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Investigation and Analysis of Lightning Mass Casualty Incident in a Ugandan Village

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Abstract— On 28 August 2020, the press reported ten children killed and four injured by a lightning strike while they were playing soccer near Odramacaku trading center, a small town close to the border between Uganda and the Democratic Republic of Congo (DRC). In October 2020, less than two months after the incident, the African Centres for Lightning and Electromagnetics Network (ACLENet) sent a team to make a detailed investigation through interviews and site inspection. Four survivors had sustained injuries, physical and psychological, many with potentially life-long medical after-effects and disabilities. Some local people connected spiritual connotations to the incident. Local officials and community members expressed frustration with the government's lack of acknowledgment and response to the disaster despite the new district structure for disaster response initiated in response to the United Nations Sendai Framework for Disaster Risk Reduction to which Uganda is a signatory.

Keywords— lightning, lightning injury, school, lightning safety, lightning injury prevention, lightning risk assessment, lightning in Africa

I. INTRODUCTION

While there have been news reports of multiple casualty lightning incidents in the past, few have reported on incidents involving children and even fewer on deaths in African rural areas [1-7]. On 28 August 2020, news headlines in Uganda and internationally reporting that ten children (ages 11-15) had been killed by a single lightning strike in far northwestern Uganda near Arua, a ten to twelve-hour drive from Kampala, the capital of Uganda [Fig 1]. The Arua regional office of the Uganda Police Force (UPF) took the lead on this incident, issuing a statement naming the children who died and confirming the survivors [8].

After successful fundraising for an investigation and with assistance pledged by the UPF regional office, ACLENet dispatched a team to the site of incident in October 2020 with two main objectives:

- To reconstruct the lightning incident through interviews, direct examination, and photographs.
- To establish and record injuries and health issues attributed to the lightning incident.

II. SETTING

Ayivu is a typical African village, covered with lush vegetation, grass thatched huts, and small iron roofed houses spread across meandering hills and valleys. Travel from Kampala to Arua, the closest regional city, is a ten-hour drive on tarmac road plus an additional two hour/approximately 20km drive on a murrum road to reach Ayivu.



Fig. 1. Top - Map of Uganda showing Arua city and Kampala, the capital. Bottom - Route from Arua city to the scene of lightning incident

Abiria Primary School, attended by all the fatally injured children, is in the remote countryside of Uganda in Ayivu

(sub-county) near Odramacaku, a town located near the border between Uganda and the Democratic Republic of Congo (DRC), near the city of Arua, in the west Nile region of Uganda. GPS coordinates of the lightning incident scene are 3.1151417, 30.8283933.

III. METHODOLOGY

A. Institutional Review Board

The need to investigate this tragic incident came at a time when public offices were closed to the public in Uganda because of the Covid-19 lockdown so that the institutional review process was not possible.

B. Instrument and Consent

Mr. RE, a leader representing the local parish of Ayivu in the district council of Arua, was unanimously chosen to represent all parents in interactions with ACLENet team and signed the consent forms to authorize the interviews and photographing of the surviving children.

C. Study Team and Training

The field study team was led by Richard Tushemereirwe and included George B. Bamu, Martin Omara, and Mary, a nurse from Kiryandongo hospital, herself a survivor of lightning in 2001. The team was briefed by their leader before the onset of the journey from Arua. The regional UPF office in Arua city also added background.

D. Recruitment and Interaction with Study Subjects

First responder/witnesses were sought for information that could be helpful in reconstructing the incident. Survivors who could still be traced from areas around or near Ayivu were gathered with the help of the UPF.

Direct interviews were conducted with each survivor, who was given a chance to recall the incident. Interviewer guided discussion was used to reconstruct the incident. Translation was done by one of the local UPF officers.

The ACLENet investigating team interviewed two groups of people. Four first responder-witnesses, the first people to come to the scene of the lightning incident, comprised the first group. The second group contained the four survivors who had been at the scene playing football or watching.

E. Time period of the investigation and interviews

The field visit to the lightning incident scene in October 2020 took three days. The first day was dedicated to orientation with the remaining two days for direct interviews.

