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Review

Video-electroencephalography investigation of ictal alterations of consciousness in epilepsy and nonepileptic attack disorder: Practical considerations

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ABSTRACT

The ictal assessment of consciousness is of central importance in the differential diagnosis of epilepsy and nonepileptic attack disorder (NEAD). Long-term video-electroencephalography (video-EEG) is currently considered the gold standard investigative technique for the evaluation of patients with recurrent attacks associated with transient alterations of arousal (responsiveness) and/or awareness (experiential states). This paper offers a concise review focusing on the practical aspects of clinical relevance in the video-EEG diagnostic workout of inpatients with suspected epilepsy or NEAD, as outlined in existing guidelines and recommendations. The reviewed literature implies that both implementation of specific procedures (e.g., activation maneuvers) and interpersonal approach (e.g., monitoring protocols) during video-EEG should be tailored to the individual patient's presentation.

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1. Introduction

Epilepsy and nonepileptic attack disorder (NEAD) are two of the most commonly reported causes of transient alterations of consciousness [1–3]. Despite the known differences between the neural bases of these conditions, the differential diagnosis can be challenging in clinical practice [4–6]. The initial steps in the assessment of ictal consciousness attempt to reveal patterns characteristic of either one of these types of attack based on the bidimensional model of consciousness [7–9]. The first element of this model is the level of consciousness or wakefulness, which can be tested in real time by assessing ictal responsiveness. Blumenfeld et al. [10,11] recently proposed an observer-rated instrument, the Responsiveness in Epilepsy Scale, specifically developed for the quantitative assessment of this dimension of ictal consciousness. The level of consciousness is likely to be lower in patients who have idiopathic generalized epilepsy, although some patients with localization-related epilepsy can present with significantly impaired responsiveness if focal/partial seizures with secondary generalization are involved. The other key element in the bidimensional model of ictal consciousness is the subjective contents of consciousness, which can be assessed retrospectively at clinical interviews or using specific psychometric instruments, such as the Ictal Consciousness Inventory [7]. Reported contents of consciousness can sometimes include vivid experiential phenomena, especially in the case of localization-related epilepsy of temporal lobe origin [12–14], along with other clinical features (ictal aphasia, forced thinking), which can complicate the assessment of responsiveness [15,16].

1.1. The investigation of ictal alterations of consciousness

Clinical signs which help the differential diagnosis between epilepsy and NEAD with regard to ictal consciousness range from the duration of the alteration of consciousness to associated automatisms and eye closure, plus information obtained from patient interviews [17,18]. This information has recently been expanded to include techniques of linguistic analysis, which focus on the different terms and metaphors used to describe ictal conscious states [19]. Electrophysiological tests are among the most useful investigations for the evaluation of transient alterations of consciousness [20,21]. The current gold standard for the differential diagnosis of epileptic seizures versus nonepileptic attacks is video-electroencephalography (video-EEG) or videotelemetry monitoring [22–25]. This technique is particularly recommended when seizures are intermittent and can assist in ascertaining the clinical characteristics and exact frequency of ictal events, in addition to establishing their etiology (i.e., epileptic/nonepileptic) in a number of cases [26–29]. Video-EEG is also recommended in the presurgical evaluation of patients with a confirmed diagnosis of epilepsy, with the aim of better localizing the seizure focus [20,21,30,31]. However, indications and

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practical uses of video-EEG can show significant differences across services and disciplines. Clinicians' backgrounds and attitudes have been shown to influence diagnostic and therapeutic pathways: for instance, neurologists tend to rely more on video-EEG findings, whereas psychiatrists are reported to rely less on their accuracy; consequently, neurologists are more likely to attribute therapeutic failures to patients' psychopathology rather than to diagnostic pitfalls, with significant implications for clinical practice [32].

In this paper, we review literature with relevance to best practices when using video-EEG in patients with suspected epileptic and/or nonepileptic attacks. We conducted a systematic literature review according to the PRISMA guideline standards [33] using PubMed to identify relevant guidelines and recommendations. The following were the entered search terms: Epilep* AND (video-EEG OR telemetry) AND (guideline* OR recommendation*). Limits were set to human studies, in English, between 1990 and 09-08-2013. Our search yielded 3 papers containing formal guidelines or consensus-based recommendations. After manually screening the reference lists of the identified articles, we obtained 2 more guideline publications, resulting in a total of 5 articles, which are presented in Table 1. We searched online indexes of scientific journals relevant to the field, including *Epilepsia*, *Seizure*, *Epilepsy & Behavior*, *Journal of Clinical Neurophysiology*, *Epileptic Disorders*, *Clinical EEG and Neuroscience*, and *Clinical Neurophysiology*, in order to ensure that no relevant articles had been omitted. Finally, gray literature was also surveyed through Google Scholar.

