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A lifesaving improvised peritoneal dialysis on a toddler with acute kidney injury following a swarm of bees' sting at Iringa Regional Referral Hospital, Southern Highland—Tanzania: a case report

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Abstract

Background Peritoneal dialysis as one of the nephrology services in children with acute kidney injury is a safe and cost-effective modality of treatment in low and lower-middle income countries. Despite evidence of its effectiveness in limited resource settings, the service is still provided only in tertiary level healthcare facilities in Tanzania.

Case presentation In this case report, we narrate the survival of a 22-month-old male patient of African descent with an acute kidney injury following a swarm of bees' stings at home. A lifesaving, although low-quality and high-risk, peritoneal dialysis was performed for 5 days at Iringa Regional Referral Hospital, a secondary level health facility in rural Tanzania with lack of standard and recommended expertise, laboratory investigations, and equipment.

Conclusion Lower- and middle-income countries in collaboration with stake holders should ensure that this service is available, accessible, and safe in the lower-level health facilities, given that access to the tertiary-level facilities is inadequate and time limited, hence serving a larger population.

Keywords Peritoneal dialysis, Acute kidney injury, Anaphylaxis, Bees' sting

Background

Peritoneal dialysis (PD) is a renal replacement modality, which has been shown to be suitable for children with acute kidney injury (AKI) in low and lower-middle income countries (LLMICs) as compared with other advanced extracorporeal techniques. This is due to its low cost, no difference in mortality, and its need of less advanced technology and expertise compared with other renal replacement therapies available, such as hemodialysis and other continuous renal replacement therapies (CRRT) [1]. Dialysis services and other nephrology services are scarce in Tanzania, a sub-Saharan African LLMIC. They are only available in a few tertiary hospitals

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in urban areas [2]. Hemodialysis is the widely available renal replacement therapy (RRT) in these hospitals, but it is mainly limited to adults because of the technology and machines available, which has a high weight limit and hence not suitable for children. The peritoneal dialysis program has been established in two tertiary hospitals in the northern zone and lake zone but has not expanded to other parts of the country for various reasons [3]. Other tertiary hospitals, apart from those with an established program, perform PD on children with AKI using the experts (nephrologists) available to them who are also concentrated in major cities.

Secondary level facilities, which are mostly upcountry regional and regional referral hospitals serving majority of the population, have little nephrology expertise and technology to provide quality nephrology services, specifically for children with kidney diseases. PD attempts in children are done in some of these hospitals by physicians with training in general pediatrics with success and a lot of challenges.

This is a case report on successful lifesaving PD done on a toddler after sustaining multiple bee stings and later developed AKI and admitted to Iringa Regional Referral Hospital, a secondary level healthcare facility in southern highland Tanzania, where he was treated for 2 weeks.

Case presentation

A 22-month-old male patient of African descent was admitted at the pediatric department as a referral from a health center 10 hours following an attack by a swarm of bees at home who were provoked by a cow while playing with his sister at their neighborhood.

He presented with acute generalized body swelling, which was more marked on the face and neck. On examination he had generalized edema, marked more on the face, with multiple sting skin marks with dyspnea and audible stridor and was irritable and in pain with a Glasgow coma score (GCS) of 13/15, respiring at the rate of 40 breaths per minute and saturating at 88% in room air but 95% after being put on 3 L/min of free flow oxygen from a concentrator. Blood pressure was not taken, as there was no blood pressure machine with an appropriate cuff of his age available. He weighed 11.5 kg.

On this day, the impression was anaphylaxis secondary to bee sting envenomation, and the patient was given a 0.12 mg stat dose of adrenaline, an intramuscular injection of dexamethasone 4 mg twice a day for 1 day, and paracetamol 125 mg per rectum thrice a day for the first day, and he was kept on oxygen concentrator.

The third day after admission, the patient had deterioration in the level of consciousness. On this day, urine output was reported to be very low, marked by a severe reduction in a number of wet nappies changed, though the exact output was not quantified due to the absence of a placed urethral catheter. The catheter was inserted, and the urine started to be monitored quantitatively on a daily basis. His kidneys were challenged with furosemide 40 mg stat dose, with no improvement in urine output after 2 hours, but he continued to be on similar medication, 20 mg twice daily for another 2 days with restriction of fluid input to match the available output and intravenous ceftriaxone 1 g once daily started. He was transfused with 50 ml of whole blood on the grounds of clinical paleness observed on examination with no signs of shock. Packed red blood cells was not available. Monitoring of the kidney functions was initiated with serial investigation of serum creatinine, electrolyte, and Blood Urea Nitrogen planned to be done twice a day, where all were elevated at baseline and kept on elevating in the following days (Figs. 1,2 and 3).

