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Case Report

Diffuse Cerebral Hypoxia in the Post Resuscitation Phase: Clinical and Ethical Reflections on a Case

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Abstract

Background: Delayed initiation of cardiopulmonary resuscitation (CPR) following cardiac arrest is strongly associated with adverse neurological outcomes, including widespread hypoxic brain damage. Prompt and effective CPR is essential to mitigate irreversible cerebral injury and improve patient prognosis.

Case Presentation: We report the case of a 57-year-old male who sustained physical assault at his workplace and subsequently collapsed due to cardiac arrest. Cardiopulmonary resuscitation was not started immediately, and there was a delay of approximately fifteen minutes before CPR was initiated. On arrival at a tertiary care facility, the patient exhibited no pulse and was unresponsive, necessitating 15 to 20 minutes of intensive resuscitative efforts to achieve return of spontaneous circulation (ROSC). Despite stabilization and mechanical ventilatory support, he remained comatose with a Glasgow Coma Scale (GCS) score of 3. MRI revealed diffuse hypoxic-ischemic encephalopathy involving the hippocampus, bilateral basal ganglia, and frontoparietal cortices. The patient was managed with neurocritical care, rehabilitation, and underwent tracheostomy. While gradual motor improvement was noted, he remained in a semi-comatose state with ongoing cognitive impairment, requiring long-term supportive care.

Conclusion: This case underscores the severe consequences of delayed CPR and highlights the significant physical, emotional, and financial burden on caregivers. It also emphasizes the pivotal role of primary care and family medicine practitioners in promoting community-based CPR education, facilitating caregiver support, and coordinating multidisciplinary rehabilitation services to improve outcomes in similar scenarios.

Keywords: *Delayed resuscitation, hypoxic brain injury, CPR, ROSC.*

Introduction

A primary cause of sudden death worldwide remains cardiac arrest, making the prompt initiation of cardiopulmonary resuscitation crucial for patient survival and neurological outcomes. While successful resuscitation is often viewed as a medical success, a late initiation of CPR can lead to lasting hypoxic brain injury even if spontaneous circulation (ROSC) is achieved [1]. Sudden cardiac arrest (SCA) poses a significant worldwide health issue, particularly exhibiting low survival rates when occurring outside medical facilities. Although the overall prevalence differs by region, in affluent countries, the estimated occurrence of out-of-hospital cardiac arrest (OHCA) is approximately 50-60 per 100,000 individuals. Survival rates following OHCA are typically low [2].

A systematic review indicated that merely 29.7% attained return of spontaneous circulation (ROSC), 22.0% made it to hospital admission, and 8.8% survived until hospital discharge. Prompt CPR, bystander assistance, and utilizing AEDs (Automated external Defibrillator) are essential for boosting survival rates [3]. Research indicates that approximately 41% of OHCA instances get CPR from bystanders, while the usage of AEDs by bystanders in public places stands at roughly 11.7%. Public education and training on the use of CPR and AED are essential for enhancing survival rates in cases of OHCA [4]. CPR, particularly when started right away and paired with quick defibrillation, can greatly enhance survival chances [5]. Particularly in situations of uncertain neurological recovery, diffuse cerebral hypoxia during the post-resuscitation phase poses significant challenges not just in medical management but also in ethical decision-making [6].

We report on an adult man who underwent a delayed CPR attempt and suffered significant global hypoxic brain damage but was effectively revived. Via this case, we consider the neurocritical care issues, prognostic uncertainty, and moral conundrums resulting from delayed resuscitation. We also highlight how a few physicians in underdeveloped countries lack sufficient emergency training and are terrible at quick thinking and avoiding long-term problems, and how alarming this condition is.

Case Presentation

Patient Information

Following a physical attack during his shift, a previously healthy 57-year-old male with no known comorbidities experienced cardiac arrest. Basic life support was not started at the location. The most frightening detail is that the patient is a physician himself and was surrounded by specialist doctors who failed to administer basic life support, demonstrating how alarming and defective the education system and basic training are in some underdeveloped countries.

