Can primary care physicians recognize type 1 diabetes in children on time?

Czy lekarze podstawowej opieki zdrowotnej potrafią na czas rozpoznać cukrzycę typ 1 u dzieci?

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Abstract

Introduction: Although the diagnostic criteria for diabetes in children and adolescents should be widely known to all healthcare professionals, many cases of type 1 diabetes (DM1) are still not recognized in time.

The aim of this study was to compare the experiences with the diagnosis of DM1 of young doctors during training and specialists working as primary health care physicians in Poland.

Material and methods: 50 specialists in paediatrics or family medicine (average professional experience of 14.6 years) and 50 doctors, and those without specialization (up to 4 years after graduating from medical studies, average professional experience of 1.4 years) participated in the survey. The questionnaires were conducted from November 2019 to November 2020.

Results: Most of the study participants correctly answered the questions about the diagnostic criteria of diabetes and its management at the moment of diagnosis, except for the question regarding diagnostic criteria for diabetes in oral glucose tolerance test. The correct answers varied from 96% to 72% among medical specialists and physicians during the training, respectively. What is interesting is the relatively small number of diagnosed cases of DM1 during the entire professional career of specialists (0-12 cases), compared to the doctors without specialization (0-5 cases). Medical specialists declared more frequently the use of a glucometer in their daily practice (mean 6 vs. 1, $p < 0.05$), but after taking into account the years of experience, the difference was insignificant.

Conclusions: It is important to educate primary care physicians, despite their professional experience. Practical education of physicians is also necessary.

Key words:

education, diabetes mellitus type 1, primary care physician, pediatrician.

Introduction

Type 1 diabetes (DM1) is a chronic metabolic disorder caused by insufficient insulin secretion due to pancreatic β-cells' destruction, which is mainly due to the autoimmune process. It is the most common form of diabetes in children and adolescents worldwide. Nevertheless, evidence shows that trends in its incidence vary between different countries, within countries, and between different ethnic populations, with the highest incidence rates observed in Finland and Sardinia (40.2 and 38.8 per 100,000, respectively), and the lowest in Japan (approximately 2 per 100,000) [1]. The higher incidence in European Caucasians is associated with unique HLA susceptibility genes [1]. It is somehow more difficult to explain the systematic increase in the incidence rate of DM1 in children from Central and Eastern Europe observed in recent decades. The EURODIAB study revealed that the incidence of DM1 is increasing by 0.6–15% per year, totalling approximately 96,000 new cases in children under 15 years old annually [1, 2]. Although diagnostic criteria for diabetes in children and adolescents based on plasma blood glucose levels and the presence or absence of symptoms should be widely known to all health professionals, there are still many cases of DM1 not being diagnosed on time [1, 3, 4]. Delayed diagnosis is the most important risk factor for the development of diabetic ketoacidosis (DKA), which is the most severe, life-threatening, first manifestation of DM1 [4]. The prevalence of DKA as the first manifestation of DM1 varies between countries from 15% to 70% in Europe and North America [4, 5]. The EURODIAB study conducted between 1989 and 1994 revealed a DKA incidence of 33% among patients with newly diagnosed DM1 in Europe [2]. Our previous study indicated that DKA was diagnosed in 22.4% of patients admitted to hospital between 2006 and 2011 [6]. That information is particularly worrying because DKA and its complications are the

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most frequent cause of death in the diabetic paediatric population, responsible for at least 50% of deaths [6–8]. Many authors have in the past attempted to identify the major risk factors for delayed diagnosis of DM1. Some of them identified, among other factors, the lesser amount of experience and inferior professional qualifications of healthcare professionals [9, 10]. For this reason, we decided to compare our own experiences of the diagnosis of DM1 by doctors at the beginning of their careers with those who have been practicing as family doctors and paediatricians for many years. The purpose of the study was to answer the question of whether general practitioners know the criteria for diagnosing diabetes in children.

Material and methods

The voluntary survey was completed by 50 doctors, specialists in paediatrics or family medicine, and 50 doctors without specialization, up to 4 years after completing their medical studies. All were living and working in Poland and were questioned by way of face-to-face or e-mail interviews during November 2019 and November 2020.