IV. RESULTS

A. Reconstruction of the Scene where the Injuries Occurred

Thursday afternoon, August 27th, 2020, children from two neighboring villages, Gbuluku and Nyaute, were playing soccer on a small open field, a few tens of square meters in size between a field of pine trees and a small hut that Mr. JN was building (Fig 2). Most children playing football attended school at nearby Abiria primary school, where classes had been suspended due to Covid.

The game continued despite a light rain starting. Spectators and substitutes took shelter under the eaves of Mr

JN's building sitting on the 'veranda,' a raised foundation of packed earth, some leaning against the wall of the building. About an hour into the game, AE (16 year old male) asked his younger brother to substitute for him. As he stood in front of his peers who were squatting on the veranda of Mr. JN's hut with his hand reaching out for his brother, lightning struck, leaving him shocked and confused.

Four boys were thrown about four feet in front of the veranda, piled together. The bodies of six others lay scattered nearby. Three surviving boys, who had been either squatting or seated near their friends, lay on the ground. AE and others



Fig. 2. Most of the children who were injured were attempting to take shelter from the drizzle by sitting on a small veranda or bench seen at the base of this unfinished hut. The top center point of the roof was not yet thatched so that rain and sunlight could penetrate to the inside.



Fig. 3. A bicycle stands in the center of the field which was being used for the football game during which lightning struck.

ran to alert nearby homesteads about 100 feet away about the incident.

Mr. RA, a local leader, was among the first responders. He recalled that he found the bodies of the victims lying on the ground with their faces looking skywards. According to RA and other first responders, they administered first aid by moving the tongues of the victims to clear the airways for better breathing. They recruited nearby motorcycle riders to help move these children to a nearby medical clinic in Odramacaku trading centre. They believed the children's hearts were beating at this time. At the clinic in Odramacaku, one boy was declared dead, and his body transferred back to his parents' home for burial.

A vehicle belonging to an international non-governmental organization helped transport nine others to Arua hospital, a 2 hour drive of about 20 kms on a bad murrum road made worse during the rainy season with gullies and potholes of varying sizes. All nine were declared dead on arrival at Arua hospital.

B. Selected Survivor and Witness Stories

1. MM, 42 years.

MM is the parent of two sons, AE, 16 years old, grade 5, the survivor who ran to raise the alarm, and AS, 14 years, grade 4, one of those who died. AE sustained burns on his back, sides of his trunk, chest, and abdomen.

AE told her mother that his younger brother, AS, had been struck by lightning. She immediately ran to the scene where she found four victims piled near a hut beside the playing ground, three facing in one direction, and another lying across their feet, with six more scattered a few meters away with their bodies facing upwards.

When MM reached the scene, she made an alarm and immediately started to remove the tongues (clear the airways) of the five children she thought were still alive, believing the others to be already dead. As four more responders joined her in the rescue starting first aid on the five, she decided to run to inform her relatives of the disaster. She did not learn how the victims were taken to the nearest clinic until much later from those who had transported them.

2. BM, 44 years.

BM, the mother of one of the dead boys, GB, 16 years, grade 5 at Abiria primary school, reported that at about 5 pm, she learned of the disaster through the alarm that was made by the first arrivals at the scene where lightning struck. The field appeared to be dark with a drizzle so it was not easy to identify her son among the victims. She saw the boys lying with their faces upwards. When she was able to identify her son, she realized his body temperature was very high, the tongue was white, and, as she touched the eyes, they would not close. She, in addition, saw burns on his back, forehead, chin, face, sides, feet, and genital area.

3. AL, 31 years

AL is the mother of AY, 14 years, grade 3 at Abiria primary school, one of the survivors. When she heard an alarm, she came out of the house to see boys running haphazardly from the scene, so she proceeded in that direction to find out what had happened. She was the third person to arrive at the scene.

AL found the victims lying on the ground and, like other rescuers, tried to remove their tongues from their throats to facilitate breathing. She was informed by one of the boys that her son could still be alive, so she concentrated on him, trying to do first aid. They carried him, together with his brothers, to their home where she removed his damaged clothes. Almost immediately, a good Samaritan took him on a motorcycle to a nearby medical clinic in Odramacaku town.

4. OC, 16 years, grade 5

OC is also a student at Abiria primary school with the other boys. She was at home cooking and suddenly heard an

alarm and, to her surprise, saw the Nyaute team running from the field where the game was being played. Someone told her that some of the boys had been struck by lightning.