Approximately fifteen minutes later, he was taken to a nearby superspeciality hospital. Upon arrival, he exhibited no pulse, had dilated pupils, suffered from bladder incontinence, and showed no spontaneous respiration.

Emergency Resuscitation and Initial Workup

The cardiologist on shift performed cardiopulmonary resuscitation (CPR) for approximately thirty minutes, resulting in the return of spontaneous circulation (ROSC). The patient was placed on ventilatory assistance and immediate oxygenation was administered. Cardioprotective and antiarrhythmic medications, including amiodarone, noradrenaline, dopamine, were initiated right away with electrolyte support, especially potassium supplementation, to establish the ABCs of emergency treatment. The patient remained in a comatose state but reacted to pain, and there was an immediate pupil response to light. The patient was quickly transferred to the ICU for ongoing critical care.

A lab work was performed while the patient was in the emergency department, the results of which are tabloid in Table 1.

An ECG was conducted in the emergency department after patient stabilization, revealing a ventricular rate of 161 bpm and a QRS duration of 166 ms. It was interpreted as extreme tachycardia and atrial fibrillation with an uncontrolled ventricular response, accompanied by frequent PVCs (Premature Ventricular Contractions) or aberrant ventricular conduction. It also exhibited significant right axis deviation, right bundle branch block, and inferior ST-T changes possibly attributed to myocardial ischaemia. An ECHO (echocardiography) conducted in the emergency department revealed left ventricular dilation, inferior wall motion and nearby septal wall motion abnormalities, age-related reductions in mitral and tricuspid diameters, and a diminished ejection fraction of 23%.

ICU and Neuroimaging Course

The MRI was initially delayed due to the patient's respiratory support and unstable hemodynamics. Although the patient had reactive pupils, they stayed in a comatose state. Once admitted to the intensive care unit, he received treatment with inotropes, antiplatelet agents, statins, amiodarone, and LMWH (low molecular weight heparin). The patient slowly developed sepsis in the first twenty-four hours after the heart attack and was given broad-spectrum antibiotics intravenously as an empirical treatment.

Potassium supplementation was continued because of hypokalemia, and a central line was inserted for medication administration, while a nasogastric tube was placed for nutritional feeding. An MRI conducted later in the ICU stay verified diffuse hypoxic-ischemic brain injury affecting bilateral basal ganglia, hippocampus (Figure 1), and both fronto-parietal and occipital cerebral hemispheres (Figure 2). An EEG (electroencephalogram) was also performed in the ICU that revealed low voltage alpha waves.

The patient was subsequently transferred to a tertiary care center overnight, equipped with improved cardiac and neurological facilities, and emergency treatment persisted over there for three days, after which inotropes were gradually reduced, while cardioprotective medications, cardiac stabilizers, antibiotics, and potassium supplements were maintained. To prevent ventilator-associated pneumonia (VAP), a challenging choice was made by the attending doctors and family, resulting in a tracheostomy on day seven. On day 3, the patient exhibited evidence of eye opening and responded to verbal stimuli, though there was no intentional movement. During ten days, the patient's muscle strength improved from M0 to M3 due to effective physiotherapy techniques; however, they remained non-verbal and disoriented, not responding to commands. The ICU stay lasted for one and a half months, during which the patient demonstrated recovery, and stabilizing treatment proceeded.

Table 1. Laboratory Findings at Time of Admission.

