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Gamma Oscillations and Near-Death Experiences

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Abstract

Recent research has identified an increase in EEG gamma activity following cardiac arrest. Gamma oscillations, which are high-frequency brain waves (30 Hz-90 Hz), are linked to various cognitive processes and states of consciousness. The synchronized activity of neurons in the gamma-band is believed to integrate different aspects of an object's properties. These findings bring to mind recent studies that indicate these oscillations may also play a role in Near-Death Experiences (NDEs), particularly concerning visual hallucinations. During NDEs, individuals frequently report vivid visual experiences, such as witnessing bright lights or seeing deceased relatives. In a recent case, we monitored a patient suffering from a heart attack using Continuous Electroencephalogram (cEEG). Interestingly gamma activity was consistently observed throughout the recording even after the patient experienced Ventricular Fibrillation (VF) and Cardiac Arrest (CA). Clinical monitoring showed that ECG activity was inadequate to support proper cerebral blood flow before VF and CA. While these results are compelling, they are not yet definitive in explaining NDEs.

Keywords: Ventricular fibrillation; Cardiac arrest; Gamma oscillations; Neuropsychiatric; Occipital lobes

Introduction

Recent research has increasingly pointed toward a rise in EEG gamma activity following cardiac arrest. This phenomenon has been observed across both human and animal studies. For instance, one study noted a surge in gamma-band activity post-cardiac arrest, attributed to hypercapnia prior to and the cessation of cerebral blood flow following the event [1,2]. Another study found a similar spike in gamma oscillations during the transition to death even as neuronal activity halted, though the activity diminished after cardiac arrest.

Posada and colleagues explored how gamma oscillations, induced by visual stimuli, are influenced by higher-order processes related to task complexity. This gamma activity was especially prominent in the right-central parietal area [3]. Gamma oscillations are linked to high-frequency brain waves (30 Hz-90 Hz) and they are important for cognitive functions such as attention and memory. In neuropsychiatric disorders alterations in gamma activity are common [2,4,5].

Recent studies suggest these oscillations might play a significant role in NDEs, particularly visual hallucinations. People undergoing NDEs often describe vibrant visual experiences, such as seeing bright lights or encountering deceased individuals. Research shows a surge in gamma wave activity before death, primarily around the temporal-parietal and occipital lobes, which are associated with visual processing and altered states of consciousness [6].

Literature Review

In a recent case study, we examined a patient who had suffered a heart attack, using the Neuronic S.A. continuous EEG monitoring system (cEEG). EEG monitoring began as soon as clinical symptoms presented. At 2 hours and 21 minutes into the recording, and again at 44 minutes, the ECG recorded alternating periods of activity and isoelectric signals. Ventricular Fibrillation (VF) began at 2 hours and 22 minutes eventually leading to Cardiac Arrest (CA) at 2 hours and 59 minutes. Throughout the monitoring process gamma activity was consistently dominant and persisted even after VF and CA. Initial clinical observations showed that the ECG did not generate sufficient cerebral blood flow before VF and CA. Additionally, we found elevated values across all Heart Rate Variability (HRV) bands. With respect to the autonomic system, brain-dead patients exhibited a considerable reduction in HRV across time and frequency domains. We also identified an unexplored HRV increase linked to supratentorial brain damage, which caused diencephalic dysfunction, leading to a progressively intense autonomic burst as the patient's Glasgow Coma Scale (GCS) dropped below eight [7,8].

We documented a second patient using HRV analysis shortly after a brain death diagnosis, where residual low-frequency waves persisted for about ten minutes [9]. In the Jahi McMath case, despite a diagnosis of brain death/non-candidacy, EEG activity and autonomic responsiveness continued in response to auditory stimuli ("Mother Talks") [10].

Discussion

Although the brain is thought to become hypoactive during cardiac arrest, the possibility of conscious brain activity during this event is still up for debate. Several studies using EEG and Bispectral Index (BIS) monitoring have reported heightened brain activity during cardiac arrest [11,12].

Gamma oscillations, the fastest brain waves are associated with consciousness, perception, memory and emotion. The rise in gamma wave activity has been linked to an increase in the brain's connectivity between various regions during the moments leading up to death. Borjigin and colleagues examined rats subjected to experimental cardiac arrest using continuous EEG. They observed a temporary increase in synchronized gamma oscillations during the first 30 seconds post-cardiac arrest, before the EEG became isoelectric. These gamma oscillations were widespread and exhibited notable coherence during the arrest. Additionally, this frequency band showed increased anterior-posterior connectivity and phase-coupling with theta and alpha oscillations. The researchers suggested that the elevated neurophysiological activity observed near death may reflect an enhanced state of conscious processing just before death [13].

Surges in EEG gamma activity after cardiac arrest have been connected to NDEs. These experiences often include sensations of leaving the body, seeing a bright light, or revisiting life memories [6,14,15]. Gamma waves, linked to attention and both short-term and long-term memory, point to increased brain connectivity, which could account for the intense visual and sensory experiences reported during NDEs [13,16].

Gamma wave activity observed after cardiac arrest exceeds the levels typically associated with a conscious waking state and may reflect the brain's last efforts to sustain consciousness. This phenomenon may provide a neural explanation for NDEs. The exact mechanisms behind this are still unclear, but some researchers hypothesize that neurons, in response to a sudden shortage of oxygen and glucose, may release an overflow of neurotransmitters, causing a final burst of activity. This might be the brain's last attempt to maintain cellular stability or a natural coping mechanism in response to severe physiological stress [17,18].

Conclusion

Despite these intriguing findings, the exact relationship between gamma wave surges and NDEs remains a topic of ongoing scientific exploration. While the studies discussed provide valuable insights more research is needed to unravel the complex cooperation between brain activity and consciousness at the end of life.

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