Hyperglycemic Crisis in Uncontrolled Diabetes Mellitus Type 2 Presenting as Breathlessness

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Abstract

**Background**
Hyperglycemic crisis is emergency caused by metabolic problems due to uncontrolled diabetes mellitus. Hyperglycemic crisis consists of Hyperosmolar Hyperglycemic State (HHS) and Diabetic Ketoacidosis. Both are caused by relative or absolute deficiency of insulin; deficiency of insulin could be caused by type 1 and type 2 diabetes.

**Case presentation**
A 46-year-old woman came to the emergency room of Unggul Karsa Medika Hospital presenting with breathlessness which had occurred for a week. Her breathlessness was more severe on the day she presented to the emergency room. One week before, she went to a clinic nearby because of epigastric pain, but after returning home she felt breathless. After a few days, her breathlessness started to worsen, so she decided to go to emergency room. The patient had severe acidosis and high blood glucose. Hyperglycemia protocol of rehydration and insulin drip intravenously, accompanied by sodium bicarbonate and potassium chloride were given. Mechanical ventilation was used. The patient was healed and discharged safely after 9 days of hospitalization.

**Conclusion**
Hyperglycemic crisis is one of true emergency that can lead to mortality, thus prompt diagnosis and treatment should be done. It is important for clinicians to differ between HHS and DKA. HHS is caused by the relative or absolute deficiency of insulin while DKA is characterized by absolute insulin deficiency which prevents the body from metabolizing carbohydrates and results in severe hyperglycemia. In DKA and HHS the main goal of therapy is to rehydrate, correct hyperglycemia, and to correct electrolyte imbalances.

**Keywords:** Diabetes mellitus, Diabetic ketoacidosis, Hyperglycemic crisis, Hyperosmolar Hyperglycemic State

Mortality rates are 2-5% for DKA and 15% for HHS. Mortality is usually a consequence of the precipitating causes, such as infection, rather than a result of the metabolic changes of hyperglycemia. Infection is the commonest precipitating factor for DKA, occurring in 30-50% of cases. Urinary tract infection and pneumonia are majority of infections. Other conditions that may precipitate DKA including cerebrovascular accident, alcohol/drug abuse, pancreatitis, pulmonary embolism, myocardial infarction, trauma, and iatrogenic. Non-compliance
with therapy has also been reported to be a major precipitating cause for DKA. As for HHS, infection is also the major precipitating factor, occurring in 30-60% of patients. Other conditions such as cerebrovascular accident or myocardial infarction could provoke the release of counter-regulatory hormones, resulting in hyperglycemia.

There are differences between treatment of DKA and HHS, mainly in treating acidosis. Fluid therapy, insulin, potassium treatments are similar for both DKA and HHS. Sepsis, renal impairment with electrolyte imbalance, and lower blood pressure were independent prognostic factors of 90-day mortality rate among patients with severe hyperglycemia in emergency department. Thus, prompt diagnosis and correct treatment which is started from emergency department until intensive care unit must be done. This case study presented hyperglycemic crisis presenting as breathlessness. We aim to enlighten all clinicians in treating hyperglycemic crisis.

Case presentation
A 46-year-old woman came to the emergency room of Unggul Karsa Medika Hospital presenting with breathlessness which had occurred for a week. Her breathlessness was more severe on the day she presented to the emergency room. One week before, she went to a clinic nearby because of epigastric pain, but after returning home she felt breathless. After a few days, her breathlessness started to worsen, so she decided to go to emergency room.

The patient had a history of type 2 diabetes since 2019. She took her diabetes medication regularly until the start of COVID-19 pandemics, since she was afraid to go to the hospital or other health facilities.

From the physical examination, we found the blood pressure was 140/80 mmHg, heart rate 134 times per minute regularly, respiratory rate 28 times per minute, oxygen saturation 99% and temperature 36.4oC. From pulmonary examination we found vesicular breath sound bilateral and rhonchi bilateral, no wheezing. Other examination results were normal.

Initial laboratory examination was conducted with the result as such: Leucocyte 31,200/mL, creatinine serum 0.5 mg/dL, blood glucose 438 mg/dL, sodium 131 mEq/L, and potassium 4.6 mEq/L. Blood gas analysis was done with the results as such: Blood pH 7.037, pCO2 9.2 mmHg, pO2 138 mmHg, Base excess -28 mmol/L, HCO3 2.5 mmol/L, tCO2 <5 mmol/L, Oxygen saturation 98%, Serum Lactate 1.81 mmol/L. Urinalysis showed hematuria and the presence of glucose in the urine (+4) without ketone. Chest x-ray was performed with the result of slight cardiomegaly without pulmonary oedema, no pneumonia and no lung tuberculosis (figure 1).