Parameter	Patient Value	Normal Range
Hemoglobin	13.4	13.5 - 17.5
WBC ($x10^9$/L)	19.8	4.0 - 11.0
Platelets ($x10^9$/L)	195	150 - 450
Sodium (mmol/L)	148	135 - 145
Potassium (mmol/L)	3.2	3.5 - 5.0
Chloride (mmol/L)	107	98 - 107
Calcium (mg/dL)	8.6	8.5 - 10.5
Urea (mg/dL)	47	7 - 20
Creatinine (mg/dL)	1.8	0.7 - 1.3
AST (U/L)	51	10 - 40
ALT (U/L)	61	7 - 56
Troponin T (ng/mL)	3.58	< 0.04
CK-MB (U/L)	72.5	< 25

This table summarizes the patient’s laboratory parameters on admission, revealing leukocytosis, elevated cardiac enzymes, mild transaminitis, and renal function compromise, all suggestive of post-arrest systemic response and hypoxic injury.

Table 2. Comparison of reported cases of hypoxic ischaemic brain injury following cardiac arrest and prolonged cardiopulmonary resuscitation.

Details	Case 1 (Ata et al.) [13]	Case 2 (Ata et al.) [13]	Case 3 (Ata et al.) [13]	Case 4 (Kilic et al.) [14]	Present Case
Age	68	43	44	24	57
Sex	Male	Male	Female	Male	Male
Cause of arrest	Not mentioned	Brugada syndrome type 1	Not mentioned	Lighter gas inhalation	Physical assault resulting in shock
ACS as the cause	No	No	No	No	No
Locus attached	No	No	No	No	No
Total CPR time	44 minutes	40 minutes	14 minutes	40 minutes	30 minutes
CPR by bystander	18 minutes	Not mentioned	10 minutes	Not mentioned	Not given
CPR by EMS	26 minutes	Not mentioned	4 minutes	Yes time not mentioned	30 minutes
Number of shocks given	9	9	0	Not stated	8
Initial rhythm	VF	PEA	Asystole	Asystole	Asystole
Reverted rhythm	Narrow-complex QRS rhythm	STD: Inferolateral leads, STE: V1 and AVR	Sinus tachycardia with frequent PVC	Not mentioned	Extreme tachycardia with AF and frequent PVC
CAG	Unremarkable	Unremarkable	Unremarkable	Unremarkable	Unremarkable
MRI head	HIE	HIE	HIE	HIBI	HIBI
EEG	Not mentioned	Not mentioned	Low voltage	Not mentioned	Low voltage alpha waves
CPC scale at admission	4	4	4	Not stated	Not available
MRS at admission	+5	+5	+5	Not stated	Not available
GCS at discharge	15/15	15/15	15/15	14/15	8/15
MRS at discharge	0	0	0	+1	Not available
Total hospital days	141	47	80	140	>365

Abbreviations: ACS, acute coronary syndrome; CAG, coronary angiogram; CPR, cardiopulmonary resuscitation; EEG, electroencephalogram; EMS, emergency medical services; HIE, hypoxic ischemic encephalopathy; HIBI, hypoxic ischemic brain injury; PEA, pulseless electrical activity; PVC, premature ventricular complex; STD, ST-depression; STE, ST-elevation; VF, ventricular fibrillation; GCS, Glasgow coma scale; MRS, magnetic resonance spectroscopy; CPC, cerebral performance category scale; MRI, magnetic resonance imaging

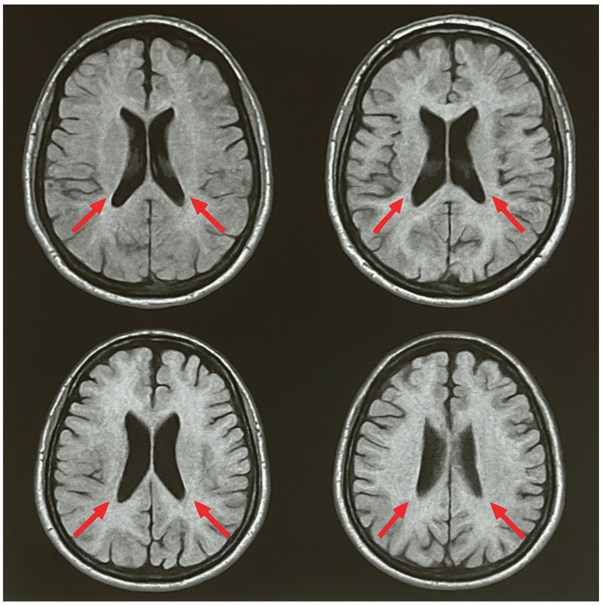

Figure 1: Axial Brain MRI – FLAIR and DWI Sequences.
Axial images demonstrate diffuse bilateral cortical and subcortical hyperintensities (arrows), indicative of global hypo toxic-ischemic injury as seen in imaging.