The survey list consisted of 3 parts. The first part concerned years of experience as a physician, specialization, years of experience in family medicine and the actual place of work. The second part included questions about their own experience with newly diagnosed diabetes: How many times did you diagnose DM1? How often do you use a glucometer in your practice? The third part checked the knowledge of the diagnostic criteria for diabetes: What is the fasting plasma glucose concentration for the diagnosis of DM1? What is the value of random plasma glucose concentration for the diagnosis of DM1? What is the value of two-hour post-load glucose concentration during OGTT for the diagnosis of DM1? Is the OGTT obligatory to diagnose DM1? What kind of fluid is used in rehydration with newly diagnosed DM1? and What are the typical early diabetes symptoms?

Statistical analysis

Data were analysed using Statistica 13.0 PL for Windows. The mean and standard deviations (SD) were calculated for continuous variables. The categorical data sets were analysed using Pearson's χ^2 test. A P-value of less than 0.05 was considered to be statistically significant.

Results

The mean professional experience of a family doctor (primary care paediatrician) among specialists was 14.6 years (SD 11.8), and 1.6 years (SD 1.4) among doctors without specialization. During that time, medical specialists diagnosed 76 new cases of DM1 – each one from 0 to 12. The highest result was obtained by a medical specialist who worked also as an emergency care unit physician. Doctors without specialization diagnosed 13 new cases of DM1 – each from 0 to 5 new DM1 cases. Medical specialists more frequently confirmed using a glucometer in their daily practice (mean 6 vs. 1, $p < 0.05$), but

after taking into account the years of work, the difference was insignificant. Most of the study participants from both groups correctly answered questions about the diagnostic criteria of diabetes and the latter's management in the event of its diagnosis (Table I). The most problematic question seems to be the one regarding diagnostic criteria for diabetes in oral glucose tolerance test. The correct answers varied from 96% to 72% among medical specialists and physicians during the training, respectively (Table I).

Discussion

According to worldwide data, being a younger child or an ethnic minority, lower socioeconomic status, a lack of health insurance, lower BMI, a previous infection, living in equatorial areas, and in a country with a low prevalence of type 1 diabetes mellitus are risk factors for delayed diagnosis and development of DKA. On the other hand, higher parental educational status and a positive diabetes family history seem to be protective factors [5]. The occurrence of DKA varies between countries. According to the EURODIAB study, DKA presentation at the time of DM1 diagnosis negatively correlates with the DM1 incidence rate [12]. The latter may confirm that the higher the diabetes incidence, the more aware healthcare professionals are of the initial symptoms present. According to a paper by Muñoz *et al*., patients with a missed diagnosis of DM1 are at a 17.6% increased risk for DKA compared to those who are correctly diagnosed at onset [13]. In the past, researchers in several countries have tried to establish if better medical education would reduce the risk of DKA. One of the most extensive intervention studies was the Parma campaign performed by Vanelli *et al*. The project was based on a general, public information campaign. The aim of the study was to check whether education about the symptoms of diabetes among doctors, teachers, and parents may have an influence on earlier diagnosis of DM1 and therefore avoiding DKA and its consequences [14, 15]. The Parma campaign obtained a reduction in DKA incidence at diabetes diagnosis unfound before, from 78% to 12.5%, while in neighbouring provinces it remained unchanged [14, 15]. Similar studies were launched in Europe and Australia, but without such spectacular effect [16–18]. Nevertheless, the authors of all the relevant studies agree that healthcare professionals, especially family doctors and primary care paediatricians, are the most important targets for education [19, 20]. According to our survey data, most Polish medical specialists and young physicians during training have some general knowledge about DM1, its symptoms, and diagnosis. However, to our dismay, this is rather theoretical knowledge. Analysing the prevalence of type 1 diabetes among Polish children, and the amount of general advice provided by general practitioners, the low number of newly diagnosed patients with DM1 is worrying. Even more astonishing is the very rare use of such an accessible tool as the glucometer. The results obtained must be interpreted within the context of the study design. Eligible participants were all members of a single healthcare system, potentially limiting the generalizability of the findings to other populations. Neverthe-

Why is type 1 diabetes not diagnosed on time?
Dlaczego cukrzyca typu 1 nie jest rozpoznawana na czas?

