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REVIEW

Near death experiences, cognitive function and psychological outcomes of surviving cardiac arrest☆

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Summary Cardiac arrest is associated with a number of cognitive processes as well as long term psychological outcomes. Recent studies have indicated that approximately 10–20% of cardiac arrest survivors report cognitive processes, including the ability to recall specific details of their resuscitation from the period of cardiac arrest. In addition it has been demonstrated that these cognitive processes are consistent with the previously described near death experience and that those who have these experiences are left with long term positive life enhancing effects. There have also been numerous studies that have indicated that although the quality of life for cardiac arrest survivors is generally good, some are left with long term cognitive impairments as well as psychological sequelae such as post-traumatic stress disorder.

This paper will review near death experiences, cognitive function and psychological outcomes in survivors of cardiac arrest.

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☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at ...

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Introduction

Although traditionally most studies of cardiac arrest have focused on prevention and acute medical treatment, in recent years a number of studies have also focused both on the study of cognitive function during resuscitation, as well as the long term psychological outcome of surviving cardiac arrest. This is an intriguing aspect of the study of cardiopulmonary resuscitation with clinical relevance for all who work within the resuscitation and critical care field. Much of the work in the study of cognitive function during cardiac arrest has evolved from the finding that a proportion of cardiac arrest survivors report thought processes, reasoning and memory formation together with the ability to recall specific details from their resuscitation that are consistent with the previously reported near death experiences. Many other studies have also indicated that survival from cardiac arrest leads to specific long term psychological and cognitive changes which include impaired concentration levels and memory function as well as post-traumatic stress disorder.

While, modern heart and lung resuscitation methods were established in the 1950s and 1960s, there is a long history, going back centuries, of attempts to resuscitate people. These involved diverse methods such as using warm ash and hot water, whipping, and rolling people back and forth on a wine barrel to help the chest expand and take air in. Even though, the outcome of these methods was understandably poor, nevertheless there have been many historical anecdotal reports of unusual experiences during a close brush with death. Despite these limited reports, it was not until as late as the 1970s that this subject entered the realms of science, after Raymond Moody, an American psychiatrist collected the accounts given by 150 survivors of near death encounters.[1] His series of survivors of near death encounters was not limited to cardiac arrest, but included reported experiences of people who were considered sufficiently ill to have otherwise died without medical intervention. He found that the survivors who had had experiences described similar phenomena including feelings of peace, a tunnel and a bright light, seeing deceased relatives, a life review, a perception of separation from the body and being able to watch events from above (out of body experience) and entering a heavenly domain.[1] The experiences were usually described as happening when the individual was unconscious and often resulted in a more spiritual and socially orientated outlook and a reduced fear of death. Moody termed these experiences 'near death experiences' (NDE) and although Moody was the first to describe NDEs in modern times, numerous historical accounts of NDEs have also been found throughout time. In fact the earliest reference to a NDE is from Plato's Republic and the first systematic study of this phenomenon was published by a Swiss geologist and mountaineer Albert Heim in 1892.[2–4]

Cognitive function and near death experiences during cardiac arrest

As well as the many general reports of NDE, there have also been many anecdotal reports recalled by cardiac arrest survivors.[5] Since the early 1970s there have been a number of retrospective and prospective studies of cardiac arrest in which patients' experiences, including NDE have been examined.[6,7] In 1994, Martens et al.[8] conducted a study to determine the occurrence and frequency of NDE during cardiac arrest. This was a small retrospective study looking at a group of out of hospital cardiac arrest survivors. Using Greyson's NDE Scale, a 16-item questionnaire they interviewed out-of-hospital cardiac arrest survivors, with documented time-intervals between call for help and restoration of spontaneous circulation, yet without obvious brain damage or known psychiatric history. No NDE were found in this group, and therefore it was concluded that this phenomenon must be very rare in cardiac arrest survivors. They also concluded that international multicentric data collection within the framework for standardised reporting of cardiac arrest events will be the only satisfactory method to address this fascinating and intriguing issue.

The first published prospective study to report cognitive processes during cardiac arrest was a small 1-year study which showed that 6% of 63 cardiac arrest survivors reported having lucid well-structured thought processes, together with

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reasoning and memory formation.[9] These were consistent with typical near death experiences. This study was based upon interviewed accounts obtained within 1 week of the arrest, and as with the study by Martens et al., memories and NDEs were classified using the Greyson scale. The main features that were recalled were coming to a border of no return, feeling peace, feeling joy, seeing a bright light, losing awareness of the body and seeing deceased relatives. There were no reports of watching resuscitation staff from above or recall of specific details of cardiac arrest resuscitation procedures. The authors found no evidence to support a specific role of drugs, hypoxia, hypercarbia or electrolyte disturbances in the causation of the experiences. However this was a small study and therefore the authors concluded that a larger study would be needed.