Her brother, AF, told her that his leg had been hurt, but he 'would be alright by God's Grace.' She took him to a medical clinic for treatment of a superficial burn on his foot which took a week to heal. The brother also had wounds on his buttocks and back. She was told that some boys were squatting, while others were seated on the verandah leaning against the wall of Mr JN's small hut adjacent to the playground.

C. Injuries Sustained by Survivors

Four survivors were available to be interviewed and examined to ascertain any injury, physical or psychological, that might have been sustained after the reported lightning incident. AY, one of the three survivors, was a spectator. He sustained burns on the back, chest, elbow, and buttocks.

Immediately after the lightning incident, each of these four were admitted to a nearby medical clinic at Odramacaku Trading Centre and were discharged after three days. The observed injuries and ailments detailed in the interview and examination are summarized in Table 1.

Most of the skin burns sustained by survivors were superficial and located either on the back or buttocks. This suggests that it was from contact with a hot surface and that the mechanism of injury for this lightning incident may have been through contact injury or ground current through the wall and soil of the veranda.

Corroborating information came from the testimonies of the survivors who recall that they were seated on the raised ground veranda around the hut. They stated that some had their backs leaning against the wall of the hut.

D. Longer term medical conditions.

MB, 14, the first interviewee among the group of survivors interviewed, reported persistent pain in his shoulders and that this pain increased whenever he gets into bed to try to sleep.

Many of the children and others related an ongoing sense of fear raising concerns about the survivors, families, and other villagers suffering Post-Traumatic Stress Disorder (PTSD). Other common sequelae of lightning injury include brain injury often manifested as learning disorders in children. School performance post-injury could not be assessed due to Covid-19 school closures. Translation probably also limited assessment and emotional expression.

D. Further observations

The witnesses in Gbuluku village volunteered information about other things that happened at about the same time as the deaths of children:

- About 40 meters from the lightning incident field, shrubs, cassava, and potatoes leaves were burnt in a neighboring field (Fig.3). This was later cleared by the owners of the garden because it was associated as a bad omen.

- Deafening noise and an extra bright flash were observed in the homesteads neighboring the field of main incident.
- About 5 children in the neighborhood, about 80 m away, were shocked and ‘jumped in fear into their mother’s laps.’

Inside the hut shown in Figure 4, it was observed that the inside grass thatching was scorched. It looked like a flame of fire had started on the grass inside and later stopped without causing much destruction. Witnesses remember seeing smoke coming from inside the grass thatching. A rosary had

TABLE 1 SUMMARY OF INJURIES AND AILMENTS TO THE FOUR SURVIVORS OF LIGHTNING INCIDENT NEAR ODRAMACAKU


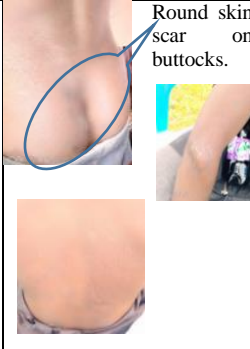

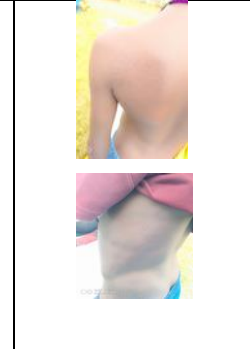
OBSERVATIONS	From Nyaute village. MB 14	From buluku village. AY14	From Gbuluku village. AF 11	From Nyaute village. AM 11
What do you remember?	He only realized his surroundings when he was already down, he can't remember what exactly happened.	He only remembers when he was already lying down on the ground.	He only remembers that he was lying on the ground.	He remembers seeing something like fire and very bright light.
How have you been feeling ever since the incident happened?	He has been feeling pain in his shoulders.	Ok. He is feeling better now.	He has not been feeling well, and he feels scared most times.	Still scared of lightning, fearing that it might come back anytime.
How have you been sleeping?	Has been feeling pain at night when in bed.	He is sleeping well.	He has been restless while sleeping at night and is scared most times.	He is sleeping well.
Where were you when the incident happened?	He was sitting on the veranda when lightning struck.	He was sitting on the veranda.	He was squatting on the veranda.	He was sitting on the veranda.
Other physical observations.				
	Scars on the left elbow and right leg.	Scars on the right elbow, back, waist, and buttocks.	Scars on the waist, buttocks, right knee and on the left side of the back.	Scars can be seen on the left side of the back.
	His clothing was visibly burnt on the left elbow as seen in the photo. He has no appetite.	He has no appetite		He has no appetite.



