

# Full Neurological Recovery From *Escherichia coli* Meningitis Associated With Near-Death Experience

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**Abstract:** A 54-year-old otherwise healthy man presented with altered mental status. On admission, the patient was confused and agitated, with a Glasgow Coma Scale (GCS) score of 11, suggesting moderate brain injury. He was sedated, placed on a ventilator, and started on tobramycin and ceftazidime for presumed bacterial meningitis, but switched to ceftriaxone once cultures returned as *Escherichia coli*. During his 8-day hospitalization, his mental status fluctuated from confused to nonresponsive, with GCS scores between 6 and 11. Although *E. coli* meningitis has a high rate of neurological complications and death, this patient recovered completely without any deficits, and recalled an elaborate near-death experience that occurred during his coma. This case highlights the importance of studying near-death experiences occurring during compromised brain function to further our understanding of the brain and consciousness.

**Key Words:** Meningitis, encephalitis, *Escherichia coli*, coma, near-death experience

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Spontaneous *Escherichia coli* bacterial meningitis in adults is rare, difficult to recognize, and rapidly progressive (Ishida et al., 2016; Pomar et al., 2013). Bacterial meningitis is one of the main causes of infection-related deaths worldwide (Pomar et al., 2013), with mortality rates reported to be 100% without treatment (Sule and Tai, 2007). We present a case of spontaneous *E. coli* meningoencephalitis. The patient was comatose for 6 days, following which he achieved full neurological recovery and reported a vivid near-death experience occurring during his coma (Alexander, 2015).

Near-death experiences are described as vivid, subjective experiences occurring usually in life-threatening conditions, such as cardiac or respiratory failure, head injury, coma, or states of shock, although they can also be associated with fear of imminent death in the absence of physiological injury (Greyson, 2015). Retrospective assessments by the experiencers themselves and by their significant others most often describe near-death experiences as life-changing, leading to profound changes in attitudes, beliefs, and behaviors (Noyes et al., 2009). Common features of near-death experiences include seeing a bright light, feelings of peace, a sensation of being out of the body, and a panoramic life review (Moody, 1975). The incidence of near-death experiences in documented close brushes with death, across prospective studies in four countries, has averaged 17% when measured with a standardized instrument (Zingrone and Alvarado, 2009).

Because near-death experiences involving elaborate perceptions, thought processes, and emotions can occur in conditions with severe brain impairment, they may contribute to our understanding of the

neurophysiologic processes involved in consciousness (van Lommel et al., 2001). An analysis of near-death experiences involving examination of contemporaneous medical records showed that patients reported enhanced mental functioning significantly more often when physiological proximity to death was well documented than when it was not (Owens et al., 1991). A high priority of research into near-death experiences thus should be to investigate cases involving close monitoring of the person's brain function and physiology. We present a thorough review of the medical records of one such case, a case that is unusual in terms of the complete documentation of his status during his week-long hospitalization and the patient's own description of his near-death experience.

## CASE REPORT

The patient, a 54-year-old otherwise healthy white man, was brought to the emergency department with altered mental status. He had no prior history of neurologic disorder or immunologic deficiency. He awoke earlier that morning with complaints of severe headache and back pain, which quickly progressed to confusion and obtundation. His wife called emergency medical services when he appeared to be seizing and seizures continued intermittently in the ambulance. Upon arrival in the emergency department, he was noted to have significant confusion alternating with agitation and was flushed with tachypnea.

On initial examination, his vital signs included a temperature of 100.9°F, pulse of 95 beats per minute, blood pressure of 142/95 mm Hg, and respiratory rate of 24 breaths per minute on room air, all consistent with an acute bacterial infection. His blood pressure ranged from 127 to 211 mm Hg systolic and 76 to 120 mm Hg diastolic over the next hour. Physical examination revealed that he was disoriented, nonverbal, and unresponsive to verbal stimuli and commands, with a Glasgow Coma Scale (GCS) score of 11, suggesting moderate brain impairment. His pupils were equal and reactive to light. He was hyperpneic, although his cardiovascular examination was normal. On neurologic examination, his reflexes, motor examination, and sensory examination were normal.