Figure 1. Chest X-ray results of the patient
- Give Potassium chloride 7.46% solution 50 mEq in Ringer Lactate 500 mL, 8 hourly if the potassium is <3.3 mEq/L, stop the insulin.
- Give Potassium chloride 7.46% solution 25 mEq in Ringer Lactate 500 mL, 8 hourly, keep the insulin drip if the potassium level is 3.3-5.2 mEq/L.
- Stop potassium chloride if potassium level is >5.2 mEq/L.

Other initial treatment from internist was Ceftriaxone 1 gram IV twice daily, Sucralfate 15 cc, thrice daily, nifedipine extended release 30 mg, once daily, ranitidine 150 mg twice daily, and potassium slow release tablets 600 mg once daily.

Since the patient's blood gas analysis was severe acidosis, intubation was performed and the patient was transferred to Intensive Care Unit (ICU). Mechanical ventilator was set with mode Synchronized Intermitten Mandatory Ventilation (SIMV), Oxygen fraction (FiO2) 100%, respiratory rate (RR) 16 times per minute, Pressure support (Ps) 15 mmHg, Positive End Expiratory Pressure (PEEP) 5 mmHg, Inspiration Expiration ratio 1:2. Sodium bicarbonate solution 100 mEq in Sodium Chloride 0.9% infusion 500 mL.

The laboratory results of the patient day by day could be seen in table 1.

Since potassium level were dropped in several occasions, Potassium chloride 7.46% solution was given regularly. The patient was getting better and better, thus was discharged safely after 9 days in hospital. The diabetes treatments were Glimepiride 4 mg once daily and Pioglitazone 30 mg once daily.

### Table 1. Day-to-day laboratory parameters of the patient

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Emergency ward</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
<th>Day 9</th>
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<tbody>
<tr>
<td>Leucocyte (cells/mL)</td>
<td>35,200</td>
<td>31,700</td>
<td>17,500</td>
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<tr>
<td>Creatinine</td>
<td>85</td>
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<td>Blood glucose (mg/dL)</td>
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<td>(initial)</td>
<td>415 (21.30)</td>
<td>324 (18.00)</td>
<td>292 (19.00)</td>
<td>184 (17.00)</td>
<td>327 (17.00)</td>
<td>180 (16.00)</td>
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<tr>
<td>456 (21.30)</td>
<td>254 (23.00)</td>
<td>244 (21.00)</td>
<td>145 (20.00)</td>
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<td>455 (22.30)</td>
<td>244 (23.00)</td>
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<td>412 (23.30)</td>
<td>145 (25.00)</td>
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<tr>
<td>Potassium (mEq/L)</td>
<td>4.6</td>
<td>2.4</td>
<td>2.3</td>
<td>2.0</td>
<td>2.0</td>
<td>2.1</td>
<td>2.2</td>
<td>2.2</td>
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<td>ph</td>
<td>7.017</td>
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<tr>
<td>pCO2 (mmHg)</td>
<td>82</td>
<td>20</td>
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<tr>
<td>pO2 (mmHg)</td>
<td>136</td>
<td>260</td>
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<tr>
<td>Base Excess (mmol/L)</td>
<td>-28</td>
<td>-41</td>
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<tr>
<td>HCO3 (mmol/L)</td>
<td>2.2</td>
<td>9.4</td>
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<td>(CO2) (mmol/L)</td>
<td>5</td>
<td>10</td>
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<tr>
<td>O2 Saturation (%)</td>
<td>94</td>
<td>100</td>
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<td>Lactate (mmol/L)</td>
<td>1.81</td>
<td>0.77</td>
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### Discussion

In this patient, we suspected that infection was preceded the hyperglycemic condition since the leucocyte was 31,200 cells/mL. Our antibiotic treatment of Ceftriaxone was effective to combat the infection. We suspect the source of infection was community acquired pneumonia since there was rhonchi. However, the chest X-ray did not conclude that there was pneumonia in this patient. There were no bacteria found in urinalysis, thus urinary tract infection could be excluded. Pneumonia is one of two major causes that often precipitates DKA and HHS.3

The patient was come to hospital with chief complaint of breathlessness. From laboratory result, the patient has metabolic acidosis, thus DKA diagnosis was very likely. Common criteria for DKA are plasma glucose >250 mg/dL, positive serum and urine ketone test, and acidosis.5 However, we did not test ketone serum level. There was no ketone in urine test.

