

Education and public information: preventing diabetic ketoacidosis in Italy

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Left untreated, diabetic ketoacidosis has a 100% death rate. Indeed, ketoacidosis is a leading cause of death and disability in children with type 1 diabetes. Severe acidosis often develops during an extended period in which hyperglycaemia-related symptoms are misdiagnosed. Reducing this period may be sufficient to prevent severe acidosis in newly diagnosed children with diabetes. Ten years ago, the author investigated this hypothesis and demonstrated that, thanks to a school-based campaign with the involvement of healthcare professionals that was centred on recognizing early symptoms, it was possible to diagnose diabetes before the appearance of ketoacidosis. This is his story.

Ketoacidosis occurs in up to 40% of newly diagnosed people with type 1 diabetes. Extremely high levels of glucose in the blood and a severe lack of insulin lead to the breakdown of fat for energy. As a result, chemicals called ketones accumulate in the blood and urine. The signs of ketoacidosis include nausea, stomach pain, fruity breath odour, rapid breathing, and frequent urination.

During the 1990s in the province of Parma in Northern Italy, it took an average of 25 days to diagnose diabetes; ketoacidosis was found in 78% of newly diagnosed children. Our group had been speculating for



Campaign messages raised parents' awareness and contributed to a reduction in the incidence of diabetic ketoacidosis in children.

some time on the misdiagnosed signs and symptoms of type 1 diabetes that are often reported in the weeks before diagnosis. We encountered two important findings:

- 22% of children with newly diagnosed type 1 diabetes underwent a fasting blood glucose test between 1 and 11 weeks before diagnosis, in which glucose levels were already over 100 mg/dl (5.5 mmol/l)
- 89% of the parents of these children had pointed out unusual bed-wetting – a symptom of diabetes and valuable information which was reported in vain to paediatricians.

In the 1990s, ketoacidosis was found in 78% of newly diagnosed children in Parma.

This was the case for 6-year-old Marina. One day in 1991, Marina's mother called the toll-free number of

our diabetes unit because her daughter had recently started wetting the bed – a shock to her since Marina had been a 'dry' child since she was 2 years old. Marina was promptly seen at our unit and diabetes was diagnosed within a few hours – before the onset of classic hyperglycaemia-related symptoms or build-up of ketones in her urine.

Marina's story provided our group with the background for an exciting double challenge: to prove whether the appearance of unusual bed-wetting in a 'dry' child was indicative of type 1 diabetes at onset; and through this warning symptom, whether it was possible to shorten the period of carbohydrate intolerance prior to diagnosis and thus prevent ketoacidosis. To test these hypotheses, we initiated a campaign of information in schools and in paediatricians' clinics in the province of Parma, with the principal focus on bed-wetting.

Poster campaign

Information was provided through a poster (above) showing a child sleeping – and potentially wetting the bed – which carried five practical messages:

- Does your child drink and urinate more than usual?
- Has he/she started wetting the bed again?

- Make sure he/she does not have high blood sugar levels.
- Call your paediatrician today.
- Children can have diabetes too.

The poster was displayed in primary and secondary schools and issued to paediatricians working in the province of Parma. Healthcare providers, including nurses, with experience in diagnosing and treating people with diabetes explained the aims of our campaign to teaching staff. The teachers were invited to show the poster to parents during routine meetings.

Healthcare providers, teachers and parents were involved in the campaign.

In addition, a card outlining guidelines for the diagnosis of type 1 diabetes was distributed to paediatricians, listing on one side the early symptoms (bed-wetting, excessive thirst) and late symptoms (including weight-loss and fatigue) of incipient diabetes, and on the other, the World Health Organization criteria for diagnosis. Paediatricians were asked to promptly refer children with the clinical features mentioned above to our diabetes unit. To facilitate contact, a toll-free number was provided by the Parents Association of Children with Diabetes of Parma (PACDA).

The campaign functioned for 8 years. At the beginning of each school year, members of PACDA undertook to verify that the posters (central to the programme) were regularly displayed. At the end of the follow-up period, the clinical and laboratory features of children who were diagnosed with

diabetes in the province of Parma were compared with those of their peers in two nearby provinces in which the campaign was not carried out. The results were surprising.

Successful and cost-effective

During those 8 years of monitoring, the cumulative frequency of ketoacidosis in the province of Parma dropped from 78% to 12.5%; after the first 2 years of the campaign, none of the newly diagnosed children with diabetes were admitted to our diabetes unit with severe or moderate ketoacidosis. In the two provinces in which the campaign was not carried out, the incidence of children with type 1 diabetes with severe or moderate ketoacidosis was higher (83%), similar to that observed in the province of Parma before the beginning of the preventive campaign.

After 2 years, no newly diagnosed children with diabetes were admitted with ketoacidosis.

It is highly likely that this decreased incidence of ketoacidosis in children with diabetes in the province of Parma resulted from the children experiencing a shorter period of metabolic disturbance prior to developing overt diabetes. This may be attributable to the messages that were displayed on the campaign poster: raising parents' awareness of the potential significance of bed-wetting led many to consult a paediatrician, who rapidly established whether the symptom was due to rising levels of blood glucose.

The effectiveness of the campaign was enhanced by the use of the toll-free

telephone number, which facilitated contact between parents and specialist diabetes healthcare providers. In 8 years, we received more than 4000 calls from parents, teachers, young people, and paediatricians requesting more information – especially on symptoms like bed-wetting. This toll-free telephone service permitted Marina's mother to directly consult a specialized centre and receive timely and valuable health advice.

Low costs and long-term benefits

The total cost of the 8-year campaign was 23 470 USD, including the toll-free telephone line, posters, and time spent by healthcare providers in answering the telephone and providing education for teachers. Given the benefits obtained, it is reasonable to consider the campaign as cost-effective.

Ten years have passed since the end of the campaign. In order to evaluate the longer-term benefits, we studied the newly diagnosed children with diabetes who were admitted to our unit between January 1999 and December 2006. We found that 81% of the children from the province of Parma did not have ketoacidosis, compared to 27% of those from the two neighbouring provinces in which no campaign had been carried out. All parents reported unusual bed-wetting in their child, but only those from Parma linked this symptom to the messages displayed on the posters and most of them promptly consulted a paediatrician.

We found also that 89% of the posters displayed in the schools had disappeared over the years since the study

ended. This finding, along with the appearance of three unexpected severe episodes of ketoacidosis in children from Parma between 2004 and 2006, appears to indicate that time has weakened the campaign and that it needs to be renewed in order to regain its effectiveness.

Conclusion

Data suggested that the campaign to prevent ketoacidosis is still effective in Parma even after several years since its promotion, confirming that bed-wetting is a key warning symptom for the early diagnosis of type 1 diabetes. These findings and the benefits that were achieved at minimal cost led us to encourage groups in other areas to repeat our experience. Given the difficulty in obtaining continuous collaboration from schools, alternative sites should be considered when deciding where to display the posters. We recommend public places, such as pharmacies and paediatrics departments, which are visited regularly by many people who are attentive to their children's health.

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Further reading

- 1 Vanelli M, Chiari G, Ghizzoni L, et al. Effectiveness of a Prevention Program for Diabetic Ketoacidosis in children. *Diabetes Care* 1999; 22: 7-9.