

# Devastating Cerebral Injury Prior to DKA Therapy - Case Report

Brittany Bare, DO<sup>1</sup>; Chandler Sapp, DO<sup>1</sup>; Evelyn Fagan, BS, MS<sup>3,2</sup>; Sunil Keshwah, MD<sup>1</sup>

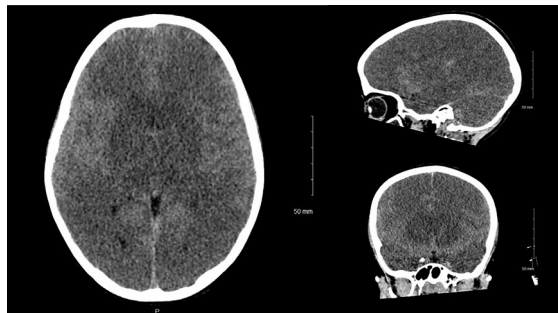
1. Memorial Health University Medical Center, Department of Pediatrics; 2. Mercer University School of Medicine



## Background

- Diabetic Ketoacidosis (DKA) can result in serious mortality and morbidity in children with type 1 diabetes. [6]
- DKA can lead to several fatal complications including cerebral injury, which is the primary cause of mortality. [1,6]
- Cerebral injury occurs in 0.3 to 0.9% of children with DKA and has a mortality rate of 24%. [8]
- Based on current literature, cerebral injury presents within the first 12 to 24 hours following initiation of therapy and is secondary to rapid osmotic fluctuation and resulting fluid shifts.
- Our case demonstrates a rare presentation of cerebral injury prior to DKA therapy in a new onset type 1 diabetic patient.

## Imaging



**Figure 1:** Diffuse hypoattenuation of the bilateral cerebral and cerebellar hemispheres. Findings are consistent with global anoxic injury.

## Clinical Details

- Chief Complaint:
  - Patient was a previously healthy 8 year old female
  - Presented with out of hospital cardiopulmonary arrest with return of ROSC after 25 minutes of presumed time of arrest
- Clinical History:
  - Preceding course significant for 2 days of worsening fatigue and decreased oral intake
  - Day prior to presentation patient demonstrated signs of progressive obtundation and possible obstructive breathing pattern, however remained alert intermittently
  - Increasing water intake over the past month
- Emergency Department Course:
  - Found to be hypotensive with cold extremities
  - Pupils fixed and dilated
  - Labs significant for hyperglycemia and significant lactic acidosis
- Pediatric Intensive Care Course:
  - CT Head notable for findings in Figure 1
  - Worsening acute kidney injury, ischemic hepatitis and progressive electrolyte derangements
  - Fixed heart rate and severe hypotension requiring extensive inotropic/vasopressor support; ultimately weaned due to development of reflexive hypertension concerning for worsening cerebral edema
  - Stress hydrocortisone for concern of adrenal insufficiency
  - Persistent hyperglycemia requiring insulin infusion; prompting collection of HbA1c which was elevated at 16.1
  - Patient's clinical examination demonstrated an absence of cerebral/brainstem functions and she was ultimately declared brain dead

## Discussion

- Cerebral injury is a rare, but devastating occurrence in pediatric patients with DKA.
- Until recently, the mechanism of development for cerebral injury was thought to be related to osmotic changes associated with initiation of DKA therapy (fluids, insulin, etc.).
- However, new studies have indicated, such as in our case, that 5 to 19% of DKA related cerebral injury actually occurs prior to onset of DKA therapy. [5]
- MRIs in those studies demonstrate vasogenic edema rather than increased intracellular water, which could indicate an intrinsic factor such as abnormalities occurring in the blood brain barrier rather than osmotic fluid shifts. [5]
- This case represents importance in both the inpatient and outpatient setting for early recognition of new onset diabetes in the pediatric population given a rare presentation of devastating cerebral injury in new onset pediatric diabetic patient.