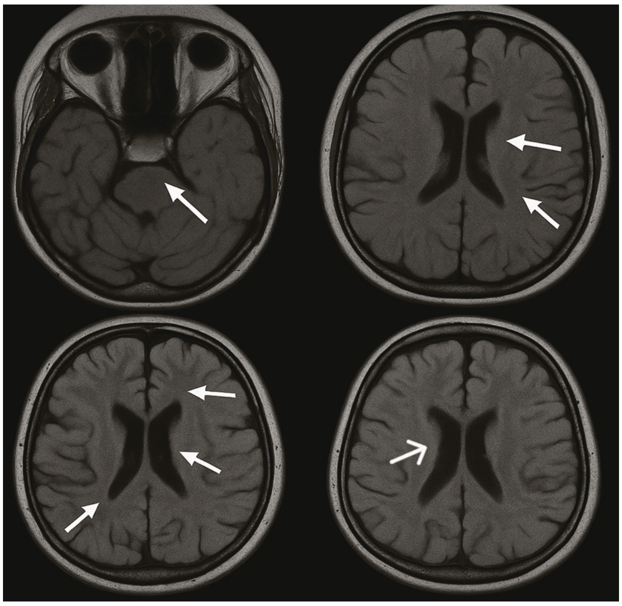

Figure 2: T2-Weighted Axial MRI Showing Diffuse Cortical and Subcortical Hypoxic-Ischemic Changes.
A pair of T2-weighted axial MRI brain images highlighting diffuse hyperintensities in the cortical and subcortical regions (arrows), consistent with hypoxic-ischemic injury. Notable findings include bilateral loss of gray-white differentiation and signal abnormalities most prominent in the parietal and occipital lobes, which are typical of diffuse cerebral hypoxia following delayed CPR.

Complications and Developments

When attempts were made to isolate the patient within the ICU to prevent nosocomial infections, inadequate or delayed suctioning of the tracheostomy tube resulted in an infection and subsequent septic shock, leading to atrial fibrillation in the already weakened heart. A tracheostomy mucus culture was performed, confirming the presence of Klebsiella pneumoniae and Pseudomonas aeruginosa. A later chest X-ray confirmed the diagnosis of a lower respiratory tract infection. Stabilization was obtained via management that involved faropenem, amiodarone, and paracetamol. A prompt reaction was observed within twenty-four hours, as the fever began to decrease. Leukocyte count that rose to 18.5 (x10^9/L) returned to 9.0 (x10^9/L). The patient remained in the ICU for another ten days before being transferred to a rehabilitation center.

Care was maintained along with supportive management. The patient continued to exhibit physical improvement despite being semi-conscious, unresponsive to commands, and showing no signs of voluntary motor activity.

Ongoing Care and Outcome

A year later, the patient remains in a semi-comatose condition. He requires care for his tracheostomy, which entails infection management, prompt replacement, and assistance with nasogastric feeding. Evaluating urinary tract infections and related issues with foley catheter use is also required. He also requires regular physiotherapy and activities to enhance posture, including sitting in a recliner for one hour twice a day, along with splinting exercises to minimize flexion in hands and feet. Despite vigorous physiotherapy, he continues to exhibit no voluntary movements, minimal visual tracking, and no significant verbal communication. Only a slight enhancement in his motor abilities is noted.

