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**THE BENEFITS OF POSTGRADUATE THERAPEUTIC
EDUCATION IN DIABETOLOGY IN THE CZECH REPUBLIC**

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Abstract

Effective diabetes education is a keystone for diabetes treatment. At the University Hospital Olomouc, postgraduate courses for diabetes therapeutic educators are based on the recommendations of the Diabetes Education Study Group of the EASD. The research question for this study was “What is the efficacy of postgraduate courses over the course of five independent years 2010-2014?” The purpose of this prospective study was (1) to determine the level of the graduates’ knowledge and skills at the end of the courses, (2) to assess their retention of knowledge after 3 months and (3) to verify the reliability of the knowledge tests applied. The research method was a longitudinal study based on a pre and post-test undertaken by the study participants between 2010 and 2014. During this time, five courses were taken by 88 healthcare professionals aged 21 through 69 from different departments. Each course consisted of 80 lessons facilitated by 24 specialists, undertaken within 4 months in 8 modules which was assessed with a knowledge test and also a practical test. The knowledge test was repeated after 3 months. The participants achieved 92.5% to 98.8% of the maximum knowledge points, while attaining 95% of the required practical skills. Three months later, the post-test showed that the level of knowledge had fallen to 88.8% - 93.8% ($p < .0001$). The tests’ reliability (Cronbach’s Alpha) at the end of the courses was .727, while 3 months later, it increased to .999. It can be concluded that the chosen methods and forms of education (verbal, demonstrative, practical, etc.) are highly effective in terms of diabetes therapeutic educators’ training.

However, after 3 months, the study showed that the level of knowledge dropped by around 5%.

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Keywords: Diabetes, therapeutic educators, course, knowledge test.



1. Introduction

A number of studies have confirmed that therapeutic education for people with diabetes mellitus (DM) involving self-monitoring and changes to their regimen improve the knowledge and skills, diabetes self-management and the clinical parameters of diabetes, leading to better cooperation with healthcare professionals, and reduce healthcare costs (ADA, 2015; Duncan *et al.* 2011; Funnell *et al.* 2012; Jirkovská, & Kvapil, 2012; Dunning (Ed.) 2013).

1.1. Specialized courses in Postgraduate Education of Therapeutic Educators

Specialized courses in Postgraduate Education of Therapeutic Educators (PETE) have been held at the Faculty of Medicine and Dentistry of Palacky University in Olomouc and Teaching Hospital Olomouc since 2000 (Chlup, Ed. 2009; Chlup *et al.* 2003). They provide future educators with the knowledge and skills focused on adequate treatment and education for people with diabetes, including diabetic complications. The first experience was presented at the IDF/EASD congress in Paris in 2003 (Chlup *et al.* 2003). The courses are based on the experience of the Diabetes Education Study Group (DESG) of the European Association for the Study of Diabetes (EASD). In 2007, this educational program was accredited by the Czech Department of Health for three medical professions (nurses, midwives and doctors).

One cycle of PETE in diabetology consists of 8 workshops/modules held over the course of 8 days (3 weekends and 2 weekdays). A total of eighty 45-minute interactive lectures, including demonstrations and practical exercises, are provided by 24 specialists from the respective departments of the Teaching Hospital.

1.1.1. Program of individual modules

The modules (one-day workshops) cover the recent aspects of practical diabetology including some historical data on diabetes mellitus; definition, classification, pathogenesis and etiology; diagnosis; and therapy of type 1 and 2 diabetes; acute and late complications; care for diabetic patients in the context of surgery, pregnancy; modern principles of nursing care; self-management (training in how to use blood personal glucometers, CGMS, insulin dispensers and pumps, diabetes and physical activity, nutrition, the glycemic index of foods, etc.); education in self-management of diabetes.

At the start of the course, the participants receive materials to study (Chlup, Ed. 2009). In the individual modules, the doctors, nurses and midwives primarily gain comprehensive understanding of diabetes, learn to listen to patients and communicate with them, and also educate them in self-management of diabetes.

1.1.2. Obtaining the certificate

The course participants are continuously tested at the beginning and end of each module. The final examination at the end of the course consists of a written knowledge test of the authors' design, as well as a practical examination.