On the fifth day post admission, he was transferred to the ICU due further oxygen desaturation, despite being on an oxygen concentrator, with markedly increased generalized body swelling, further reduced urine output to only 10 ml in 24 hours, and steady elevation of renal function tests. Acute kidney injury was diagnosed using KDIGO criteria [4].

The decision to start peritoneal dialysis was reached on the sixth day post admission based on increasingly generalized body swelling with chest crackles and dyspnea, deterioration of level of consciousness, and elevating kidney functions, which were not responding to medical therapies provided in the first few days of admission.

The surgical team was consulted, and an improvised single barrel nasal gastric tube size 18 FG with added tunnels at the end was placed into the peritoneum through a midline incision, and a curved forceps advanced to pick the improvised PD catheter (NGT) on the point between the umbilicus and the left anterior superior iliac spine, bed side in the ICU under local anesthesia using 2% lignocaine. During this procedure, the patient had an episode of generalized tonic–clonic convulsions, lasting for about 15 seconds and was managed with intravenous dose of 2.5 mg diazepam while the surgeon was finishing up the catheter placement.

An intravenous central catheter was inserted through an internal right jugular vein after multiple attempts to find the peripheral veins failed, and during this procedure, the patient had cardiac arrest, whereby he was resuscitated with an Ambu bag and chest compressions for about 1–2 minutes successfully.

Peritoneal dialysis was started with 120 ml of 1.5% glucose dialysate obtained by adding 15 ml of dextrose 50% to a 500 ml bottle of lactated Ringer's solution, every 2 hours on the first day. The first two sessions had a 30 minute dwell time, and the subsequent sessions

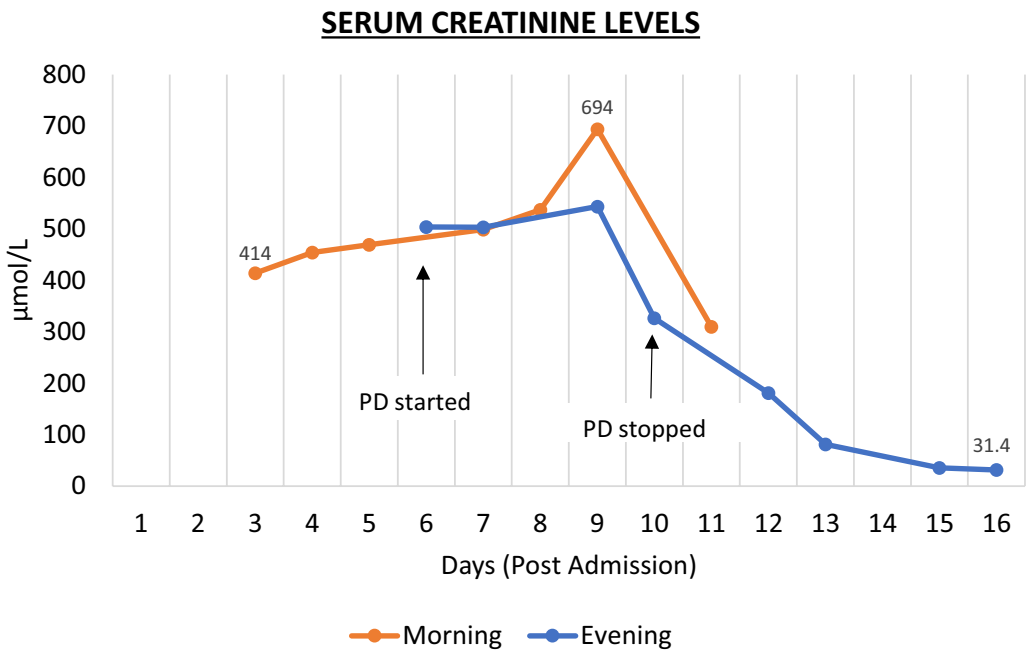

Fig. 1 Rising and falling of serum creatine levels before and after peritoneal dialysis

