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# Type 1 Diabetes Onset in a Pediatric Emergency Department: Impact of an Evidence-Based Checklist on its Management

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## Abstract

Type 1 Diabetes Mellitus (T1DM) onset management in the Paediatric Emergency Department (PED) could be complex, being a challenge for pediatricians. It has been described that the implementation of evidence-based diagnostic-therapeutic guidelines is a simple and cost-economically efficient intervention. The aim of the study was to elaborate a checklist of T1DM onset management and study its impact on assistance before and after its implementation.

**Methodology and Results:** a checklist for T1DM onset management was prepared based on the diagnostic-therapeutic guidelines of a tertiary pediatric hospital in Spain. A descriptive and retrospective comparative study was carried out: group 1 included patients with T1DM onset who attended the PED from February-December 2020 and group 2, patients with T1DM onset from February-December 2021, once the new checklist was implemented. Clinical, diagnostic and therapeutic variables were analysed. 145 patients were included; 87 in group 1 (56.3% female and mean age 10 years); and 58 in group 2 (60.3% female and mean age 9 years). The most frequent degree of severity was hyperglycaemia with ketosis without acidosis in both groups. No statistically significant differences were found between the two groups analysing: 1) differences between the time of the patient's attendance and the time of the first blood test, 2) the time for the second blood test in severe diabetic ketoacidosis, 3 ) the days of admission, 4) the correct indication for admission to the Intensive Care Unit, 5) the adequacy in the percentage of the different types of insulin 6) the differences between the subcutaneous insulin regimen on admission and on discharge, 7 ) the sensitivity factors according to the age of the patient. Intravenous potassium contributions were applied correctly in 52.5% in group 1 and in 90.5% in group 2 ($p<0.05$).

**Conclusion**: The checklist use represents an approach to the standardization of the T1DM onset patients' management. In our study, important changes in care when implementing the checklist were not observed, probably because of the correct use of the existing management guidelines. Nevertheless, having these tools lead to an improvement in the quality of care and in patient safety.

**Keywords:** Type 1 diabetes mellitus onset; Diabetic ketoacidosis; Paediatric emergency department; Checklist; Quality study

## Introduction

Type 1 Diabetes Mellitus (T1DM) is the most common chronic disease in childhood and young adults. It is characterized by a state of hyperglycaemia due to an inadequate insulin secretion [1,2]. It has been described an increase in Europe from 2 to 4% during last years [3]. Its onset occurs typically during childhood with a Diabetic Ketoacidosis (DKA) state, with an incidence that ranges from 15 to 70% in developed countries [4-8]. DKA could bring fatal complications, being the most common cause of mortality of these patients [9]. The T1DM onset could lead to life-threatening complications such as cerebral oedema,




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hypokalaemia, hypoglycaemia and hyperchloremic acidosis, among others. Therefore, a promptly recognition of this condition with initial resuscitation and treatment is mandatory, being usually performed in the Pediatric Emergency Department (PED) [1,10,11].

The management of T1DM onset could be complex; hence, it should be conducted in an experienced centre where clinical status and laboratory results can be frequently monitored [3,4]. Sometimes, the initial handling is performed by a less experienced professional team: it has been described that the evidence-based diagnostic-therapeutic algorithms implementation, order sets or simulation programs are simple and cost-economically efficient interventions [8,12] to improve the T1DM onset management. Appropriate and timely management of DKA is essential to avoid clinical fatal outcomes and lengthy hospitalizations [12].

The aim of the study was to develop a checklist for standardizing the management of the T1DM onset in a tertiary PED and to analyse if an improve of the quality of clinical care of these patients was demonstrated. Secondly, another objective was to evaluate whether the use of a standardized checklist versus an individualized approach improves clinical outcomes during the clinical management of T1DM onset patients.

## Methods

A T1DM onset management checklist (Supplementary Figure1) was elaborated based on the diagnostic-therapeutic guidelines for DKA [2,3,13] available at a tertiary paediatric hospital in Spain. The order set development was carried out by a multidisciplinary team including paediatric endocrinology experts, the paediatric emergency team, fellowships and residents. The project was communicated to all the emergency paediatric team and was available from February 2021, with previous ethical approval. A descriptive and retrospective comparative study was performed among children under 18 years with clinical suspicion or confirmed onset of T1DM presented to the PED. Patients were divided into 2 groups: group 1, prior the implementation of the checklist (February 2020- December 2020) and group 2, post implementation (February 2021- December 2021). Demographic, clinical, diagnostic, therapeutic and outcome data were analysed.

### Statistical Analyses

Statistical analyses were performed using SPSS Statistics, version 21 (IBM, Chicago, IL), specifically the Pearson chi-square test (P<0,05 was deemed statistically significant).

## Results

A total of 145 patients were included: 87 in group 1, before checklist implementation, and 58 in group 2, after its implementation. In group 1 there were 49 (56.3%) females, and the median age was 10.2 years; in group 2 there were 35 (60.3%) females, and the median age was 9.4 years. In both groups the most frequent type of diabetic onset was hyperglycemia with ketosis: 37 (42.5%) in group 1 and 21 (36.2%) in group 2. Other types of diabetic onset are reported in Table 1. No deaths were reported in any group.

The statistical analysis of differences between two groups is shown in Table 2. In terms of severity, in group 1, 20 (23%) patients had pediatric intensive care unit (PICU) admission criteria and 12 (13.8%) were admitted; while in group 2 there were 8 (13.8%) with PICU admission criteria and 4 (6.9%) patients were admitted. The median time of hospital admission was 4 days in both groups.