In order to receive the certificate, the course participants must have 90% participation in the lectures, pass all the final tests in the course of the program, and also achieve a success rate of 75% or

higher on the final written test (i.e. 60 out of 80 possible points); they must also meet the practical examination criteria with a score of at least 75% in five skills (i.e. 15 out of 20 possible points). In the practical part, the participants are supposed to perform the following 5 tasks on their own: 1. to use a selected insulin dispenser/pump and adjust prandial insulin doses; 2. to perform self-monitoring using a selected glucometer, including taking a sample of capillary blood; 3. to explain the principles of a liberalized diet and prepare a diet for 1 day; 4. to deal with hypoglycemia (mild, moderate, severe) using suitable foods or injecting glucagon; 5. to demonstrate care and training related to the treatment of diabetic foot, including indicative neurological examination of the foot using a graduated tuner and monofilaments.

This certificate confirms the graduates' professional competence to perform the following educational and practical activities:

- To train people with diabetes, their families and/or loved ones to use insulin dispensers, to measure glycemia using a blood glucometer, and the basic principles of using an insulin pump;
- To prepare a simple diet focused on the distribution of carbohydrates,
- To adjust prandial insulin doses,
- To deal with acute hypoglycemia and hyperglycemia;
- To prepare aids to care for diabetic foot and nursing care training for people with diabetes and their families and/or friends;
- To perform indicative neurological examinations of the lower limbs using a graduated tuner and monofilaments.

This special professional competence enables the participants to perform a defined set of professional activities within an interdisciplinary team.

2. Problem Statement

This work is aimed at assessing the effectiveness of postgraduate courses for educators in diabetology during five separate years from 2010-2014. For this purpose, we used a quasi-standardized pre and post-test to determine the graduates' level of knowledge at the end of the courses and evaluated how well they had retained this knowledge after a period of three months. The reliability of the knowledge tests was assessed independently. The advantages of our single-center study include the fact that throughout the course the material was taught by a stable team of 24 medical and educational experts – specialists in different fields of medicine. An almost identical study plan and learning materials were used, the teaching and testing methods were the same, and the tests were to a high standard. In contrast, the disadvantages of the study included the heterogeneity of the graduates in the individual years.

3. Research Questions

- 3.1 What is the effectiveness of PETE over the course of five independent years 2010-2014?
- 3.2 Does PETE improve the knowledge and skills of graduates?

4. Purpose of the Study

The aims of this study were: (1) to determine the level of knowledge and skills of graduates at the end of the courses, (2) to assess their retention of knowledge after a period of 3 months, and (3) to verify the reliability of the knowledge tests.

5. Research Methods

5.1. Characteristics of course participants

This prospective study evaluated a total of 88 graduates of the accredited course named “*Basics of Modern Diabetes Diagnosis and Treatment*” (Table 01) over the period of five years (2010-2014). Out of three men, two were physicians and one worked as head nurse in home care. Of 8 physicians (2 men and 6 women), 6 worked as general practitioners, and 2 as internists. The nurses mostly worked in home care, at general practitioners’ surgeries and at diabetic surgeries, while some worked at various hospital wards and in aftercare wards. The midwives worked at gynecological and obstetrics wards.

Table 01. Basic characteristics of the course participants (number, sex, age, profession)

Year	N	Men	Women	Nurses	Midwives	Doctors	Age [years] \bar{x} (min-max)
2010	24	1	23	23	0	1	36.1 (21-69)
2011	23	0	23	16	1	6	40.2 (25-60)
2012	15	1	14	12	2	1	34.9 (23-50)
2013	17	1	16	15	2	0	38.0 (26-60)
2014	9	0	9	9	0	0	36.2 (26-46)
Total	88	3	85	75	5	8	37.1 (21-69)

n – number of members in the respective group; \bar{X} - arithmetic mean; (minimum-maximum)

5.2. Arrangement of the study

Each year of the course ended with a *quasi-standardized objectively scorable didactic knowledge test* designed by the authors, together with a practical examination. The text focused on determining the knowledge of the diabetology subject taught within the course. The knowledge test was repeated 3 months after the completion of the course (at the occasion of the certificates being awarded) without the graduates being informed beforehand.

