Intensive Education Improves Knowledge, Compliance, and Foot Problems in Type 2 Diabetes

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Despite the established role of foot care education in diabetes management, reports evaluating such interventions are rare. The effectiveness of an intensive foot care intervention programme and a conventional one were therefore compared in Type 2 diabetes. The intensive group showed significantly greater improvements than the conventional group in foot care knowledge ($p < 0.001$), compliance with the recommended foot care routine ($p = 0.012$), and compliance with the initial advice to consult a podiatrist (other than the project podiatrist) for further treatment ($p = 0.008$). At the first follow-up visit the intensive group also showed a significantly greater reduction in the number of foot problems requiring treatment than the conventional group.

KEY WORDS **Diabetes mellitus Foot care Education**

Introduction

Foot complications are one of the major health problems for people with diabetes, contributing to high morbidity, mortality, and costs of the disease.[1,2] The (age-adjusted) rate of lower-extremity amputations for people with diabetes is about 15 times greater than the rate for non-diabetic people.[3] Of all patients who experience amputations, 50–70 % have diabetes.[4] For a lot of people with diabetes amputations are multiple. Patients who had a previous amputation have a considerably greater risk of requiring a contralateral amputation in the following 3 to 4 years.[3] An additional concern is the reduced survival rate after an amputation. Only about 50 % of diabetic patients survive the first 3 years.[5]

These are very grim figures, but there are strong indications that the number of amputations can be drastically reduced through the implementation of foot care programmes. Studies investigating the effects of such programmes report amputation reduction rates between 44 % and 85 %.[6–9] In the last two decades or so there has been a strong move towards preventative and educational approaches to the treatment of diabetes, and teaching patients how to practise foot care in order to prevent foot complications and amputations has become widely recognized as an important aspect of diabetes education programmes. However, there seems to be a lack of studies investigating differences between various types of foot care education programme.

The aim of the present study was therefore to determine whether a comprehensive and intensive foot care education programme would have a greater impact on knowledge, compliance, and the number of foot problems than a conventional programme. The features of the intensive programme were: extended timespan, greater patient contact time, inclusion of practical foot care training sessions, and use of cognitive motivational techniques. It was accepted that if the intensive programme was more successful, further studies would be required to define the relative importance of the individual components of the intensive programme. This study describes the foot care results in a programme with a dual approach aimed at diet and foot care in people with Type 2 diabetes.

Patients and Methods

Patients

Eligibility for the study was restricted to Type 2 diabetic patients (on any type of treatment) who met the following criteria: age of onset > 30 years; duration of diabetes > 3 months; duration of current type of treatment > 1 month; suboptimal blood glucose control (glycosylated haemoglobin (HbA_1) ≥ 9.5 %, normal reference range 6.0–9.0 %); overweight (body mass index (BMI) ≥ 25 kg m^{-2}); total energy intake as fat ≥ 35 % (the last four criteria were necessary for the dietary component of the programme); no attendance at a diabetes education programme in the previous 6 months; competence in the English language and no major physical or mental disabilities preventing full participation in the programme.

Patients were recruited through an extensive radio and newspaper campaign, from referrals by general practitioners, and from people attending the Diabetes Centre, St Vincent's Hospital and other diabetes centres in Sydney.

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Of the 350 people interested in joining the study only 86 passed the strict entry criteria. Due to work commitments, family problems, etc. only 70 finally participated and were randomly allocated to the interventions. Three members of the conventional programme and five members of the intensive programme failed to complete programmes or follow-up visits due to work commitments, family problems or being relocated to other cities. The major demographic and diabetes-related characteristics of the 62 patients who provided the data set for the study are presented in Table 1. In these variables the two groups differed significantly only with regard to the presence of peripheral vascular disease. Significantly more participants of the intensive treatment condition had peripheral vascular disease than participants of the conventional treatment condition. This is consistent with the significantly higher baseline cholesterol level in this group. Table 2 gives a differentiated account of the foot problems presented by study participants at commencement of the interventions.