In a larger Dutch study 344 cardiac arrest survivors from 10 hospitals were interviewed over a 2-year period, and 41 or 12% reported similar experiences to those from the British study.[10] Approximately 24% of those who had a NDE also reported having been able to watch and recall events from their cardiac arrest. Although such experiences had been recalled anecdotally in the past, unlike the smaller British study, the occurrence of out of body experiences during cardiac arrest was also confirmed.

During this study it was reported that in one case, a nurse had reported having removed a patient's dentures and placed them in a drawer in a special trolley. Throughout the one and a half hours of his resuscitation the patient had remained in a coma. One week later he had returned to the same ward where the nurse worked and after seeing her said 'Oh, that nurse knows where my dentures are.' He went on to describe how she took his dentures out of his mouth and put them into the crash trolley. He added ''It had all these bottles on it and there was this sliding drawer underneath and that's where you put my teeth.'

The nurse is quoted as saying:

'I was especially amazed because I remembered this happening while the man was in a deep coma and in the process of CPR. When asked further, it appeared that the man had seen himself lying in bed and that he had perceived from above how the nurses and doctors had been busy with CPR. He had also been able to describe correctly and in detail the small room in which he had been resuscitated as well as the appearance of those present. . . At the time. . . he had been very much afraid that we would have to stop CPR and that he would die. And it is true that we had been very negative about his prognosis due to his very poor medical condition when admitted.'

The authors found that the occurrence of cognitive processes and NDE was not influenced by the duration of unconsciousness, the type of cardiac arrest, or by medication. This study also indicated that those who had suffered a cardiac arrest and had experienced cognitive processes and near death experiences were left with long term positive life enhancing sequelae.

Two other studies of NDE in cardiac arrest were published from the US. One study of 1595 people who had been admitted to a cardiac unit over a 30-month period, also found that the incidence of NDE increased with the severity of the cardiac disease: only 1% of those admitted with stable cardiac disease reported NDEs, this increased to 10% of those with cardiac arrest. Those who had had an NDE were no different from those who had not in terms of social or demographic variables, cognitive function or degree of heart disease.[11] Another US study found that 23% of cardiac arrest survivors had an NDE and that again those with NDEs became transformed in a positive manner after 6 months.[12]

These studies have indicated that approximately 10—20% of cardiac arrest survivors report cognitive processes and memories from the period of cardiac arrest resuscitation. In addition the occurrence of NDE during cardiac arrest appears to have life enhancing sequelae. In general those with a NDE are happier, more socially orientated, less materialistic, more altruistic and less afraid of death than those who do not have this experience.[1,10,12]

Scientific theories and possible explanations for the causation of NDE

Unfortunately despite interest, to date no studies have been able to determine the mechanisms leading to cognitive processes and NDE during cardiac arrest. Nevertheless, despite this many theories to account for the occurrence of NDE under general circumstances have been proposed. These include physiological states such as cerebral hypoxia,[13,14] hormone and neurotransmitter release such as endorphins,[15,16] serotonin,[17] and abnormal NMDA receptor activation,[18] abnormal activation of the temporal lobes leading to seizures,[19] or limbic lobe activation.[20—22] Various drugs and in particular drugs that are known to cause hallucinations, such as ketamine which activate the NMDA receptor have been suggested. It has also been proposed that hypoxia may induce hyperactivity of the NMDA receptor that may in turn lead to a NDE.[17] Other

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theories involving other neurotransmitters or hormones such as serotonin and endorphins have also been proposed.[19–21]

More recently some have suggested that the sensation of separation from the body (out of body experiences) may be related to a dysfunction at the temporo-parietal junction.[23–25] This theory has followed from a case report of a single patient who was undergoing evaluation for epilepsy treatment in whom an 'out-of-body' like experience was induced following focal electrical stimulation of the brain's right angular gyrus.[30] Unfortunately this explanation does not take into account the observation that people who have had an out of body experience report actually being able to recall specific details of events that had taken place at a time when they had been unconscious. If correct, this would make it unlikely that such experiences are simply illusions even if the trigger for the experience, and hence the neurological intermediary pathway, for such an experience may lie in the temporo-parietal region of the brain.