The final test contained 40 questions/open tasks that the candidate had to answer on their own in writing within 30 minutes. The questions/open tasks were prepared by the teachers in accordance with the course curriculum and are updated every year in line with new findings in the field (Table 02). The content validity of the test was verified (how well the content of the test matches the objectives and the content of the curriculum) in collaboration with experts and related disciplines (a psychologist, educator, and statistician). All the participants of the course took the test under the same conditions. They completed the test under the supervision of the course guarantor.

Table 02. Example of questions/open tasks from the final test. A total of 40 questions

	Question/open task	Answer	Assessment
1.	What does the glycosylated hemoglobin (HbA1c) value tell us?		
2.	How to differentiate between hypoglycemia and intoxication?		
3.	State 3 alternative places from which to take a blood sample during self-monitoring:		
4.	State at least 5 clinical and/or laboratory indicators used to assess the efficacy of diabetes treatment:		
5.	State at least 2 essential things a person with type 1 diabetes must always carry on them:		
6.	Explain the term replaceable unit. What is it used for in diabetology?		
7.	Which nutrient is <u>most</u> limited in a restricted diet?		
8.	Name at least 3 factors that lead to diabetic foot syndrome:		

This research was approved by the managers of the relevant workplaces. The answers were classified in the following manner: 0 (incorrect), 1 (acceptable), 2 (exact). Thus, the maximum possible number of points in the final written test was 80. This maximum number of points was considered as equivalent to a knowledge level of 100%. Evaluation criteria were prepared for the tasks, as well as for the practical skills (Chlup *et al.* 2003). The results of the tests were evaluated for each year separately, and also for all the years combined. The reliability of the knowledge test (i.e. the extent to which the results are repeatable) was verified using Cronbach's Alpha and the split-half method. The statistics were processed using the IBM SPSS Statistics version 22 (U.S.A.). The forty questions in the final written test were divided into 5 areas:

- 1) Insulin therapy and oral antidiabetic drugs (8 questions);
- 2) Classification, diagnosis and monitoring of treatment efficacy (7 questions);
- 3) Education and social nursing issues (10 questions);
- 4) Complications (7 questions);
- 5) Other treatment (8 questions).

6. Findings

The principal characteristics of the didactic test are validity, reliability, practicality, difficulty, sensitivity (Průcha *et al.* 2003). The didactic test is only accurate if it does not result in major measurement errors.

The results of the final written test and the repetition of the test after three months in the individual years are shown in Table 03. The Kruskal-Wallis test showed a significant difference between the individual years in the final test. A significantly higher test score was observed in 2014 in comparison to 2011 ($p = .014$) and in comparison to 2012 ($p = .016$). The differences are not significant 3 months after the completion of the course.

Table 03. Point score* of the knowledge test at the end of the course and 3 months after its completion in the individual years 2010 – 2014

Years		End of course	After 3 months	Difference
2010	Average	74.0	69.0	-5.0
	SD	5.5	7.1	5.6
	Median	76	71	-5
2011	Average	75.3	69.6	-5.7
	SD	2.3	5.5	5.7
	Median	76	72	-5
2012	Average	74.2	70.7	-3.9
	SD	2.9	3.0	3.6
	Median	74	71	-4
2013	Average	75.4	71.7	-3.8
	SD	5.0	4.5	3.6
	Median	78	72	-4
2014	Average	78.3	73.3	-5.0
	SD	2.3	3.1	3.0
	Median	79	75	-4
Kruskal-Wallis test p		.009	.200	.796

* The maximum number of points is 80

Table 04 summarizes the results of the reliability test of the knowledge test using Cronbach's Alpha and the split-half method.

Table 04. Reliability of the knowledge test (Cronbach's Alpha and the split-half method)

Question group	Cronbach's Alpha		Spearman-Brown coefficient		Guttman Split-Half coefficient	
	End of course	After 3 months	End of course	After 3 months	End of course	After 3 months
Entire test (40 questions)	.727	.999	.748	.997	.743	.995
Insulin therapy and OAD* (8 questions)	.400	.995	.360	.999	.358	.999
Classification, diagnosis and monitoring of treatment efficacy (7 questions)	.241	.993	.315	.998	.295	.974
Education and social nursing issues (10 questions)	.408	.990	.463	.994	.463	.963
Complications (7 questions)	.362	.993	.341	.996	.152	.988
Other treatment (8 questions)	.344	.996	.463	.999	.461	.984

* OAD – oral antidiabetic drug

6.1. Discussion

To date, there are no universal standardized tests used in diabetes education for nurses and physicians in the Czech Republic. There is no national database providing an up-to-date status of the situation in this area. So far, only local studies have been carried out (Kudlová *et al.* 2009, Kudlová & Chlup 2010).

