.9	***B	33.3	40.1	**
d) reflects the average blood glucose over the last 24 hours	FALSE	32.8	18.7	35.8	47.0	16.3	5.5	***B	29.6	37.5	*

§ Valid percentages given (i.e. excluding missing data and n/a responses in cases of treatment specific items);
† Disputed answer - see discussion.
* p<0.05; ** p<0.01; *** p<0.001; ***B p<0.00016 (Bonferroni corrected significance level to adjust for familywise Type I error).

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Figure 1 Patients' and health professionals' knowledge: examples of items where knowledge deficits are likely to have serious short-term consequences.

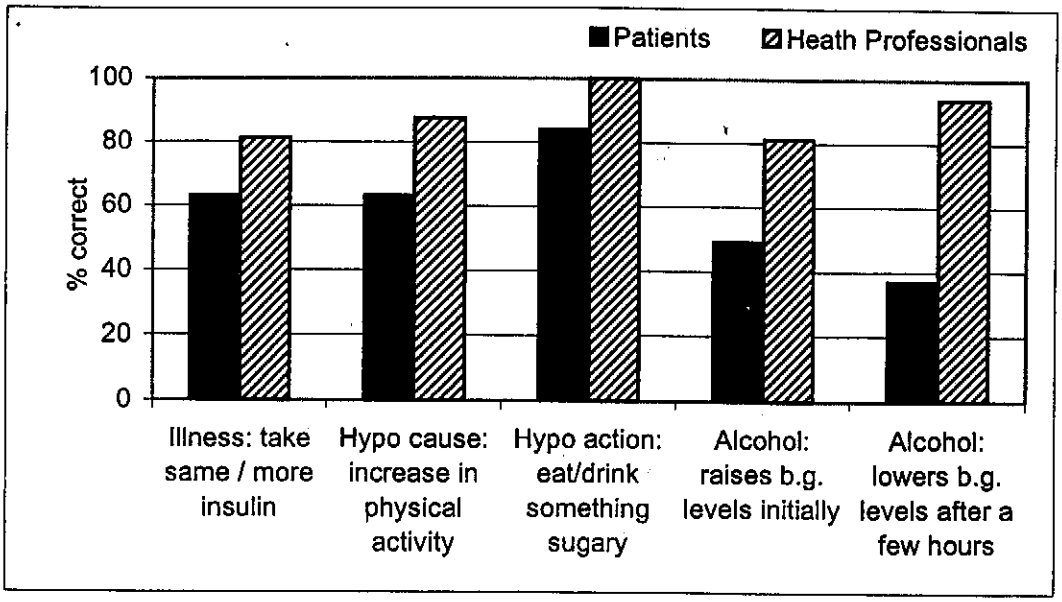

Figure 2 Patients' and health professionals' knowledge: examples of items where knowledge deficits are likely to impair long-term biomedical and/or psychological outcomes.