Admission laboratories were significant for a white blood cell count of 22.9 kU/L with bands of 31%, and an absolute neutrophil count of 20.2 kU/L, again consistent with an acute bacterial infection. His metabolic panel was significant for a potassium level of 3.3 mEq/L, bicarbonate of 14 mEq/L, an anion gap of 17, and a lactate of 7.99 mmol/L, suggesting a metabolic lactic acidosis. His arterial blood gases showed a pH of 7.67, PCO<sub>2</sub> of 29 mmHg, PO<sub>2</sub> of 107 mm Hg, and bicarbonate of 11 mmol/L on room air, signifying metabolic acidosis and respiratory alkalosis. A head computed tomography (CT) scan revealed excessive meningeal enhancement, and a repeat head CT without contrast 2 days later (on hospital day 3) revealed obscuration of the cortical sulci, particularly near the vertex, suggesting a pyogenic meningitis with purulent CSF in the sulci.

In the emergency department, he became increasingly confused, agitated, and unresponsive, was intubated for airway protection, and then underwent emergency lumbar puncture. Opening pressure was elevated. Initial evaluation of the CSF was yellow and cloudy in appearance with 4257 nucleated cells/mm<sup>3</sup>, a protein of 1341 mg/dL, and a glucose of 1 mg/dL, suggesting an extremely severe bacterial meningitis with little likelihood of a complete medical recovery. Gram stain

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evaluation of the cerebrospinal fluid was significant for many polymorphonuclear leukocytes and many Gram-negative bacilli. CSF was cultured and eventually grew *E. coli*.

The patient was sedated and placed on ventilator support. He was given intravenous dexamethasone, ceftriaxone, and vancomycin, along with lorazepam 2 mg for agitation and seizure prophylaxis, and he was placed in soft restraints and transferred to the medical intensive care unit (ICU).

During his course in the medical ICU, he was evaluated by consultants from neurology, infectious disease, and physical medicine. He was started on tobramycin and ceftazidime due to presumed Gram-negative sepsis and then switched to intravenous ceftriaxone once cultures returned as *E. coli* and he was noted to be critically ill.

Notable examination findings during the next few days included sedation, intubation, minimal responsiveness to sternal rub, and 1-mm pinpoint pupils, suggesting damage to the brainstem. Some spontaneous movements of his upper extremities were noted, which seemed semipurposeful. Reflexes were 1+ symmetric without pathological reflexes except for bilateral Babinski's, indicating bilateral CNS impairment. Although he was reported to have had seizures in the morning before admission, there was no indication that the patient continued to have seizure activity after he was sedated with intravenous lorazepam and fentanyl. However, no EEG was obtained during his hospitalization because his treatment team decided that it would provide no actionable diagnostic information or treatment guidance, given his dismal prognosis.

Over the next 4 days, he remained sedated and intubated, with little to no neurological improvement. His pupils remained small but nonreactive, with neck stiffness and pain on flexion. He received sedation with haloperidol, lorazepam, and fentanyl. He was clearly critically ill during the first 5 days of his hospitalization, as documented in his medical records and supplementary documentation from and discussions with the consulting neurologists. In addition, the infectious disease specialist consulting on this case noted that, despite his aggressive antibiotic treatment, his symptom profile and extended coma suggested a mortality rate of over 97% (Wade, 2012). During this period, his GCS scores were between 6 and 7, indicating severe brain impairment.

The patient was extubated on hospital day 6. He remained awake but appeared confused. On hospital day 7, he appeared dramatically improved, recognized family and colleagues, but repeatedly asked the same questions about his illness, suggesting impaired short-term memory. He was moved to the neurologic step-down unit and continued to be awake but disoriented. On physical examination, he was noted to be clumsy in his upper and lower left extremities; motor function was 5/5 otherwise. Babinski's signs were absent at the time of discharge.

