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Original article

Ketoacidosis at diagnosis of type 1 diabetes in French children and adolescents

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Abstract

Objectives. – This study aimed to evaluate the frequency of diabetic ketoacidosis (DKA) and its associated factors at the diagnosis of type 1 diabetes (T1D) in French children and adolescents prior to launching a public-health campaign of information to prevent DKA.

Patients and methods. – Over a 1-year period, 1299 youngsters (aged < 15 years) were diagnosed with T1D at 146 paediatric centres in all regions of France. Age, gender, duration of symptoms, patient's pathway to diagnosis, clinical and biological signs, and family history of T1D were collected for each newly diagnosed patient. DKA was defined as pH < 7.30 or bicarbonate < 15 mmol/L, and severe DKA as pH < 7.10 or bicarbonate < 5 mmol/L.

Results. – At the time of diagnosis, 26% of the children were aged 0–5 years, 34% were 5–10 years and 40% were 10–15 years. The overall prevalence of DKA was 43.9% (0–5 years: 54.2%; 5–10 years: 43.4%; and 10–15 years: 37.1%) and 14.8% for severe DKA (0–5 years: 16.6%; 5–10 years: 14.4%; and 10–15 years: 13.9%; < 2 years: 25.3%). Severe DKA was more frequent when the child was hospitalized at the family's behest (26.6%) than when referred by a general practitioner (7.6%) or paediatrician (5.1%; 30.6%, 53.7% and 9.2%, respectively, by patients' age group). The frequency of DKA decreased to 20.1% (severe DKA: 4.4%) in families with a history of T1D. Multivariate analysis showed that age, pathway to diagnosis, duration of polyuria/polydipsia (< 1 week) and family history of T1D were associated with the presence of DKA, while pathway to diagnosis and family history of T1D were associated with severe DKA.

Conclusion. – DKA at the time of T1D diagnosis in children and adolescents is frequent and often severe. Patients' age, pathway to hospitalization and family history of diabetes were the main factors associated with DKA. These data suggest that a public-health campaign to prevent DKA at diagnosis can help reduce the frequency of DKA and also provide baseline data for evaluating the efficacy of such a campaign.

Keywords: Ketoacidosis; Type I diabetes; Diagnosis; Public-health campaign

1. Introduction

The incidence of type 1 diabetes (T1D) is steadily increasing in children and adolescents by 3–4% annually in those 0–15 years of age [1–3], and is growing approximately twice as fast in children aged < 5 years [4,5]. The symptoms of diabetes often develop acutely in children and adolescents, especially in

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the youngest ones. The clinical condition can deteriorate rapidly, and diabetic ketoacidosis (DKA) is a common complication at the time of diagnosis [6–8]. The prevalence of DKA varies widely in different countries (15–67%) [9–22]; it has also been reported that DKA at diagnosis is less frequent when there is greater awareness, and when the disease is more common and better known [19]. In France, a study from about 20 years ago showed that the prevalence of DKA at diagnosis was > 40% [21].

DKA at diagnosis has a major impact in terms of morbidity and even mortality. In France [21], severe DKA represents a life-threatening risk and may require hospitalization in an intensive care unit (ICU), as described in around 10% of new cases, while five to six young people are expected to die of it every year [22], which is particularly intolerable as it can be avoided. Indeed, a campaign directed at health professionals and families launched in the Italian province of Parma lowered the prevalence of DKA from 78 to 12.5%, and has had long-lasting effects [23,24]. For this reason, the association *L'Aide aux jeunes diabétiques* (AJD ; help for young diabetics) has decided to launch a national campaign for the prevention of DKA at the time of T1D diagnosis. The campaign's objective is to inform families and their doctors of the symptoms to look out for and that a quick diagnosis can shorten the time lag between the onset of symptoms and initiation of insulin treatment, thereby reducing the risk of DKA.