Almost all of our understanding of cognitive neuroscience and its representation in brain structure depends on correlates of cognition. The models of cognition that are built from this data however are correlative models and not causative models. Although none of the hypotheses can account for the NDE in its entirety, the NDE is undoubtedly mediated by neuronal intermediaries and may be triggered by either a physical or psychological stimulus. However identifying the neurological changes that mediate an experience cannot identify or determine the 'reality' of the experience and this includes near death experiences.[26] Every subjective experience is mediated by neuronal changes, and is triggered by physical or psychological triggers, including familiar experiences such as maternal love and compassion, however identifying the detailed neuronal circuitry that mediates these experiences does not define their 'reality'. In the same way eventually identifying the neuronal pathways that mediate NDE cannot determine their 'reality'. Reality on the other hand is socially and not neurologically determined,[26] so simply identifying the neurological triggers for the experience may not help determine its reality.

Consciousness and awareness during cardiac arrest—what can we learn from awareness during anaesthesia?

Although the reports of consciousness, thought processes, reasoning and memory formation during cardiac arrest are relatively new, reports of awareness while under general anesthesia have been noted since the introduction of anesthesia in the 19th century. In these cases such awareness is usually caused by insufficient anesthesia or by light levels of anesthesia allowed by the use of muscle relaxants. Following awareness during general anesthesia, patients report hearing conversations, sensations of paralysis and pain, anxiety, panic and helplessness.[27] Subsequent psychological sequelae may arise, with sleep disturbances, nightmares, flashbacks and a preoccupation with death.[28] This phenomenon is rare and is thought to arise in less than 1% of patients who undergo general anesthesia, but following its occurrence a longer term post-traumatic stress disorder may also arise.[29]

Using what is understood from awareness during anaesthesia it may thus be possible to conclude that perhaps during cardiac arrest there are different levels of consciousness depending on the degree of cerebral depression which occurs as a consequence of reduced cerebral blood flow. However much of the evidence regarding cerebral function during cardiac arrest indicates that there is a lack of electrical activity in the brain during cardiac arrest.[30] This has raised a number of questions regarding the mechanism of causation of cognitive processes and memory during cardiac arrest. It has also raised questions regarding the relationship of the mind and the brain. This is because using current theories of neuroscience this should not be possible. This lack of measurable cerebral function is also a feature that distinguishes the study of consciousness during cardiac arrest with consciousness during anaesthesia. In order to understand this phenomenon better, it has thus been proposed to study consciousness, cognition and their relationship to cerebral function during cardiac arrest using specific measures of cerebral activity. This, it is hoped, will help determine the actual timing and relationship of cognitive processes to cerebral function.[30]

Long term psychological and cognitive effects after surviving a cardiac arrest

Relatively few studies have addressed this issue, nevertheless sufficient work has been done to show that cardiac arrest survivors enjoy a good overall quality of life, but may suffer from cognitive and emotional impairments. In one study, in which quality of life was compared between cardiac arrest survivors with matched ICU survivors, six months after cardiac arrest, there was no difference in the health related quality of life scores between the

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survivors of cardiac arrest and those from ICU.[31] In another study by Nichol et al.,[32] examining both in-hospital and out-of-hospital cardiac arrest survivors, quality of life issues were correlated with clinical variables. Although, survival was considered to be poor, most of the survivors retained an acceptable health-related quality of life.

Long term emotional effects and the occurrence of post-traumatic stress disorder after cardiac arrest

Posttraumatic stress disorder is a unique symptom configuration after an extreme event consisting of intrusion re-experiencing (flash-back), avoidance and numbness, and hyperarousal symptoms.[33] It has been shown that NDE may have a protective effect against PTSD and other psychological impairments.[34,35] Until recently few studies had examined the occurrence of post-traumatic stress disorder (PTSD) in cardiac arrest patients, even though this condition may potentially be one of the most traumatising conditions for patients.

In a study aiming to examine the long-term prevalence and emotional disability in cardiac arrest survivors a cohort of cardiac arrest survivors was selected from in-hospital patients who had experienced VT or VF arrest specifically. These were then compared to a 'control' group containing cardiac patients with unstable angina, but who did not suffer cardiac arrest. When surveyed via self-assessment the cardiac arrest group showed no differences to the angina group with respect of mental condition and their somatic condition or illness related quality of life issues. The only detectable difference between the two groups concerned concentration levels, which were more impaired in the cardiac arrest group. Over half of the cardiac arrest group patients stated that having had a cardiac arrest had significantly affected their lives. Identification of a subset of the cardiac arrest patients who had PTSD showed that patients who had PTSD scored higher for depression and anxiety.[36] These patients had a more negative outlook regarding their disease progression, were less able to concentrate and were more pre-occupied with somatic complaints.