Experimental Design

The study was conducted using two experimental samples (conditions). It was not considered ethical to incorporate a control (non-intervention) group in the design since all patients selected were in need of treatment/education. Patients were randomly allocated in groups of 8–10 participants to either a conventional or intensive education programme. Both types of programme were conducted four times. The intensive groups were held parallel in time. In order to compensate for seasonal effects the conventional groups were staggered over the time span of the intensive groups.

Intervention Programmes

Conventional Programme

The conventional programme was designed to reflect current standard educational practice in Australia for people with Type 2 diabetes mellitus. It was based on information of the average duration, content, staffing, and group size of education programmes obtained from 42 diabetes centres throughout the country. The programme therefore totalled 14 h and was held on three consecutive days with 8–10 participants per group. A wide range of topics typically covered in standard programmes was included (what is diabetes, complications, diet, exercise, etc.). Although it may seem surprising that greater time was not given to foot care education, the average foot care component in Australian programmes was a 1 h lecture/discussion session. Thus in the conventional programme a 1 h session was given by a podiatrist. Main areas covered were: washing, drying, and inspecting feet; cutting toe nails; treating minor foot problems; suitable footwear; and dealing with temperature extremes.

Intensive Programme

The intensive foot care intervention evaluated in the study was spaced over four weekly sessions of 1.5 to 2.5 h duration (totalling 9 h) and took place at the end of the total programme (after the diet intervention). Three sessions were conducted by a podiatrist and one session was conducted by a psychologist. The motivational techniques used in the programme were based on a cognitive motivation theory of Heckhausen and Kuhl.[10] This theory delineates the mental processes which take place between the very beginning of a motivational tendency (the desire to achieve a particular goal) and the onset of actions directed towards achieving that goal.

Table 1. Characteristics of the patients taking part in the two foot care education programmes

	Conventional programme	Intensive programme	*p*
n	29	33	
Age (yr)	59 ± 9	58 ± 9	NS
Sex (M/F)	17/12	18/15	NS
Mother tongue (English/other)	25/4	25/8	NS
Time from diagnosis (months)	76 ± 72	104 ± 94	NS
Treatment (tablets/insulin)	23/6	25/8	NS
Glycosylated haemoglobin (%)	11.2 ± 1.8	12.0 ± 1.9	NS
Number of foot problems requiring treatment	3.6 ± 2.2	4.0 ± 1.2	NS
Peripheral vascular disease (*n*)	6	19	< 0.05

Mean ± SD, or number.
HbA_1 normal reference range 6.0–9.0 %.

Table 2. Profile of foot problems before commencement of the education programmes

	Conventional programme		Intensive programme	
	Condition present (%)	Treatment needed (%)	Condition present (%)	Treatment needed (%)
Nail status				
Curved	20.0	3.3	20.0	2.9
Involuted	6.7	3.3	14.2	8.6
Gryphotic	20.0	20.0	14.2	11.4
Thickened	53.3	23.3	40.0	20.0
Onycholysis	20.0	3.3	0	0
Paronychia	0	0	2.9	2.9
Subungual lesions	6.7	6.7	14.2	14.2
Sulci problems	36.6	36.6	62.8	62.8
Fungal infection	13.3	6.7	22.8	17.1
Stress marks/bruises of nail plate	43.3	13.3	14.2	2.9
Crumbling nail plate	16.6	13.3	5.7	2.9
Skin status				
Soft corns	10.0	10.0	0	0
Corns	20.0	20.0	14.2	14.2
Calluses	76.6	76.6	88.5	88.5
Hyperkeratosis	73.3	73.3	91.4	91.4
Xerosis diabetica	3.3	0	2.9	0
Fissures	6.7	3.3	14.2	8.6
Interdigital maceration	16.6	13.3	31.4	14.2
Fungal infection	3.3	3.3	5.7	5.7
Cuts	0	0	5.7	5.7
Abrasions	0	0	0	0
Blisters	0	0	0	0
Ulcers	3.3	3.3	0	0
Gangrene	0	0	0	0
Verruca pedis	3.3	0	0	0
Burns/scalds	0	0	0	0
Splinters	0	0	0	0
Chilblains	0	0	2.9	2.9
Biochemical problems	93.3	80.0	91.4	60.0