Fig. 4. Photo of the wall where thatch roof meets the mud wall. The inside was scorched by fire apparently started by lightning. A rosary was hung to chase away evil spirits.

been hung on the scorched grass thatch with some witnesses claiming this had the ability to chase away evil spirits that were thought to have caused this incident (Fig. 4).

Mr. JN has abandoned plans to finish the home and settle in it. The land around the hut is owned communally by the extended family headed by his father. Attempts by the family to sell the field with the hut have failed because no one wants to buy what is believed to be a cursed, demon-possessed piece of land. Cassava and potato plants scorched by lightning near the scene were immediately uprooted to disassociate the garden owners from the evil spirits or bad omens (Fig 3).

E. Lightning Location Data

The investigating team consulted Vaisala, Inc., the operators of Global Lightning Data (GLD-360), to ascertain the occurrence of lightning in and around the scene in the evening of Thursday 27 August 2020. The GPS coordinates

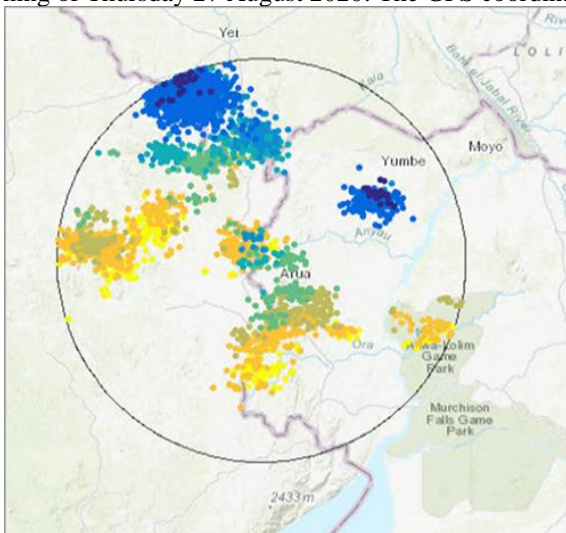


Fig. 5. GLD-360 data in a 25 km radius around the lightning incident scene, between 3 – 8 pm on August 27th, 2020.

were submitted for the search with the time period specified as between 3–8 pm EAT.

GLD-360 data indicated that there were many lightning flashes in the specified period in a 25 km radius around the

scene of incident (Fig. 5). This corroborated the time given by witnesses as ‘approximately 5 pm in the evening.’

F. Comments Offered by the General Public about Response by the Government

Members of the public, after learning of the ACLENet’s team presence in the village on the first day, came forward to provide information. They were eager to narrate how the lightning incident happened and the unfolding of subsequent events. However, the investigating team soon learned that much of what they had to offer was hearsay, so much was disregarded by the investigating team. Nevertheless, it shows how the incident has impacted the community’s experience.

However, these members of this public expressed views which were important in the overall picture of Disaster Risk Reduction (DRR) plus Disaster Response and Management (DRM). They expressed their dissatisfaction towards the lack of government response to this lightning disaster. After the incident, no member of the District Disaster Committee nor Ministry of Disaster Preparedness responsible for disaster response ever visited the scene nor interacted with the affected families. This left them wondering if there was any program responsible for disasters from the government.

They further asked whether they should expect any relief item(s) or compensation, especially the families who had lost children in this lightning incident. In developing countries, a death payment or compensation is often given to families of those who die. The investigating team referred these people to their local district authorities.

Members of the public corroborated their belief in hanging the rosary in the hut to help in repulsing evil spirits thought to be responsible for the deadly lightning incident.

V. DISCUSSION AND LIMITATIONS OF THE STUDY

Results obtained from this investigation were reviewed against the initial objectives.

A. Team Training

Review of the findings of this investigation along with those of a prior investigation make it apparent that the team requires more extensive training and standardization [7].