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Table I. Comparison of correct answers [%] given by specialists and non-specialized physicians to questions concerning the diagnosis of type 1 diabetes in children

Question		% of correct answers	
What is fasting plasma glucose concentration for the diagnosis of DM1?	Specialists	88%	χ^2 0.1 $p = 0.75$
	Physicians without specialization	90%	
What is the value of random plasma glucose concentration for the diagnosis of DM1?	Specialists	88%	χ^2 6.38 $p = 0.001*$
	Physicians without specialization	100%	
What is the value of 2-hour post-load glucose concentration during OGTT for the diagnosis of diabetes?	Specialists	96%	χ^2 10.7 $p = 0.001*$
	Physicians without specialization	72%	
What kind of fluid is a first choice in rehydration with newly diagnosed DM1?	Specialists	94%	χ^2 0.21 $p = 0.6$
	Physicians without specialization	96%	
Is the OGTT obligatory to diagnose DM1?	Specialists	96%	χ^2 0.34 $p = 0.55$
	Physicians without specialization	98%	
What are typical early symptoms of DM1?	Specialists	100%	χ^2 0.0 $p = 1.0$
	Physicians without specialization	100%	

less, similar observations were published recently for the US population of adult patients with type 2 diabetes, also indicating insufficient engagement of doctors despite having the appropriate tools [21]. Patients may be misdiagnosed or overlooked at disease onset because the initial symptoms of type 1 diabetes may be nonspecific [22]. As stated previously, many children with newly diagnosed DM1 had seen a paediatrician or family doctor within the previous 4 weeks [23]. That proves that hyperglycaemia is initially missed in some patients. The most common alternate diagnoses in children and adolescents are infectious diseases, common in these age groups [13]. Many symptoms of viral illnesses are nonspecific and may overlap with DM1. As was shown in the past, awareness campaigns focusing on symptoms more specific to DM1 should be performed. However, as our research shows, knowledge alone is not sufficient. Practical education of physicians is also neces-

sary. In the Polish healthcare system, the primary care physician is responsible for conducting the interview and examining the patient. Procedures such as measuring blood glucose with a glucometer are performed by a nurse, while some doctors are not even able to operate such equipment. This can raise an objective difficulty in some situations. It also seems that, as in the case of the Parma campaign, closer cooperation between primary care physicians and diabetes departments, and greater availability of consultations would be beneficial [14,15].

Conclusions

It is important to increase awareness and promote early diagnosis for DM1 in primary care physicians, despite their professional experience and qualifications. Even more attention should be paid to the practical aspects of education.

References

1. Mayer-Davis EJ, Kahkoska AR, Jefferies C, et al. ISPAD Clinical Practice Consensus Guidelines 2018: Definition, epidemiology, and classification of diabetes in children and adolescents. Pediatric Diabetes 2018; 19 (Suppl. 27): 7–19.
2. Patterson C, Dahlquist G, Gyürüs E, et al. EURODIAB Study Group: Incidence trends for childhood type 1 diabetes in Europe during 1989 2003 and predicted new cases 2005-20: A multicentre prospective registration study. Lancet 2009 13; 373: 2027–2033. doi: 10.1016/S0140-6736(09)60568-7.
3. Araszkiewicz A, Bandurska-Stankiewicz E, Budzyński A, et al. 2020 Guidelines on the management of diabetic patients. A position of Diabetes Poland. Clin Diabetol 2020; 9: 1–101.
4. Wolfsdorf JI, Glaser N, Agus M et al. Diabetic ketoacidosis and the hyperglycemic hyperosmolar state, ISPAD Clinical Practice Consensus, 2018. Pediatric Diabetes, 2018;19 (Suppl. 27): 155–177.

5. Usher-Smith AJ, Thompson M, Ercole A. Variation between coun-tries in the frequency of diabetic ketoacidosis at first presentation of type 1 diabetes in children: a systematic review Diabetologia 2012; 55: 2878–2894. doi: 10.1007/s00125-012-2690-2

6. Wojcik M, Sudacka M, Wasyl B, et al. Incidence of type 1 diabetes mellitus during 26 years of observation and prevalence of diabetic ketoacidosis in the later years. Eur J Pediatr 2015; 174: 1319–1324. doi: 10.1007/s00431-015-2537-1.

7. Patterson CC, Dahlquist G, Harjutsalo V, et al. Early mortality in EURODIAB population-based cohorts of type 1 diabetes diag-nosed in childhood since 1989. Diabetologia 2007; 50: 2439–2942.