To evaluate the impact of the campaign, paediatric centres across France were invited to participate in a survey to prospectively determine the prevalence of DKA at diagnosis. The collection of data started a year before launching the campaign to establish current baseline rates on the frequency of DKA at diagnosis to allow for later evaluation of the impact of the campaign, and to identify any factors that might inform the best design for such a campaign. The present report is of the results on the frequency of DKA and its associated factors observed at centres participating in the French survey during the year prior to the campaign.

2. Patients and methods

Between June and November 2009, all metropolitan paediatric centres in France were invited to participate in the evaluation and follow-up study of the prevalence of DKA at diagnosis of T1D. Out of 230 paediatric centres in 22 metropolitan regions, 146 agreed to participate, representing 63% of all centres (33–83% depending on the region), 19% of which were university hospitals. Hospitals had the use of an ICU in 46% of cases. Healthcare providers at each participating centre volunteered to complete an anonymous information sheet for each new patient hospitalized in paediatrics departments with a diagnosis of T1D, starting from 14 November 2009 (November 14 is World Diabetes Day).

The information survey sheet was developed by the AJD scientific and educational committees to collect the following data: date of birth; date of first insulin injection; gender; zip code of residence; duration of symptoms (polyuria/polydipsia, enuresis); pathway to hospitalization (number of days between first medical consultation and first insulin injection, person referring the patient to hospital, department of initial hospitalization); clinical (weight loss, nausea/vomiting, dehydration, polypnoea, coma) and metabolic (blood glucose, ketonaemia/ketonuria, pH, bicarbonate, HbA_{1c}) symptoms on admission; initial treatment (intravenous insulin); and family history of T1D (siblings, parents, grandparents). These data were transmitted *via* the Internet or fax and entered into the AJD database. Consistency and quality controls were regularly performed and quarterly email contacts were established with the participating centres to check on the accuracy and completeness of the data, and to offer regular feedback on the progress of the evaluation. The diagnosis of T1D was based on clinical criteria, but could later be corrected on request by the centre or AJD if justified (for example, in cases of excess weight or absence of autoantibodies). DKA was defined as per International Society for Pediatric and Adolescent Diabetes (ISPAD) recommendations: pH < 7.30 or bicarbonate < 15 mmol/L; severe DKA pH < 7.10 or bicarbonate < 5 mmol/L [6]. In cases of missing data, classification was based on the available data.

3. Statistical analyses

Data for patients aged < 15 years were included in the analyses. Categorical data were expressed as numbers and percentages, with continuous quantitative data as means ± standard deviation (SD). Comparisons were performed across three groups (no DKA, moderate DKA and severe DKA) by univariate analysis, using analysis of variance (ANOVA) for quantitative variables and chi-square test for categorical variables. Variables significantly associated with the presence of DKA or severe DKA were then selected for multivariate analysis using two logistic-regression models, one for the presence of DKA independent of its severity, the other for the presence of severe DKA. *P* values < 0.05 were considered statistically significant. All analyses were performed using R software (R Development Core Team (2010). R*: A* Language *and* Environment *for* Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria; www.R-project.org).

4. Results

During the year of data collection, 146 paediatric centres provided information on 1322 patients aged < 15 years : 46.6% of the centres had five new patients or less, while 28.1% had six to 10, 13.7% had 11–20, 6.8% had 21–30, 2.7% had 31–50 and 2.1% had 51–70 new patients. However, 23 patients were not included in the analyses because of missing pH and bicarbonate data. Thus, the analyses included 1299 patients (48% girls and 52% boys). The number of new cases per month varied from 65 in June to 140 in January. Mean age at diagnosis was 8.2 ± 4.0 years, while 26.4% were aged 0–5 years (6.1% < 2 years), 35.3% were 5–10 years and 38.3% were 10–15 years. T1D was reported in 4.8% of siblings, 6.1% of parents and 5.1% of grandparents, yielding a total of 14.5% of families affected (with several cases of T1D in 20 families).

More than half the patients (53.7%) were referred to hospital by a general practitioner, 9.2% by a paediatrician, 6.5% by another hospital and 30.6% by their families directly.