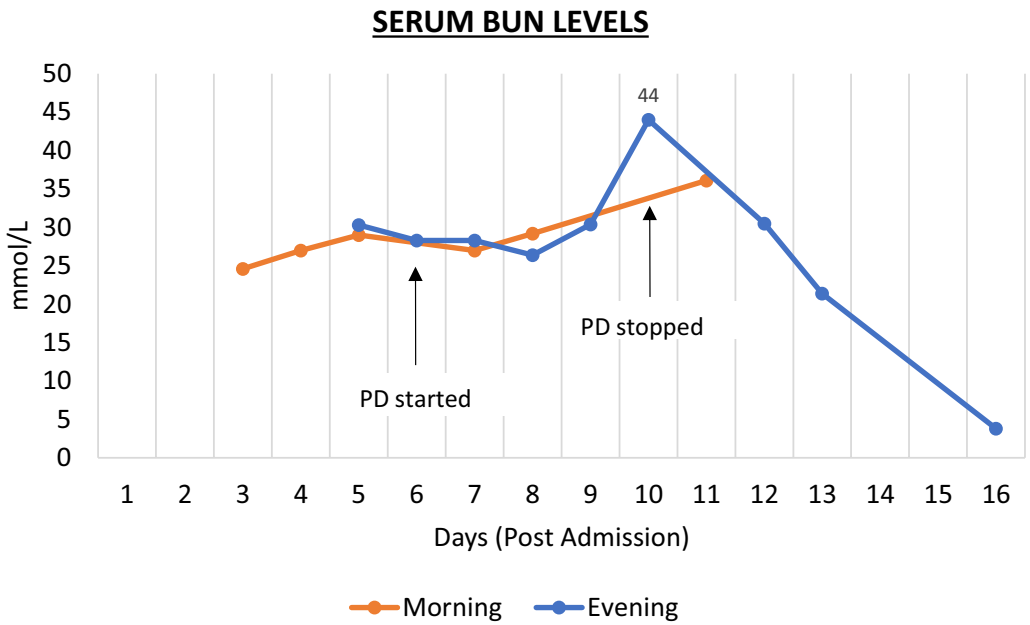

Fig. 2 Raising and falling of serum blood urea nitrogen before and after peritoneal dialysis

had 2 hour dwell time. Ceftriaxone was being added on every final 120 ml of input from the bottle. Through the second day, the patient had no improvement despite seven sessions of PD since initiation with zero fluid balance in all sessions, and he developed abdominal distension, which was tympanitic on percussion and had a heightened temperature of 40 ℃ for the first time since admission. The diagnosis of peritonitis was reached specifically after a full blood picture of the same day showing leukocytosis of $40 \times 10^3/\mu l$. It was decided to stop the PD, to start meropenem antibiotic, and for the surgical team to remove the improvised PD catheter immediately. For