Two sequential processes are distinguished:

1. The pre-decisional process involves subjective estimates of goal value, goal potency-expectancy vis-a-vis achievement and goal consequences vis-a-vis achievement. There are also a number of prospective 'OTIUM' variables (Opportunity and Time for, and Importance, Urgency and Means of achievement).
2. The post-decisional process focuses on the implementation of action and involves 'OTIUM now' variables and a control check. The decision about action is made between the first and the second process.

Applying this theory, the foot care intervention focused on increasing participants' desire to engage in performing daily foot care procedures so as to avoid foot problems and thus reduce the risk of diabetic foot complications. In an attempt to achieve this, group members were given: simplified realistic medical information about foot complications; visualizations of the impact of foot complications on their lives; and a persistent 'message' that foot complications could be avoided by self care. Detailed foot care recommendations and demonstrations were given with regard to: washing, drying, and inspecting feet; cutting toe nails; distinguishing between foot problems which can be self-treated, need attention of podiatrist soon, or need attention of doctor, podiatrist or hospital emergency department urgently; treating minor foot problems themselves; suitable footwear; and dealing with temperature extremes. A central part of the intervention was to give group members the opportunity to practise most parts of the recommended foot care procedures during the sessions. Finally, participants were assisted to reach and announce a free personal decision about whether or not they wanted to commit themselves to following the recommended foot care procedures over a long period of time. For a detailed session by session account of this intervention see Barth *et al.*[11]

Measurements

This study, being a combined diet and foot care intervention with a limited follow-up period of 6 months, focused on foot problems which (a) directly contribute to infections and gangrene in diabetic patients (callus, fissures, interdigital macerations, etc.) and (b) are modifiable within a 6-month period. The podiatry variables of the study are presented in Figure 1. 'Foot care knowledge' and 'foot care routine compliance' (participants' compliance with the recommended foot care procedures) were assessed with a newly designed questionnaire using multiple choice answers. (Example of foot care knowledge question: I should wash my feet in: (a) hot water, (b) warm water, (c) cold water, (d) other, (e) don't know. Example of foot care routine compliance question: Currently I wash my feet in: (a) hot water, (b) warm water, (c) cold water, (d) others.) A documentation sheet was developed to record the results of participants' foot assessments (the number of foot problems present and the number of foot problems requiring treatment) which were performed by an independent podiatrist, who was not aware of the patients' experimental conditions. Also recorded on the documentation sheet were (1) whether or not participants were given the advice to consult a podiatrist (other than the project podiatrist) for further treatment and (2) whether or not participants who were given such advice at one assessment session had done so by the next.

Peripheral vascular disease was assessed by palpation of peripheral pulses. Presence of peripheral vascular disease was scored if one or more of the pulses (right and left dorsalis pedis and tibialis posterior) were completely absent. Reliable assessment of neuropathy was judged to be beyond the scope of this study.

Foot assessments were conducted immediately before commencement of the interventions (baseline) and 1, 3, and 6 months after completion of the programmes. Assessments were not performed immediately following completion of the interventions because changes were not expected to occur so soon. Assessments were undertaken by researchers who had not been involved in the teaching and who were unaware of patients' treatment conditions.