2. Video-electroencephalography in epilepsy and nonepileptic attack disorder

The National Institute for Health and Clinical Excellence (NICE) guidelines recommended the use of video-EEG especially in situations where a diagnosis had been difficult to reach via clinical assessment and standard EEG [20,21]. In particular, video-EEG was recommended to differentiate between epileptic and nonepileptic attacks and to classify seizure type and syndrome [20,21]. Video-EEG was therefore confirmed as the 'gold standard' for diagnosis of nonepileptic attacks. The National Association of Epilepsy Centers (NAEC) report [34] referred to the services which offer video-EEG as level 3 or level 4 specialized epilepsy centers, to which patients with epilepsy should be referred if seizures are uncontrolled by initial pharmacological interventions after one year. However, earlier referral was recommended if possible nonepileptic attacks are suspected, with immediate referral needed in more serious cases, such as those involving status epilepticus. In addition to recommending the use of video-EEG to ascertain the diagnosis of epilepsy (versus nonepileptic attack disorder, syncope, narcolepsy, etc.), the American Clinical Neurophysiology Society (ACNS) guidelines [35,36] highlighted the utility of video-EEG monitoring for the identification of seizure localization, distribution, relationship to stimuli, and behavioral consequences, as well as for the quantification of seizure frequency under normal circumstances or in relation to specific events (e.g., antiepileptic medication withdrawal). The International League Against Epilepsy (ILAE) guidelines [37] further specified the importance of video-EEG inpatient monitoring for the presurgical assessment of patients with epilepsy, documentation of diurnal or circadian variations, and abnormalities during sleep, as well as its use in the intensive care unit in relation to clinical or subclinical status epilepticus.

Detailed recommendations about technical issues, including equipment and setting specifications, were developed in the ACNS guidelines [35,36], while the essential requirements for monitoring units across level 3 and 4 epilepsy centers were presented in the NAEC guidelines [34]. More recently, an expert consensus statement was published about safety issues relevant to long-term inpatient video-EEG monitoring [38]. This highlighted the persistence of controversial issues on which expert opinions are in disagreement: for example, the use of more detailed cardiac monitoring as clinically indicated remained short of consensus, although the use of a single-lead electrocardiogram was regarded as standard practice.

An obvious problem with the application of video-EEG monitoring in cases with intermittent seizures is the possible absence of alterations of consciousness throughout even a longer-term recording session. This advocates the use of special procedures, including provocation maneuvers, aimed to elicit clinical events in order to shorten monitoring time, thus improving both cost-effectiveness and feasibility. The NICE guidelines not only categorized seizure induction measures as either physiological (e.g., photic stimulation, hyperventilation) or psychological (e.g., indirect suggestion for nonepileptic seizures) but also stated that the evidence for the use of provocation techniques is, in general, controversial. Specifically, it was reiterated that it has a limited role and may lead to false-positive results in some patients [20,21]. The ILAE guidelines noted that seizure diaries might prove helpful in planning the video-EEG monitoring sessions and that known techniques to provoke clinically significant events could be employed during monitoring, such as sleep deprivation or antiepileptic drug withdrawal, although the latter is likely to be associated with a higher risk of complications in patients with epilepsy [37]. Iriarte et al. [39] discussed the pros and cons of such approaches extensively, including an aid to diagnosis as a result of high specificity and sensitivity versus ethical concerns or untoward clinical events in patients with epilepsy. One further problem is that even if an epileptic seizure can be provoked, this does not rule out the possibility of co-occurring nonepileptic events in the same patient [22].

A randomized controlled trial on 30 patients with nonepileptic attack disorder [40] showed that the majority of patients developed attacks after suggestive provocation techniques linked to hyperventilation or photic stimulation and that these methods may be most successful in patients with a previous history of attacks in clinical settings. Benbadis et al. [41] reported a high success rate (84%) in eliciting seizures in 19 patients with nonepileptic attacks via an induction procedure involving suggestion, hyperventilation, and photic stimulation. Of note, 94% of these events were elicited within 4 min of provocation. A later study by the same group [42] analyzed the yield of short term (1–2 h) outpatient video-EEG monitoring for the diagnosis of

Table 1
Summary of guidelines/recommendations on the use of long-term video-EEG in epilepsy units.

Author/committee	Year	Focus	Country	Reference number
ILAE Diagnostic Methods Commission Subcommittee on Neurophysiology	2007	Recommendations on requirements and applications for long-term recordings in epilepsy	International	[37]
American Clinical Neurophysiology Society	2008	Guidelines for long-term epilepsy monitoring	USA	[35,36]
National Association of Epilepsy Centers	2010	Guidelines for essential services, facilities, and personnel in specialist epilepsy centers	USA	[34]
National Institute for Health and Clinical Excellence	2012	Guidelines on diagnosis and management of epilepsies in children and adults	UK	[20,21]
Shafer et al.	2012	Recommendations to maintain patient safety in inpatient monitoring units	USA	[38]

Abbreviations: ILAE, International League Against Epilepsy.