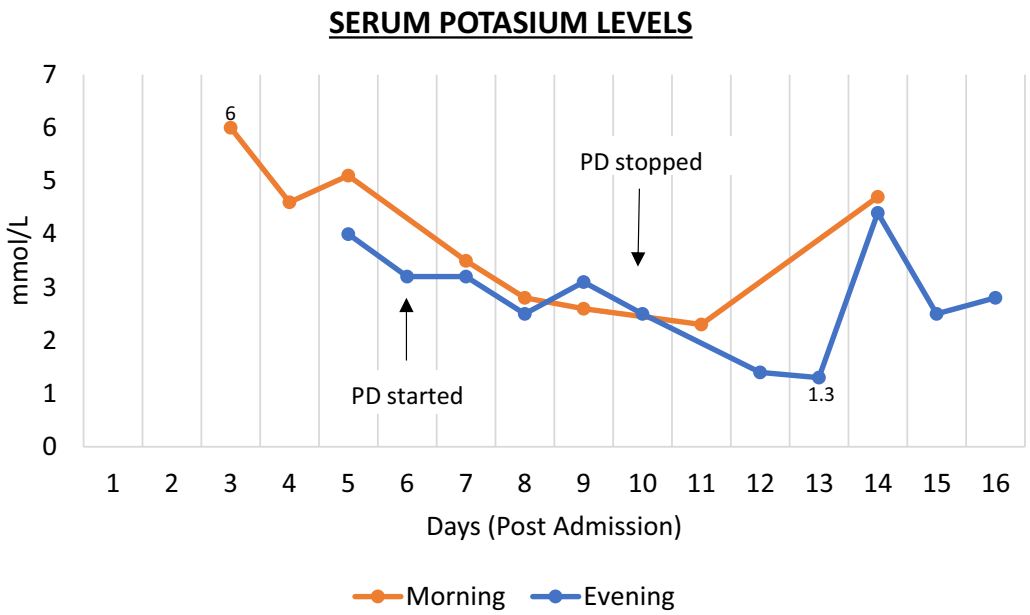

Fig. 3 Trend in serum potassium levels before and after peritoneal dialysis

2 days, the team was unavailable for the procedure, and the catheter kept on draining 200 ml of turbid, yellowish fluid without any input.

However, clinically, there was improvement during these 2 days in the aspects of temperature, edema, and level of consciousness. Urine output through the urethral catheter increased to 2.3 ml/kg/day, with kidney function tests falling from the maximum reached the previous day.

Throughout this time, patient oral feeds through the nasal gastric tube were calculated to match the output from both PD catheter, urethral catheter, and insensible losses according to body surface area. No intravenous fluids were administered.

On this fourth day post initiation of PD, the PD catheter was decided to be removed, and the wound closed successfully. The patient remained in the ICU for one more day, and he was transferred back to the pediatric general ward with notably improvement where he was discharged home 4 days later fully recovered. His creatine levels remained within a normal range (15–31 µmol/l) when he came back for follow-up visits after a week and a month, measuring 24.2 µmol/l and 28.2 µmol/l, respectively.

Discussion

Bee sting is one of the common causes of AKI in children in the tropical setting [5]. Several cases have been reported and documented about multiorgan system failure after bee sting envenomation. Children are widely and severely affected due to environmental factors, poor parental guide, curiosity, and inability to flee and protect themselves against bees after provocation [6]. Furthermore, their low weight contributes to the serious envenomation effect after sting [7]. African bees are the most aggressive bees, attacking in large numbers and fast, and their venom can easily affect the kidneys and other organ systems through various ways. One of them is through a systemic allergic response (anaphylaxis) to the bees' venom in some of the children, which ensues after multiple stings and presents with low blood pressure or shock, skin edema, wheezing, or stridor and/or gastrointestinal symptoms. The venom also causes rhabdomyolysis with spillage of myoglobin and uric acid, which are toxic to the kidneys. It can also cause a direct effect on the renal tubular cells causing necrosis and impairment of kidneys' reabsorption capabilities [7].

High incidence of bees' stings coupled with the low level of awareness on subsequent complications in the pediatric population among healthcare workers in rural areas, as well as challenges in accessing higher level and better facilities, puts children in these settings at higher risk of long-term morbidity and mortality. In addition, the absence of nephrology services including less complicated peritoneal dialysis, aggravates the crisis.

In this report, whereby the patient survived the fatal severe kidney injury, it was observed that there were several challenges which reduced the quality of the service rendered and raised the risk of mortality for the toddler.

Early diagnosis and adequate management of anaphylaxis in this child at the primary healthcare facility before

referral could have prevented the severe kidney injury. The delay could be due to the low level of awareness and ability to diagnose anaphylaxis reaction among healthcare workers in both levels of healthcare facilities. Additionally, the incidence of anaphylaxis following insect bites in LLMIC children is not known. It is estimated that in Northern America, 0.4–0.8% of the children will develop the systemic allergic reaction following a bite by various insects, the common ones being bees, wasps, vespids, hornets, and so on [8]. Healthcare workers in LLMICs, especially in rural areas, must be aware of the effects bee sting envenomation can bring so that measures are taken to secondarily prevent complications and sequels. Anaphylaxis reaction due to any allergen is managed by intramuscular adrenaline (epinephrine) injection given immediately on the outer aspect of the thigh every 5–15 minutes as needed until the symptoms are controlled, and this was not the case in our patient, where it was provided as a stat dose [8].