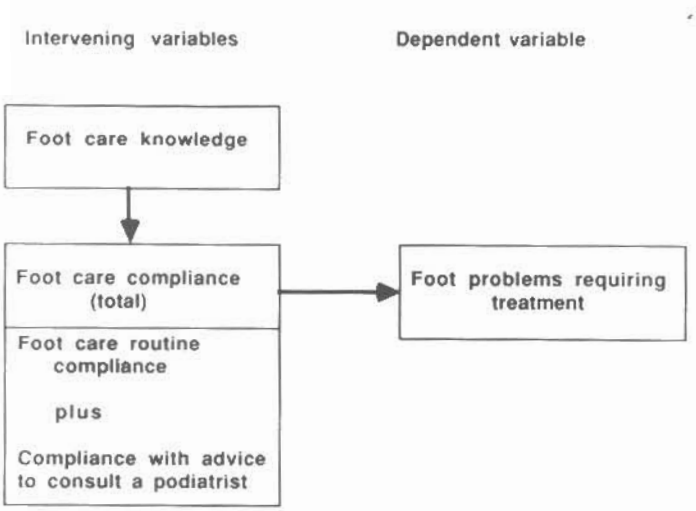

Figure 1. Podiatry variables of the study and the tested relationships among them

Statistical Procedures

Although patients were randomly allocated to the two types of programme there were some differences in biochemical variables (for example, total cholesterol levels) in the two groups at baseline. To assess the relative effectiveness of treatments, most data (including the podiatry variables) were therefore analysed using 2(group) × 3(time) analyses of covariance with repeated measures and with baseline values as covariates. This was to ensure that any baseline differences would be controlled for in the analyses. Within-group changes over time were assessed using *t*-tests. For those comparisons alpha levels were set at $p < 0.01$. In all analyses of the study involving repeated measures, multivariate tests of significance were used because in some cases the assumptions of the procedures were not met. For the data relating to foot problems distributions of the scores were skewed at the 1, 3, and 6 month follow-up assessments. However, differences from baseline satisfied the normal distribution assumption (symmetry) enabling comparisons to be made using the two sample *t*-test on these differences.

Multiple linear regressions were performed to determine whether age, sex, duration of diabetes, type of treatment, and peripheral vascular disease were potential confounding factors. Chi-square tests were employed to examine differences between groups on categorical data. Relationships between intervening and dependent variables (Figure 1) were analysed using bivariate and multiple regressions.

Results

Foot Care Knowledge

The intensive group showed a significantly greater improvement in foot care knowledge than the conventional group over the period of study (effect for group $p < 0.001$) (Figure 2). Analyses of changes within each group revealed that both groups showed significantly increased foot care knowledge at 1 month ($p < 0.001$ for both groups), a change maintained at the next two follow-up visits.

Foot Care Routine Compliance

The intensive group also demonstrated a significantly greater improvement in their foot care routine compliance than the conventional group over the period of study