8. Vellanki P, Umpierrez GE. Increasing Hospitalizations for DKA: A Need for Prevention Programs. Diabetes Care 2018; 41: 1839–1841. doi: 10.2337/dci18-0004.

9. Bismuth E, Laffel L, Can we prevent diabetic ketoacidosis in chil-dren? Pediatric Diabetes. 2007; 8 Suppl 6: 24–33.

10. Lévy-Marchal C, Patterson CC, Green A; EURODIAB ACE Study Group. Europe and Diabetes. Geographical variation of presenta-tion at diagnosis of type I diabetes in children: the EURODIAB study. European and Diabetes. Diabetologia 2001; 44 Suppl 3: B75-80.

11. Zhong VW, Juhaeri J, Mayer-Davis EJ. Trends in Hospital Admis-sion for Diabetic Ketoacidosis in Adults With Type 1 and Type 2 Diabetes in England, 1998-2013: A Retrospective Cohort Study. Diabetes Care 2018; 41: 1870–1877. doi: 10.2337/dc17-1583.

12. Soltesz G, Patterson CC, Dahlquist G. EURODIAB Study Group. Worldwide childhood type 1 diabetes incidence – what can we learn from epidemiology? Pediatr Diabetes 2007; 8 Suppl 6: 6–14.

13. Muñoz C, Floreen A, Garey C, Misdiagnosis and Diabetic Ketoacido-sis at Diagnosis of Type 1 Diabetes: Patient and Caregiver Perspec-tives. Clinical Diabetes 2019; 37: 276–281. doi: 10.2337/cd18-0088.

14. Vanelli M, Chiari G, Ghizzoni L, et al. Effectiveness of a prevention program for diabetic ketoacidosis in children. An 8-year study in schools and private practices. Diabetes Care 1999; 22: 7–9.

15. Vanelli M, Scarabello C, Fainardi V. Available tools for primary ke-toacidosis prevention at diabetes diagnosis in children and ado-lescents. "The Parma campaign". Acta Biomed 2008; 79: 73–78.

16. Cangelosi AM, Bonacini I, Pia Serra R, et al. Spontaneous dis-semination of DKA prevention campaign successfully launched in Nineties in Parma's province. Acta Biomed 2017; 88: 151–155. doi: 10.23750/abm.v88i2.655317.

17. Choleau C, Maitre J, Filipovic Pierucci A, et al. Ketoacidosis at diag-nosis of type 1 diabetes in French children and adolescents. Diabe-tes Metab. 2014; 40: 137–142. doi: 10.1016/j.diabet.2013.11.001.

18. Gunn ER, Albert BB, Hofman PL et al. Pathways to reduce diabetic ketoacidosis with new onset type 1 diabetes: Evidence from a re-gional pediatric diabetes center: Auckland, New Zealand, 2010 to 2014 Pediatr Diabetes. 2017; 18: 553–558. doi: 10.1111/pedi.12456.

19. Fritsch M, Schober E, Rami-Merhar B, et al. Austrian Diabetes In-cidence Study Diabetic ketoacidosis at diagnosis in Austrian chil-dren: a population-based analysis, 1989-2011. Group. J Pediatr 2013; 163: 1484–1488.e1. doi: 10.1016/j.jpeds.2013.06.033.

20. Choleau C, Maitre J, Filipovic Pierucci A, et al. AJD Study Group. Ketoacidosis at diagnosis of type 1 diabetes in French children and adolescents. Diabetes Metab 2014; 40: 137–142. doi: 10.1016/j.diabet.2013.11.001.

21. Gopalan A, Mshira P, Alexeeff SE, et al. Prevalence and predictors of delayed clinical diagnosis of Type 2 diabetes: a longitudinal cohort study. Diabet Med 2018; 35: 1655–1662. doi: 10.1111/dme.13808.

22. Maahs DM, West NA, Lawrence JM, Epidemiology of type 1 dia-betes. Endocrinol Metab Clin North Am 2010; 39: 481–497. doi: 10.1016/j.ecl.2010.05.011.

23. Baldelli L, Flitter B, Pyle L, et al. A survey of youth with new onset type 1 diabetes: opportunities to reduce diabetic ketoacidosis. Pe-diatric Diabetes 2017; 18: 547–552.