B. Reconstruction of the Scene

Errors common to studies that rely on translation undoubtedly affected this investigation [9]. Additionally, the presence of the UPF police officer/translator can be a source of anxiety for both adults and children hampering responses. Interviewers recognized that expectations of some respondents for material compensation colored narratives and made every effort to corroborate information from numerous witnesses and survivors to produce a reasonably coherent and believable picture of events. Adults who responded to the first alarm had minimal knowledge of first aid.

Interviewers found the surviving children lacked the capacity for vivid narration, probably due to their young age, lack of confidence to express themselves or amnesia for the event, common for survivors of lightning incidents [10]. Nonetheless, their testimonies were filled with critical pieces

of information. As would be expected, the events were most confused immediately after the lightning strike during the dramatic events afterwards. Most agreed the children were seated on the raised soil surrounding the hut or squatting with their buttocks touching the ground. This may explain the burns that were consistently located on the buttocks and backs.

Respondents corroborated the smoke seen emerging from the hut which agrees with the scorching found inside the grass thatching near the roof/wall juncture (Fig. 4).

C. Medical records

Reports of lightning mass casualty incidents (MCI) in the medical literature often detail the acute medical findings. Unfortunately, this investigation was delayed due to accessibility and the need for fundraising [1-7]. Additionally, Covid restrictions on non-emergent medical care and access to medical records as well as the lack of digitized medical records and internet in this remote location prevented access to the records of the acute medical care to the victims either by visits to the medical facility or by electronic request.

Some media accounts reported the bodies of victims had been removed to a medical facility for 'postmortem examination.' However, they also reported the bodies were released to families on the same or subsequent day, making true postmortems, typically requiring several days, forensic medical expertise, and laboratory examinations, all lacking in this remote area of Uganda, very unlikely [11, 12].

D. Effects of beliefs about spiritual causation

Members of the public, especially those who talked to investigators, believed that there was a spiritual cause to this lightning incident. It was not something solid that they could point a finger at, but they all believed there must have been demons responsible for this tragic incident.

The lack of solutions for lightning hazard seems to create hopelessness especially when deaths happen in the local population. This hopelessness, in turn, creates a void which is often filled by conspiracy theories involving a spiritual causation. This process of myth creation can hamper lightning safety because people lack knowledge or may not believe there is any effective preventive behavior they can take against a 'spiritual' cause such as demons, as a punishment for sins, or because lightning has been called down by witches hired by enemies, all common beliefs in African countries.

E. Disconnect with government disaster response

Uganda is a participant in international efforts to reduce and manage disasters and is a signatory to the Sendai Framework [13]. As a result of recommendations from the United Nations International Strategy on Disaster Reduction (UN/ISDR), the Uganda government established a Ministry responsible for disaster risk reduction. The Ministry of Response, Disaster Preparedness and Refugees was to include Disaster Risk Reduction (DRR) in the Sustainable Development agenda [14]. Consequently, in planning for and mainstreaming of DRR, the Ministry has established disaster reduction/response committees at the local government

district level but it is likely that the Covid closures hampered their development.

The discontent expressed by the Ayivu community further suggests a disconnect between the district DRR committees and the people they are constituted to serve. If the local district committee is not provided with enough resources, appropriate infrastructure, and training to support the communities, their activity remains ineffective and is perceived as unresponsive. Alternatively, it might be a problem of strategy and work-plans. If neither the DRR committee or the central government department have appropriate work plans, the district committees can remain useless. Also, if the district committee were educated in lightning safety, they would take appropriate messages to the affected communities and teach effective safety behaviors.

VI. CONCLUSIONS

Findings from a prior mass casualty lightning investigation in Uganda can be called forward to this study [7]:

- This was a mass casualty incident that overwhelmed the village's capacity and medical resources to care for the victims. Adults on the scene had minimal knowledge of first aid to care for the victims acutely.
- There was no warning nor weather forecast available to the public to warn them of bad weather and lightning danger.
- There were no lightning-safe places to go for safety and no knowledge of effective lightning safety behaviors by the community.
- Reports from the villagers indicate the failure of the new decentralized local response team for disaster management since no one from the team had contacted them, offered aid, nor sought their accounts by the time our team visited two months after the incident occurred.
- Fear, superstitions, and blaming of curses and demons were consistent with beliefs about lightning across much of Africa.
- ACLENet's investigative team needs more extensive training and standardization for future MCI investigations.

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