On hospital day 9, after his recovery, the patient reported that he had had a near-death experience, including accurate descriptions of events that he claimed to have perceived from a visual perspective outside his physical body. For example, he reported to his family and to his physicians having seen specific individuals who were not family members praying around his bed in the ICU, an event that had occurred on hospital day 5 while he was in a deep coma. This event, which was corroborated by his family and by hospital staff, was unlikely to have been an informed guess, as visitors other than family were routinely not permitted to visit in the ICU. Based on details of events that he accurately described having observed during his coma, his near-death experience can be placed between hospital days 1 and 5. On those 5 days, his GCS scores, charted twice a day, ranged between 6 and 7, indicating severe brain impairment.

Two months later, at his follow-up visit with the neurologist, his doctor reported that, although at the time of his hospitalization "the patient had a severe case of *E. coli* meningitis and was near death" with a CSF glucose of 1, since that episode, he had made a "complete and remarkable recovery" without any residual neurological issues.

This patient's score on the NDE Scale (Greyson, 1983), a self-rated, 16-item questionnaire used to assess near-death experiences, was 29 of 32, which placed his reporting of the event among the most profound 2% of such experiences. He described his NDE as beginning in a coarse, murky realm, from which he was pulled by a slowly spinning white light of great clarity, associated with a musical melody into "an ultrareal valley" filled with light and colors beyond the normal visual spectrum, in which he seemed to have no body but existed as a speck of awareness. He was met by a young woman whose thoughts of unconditional love and assurance promised he would be taken care of, that he had nothing to fear, and that he was completely loved by God. He then entered increasingly refined spiritual realms, finally arriving at an infinite inky blackness, filled to overflowing with divine unconditional love and with brilliant light.

Prominent features of his account typical of a near-death experience included being surrounded by darkness followed by a bright light, a sensation of existing outside his physical body, subjective transition to an unfamiliar place, reported meeting with a deceased relative (unknown to him at the time of the experience, as described below), reported encounter with a spiritual being, sensation of communicating without words, and retrospective feeling that his experience was "realer" than his usual experiences. There have been some reports of near-death experiences in which the patient had been ostensibly led to think during the experience that he or she would have a full recovery. That did not occur in this patient's experience. Neither was there any suggestion in this patient's experience that he was given a choice to return to life or not. In fact, he reported that during his near-death experience, he had no awareness whatsoever of ever having had an existence in any realm outside the near-death experience to which to return.

After his recovery, he described to his wife and to others a detailed physical description of the unidentified young woman who had accompanied him in his near-death experience. The patient had been adopted at birth, and grew up without knowing his birth family. Four months after his coma, his birth sister, whom he had met shortly before, sent him a photograph of his other birth sister who had died 10 years earlier. When he saw the picture, the patient was stunned to recognize this full biological sister whom he had never known as the unidentified woman who had accompanied him in his near-death experience.

## DISCUSSION

It should be noted that the authors of this case report were not involved in this patient's care, but were external consultants asked to perform independent reviews of the medical record of his hospitalization, due to the unusual circumstances and outcome of this case.

Patients with Gram-negative bacterial meningitis have a high rate of neurological complications, particularly impaired mental status, systemic complications such as septic shock, acute respiratory failure, acute renal injury, and death (Pomar et al., 2013). There is a reported mortality rate of 53%, with *E. coli* accounting for 38% of such deaths (Pomar et al., 2013). Most reported cases have residual neurological deficits; however, this patient attained full neurological recovery within 2 months, which is remarkable and rare. This recovery is particularly striking in light of the poor prognostic signs, including descent into coma within 3 hours of symptom onset, GCS score of 6 to 11 with absent oculocardiac reflex, and CSF glucose of 1.

To our knowledge, this is the first medical record review of a case of severe meningoencephalitis associated with a near-death experience. This is particularly relevant because of the specific and devastating effect of meningoencephalitis on the neocortex, compared with cardiac arrest and other more common conditions associated with near-death experiences. Of interest, other near-death experiences occurring under well-documented medical supervision have been associated with unexpected recovery from conditions thought to be irreversible (Alexander, 2017; Dossey, 2011), suggesting possible benefits from

research into possible mechanisms by which near-death experiences might facilitate healing.