HHS patients usually have plasma glucose over 600 mg/dL with pH >7.30 and serum bicarbonate >18 mEq/L. The effective serum osmolality is >320 mOsm/kg, calculated with formula: [2(mea- sured sodium ion in mEq/L) + glucose (mg/dL)]/18. The mental status of the patient usually stupor/coma.6

There are 3 levels of DKA severity based on laboratory results: mild, moderate, and severe. The criteria were arterial blood pH (mild: 7.25-7.30, moderate: 7.00 to <7.25, severe: <7.00), plasma bicarbonate (mild: 15-18 mEq/L, moderate 10 to<15 mEq/L, severe<10 mEq/L), serum anion gap (mild: >10 mEq/L, moderate>12 mEq/L, severe: >12 mEq/L)
and mental status (mild: alert, moderate: drowsy, severe: coma/stupor). In our patient the pH was 7.037 but the bicarbonate was 2.5 mEq/L, so, it was severe DKA.

The most important initial therapeutic intervention in ketoacidosis is appropriate fluid replacement followed by insulin administration. The main aims for fluid replacement are restoration of circulatory volume, clearance of ketones, and correction of electrolyte imbalance. Initial fluid replacement of choice is 0.9% sodium chloride solution. Clinicians should give 500 mL of crystalloid over 10-15 minutes. Most people require between 500-1000 mL to be given rapidly in the first hour. After that, administer 0.9% of sodium chloride at 500-1000 mL/hour in the first 2-4 hours. When serum glucose reaches 200 mg/dL, change to 5% dextrose with 0.45% of sodium chloride at 150-250 mL/hour.

Potassium replacement is also needed if the level of potassium is below 5.2 mEq/L. If the potassium is below 3.3 mEq/L, hold the insulin and give 10-20 mEq/hour until reaches >3.3 mEq/L. If the potassium is 3.3-5.2 mEq/L, give 20-30 mEq in each liter of IV fluid. In our case, potassium level is below 5.2 mEq/L thus she was given Potassium Chloride 7.46% solution.

Insulin therapy can be start at 0.1 U/kg body weight bolus, followed by continuous fixed rate of 0.1 IU/kg/hour until the blood glucose is more or less 200 mg/dL. Ideally, check serum glucose every 1-2 hours. However, we could not do it in our patient due to economic reason. The target of serum glucose is between 150-200 mg/dL until the resolution of DKA. For HHS, the target is more or less 200 mg/dL. Reduce the rate of infusion to 0.05 IU/kg/hour if, in DKA, it reaches 200 mg/dL and 250 mg/dL in HHS.

Bicarbonate is crucial in severe DKA, but not given in HHS. If pH < 6.9, clinicians should administer 100 mmol in 400 mL of water, plus 20 mEq of potassium chloride for 2 hours. It could be repeated every 2 hours until pH > 7.6 Sodium bicarbonate use in mild to moderate academia is associated with delay in resolution of ketosis, post treatment metabolic alkalosis, increased need for potassium supplementation, and worsened tissue hypoxia. However, we give bicarbonate to our patient since the bicarbonate was very low. It may be the reason why hypokalemia happened in several times along the period of treatment.

Our patient was stay in hospital for 9 days. Among DKA patients, those with insulin noncompliance had a shorter hospital stay (2.8 days) than those with an underlying illness as the DKA trigger (4.8 days). However, our patient had those two factors, thus may lengthen the length of stay.

Baseline bicarbonate of our patient of 2.5 mEq/L was also being a factor of long stay in ICU. Higher initial bicarbonate is found to be associated with short stay in ICU among DKA patients.

**Conclusion**

Hyperglycemic crisis is one of true emergency that can lead to mortality, thus prompt diagnosis and treatment should be done. It is important for clinicians to differ between HHS and DKA. HHS is caused by the relative or absolute deficiency of insulin while DKA is characterized by absolute insulin deficiency which prevents the body from metabolizing carbohydrates and results in severe hyperglycemia. In DKA and HHS the main goal of therapy is to rehydrate, correct hyperglycemia, and to correct electrolyte imbalances. Bicarbonate is crucial in severe DKA. Higher initial bicarbonate and those with insulin noncompliance are factors associated with shorter stay in ICU. Prompt diagnosis and treatment, also frequent monitoring are keys to reduce mortality of hyperglycemic crisis.

**List of abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>HHS</td>
<td>Hyperosmolar hyperglycemic state</td>
</tr>
<tr>
<td>DKA</td>
<td>Diabetic ketoacidosis</td>
</tr>
<tr>
<td>ICU</td>
<td>Intensive Care Unit</td>
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</table>

**Declarations**

**Ethics approval and consent to participate**

Informed consent from the patient has been obtained before the study.

**Consent for publication**

Consent for publication regarding patient data has been obtained before the study. All the patient identity has been kept secret.

**Availability of data and materials**

Not Applicable

**Competing interests**

The authors declare that they have no competing interests.

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References