6.1.1. Diabetes knowledge of nurses in different countries

Several studies have been carried out in other countries aimed at ascertaining nurses' knowledge of diabetes and its complications (Scheiderich *et al.* 1983, Drass *et al.* 1989, Burden & Burden 1993, Livingston & Dunning 2010, Yacoub *et al.* 2014, Alotaibi *et al.* 2017). These studies were always carried out on selected groups and sometimes with only few respondents (137 nurses in the study by Scheiderich *et al.* 1983; 184 nurses in the study by Drass *et al.* 1989; 21 nurses in the study by Livingston & Dunning 2010, 277 registered nurses in the study Yacoub *et al.* 2014, 423 nurses in study Alotaibi *et al.* 2017 etc.). The nurses' confidence and competence in providing care in diabetology can be affected by a lack of knowledge. Alotaibi *et al.* (2016) conducted systematic research in English in library databases from 2004 until 2014. The aim of this study was to identify, critically appraise and synthesize evidence of nurses' knowledge of diabetes and identify factors that function as barriers to nurses' acquisition of diabetes knowledge. 25 studies were included in the review and synthesized based on the studies' characteristics, design and findings. Factors/barriers affecting nurses' acquisition of diabetes knowledge were identified. Overall, findings indicated wide-spread serious and sustained deficiencies in nurses' knowledge of diabetes and diabetes care.

Further opportunities for professional development generally led to increased knowledge of care for diabetics and diabetes management after the completion of the program (Graham *et al.* 1998, Peters *et al.* 2003).

One relevant study including the provision of a training program for nurses and doctors in Great Britain found that the nurses' knowledge improved from 66% prior to their taking part in the training program to 86% after its completion (Hearnshaw *et al.* 2001).

6.1.2. Standardized tool for measuring nursing knowledge of diabetes

Scheiderich, Freibaum, and Peterson (1983) were some of the first nursing researchers to create a standardized tool for measuring nursing knowledge of diabetes – the Diabetes Knowledge Test (DKT). The DKT was later revised by Drass, Muir-Nash, Boykin, Turek, and Baker in 1989. The standardized DKT, was used in Slovakia by Majerníková to determine the knowledge of persons with type 2 diabetes treated with insulin in studies performed in 2009-2010 on a set of 311 patients (Majerníková 2011).

However, the most well-known tools used to gauge nurses' knowledge of diabetes are the Diabetes Basic Knowledge Test - DBKT and Diabetes Self-Report Test – DSRT (Drass *et al.* 1989). The DBKT reflected standard care in the treatment of diabetes in 1989. Its reliability coefficient was .79.

The Diabetes Self-Report Test (DSRT) was developed in order to determine how nurses perceive their own knowledge of diabetes. In the past 25 years, several authors have modified the DBKT and DSRT in order to reflect changes in practice and have used these tools with practicing nurses in an acute

care environment (Adams & Cook 1994; Eaton-Spiva & Day 2011; Gossain *et al.* 1993; Jayne & Rankin 1993). A good didactic test should always contain an adequate number of tasks (approximately at least 10 in most cases).

Our final test contains 40 test questions. In addition to validity and reliability of the test, we also took into account the *practicality* of its assessment, and the practical advantages of using it. A good test should be easy to use and the results should be quick and easy to check.

6.1.3. Quasi-standardized didactic knowledge (cognitive) test

In our quasi-standardized didactic knowledge (cognitive) test, we opted for open test tasks, which are easy to grade. We prepared evaluation criteria for each task. The time limit for the completion of the final test was 30 minutes, and the test was taken under strict supervision.