**Table 1:** Type of diabetic onset in each group.

| | Group 1 | Group 2 | Total |
|---|---|---|---|
| | n (%) | n (%) | n (%) |
| **Sex (females)** | 49 (56.3%) | 35 (60.3%) | 84 (57.9%) |
| **Median age (years)** | 10.2 | 9.4 | |
| **Type of diabetic onset** | **n (%)** | **n (%)** | **n (%)** |
| Simple hyperglycemia | 6 (6.9%) | 13 (22.4%) | 19 (13.1%) |
| Hyperglycemia with ketosis | 37 (42.5%) | 21 (36.2%) | 58 (40%) |
| Mild ketoacidosis | 16 (18.4%) | 7 (12.1%) | 23 (15.9%) |
| Moderate ketoacidosis | 17 (19.5%) | 13 (22.4%) | 30 (20.7%) |
| Severe ketoacidosis | 11 (12.6%) | 4 (6.9%) | 15 (10.3%) |
| Total | 87 (100%) | 58 (100%) | 145 (100%) |

**Table 2:** Statistical analysis of differences between two groups.

| | Group 1 | Group 2 | p |
|---|---|---|---|
| | n/total (%) | n/total (%) | |
| PICU criteria | 20/87 (23%) | 8/58 (13.8%) | 0.169 |
| PICU admission | 12/87 (13.8%) | 4 /58(6.9%) | 0.194 |
| Hospital admission | Days (p50) | Days (p50) | p |
| | 4 | 4 | 0.663 |
| % of slow insulin distribution | % (p50) | % (p50) | p |
| | 40 | 40 | <0.01 |
| | n/total (%) | n/total (%) | p |
| Saline volume infusion at initial attention | 76/86 (88.4%) | 44/58 (75.9%) | 0.048 |
| Correctly potassium iv supplementation | 21/40 (52.5%) | 19/21 (90.5%) | 0.003 |
| Sensitivity factor correctly calculated | 24/42 (57.1%) | 25/36 (69.4%) | 0.120 |
| Fast insulin distribution: difference in breakfast pre and post admission | UI (p50) | UI (p50) | p |
| | 1 | 0.5 | 0.395 |

In relation to the treatment management, initially a saline volume load was infused in 76 (88.4%) patients and 44 (75.9%) in group 2 (p = 0.048). The median percentage of long-acting insulin distribution was 40% in both groups. No difference was found in the distribution of rapid-acting insulin in both groups (p = 0.395). The sensitivity factor was correctly calculated in 24 (57.1%) in group 1 and 25 (69.4%) in group 2, while it was not noted in the medical report in 14 (33.3%) cases in group 1 and 5 (13.9%) in group 2 (p 0.12). In cases with DKA, the potassium supplementation was correctly calculated in 21 (52.5%) patients in group 1 and 19 (90.5%) in group 2 (p = 0.003).

## Discussion

During last years, different strategies have been proposed to enhance the management of T1DM onset in the PED. Some of them have been reported, such as an order set in the management of DKA in the PED [11], point of care settings [10], quality improvement initiatives [5] or simulation-based programs [12,14]. It has been described that standardized order sets with the T1DM onset management improves clinical outcomes of these patients [11,15].

Our study contributes with a checklist that includes all type of forms at T1DM onset. To our knowledge, this is the first order set published in the literature that also includes the management of the simple hyperglycaemic forms with subcutaneous insulin therapy management, being a complete tool for all pediatricians at PED [11].

In our study only statistical differences have been found in the correct use of intravenous potassium supplementation after the checklist implementation. The correct use of potassium replacement is vital in these patients as hypokalaemia has been found to be an independent marker of poor treatment outcome and mortality [4,16,17].

One possible hypothesis that could elucidate the absence of significant differences is that the period analysed prior the checklist implementation was 2020, when the COVID pandemics occurred and restrictions to visit the Hospital were established [18,19]. Therefore, there was a decrease in the global number of visits in the PED [18,19]. Hence, professionals could dedicate more time to each patient and could have more time to review the current guidelines in the T1DM onset management. Moreover, the number of T1DM onset patients in 2020 was higher than 2021, as our centre was designated as a reference hospital for the paediatric emergencies during COVID pandemics [20]. Therefore, health care professionals had more time management on these patients [20].

Furthermore, no differences were observed in certain parameters that were already being correctly managed prior the checklist implementation, such as the time to perform the first blood test (within an hour), the duration of hospital admission (less than 5 days), subcutaneous insulin distribution, total insulin dose calculation and sensitivity factor. An updated guideline was published in our centre before the checklist implementation, contributing to the correct management of these patients. It would be interesting to analyse if the checklist could lead to improvement in non-tertiary centres with less specialized paediatric teams.

One limitation of our study was its retrospective nature, as it was based on medical histories reports review, thus, data which was not recorded could not be analysed. It would have been interesting to see if after the checklist implementation the quality of the medical reports was improved.

Moreover, the checklist was only used by physicians but not by other health care professionals, such as nurses and assistants. In the future it would be profitable to facilitate its use to all the professionals in the PED, as it could facilitate and enhance the team building and therefore, it would improve the clinical assistance that we offer to our patients and their families.

## Conclusion

The implementation of the T1DM onset checklist could serve as a valuable and cost-effective tool which facilitates the standardized management of these patients in the PED. In future research, it would be interesting to focus on its utilization among the health care professionals in the PED, to analyse if the satisfaction, security perception and efficacy of them. Additionally, exploring its application in non-tertiary hospitals could be a promising avenue for further investigation.

## Author Statements

### Conflict of Interest

The authors have nothing to disclose.

### Ethical Approval

This study was approved by Sant Joan de Déu Children's Hospital Ethics Committee.

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