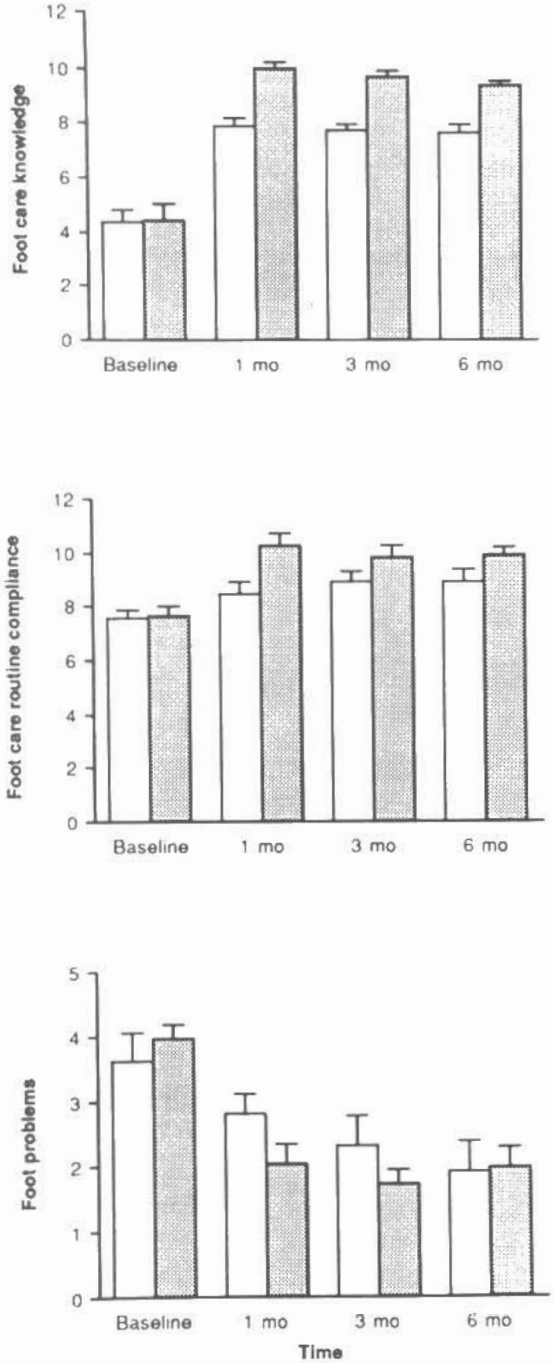

Figure 2. Foot care knowledge scores, foot care routine compliance scores, and foot problems requiring treatment of the conventional education group (□) and the intensive group (■) at baseline and at 1,3, and 6 months follow-up. Group differences were: knowledge $p < 0.001$; foot care routine compliance $p = 0.012$; foot problems requiring treatment $p = 0.006$ at 1 month. Mean ± SE

(effect for group $p = 0.012$) (Figure 2). Analyses of changes within each group showed that the intensive group had significantly improved foot care routine compliance at 1 month ($p < 0.001$) which was maintained at 3 and 6 months. Improvements in the conventional group were slower. They reached significance at 3 months and were maintained at 6 months.

Compliance with Advice to Consult a Podiatrist

Inspection of Table 3 shows that 25 members of the conventional group and 26 of the intensive group were advised at baseline to consult a podiatrist (other than the project podiatrist) for further treatment. Significantly more participants of the intensive treatment condition had complied with this advice at 1 month follow-up ($p = 0.008$). Subsequently considerably fewer participants of the intensive treatment required podiatry referral than participants of the conventional treatment (Table 3). Compliance with advice to consult a podiatrist was similar in the two groups at 3 and 6 months.

Foot Problems Requiring Treatment

Figure 2 shows that participants commenced the interventions with an average of 3.6 (conventional group) or 4.0 (intensive group) foot problems requiring treatment. At the first follow-up visit the intensive group showed a significantly greater reduction in the number of foot problems requiring treatment than the conventional group ($p < 0.006$), despite the presence of significantly greater peripheral vascular disease in the intensive group. This difference in the number of foot problems between the two groups was not maintained over the next two follow-up visits (p values for group differences at 3 and 6 months 0.062 and 0.216, respectively). Further multivariate analyses did not reveal any significant confounding effects in the demographic variables sex and age. Also, peripheral vascular disease, duration from diagnosis, and type of treatment (insulin, tablets) were not significant factors. Analyses of changes within each group showed highly significant improvements at 1 month in the intensive group ($p < 0.001$) which were maintained over the next two follow-up visits. Again, improvements in the conventional group were slower. They first reached significance at 3 months ($p = 0.005$) and were maintained at 6 months.