This test enabled us to determine the level of knowledge of the course participants in several areas of diabetology. *Open tasks with a brief answer* were used exclusively. This type of task requires the participants to *state their own short answers*, which was most suitable for the purposes of our course, for example, stating numbers, signs, symbols, equations, certain words or several words or sentences. We opted for production types of questions (How to differentiate between hypoglycemia and intoxication?), as well as supplemental types (State 3 alternative places from which to take a blood sample when performing self-monitoring). The participants did not select their answers, but had to actively demonstrate their own cognitive knowledge.

A study published in the Journal of Nursing Measurement reviewed 7 published tools aimed at determining psychometric knowledge (Francisco, 2013). It was found that the most frequently used tools, the Diabetes Basic Knowledge Test – DBKT and Diabetes Self-Report Test – DSRT (Adams & Cook 1994; Drass *et al.* 1989; Gossain *et al.* 1993; Jayne & Rankin 1993), as well as another five constructed tools focused on the knowledge, skills and reliability of specific healthcare providers providing care to patients with diabetes in various environments, lack good measurement validity and reliability, despite the fact that they have been modified in the past 25 years by many authors in response to changes in practice. These additional 5 tools were: 1) Tool testing the level of knowledge of registered nurses working in long-term care facilities (Leggett-Frazier *et al.* 1994); 2) the Diabetes Knowledge Questionnaire – DKQ, tested pediatric nurses' and nursing students' knowledge of diabetes (Lipman, & Mahon 1999); 3) the Questionnaire for testing nurses' knowledge of diabetes, as well as that of trainees in surgery, internal medicine and family practice (Rubin *et al.* 2007); 4) the Diabetes Survival Skills Knowledge Test – DSSKT, is a 20-question true-false test for cardiology nurses (Modic *et al.* 2009); and 5) the Confidence in Teaching Diabetes Education Scale, which measures nurses' perceived level of trust in teaching diabetes through self-management education (Eaton-Spiva, & Day, 2011).

Although most of these studies were not carried out under the correct test conditions (completion of the test under supervision), the researchers came to the conclusion that nurses do not possess the basic knowledge set or resources to enable them to adequately educate patients with diabetes. This finding showed that the current range of tools used to measure nurses' knowledge of diabetes comprises outdated tools whose reliability and validity are marginal. In order to test the basic knowledge of nurses caring for

patients with diabetes, these tools need to be revised or a new tool developed based on contemporary proof-based practice (Francisco 2013). Thus we felt justified in using a test we had designed ourselves.

6.1.4. Reliability test

Cronbach's Alpha of a particular test should be neither too low nor too high. If a test is inconsistent, the results will be interpreted incorrectly. At the end of the course, the average Cronbach's Alpha was .727. When the final test was repeated three or four months, the Cronbach's Alpha even increased to .999, indicating a high degree of consistency.

The definition of reliability involves an important feature, in that it is dependent on the homogeneity of the test subjects. If we are to test a group with similar levels of knowledge, the estimated reliability will be lower than if we were to test a less homogenous group – e.g. a group from a variety of subgroups. Significantly higher test scores were found in 2014 in comparison to 2011 ($p = .014$) and in comparison to 2012 ($p = .016$). In 2014, the course was taken by a smaller group (9 people), with all the participants being nurses by profession. However, nothing can be derived from this observation in practical terms.

7. Conclusion

The effectiveness of the PETE courses in the course of five independent years 2010-2014 was high. During the final testing the students achieved 77 out of 80 points on average (i.e. 96% of the maximum level of knowledge). They achieved the fewest points in 2012 (74 points, i.e. 92.5%), and the most in 2014 (79 points, i.e. 98.8%). In 2014 the lowest participation was recorded (only 9 persons). We can only guess that this variable had a significant impact on the positive outcome of the final testing.

It would be interesting to look further into the connection between the number of students and the quality of the results.

Within three months after the end of the course the level of knowledge had dropped by five points on average (i.e. 5%). Forgetting is a form of protection against being flooded with information. People best remember information that they consider as important, understand it, and are able to imagine it. Testing after three months proved that information within the course had been conveyed in a quality way by lecturers, using methods and teaching techniques, including continuous testing (another partial output being prepared based on this longitudinal study), and well processed by the participants themselves.

The reliability of the knowledge test used for the final testing of the PETE participants was very good, which is proof of its very good consistency. The tests used were very well and carefully prepared.

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Conflict of interest

There is no conflict of interest that the authors are aware of.

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