He is still unable to support his neck independently and needs a collar for assistance. Along with hospital meals, supportive stimulation also comprised nutritional enhancement through tailored high-protein, high-calorie dishes and auditory, visual and tactile therapy that includes, playing him his favorite songs, his favorite movies, telling him the latest news and orienting him to time, place and person. He shows a strong response to pain and has a motor power of M4. Despite a reduction in his nystagmus and having gained some weight with regular routine counts, he continues to have deficits in higher cognitive function and voluntary responsiveness.

Later ECHO results indicate an enhanced ejection fraction of 39% and left ventricular dilation, along with improved motion in the inferior and septal walls. The ECG reveals sinus rhythm, without PVCs and Q waves, suggesting prior myocardial infarction. An MRI conducted displayed healed focal hemorrhages and enhanced signaling in hippocampal areas, yet no marked change in cerebral hemispheres, indicating diffuse hypoxic brain damage.

Discussion

A significant consequence of cardiac arrest remains hypoxic brain injury, particularly when cardiopulmonary resuscitation (CPR) is postponed [7]. A previously healthy 57-year-old man in this instance suffered a cardiac arrest following a physical assault, but he did not receive immediate CPR, resulting in an extended no-flow condition. Due to this delay, the likelihood of global cerebral hypoxia and subsequent neurological impairment was significantly increased [8].

Energy deficit, disruption of ionic homeostasis, excitotoxic damage, oxidative stress, and programmed cell death are all outcomes of the pathophysiology associated with hypoxic-ischemic brain injury [9]. Regions that are especially susceptible comprise the cerebral cortex, basal ganglia, and hippocampal areas [10]. Research on extended hypoxia indicated that our patient's MRI findings revealed widespread involvement of these regions.

Delayed initiation of basic life support (BLS) is recognized to predict poor neurological outcomes. To ensure cerebral perfusion, the American Heart Association emphasizes the importance of prompt identification and the swift delivery of effective CPR [11]. Regrettably, in this case, the extended period of anoxia was partially due to the inaction of those present. The patient showed only slight functional improvement over time and continued to be in a persistent condition of altered consciousness despite achieving a successful return of spontaneous circulation (ROSC).

Alongside hemodynamic and ventilatory stabilization, post-cardiac arrest management also includes neuroprotection and rehabilitation [12]. Tracheostomy, mechanical ventilation, antibiotic therapy for sepsis, and nutritional optimization were included in the standard care for our patient in the intensive care unit. Advanced cognitive abilities and voluntary movements remained significantly hindered, even though there were slight enhancements in motor responses likely resulting from partial cortical recovery.

While researching similar cases, we came across a case report and case series that we compared to our own case. The various findings are presented in Table 2.

The comparison table above clearly demonstrates the importance of providing basic life support and CPR promptly. A prompt response to emergency services is vital for the patient's outcome.

It is alarming that in developing nations, the medical education system is so inadequate that even doctors trained at the specialist level struggle to think on their feet when immediate action is needed to save a life, and some may totally lack this essential training or have never taken the initiative to learn, owing to insufficient oversight and inadequate medical policies. Lack of infrastructure is also a concern. In many developing nations,'s a significant need for improved BLS (Basic Life Support) training for healthcare professionals, including doctors.developed countries often have stricter licensing requirements mandating BLS/ACLS (Advanced Cardiac Life Support) training, developing nations may lack such mandates.leads to potential deficiencies in knowledge and practice of essential BLS skills, especially among doctors and medical students directly involved in emergency care [15,16,17].

Although the patient in our case collapsed while working in a government hospital, colleagues took no action and a defibrillator was absent, leading to a transfer to a nearby private hospital after a significant delay. This might have taken our patient’s life, but once more, a skilled physician saved it through rapid thinking and expertise, proving that not all doctors are under trained. However, following that delay and the absence of bystander CPR, while the patient's life was preserved, it led to lasting disability and an uncertain outlook, inflicting a physical and emotional burden on both the patient and their family. Additionally, we should consider the expense of rehabilitating someone who has been suffering for a long time. It’s important to remember that such instances are quite uncommon in developing countries, as the majority of patients do not survive following such a delay in CPR. That’s the reason why their care and clinical management also becomes more difficult.

