Value Your Training and Don’t Lead Me into Temptation – Pitfalls in Neuroprognostication After Cardiac Arrest

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1. Abstract

We present the case of an 81-year-old man who was found in cardiac arrest after an unwitnessed car accident. After successful resuscitation on scene, the patient was transferred for post-resuscitation care to our intensive care unit. Because of the unexplained trauma mechanism, a whole body CT Scan was performed including brain perfusion scan, that showed severely reduced cortical perfusion globally, indicating severe hypoxic brain injury. During a first sedation hold after 24 hours in therapeutic normothermia, the patient spontaneously moved his limbs with all his brain stem reflexes present. A follow-up brain scan 72 hours after the incident was normal without any signs for cortical perfusion deficit. Based on this case, we discuss some important pitfalls in neuroprognostication and how easily even experienced critical care teams with knowledge of the current guidelines can be led astray. On the other side we highlight some principles in the communication with relatives.

2. Case Presentation

An 81-year-old man known for chronic heart failure due to coronary atherosclerosis, hypertrophic left ventricle and obstructive sleep apnea syndrome was found in cardiac arrest in his car when rescued by paramedics after an unwitnessed car accident. The reason for the accident remained unclear. When the first responders arrived on the scene, the patient presented with pulseless ventricular tachycardia for which high quality cardio-pulmonary resuscitation (CPR) was immediately started. Return of spontaneous circulation (ROSC) was achieved after 15 minutes of CPR. The Patient was intubated and transferred to our tertiary, academic hospital.

In our Emergency Department a CT-Scan was performed – as per our trauma protocol - which showed multiple fractures including a Jefferson fracture of the C1 and a non-displaced odontoid process fracture (dens fracture). In addition, a narrow epidural blood lamella was seen at the level of spinal fractures without compression of the spinal cord. In order to the unexplained accident, a perfusion CT-scan of the brain was performed as well. This showed no traumatic or ischemic brain injuries but a profound global cortical hypoperfusion, interpreted as possible early sign of a severe hypoxic-ischemic encephalopathy (Figure 1A-B and Figure 2A).

The relatives, waiting in front of the Emergency Department, were informed about these serious findings and the possible poor neurological outcome.

According to our institutional protocol, therapeutic normothermia was performed at 36.0°C for 24 hours.

After completion, sedation was hold on the next day and a first detailed clinical neurological examination was performed in which the patient – although he remained unconscious – started to move his legs spontaneously and showed preserved brain stem reflexes. Clinically, there were no signs indicative for imminent brain death.
These findings were contradictory to the initial brain scan and as per consensus within our multidisciplinary team, we performed a follow-up brain perfusion scan at 72 hours after incident. Due to an implanted cardiac pacemaker with no MR-compatibility, again a CT scan was performed. The results were striking, near-normal, with an unrestricted perfusion distribution without any signs of hypoxic encephalopathy (Figure 1C-D and Figure 2B).

The patient subsequently remained deeply comatose. Following our institutional multimodal protocol for neuroprognostication after OHCA, electrical brain activity was repeatedly assessed by electroencephalography (EEG) showing persistent non-convulsive status epilepticus (NCSE), refractory to a four-drug medical therapy regimen.

During his time on our ICU we were in close contact with his family on a daily basis. When the EEG pattern deteriorated further over time, rendering a good neurological outcome even more unlikely, we took a decision not to increase a most likely futile treatment, but instead to withdraw from intensive care treatment, based on the patient’s advance directive and our interdisciplinary medical judgement, fully supported by the family.

According to his will, the patient was further evaluated for organ donation after cardiac death. However, when organ allocation could not identify a suitable organ recipient, intensive care was finally withheld, the patient was put on a palliative care regimen and he finally died in presence of his family.

Figure 1: Comparison of the Cortex perfusion. A-B: CBF-Sequence and CBV-Sequence at admission with reduced cortical perfusion. C-D: CBF-Sequence and CBV-Sequence after rewarming from TTM and 72 hours after admission showed no relevant abnormalities.
3. Discussion

Neuroprognostication is challenging and it is crucial that widely accepted and evidence-based algorithms are followed accurately. As a critical care team in an academic hospital we are experienced in dealing with patients after resuscitation. All of us are skilled in neuroprognostication and familiar with the current guidelines. This case shows that even skilled teams may be influenced and lead in the wrong direction.