Comprehensive nephrology services are highly needed in rural areas, as more children are prone to develop kidney dysfunction due to malaria, diarrhea disease, anaphylaxis due to insect bites, anemia, and HIV [3]. These services need timely, easily accessible, and precise lab investigations, including renal function tests, serum electrolytes, blood gas and serum pH levels, full blood picture, and blood culture. Furthermore, equipment such as standard PD catheters and dialysate fluids, electrolyte replacement fluids, antibiotics, comprehensive intensive care services, and technical skills of insertion of PD catheters are needed for the initiation of the procedure and monitoring of the patient throughout the process. Most of these are missing in the secondary level facilities in Tanzania, making the provision of peritoneal dialysis services to be inaccessible or, even when performed, the quality of the service to be undermined.

As in our case, PD catheter and dialysate were all artificially improvised using local available nasal gastric tube and intravenous fluids (dextrose 50% and Ringer's solution). Dialysate was made using smaller bottles and buretrols to control the volume of intravenous fluids bedside, which led to repeated touch contamination to the peritoneal dialysis system designed for this patient, risking introducing infection to the peritoneum. Commercially available peritoneal dialysis pediatric systems are advised to be used, but in a limited resource setting, a closed system containing a fluid bag, buretrol, and a delivery giving set attached to a three-way peritoneal catheter should be designed to minimize contact [1].

In this hospital, no one had the trained skills for peritoneal insertion of the PD catheter by the time the decision to start PD was made. The general surgeon consulted used a technique of insertion, which resulted in two incisions made on the midline and left lower abdomen, risking leakage of the dialysate once infused. This led to a smaller amount of 10 ml/kg of dialysate infused, hence compromising the ultrafiltration pressure of the fluid. It is recommended that, whichever technique is used, the insertion of the catheter should result in only a single puncture, either on the midline or on the point between the umbilicus and the anterior superior iliac spine and not both [1].

Availability of timely and precise investigations are of paramount importance to initiate, monitor, and make decisions for the patient on peritoneal dialysis [3]. As in our case, creatinine, blood urea nitrogen, and serum potassium were missing either morning or evening or incorrect at times. Other important investigations such as serum calcium levels and blood gas analysis for measuring blood pH were not available at all. All these made a delay in decision making of starting, stopping or changing modality of treatments and further increasing the chances of poor outcome of the procedure [1, 3].

Calcium and potassium replacement fluids were also out of reach before and even after initiation of PD in our case, making replacing serum potassium which reached a nadir of 1.3 mmol/l in this patient to be impossible. This could have brought cardiovascular instability and further increases the chances of death [9] Peritoneal dialysis leads to rapid removal of potassium from the circulation, and it is recommended that once potassium has reached to a normal range, typically within 6–12 hours of dialysis, potassium should be added to the dialysate to maintain a concentration of 3–4 mmol/l [1].

Conclusion

Children with AKI after multiple bees' envenomation can be successfully dialyzed peritoneally using the minimal resources available in a secondary level health facility. Lifesaving peritoneal dialysis services for children should be made readily available in at least all these facilities in Tanzania. The government, through the medical store department and other identified prime vendors, should strive to provide all the needed medications, fluids, machines, and reagents for investigations needed for early kidney dysfunction diagnosis and treatment. In addition, in collaboration with other national and international nephrology organizations, the government should train more clinicians and nurses on the prevention and early diagnosis of kidney diseases and performing crucial peritoneal dialysis in children. More research is needed on the incidence of community acquired acute kidney injury and its precipitating factors in Tanzanian children so that the burden of the condition and hence scaling up intervention measures are put in place.

Abbreviations

AKI	Acute kidney injury
CRRT	Continuous renal replacement therapy
GCS	Glasgow coma score
HIV	Human immunodeficient virus
ICU	Intensive care unit
KDIGO	Kidney Diseases Improving Global Outcome
LLMIC	Low and lower-middle income country
NGT	Nasal gastric tube
PD	Peritoneal dialysis
RRT	Renal replacement therapy

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Author contributions
IEM prepared and wrote the manuscript, HMJ and MPS prepared the case presentation by compiling all laboratory results of the patient, TSM revised the manuscript with some additional comments, and AML provided the guidance during revision and access to the patient's data.

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Availability of data and materials
Not applicable.

Declarations

Ethics approval and consent to participate
Ethical approval for the publication of this manuscript was sought from University of Dodoma Ethical Review Board on August 2022. Written informed consent was obtained from the patient's legal guardian for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Competing interests
None declared by the authors.

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