This situation emphasizes the need to reform the medical education system in developing nations and to guarantee that the physicians they employ possess not only degrees and certifications for employment but also the capability to save lives and avert long-term disabilities by utilizing their knowledge and skills in critical situations. Instead of investing billions in military equipment, allocating a few million dollars toward government healthcare infrastructure, like providing at least one defibrillator in every government hospital, will enhance the long-term reputation of these nations and, at the very least, save lives.

In summary, tackling the requirement for BLS training in developing countries is crucial for enhancing emergency services and preserving lives. This necessitates a comprehensive strategy, incorporating heightened awareness, specialized training initiatives, distribution of resources, and possibly compulsory training mandates [15,16,18].

Family physicians are uniquely positioned to emphasize the importance of BLS training for non-medical personnel, caregivers, and family members since they often serve as the first point of care in community environments [19]. This case highlights the dire consequences of delayed cardiopulmonary resuscitation and the urgent need for enhanced education, training, and preventive strategies in both public and healthcare environments.

Additionally, several specialties such as neurology, rehabilitation, nutrition, and psychosocial support must collaborate in their care for patients experiencing severe hypoxic brain injury over the long term. This method aligns well with the ongoing, comprehensive care model that lies at the core of family medicine. In these circumstances, family physicians are crucial in guiding end-of-life choices, providing emotional support, and educating caregivers.

This situation greatly affected the patient's family alongside the clinical challenges. Witnessing a cherished individual transition from being fully capable and independent to a semi-comatose condition was an immense emotional burden. Family members faced the emotional burden of ambiguous loss—grieving the cognitive absence while the patient remains physically alive—along with adapting to the challenges of long-term care. The strain worsened due to the financial impact of extended stays in the intensive care unit, rehabilitation, and support services. Healthcare providers, particularly in family medicine, should assist caregivers in these challenging circumstances by providing resources for mental wellness, compassionate communication, and guidance on home care [20].

Conclusion

This case illustrates the devastating neurological consequences of delayed cardiopulmonary resuscitation following cardiac arrest, even in previously healthy individuals. Although the patient was successfully resuscitated, the prolonged hypoxia led to widespread hypoxic brain injury, resulting in an extended semi-comatose condition with significantfunctional deficits. In numerous instances, timely CPR is essential for achieving positive neurological results. This situation also emphasizes the necessity for prolonged multidisciplinary initiatives to care for such patients, encompassing neurological treatment, rehabilitation, nutritional assistance, and caregiver participation. From the perspective of primary care, it highlights the significance of family physicians monitoring post-ICU treatment, providing caregiver assistance, and implementing coordinated rehabilitation methods to improve quality of life. This situation also highlights the unseen emotional toll on families, who often assume the role of long-term caregivers while coping with emotional turmoil, sorrow, and uncertainty. Enhancing patient and caregiver results necessitates knowledge and understanding about early resuscitation, outcomes of hypoxic injury, and care that focuses on the family.

Declaration

Ethics approval and consent to participate

Ethics approval for publication of this case report was taken from the Institutional review board.

Consent for publication

Informed written consent was secured from the patient's legal guardian for the publication of this report and any associated images.

Availability of data and materials

Not applicable. All relevant case details are provided within the manuscript.

Competing interests

The authors affirm that there are no conflicts of interest to disclose.

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Authors' contributions

Dr. Mehak Bhagat led the conceptualization of the case report, conducted the literature review, and prepared the initial draft.

Mohammad Aquib assisted in case evaluation, interpretation of findings, and contributed to revising the manuscript.

Dr. Moayad Moawia Zain Elabdin Ahmed offered senior oversight, provided critical feedback, and approved the final version.

All authors reviewed and endorsed the final manuscript.

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