Recent studies show that the guidelines are perhaps not followed as precisely as they should be. Up to 25% of physicians use premature time windows and a huge range of different test, often not compatible with the current guidelines [1]. Cardiac arrest is one of the leading health care problems in Europe and Northern America. EMS-threatened, all-rhythm Out-of-hospital cardiac arrest (OHCA) has an incidence of 37.5-55 per 100’000 person-years [2-3]. Survival rate after cardiac arrest at hospital discharge in Europe is less than 10% with significant variation between different countries [4, 5]. Furthermore, only less than 10% were discharges without any neurological deficits [6]. Two third of the patients who die after admission to an intensive care unit suffer from some neurological injuries, both before and after implementation of target temperature management (TTM) in 2002 [7]. The most often reason for death after cardiac arrest is withdrawal of care because of poor neurological prognosis [8]. Therefore, the prognosis of neurological outcome is crucial and the evaluation of it has to be very accurate. Falsely positive rates (FPR) of tests about prognostication of a poor neurological outcome must be next to zero with narrow confidence intervals.

So far, no single measurement is known to distinguish sufficiently between non-survivor, survivor with a poor outcome and survivor with a good outcome [9]. The ERC/ESICM publish at regular intervals well noticed algorithms for prognostication poor neurological outcome after ROSC after cardiac arrest [7, 10].

When the patient presented here was treated, we followed the 2015 ERC/ESCIM algorithm [7]. Shortly after the patient died, the updated 2021 guidelines were published which significantly simplified the algorithm for prognostication. There was a change away from a two-stage approach. Now, all unconscious patients with a strongly impaired motor response (abnormal flexion or worse in response to pain) 72 hours after ROSC should be evaluated for no pupillary and corneal reflexes, bilateral absent N20 SSEP wave, highly malignant EEG > 24 hours, NSE > 60μg/l 48 and/or 72 hours, Status myoclonus ≤ 72 hours and/or diffuse and extensive anoxic injury on brain CT/MRI. If there are at least two pathological findings, a poor neurological outcome is to be assumed [10].

Of extremely high importance is the right time point of such investigations, again highlighted in the new guidelines. [7, 10-11] Premature testing can strongly influence the reliability of the tests with a higher rate of FPR concerning poor outcome [10, 12-13]. Imaging tests play an important role in the neuro-prognostication because they are almost independent from sedative drugs. But their major limitation is the lack of standardization of techniques. So, different methods are used, and no specific test is recommended so far [10]. Perfusion CT scans, as performed in the presented case to exclude a cerebral hypoperfusion as reason for the initial accident, is not mentioned in recent guidelines, although it is known to have a significant correlation to intraparenchymal brain tissue oxygen tension [14]. But known reperfusions-induced normalization in the course make perfusions-imaging a poor player in neuro-prognostication [15]. In practice we are often confronted with relatives who wait for further information regarding their beloved, even as early

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as at arrival in hospital. On the other hand, health care workers want to prevent a futile therapy from being prolonged and thus possibly causing unnecessary harm to the patient. In our case, there was no pressure neither uttered from the relatives nor from any logistical reasons. Nevertheless, the initial pathologically altered brain perfusion scan, done because of the trauma with unclear genesis and affirmatively reported by a senior neuroradiologist, misled the multi-professional treatment team to believe that a poor neurological outcome had most likely to be expected. Knowing that neuroprognostication must be multimodal and that at this point of time no assessment of outcome prognostication is reliable, therapy was continued according to our institutional protocol with no premature decision taken. However, to what extent these expectations of a poor outcome influenced the therapy and especially the communication with the relatives cannot be determined with certainty. Admission of a patient on an ICU is very stressful for relatives and even in case of a good outcome it can lead to post-traumatic stress disorders to the patients as well as to the relatives [16-17]. Communication, especially end-of-life discussions with relatives are difficult and it is a growing field of interest in research. Respecting the ethical principles, especially the autonomy issue, seems to be very important [18]. Give them clear and structured information and explain their role in decision-making is essential [10]. Existing data support the early and frequent contact of the relatives with interdisciplinary teams [19]. Often, the expectations of relatives and those of the physicians are not the same. Communication between health care workers and patient relatives is more than exchanging information about epicrisis and it is of great importance to always be aware of that [20]. Proactive communication is very important and can also prevent relatives from developing long-term mental health issues [21].

Beyond all this points, communication with relatives in stress situations is difficult. Several studies highlighted the evidence-based potential impact of structured discussions with relatives, the Society for Critical Care Medicine (SCCM) for example recommends the use of the VALUE mnemonic, developed by University of Washington End-of-Life Care Research Program at Harborview Medical Center, to guide discussions with relatives. The mnemonic stands for Value comments made by the family, Acknowledge family emotions, Listen, Understand the patient as a person, Elicit family questions [22]. Contradictory information and delays in already discussed processes like in our case should of course absolutely be prevented. In Conclusion, this case reminds us how susceptible even highly qualified personnel are to "fake news" and that even if you know how to do it the right way, you always have to be aware not to be led astray. Without any doubt, neuroprognostication is a complex and difficult task with a great need for further high-quality studies. Beside the medical approach, the communication with the relatives is crucial. Thus, in addition to further research, also further teaching is needed to improve the quality of neuro-prognostication after cardiac arrest and the holistic management and care of patients relatives.

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