In another study of 143 cardiac arrest survivors who had been followed up on average 45 months after the arrest, it was found that 27% fulfilled criteria for PTSD and these had a significantly lower quality of life. The only independent risk factor for the development of PTSD was younger age. However, in this study there was no difference between patients with or without PTSD regarding the use of sedation and analgesia during or after cardiac arrest.[37] In a smaller study comparing 27 patients who had survived an in-hospital cardiac arrest with 27 patients who had an MI uncomplicated by cardiac arrest, a similar incidence of PTSD was found. In this study 19% of the cardiac arrest survivors and 7% of the MI survivors fulfilled the DSM-IV criteria for PTSD when assessed by structured clinical interview.[38]

Cognitive and behavioural changes after cardiac arrest

Despite the relatively good quality of life, many studies have indicated that cardiac arrest may be associated with long term memory impairment in approximately 20—50% of survivors. In particular studies have indicated long-term memory and executive function impairment together with focal cognitive deficits.

Grubb et al.[39] found that when assessing cognitive function, between 2 months to 1 year after cardiac arrest, up to 40% of survivors from out-of-hospital cardiac arrest demonstrate memory impairment of the ability to 'recall' rather than 'recognition' memory. In a further study by the same group which aimed to assess longer term memory effects of surviving cardiac arrest, they were able to show that although the short and long term memory scores declined in both groups, nevertheless the cardiac arrest group were significantly more affected. Recall memory remained poor in the cardiac arrest group whereas they were normal in the MI group. This study demonstrated that the memory deficits that take place after a cardiac arrest are persistent and focal, and that ''cognitive impairment is a serious and under diagnosed complication of prolonged cardiac arrest'' with considerable affects on normal living activities.[40]

Further work by O'Reilly et al.[41] regarding memory impairment compared three groups: in-hospital cardiac arrest survivors, out-of-hospital cardiac arrest survivors and patients with myocardial infarction without cardiac arrest. The in-hospital cardiac arrest survivors displayed higher anxiety levels than the other two groups and moderate or severe memory loss was identified in 26% of these patients. The memory impairment in these patients was not significantly different for the out-of-hospital survivors, however 38% of them were categorised as moderately or severely impaired. None of the MI group experienced this level of memory impairment. There were no significant

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differences between the groups as regards premorbid intelligence and short term memory tests, with both groups scoring within the normal range expected for unimpaired adults.

Some cognitive defects have been shown to be present early on following cardiac arrest. In one study 60% of patients were found to have moderate to severe cognitive deficits, three months after cardiac arrest. At 12 months, almost 50% of survivors still had moderate to severe deficits. The 45% had evidence of depression and 24% had severe depression.[42]

Nunes[43] studied the long term effects of surviving a cardiac arrest. Eleven cardiac arrest survivors from the intensive care unit were examined between 1 and 3 years after cardiac arrest. Patients were classified using the cerebral performance categories (CPC), neurological examination, detailed cognitive testing and computerised tomography (CT) scan with qualitative and quantitative imaging analysis. Six of the 11 patients had good cerebral performance. Defects in the verbal and visio-spatial short-term memory scores were associated with lower CPC. Visio-spatial short-term memory was abnormal in four moderately affected survivors and normal in those with good CPC score (CPC 1). CT scan findings correlated with the verbal memory score and the executive functions score, suggesting involvement of different brain areas in these functions. CT imaging revealed atrophy both in qualitative and in quantitative analysis, and correlated with impairment in cognitive testing. This was found in the frontal and temporal areas. Another study using MRI has also suggested that memory impairment in cardiac arrest survivors is associated with global cerebral atrophy and not just selective hippocampal damage,[44] which relates to executive and language dysfunction found in affected patients.

Summary

Although the study of cognition and consciousness during cardiac arrest as well as the longer term psychological outcomes of surviving a cardiac arrest is a relatively new area of study, significant advances have been made in this field in the last decade. It has been demonstrated that many cardiac arrest survivors may have cognitive processes during the time of their arrest and anecdotally some have also been able to describe accurately verified events during their arrest, indicating the presence of consciousness. Near death experiences appear to have a long term protective psychological effect, even though many studies have shown that a significant proportion of cardiac arrest survivors may suffer from behavioural, cognitive and emotional disturbances that may begin soon after the cardiac arrest and persist for many years. More work is needed to identify ways of preventing and treating these impairments in cardiac arrest survivors.

To date there are no standardised programmes for the long term psychological care of cardiac arrest survivors. However as recent studies have indicated that many patients who undergo a cardiac arrest may have long term psychological outcomes, care should be focused on identifying and appropriately managing patients following cardiac arrest. The authors suggest the establishment of follow up procedures for cardiac arrest survivors through trained health care professionals who can identify those who may be suffering depression, post-traumatic stress disorder, emotional or other cognitive effects.

Conflict of interest

None.

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