Relationships Between Variables

The relationships between the variables (Figure 1) were tested using difference scores of the entire sample between baseline values and values at 1 month (Δ = 1 month – baseline). There was a significant positive relationship between change in foot care knowledge scores and foot care compliance scores (total) ($r = 0.38$, $p = 0.003$). Thus an increase in foot care knowledge was associated with an increase in foot care compliance (total). The regression equation calculated was:

$$\Delta \text{ foot care compliance scores (total)} = 0.18 + 0.38\ (\Delta \text{ foot care knowledge scores}).$$

Table 3. Compliance with advice to consult a podiatrist in patients given conventional or intensive foot care education

Time	Programme	Advice to consult podiatrist (*n*)	Compliance (*n*)	Non-compliance (*n*)	*p*
Baseline to month 1	Conventional	25	7	18	0.008
	Intensive	26	17	9	
Month 1 to month 3	Conventional	22	6	16	0.116
	Intensive	13	7	6	
Month 3 to month 6	Conventional	19	8	11	0.653
	Intensive	14	7	7	

Results of chi-square tests.
Compliance is represented by the number of patients who had been advised to consult a podiatrist at one assessment session and had done so by the next.

The regression equation explained 14 % of the variation in change in foot care compliance scores (total).

Change in foot care compliance scores (total) was found to be a significant predictor of change in the number of foot problems requiring treatment ($r = 0.40$, $p = 0.002$). Increased foot care compliance scores (total) were associated with a decreased number of foot problems requiring treatment. The regression equation calculated was:

Δ number of foot problems requiring treatment = 31.73–0.26 (Δ foot care compliance scores (total)).

The regression equation explained 16 % of the variation in change in the number of foot problems requiring treatment.

Discussion

Foot complications and lower-extremity amputations are a major concern for people with diabetes, especially for people with Type 2 diabetes.[1,2] A number of studies have reported marked reductions in amputation rates following the implementation of foot care interventions.[6–9] However, there is a lack of studies which are concerned with investigating differences between various types of foot care education programmes in terms of improving knowledge, compliance, and outcomes. We therefore designed a very extensive foot care education programme using cognitive motivational techniques (intensive programme) and evaluated it against a conventional programme which was representative of current practice in Australia. In order to be representative the conventional programme consisted of a 1 h lecture session only. The intensive programme totalled 9 h and occurred once a week over 4 weeks.

The intensive group showed significantly greater improvements than the conventional group in foot care knowledge, compliance with the recommended foot care routine, and initial compliance with the advice to consult a podiatrist (other than the project podiatrist) for further treatment. At the 1-month follow-up visit the intensive group also demonstrated a significantly greater reduction in the number of foot problems requiring treatment than the conventional group. It is important to note that this occurred despite the presence of significantly more participants with peripheral vascular disease in this group. However, these significant group differences in foot problems at 1 month were not present at 3 and 6 months, although the initial improvement in the intensive group was maintained over this period of study. Lack of group differences at these later follow-up visits were thus primarily related to an unusual pattern in the conventional group. Significant improvement in this group did not occur (as expected and as found in the intensive group) at 1 month but rather at 3 months with a further (non-significant) improvement at 6 months. This might suggest that this late improvement was not entirely related to the intervention. It is possible that it was influenced by the thorough follow-up procedures of the study, consisting of extensive foot assessments by a podiatrist who, when necessary, recommended attendance at an independent podiatrist.

Innovative approaches to health care must also be examined in terms of the manpower required. The implementation of the intensive programmme is more expensive than the implementation of a conventional approach. It involves 8 additional man-hours per group or about 1 h per person for a group of 8–10 participants. This study has shown that these time and financial investments resulted in greater improvements in knowledge, compliance, and foot problems. Due to the follow-up period of 6 months it was not possible to investigate whether the intensive group's significantly greater improvements in intermediate variables such as knowledge, compliance, and foot problems are followed by a significantly greater reduction in the eventual number of

amputations. It is recognized that the two programmes differed in a number of ways (time span, total hours, teaching methods, motivational techniques). This study cannot therefore provide an answer as to what elements of the intensive programme were responsible for its greater success. Further studies will have to determine which of the substrategies used in the intensive intervention were essential for the outcome.

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