Evolutionary biologists have speculated that the serenity experienced during a near-death experience might lower metabolic demands and conserve energy reserves, enhancing the possibility of recovery in a potentially fatal crisis (Watson, 1987). More specific to the current case, it is known that the acute host inflammatory response plays a major role in survival and neuropsychological sequelae of meningitis, although the underlying pathologic mechanisms of both mortality and long-term neurologic deficits in meningitis remain unclear (Too et al., 2014). It is plausible that near-death experiences may influence the triggering of immune and inflammatory responses to combat bacterial challenges and reduce neurologic sequelae.

It is noteworthy that the patient's near-death experience can be placed between hospital days 1 and 5, when his GCS scores were lowest. This association of a mystical state of consciousness with diminished brain function is consistent with recent neuroimaging studies of psychedelic drug-induced states showing that brain connectivity in the default mode network is inhibited rather than excited by psilocybin (Carhart-Harris et al., 2012), ayahuasca (Palhano-Fontes et al., 2015), and LSD (Carhart-Harris et al., 2016).

It has been suggested by persons without access to this patient's medical records that his coma might have been pharmacologically induced, with the implication that that might reduce the credibility of his near-death experience account (Mays, 2016). His medical records suggest that his coma was not drug-induced, as his brain function and level of consciousness were clearly impaired and on a downward trajectory before sedation and started to improve before sedation was discontinued. Nevertheless, it is impossible to determine how much of his unresponsiveness in the ensuing days was due to sedation or to the *E. coli* meningoencephalitis. However, near-death experiences have been reported previously in both medical comas and pharmacologically induced unconsciousness, so the contribution of each to this patient's coma may be irrelevant.

It should be noted that subjective experiences of darkness, light, and love as reported in this case are not exclusive to alterations of consciousness related to brain damage or other near-death events. For instance, highly hypnotizable individuals may spontaneously report blackness, light, and love during "deep hypnosis" (Cardena, 2005), and such experiences may be related to brain desynchronization, as found with research on psychedelics (Carhart-Harris et al., 2012).

The question has also been raised as to whether this patient's subjective report is more consistent with a dream, hallucination, or delirium, rather than a near-death experience (Mays, 2016). Phenomenologically, this patient's description of his experience was consistent with other near-death experiences, with an impressively high NDE Scale score, and bears little resemblance to a dream or hallucination. Furthermore, the fact that he maintained elaborate memories of his experience after his illness resolved argues against it having been a dream, hallucination, or delirium, as memories of those experiences typically fade with time. Near-death experiences can be differentiated from dreams, hallucinations, and deliria by their phenomenology and sequelae (Greyson, 2014), and represent an entirely different phenomenon, the memory of which does not fade over time (Greyson, 2007; Moore and Greyson, 2017), although the mechanism of near-death experiences remains the subject of investigation (Holden et al., 2009). We encourage other clinical investigators to report additional examples of near-death experiences in patients with severely compromised brain function to explore further the brain mechanisms associated with complex consciousness.

## CONCLUSIONS

Patients who appear to be comatose and unresponsive to the environment may nonetheless retrospectively report complex cognitive

processes during the period of coma. EEGs and other functional neuroimaging, which may appear superfluous for clinical decision making, may be helpful in providing clarity regarding neural processes associated with complex cognitive processes during apparent coma. The association of unexpected neurological recovery with a near-death experience suggests the need for further research into mechanisms by which such experiences may contribute to survival in critical illness.

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## DISCLOSURE

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## ETHICS APPROVAL

The University of Virginia Institutional Review Board for Health Sciences Research considered this medical record review and determined that, as a single case report, it did not meet their criterion for a research study and therefore was approved to proceed without further review by that committee (committee reference number 19570).

Written consent was obtained from the patient for publication of this case report, which he has reviewed for accuracy.

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