## References

- 1 Cashen, K., & Petersen, T. (2019). Diabetic Ketoacidosis. *Pediatrics in Review*, 40(8), 412-420. <https://doi.org/10.1542/pir.2018-0231>
- 2 Glaser, N., Barnett, P., McCaule, L., Nelson, D. A., Trautner, J. L., Louie, J. P., Kaufman, F., Quynh, K. S., Roback, M. G., Malley, R., & Koppelman, N. (2001). Risk Factors for Cerebral Edema in Children with Diabetic Ketoacidosis. *The New England Journal of Medicine*, 344(4), 264-269. <https://doi.org/10.1056/nejmoa2001023144044>
- 3 Glaser, N. (2009). Cerebral injury and cerebral edema in children with diabetic ketoacidosis: could cerebral ischemia and reperfusion injury be involved? *Pediatric Diabetes*, 10(6), 544-547. <https://doi.org/10.1111/j.1399-5448.2009.00511.x>
- 4 Glaser, N., Chu, S., Hung, B. Y., Fernandez, L., Wolff, H., Tancredi, D. J., & O'Donnell, M. E. (2020). Acute and chronic neuroinflammation is triggered by diabetic ketoacidosis in a rat model. *BMJ Open Diabetes Research & Care*, 12(2), e001793. <https://doi.org/10.1136/bmjopen-2020-001793>
- 5 Glaser, N.S., Storer, M.J., Gatto, A., Baid, S., Myers, S.R., Riewers, A., Brown, K.M., Trautner, J.L., Quynh, K.S., McManney, J.K., DePetro, A.D., Nigrovic, L.E., Tanenhaus, L., Schank, J.E., Olsen, C.S., Casper, T.C., Ghetti, S., Koppelman, N., & Pediatric Emergency Care Applied Research Network (PECARN) DKA FLUID Study Group (2021, September). Serum Sodium Concentration and Mental Status in Children With Diabetic Ketoacidosis. *Pediatrics*, 148(3). <https://doi.org/10.1542/peds.2021-090243>
- 6 Glaser, N., Fritsch, M., Priyadarshi, L., Riewers, A., Cherubini, V., Estrada, S. C., Wolford, J. L., & Coder, E. (2022). ISPAD Clinical Practice Consensus Guidelines 2022: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Pediatric Diabetes*, 23(7), 835-856. <https://doi.org/10.1111/pedi.13406>
- 7 Jensen, E. T., Stafford, J. M., Seydahl, S., D'Agostino, R. B., Dolan, L. M., Lawrence, J. M., Marcovina, S. M., Mayer-Davis, E. J., Phoker, C., Riewers, A., & Dabelea, D. (2021). Increase in prevalence of diabetic ketoacidosis at diagnosis among youth with Type 1 Diabetes: The SEARCH for Diabetes in Youth study. *Diabetes Care*, 44(7), 1573-1578. <https://doi.org/10.2337/dcc20-0389>
- 8 Koppelman N, Ghetti S, Schank JE, Storer MJ, Riewers A, McManney JK, Myers SR, Nigrovic LE, Gatto A, Brown KM, Quynh KS, Trautner JL, Trimenatus L, Bennett JE, DePetro AD, Kook MY, Pory CS, 3rd, Olsen CS, Casper TC, Dolan JM, Glaser NS. PECARN DKA FLUID Study Group. Clinical Trial of Fluid Infusion Rates for Pediatric Diabetic Ketoacidosis. *N Engl J Med*. 2018 Jun 14;378(24):2275-2287. doi: 10.1056/NEJMoa1706816. PMID: 29897851. PMCID: PMC6051773
- 9 Muir, A.B., Quinlan, R.G., Yang, M.C., & Rosenbloom, A.L. (2004, July). Cerebral edema in childhood diabetic ketoacidosis: Natural history, radiographic findings, and early identification. *Diabetes care*, 27(7), 1541-1546. <https://doi.org/10.2337/diacare.27.7.1541>
- 10 Shifren, M. Y., Tamarian, T. L., Akiba, A. T., Akiba, Y. B., & Woods, B. Y. (2022). Diabetic ketoacidosis (DKA) induced cerebral edema complicating small chronic subdural hematomas/lyngmas at Zerwudin memorial hospital: a case report. *BMC Endocrine Disorders*, 22(1). <https://doi.org/10.1186/s12902-021-00916-1>
- 11 UpToDate. (n.d.). UpToDate. <https://www.uptodate.com/contents/diabetic-ketoacidosis-in-children-cerebral-injury-cerebral-edema>