

# Utility and Validity of Incidental Video Recordings in the Differential Diagnosis of Consciousness Loss

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## ABSTRACT

**Background:** Loss of consciousness (LOC) is one of the most common reasons for seeking neurological advice in clinics and emergency departments. There is considerable difficulty in determining the nature of the events according to patient reports, and collateral history is often difficult to interpret due to multiple versions and observer interpretations.

**Objectives:** To examine the utility and validity of incidental video recordings (IVR) in the differential diagnosis of LOC.

**Methods:** In this retrospective study, I included patients with a documented IVR description. Results were divided into three categories: definite approval (IVR conclusion was decisive and congruent with the gold standard test), partial approval (IVR conclusion was decisive and diagnosis was confirmed by treatment response or clinical course), and inconclusive (IVR conclusion was not decisive, no gold standard test was performed, or the gold standard test was either not decisive or incongruent with the IVR).

**Results:** I evaluated the results of 31 patients with IVR documentation. Overall, in 18 patients (58%), the IVR conclusion was decisive and congruent with the gold standard test. In 8 patients (25.8%), the IVR conclusion was decisive and congruent with the clinical course or treatment response. In 5 patients (16.1%) the IVR was regarded as inconclusive.

**Conclusions:** IVR have a substantial yield and are highly accurate in the differential diagnosis of LOC, mainly differentiating between epileptic seizures and psychogenic nonepileptic seizures, yet it is utilized in a minority of the patients in real life.

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**KEY WORDS:** cell phones cameras, epileptic seizures (ES), psychogenic non-epileptic seizures (PNES), surveillance cameras, video recordings of seizures

Loss of consciousness (LOC) is one of the most common reasons for seeking neurological advice in clinics and emergency departments [ED] [1]. Since LOC is a paroxysmal event in which the patient loses awareness of self and surroundings, there is considerable difficulty in determining the nature of the events according to the patient reports. Hence collateral history is often required. Collateral history is often difficult to interpret due to multiple versions and observer interpretations [2]. For example,

when diagnosis of epilepsy is based solely on clinical information, physicians misdiagnose epilepsy in up to 30% of cases [3].

In the last few years there has been a proliferation of video documentation in the public space, whether using security/surveillance cameras or personal cell phones [4].

Obtaining video records of LOC events can aid in the differential diagnosis of LOC. This research showed the utility and validity of incidental video recordings (IVR) in the differential diagnosis of LOC.

## PATIENTS AND METHODS

In this retrospective study, all patients admitted to the epilepsy clinic or receiving epileptologist consultation by the author between 01 January 2019 and 10 June 2021 were screened for the study. Demographic information, including sex, age, medical background, and drugs taken, was extracted from the medical records.

I documented all observed videos in the patient's file during a consultation and based the study on these descriptions. Hence, patients included in the study were patients whose video description was documented in their file during a consultation or during clinic visits. I did not include remarks regarding the quality of the video footage, rather video footage was described in the patient's file only if a clear conclusion was made.

I then compared the conclusions made according to the IVR to additional tests such as long-term video electroencephalogram monitoring (LTVEM), electroencephalogram, imaging tests, and response to treatment.

I divided the results into three groups: definite approval = IVR conclusion was decisive and congruent with the gold standard test in most cases (LTVEM); partial approval = IVR conclusion was decisive, and the diagnosis was confirmed by treatment response or clinical course; inconclusive = IVR conclusion was not decisive, no gold standard test was performed, or the gold standard test was either not decisive or incongruent with the IVR.

Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 25 (SPSS, IBM Corp, Armonk, NY, USA).

All data gathering was approved by the local institutional review board.

**RESULTS**

Between 01 January 2019 and 10 June 2021, I conducted 1433 consultations. In 31 of the patients, there was documentation of an event recorded by IVR. In seven patients, the events were recorded by surveillance cameras either in a workplace or a public place like a supermarket or a school. In 15 patients, the events were recorded by caregivers or family members of patients. In 9 patients the events were recorded by medical personnel in the hospital.

Low frequency events or first events were recorded mainly by surveillance camera. Medium to high frequency events were recorded mainly by cellphones.

Seven patients were recorded by surveillance cameras. Six of them presented either with first or low-frequency events (one every several months). One patient had a high-frequency epileptic seizures (ES) rate of which she was not aware.

Twenty-four patients were recorded by cell phones of either caregivers or medical personal. One of them had a first event, and two had medium frequency events (1 per month). Twenty-one patients had a high-frequency event rate of at least once per week.

The mean age of patients was  $31.9 \pm 14.4$  (15–67) years. Twenty-two were women, and nine were men.

In 14 patients, the IVRs were compatible with ES. In 12 patients the IVRs were compatible with psychogenic non-epileptic seizures (PNES). One patient had several IVRs with a coexistence of PNES and ES. In one patient, the IVR showed a decerebration reaction. In one patient the IVR was compatible with a syncope event. The IVR was indecisive in two patients.

Overall, in 18 of 31 patients (58%), the IVR conclusion was decisive and congruent with the gold standard test (in most cases LTVEM) and was regarded as definitive. In eight patients (25.8%), the IVR conclusion was decisive and congruent with the clinical course or treatment response. In five patients (16.1%) the IVR was regarded as inconclusive. In two patients, IVR was decisive, but no confirmation was achieved either by a gold standard test or clinical course. In one patient PNES diagnosis was reached by IVR, but the events were later classified as ES by LTVEM. In two patients, the IVR was not decisive. In one of them, the LTVEM was not decisive. Hence, the yield of IVR to reach a diagnosis was 26–28 of 31 patients (83.8–90.3%). The accuracy of IVR compared to the gold standard test or clinical course was

26/27 patients (95%). Table 1 and Figure 1 summarize the utility and validity obtained in IVR in the different entities.

**EXAMPLES OF THE UTILITY OF IVR**

**Case 1**

A 27-year-old healthy male presented with recurrent episodes of LOC. He was referred to the epilepsy clinic with suspected PNES after the failure of two anti-seizures medications (valproic acid, lamotrigine). Video recording by a security camera in his workplace confirmed an epileptic seizure with typical insular semiology. Electroencephalogram and magnetic resonance imaging (MRI) were normal. He was treated with carbamazepine. He is currently seizure-free.

**Case 2**

A 43-year-old woman with a history of thrombophilia, sinus vein thrombosis, and cavernous hemangioma was referred to our clinic due to recurrent events of LOC since the age of 24 years. She was regarded as having drug resistant epilepsy and underwent excision of the cavernoma without improvement in seizure frequency. During LTVEM, no specific events were recorded. Her husband was instructed to record an event if possible. A video recorded by her husband's cellphone confirmed that she showed signs of PNES. She received psychological therapy. It was later determined that her husband used to beat her. They started couple's therapy.

**Case 3**

A 55-year-old man was admitted to the ED with suspected convulsion. Neurological examination showed findings congruent with a medullar stroke. Computed tomography angiography (CTA) revealed a left vertebral artery occlusion. The patient presented with LOC an hour later, and the neurologist was recalled due to a suspected seizure. Video recording confirmed that the patient presented with a decerebration reaction in his four limbs. The patient underwent a second CTA, which revealed a basilar artery occlusion, and was catheterized with successful reperfusion.

**Case 4**

A 15-year-old healthy male was referred to our clinic due to recurrent episodes of LOC. The history implied probable syncope events. A thorough workup including MRI, electroencephalo-

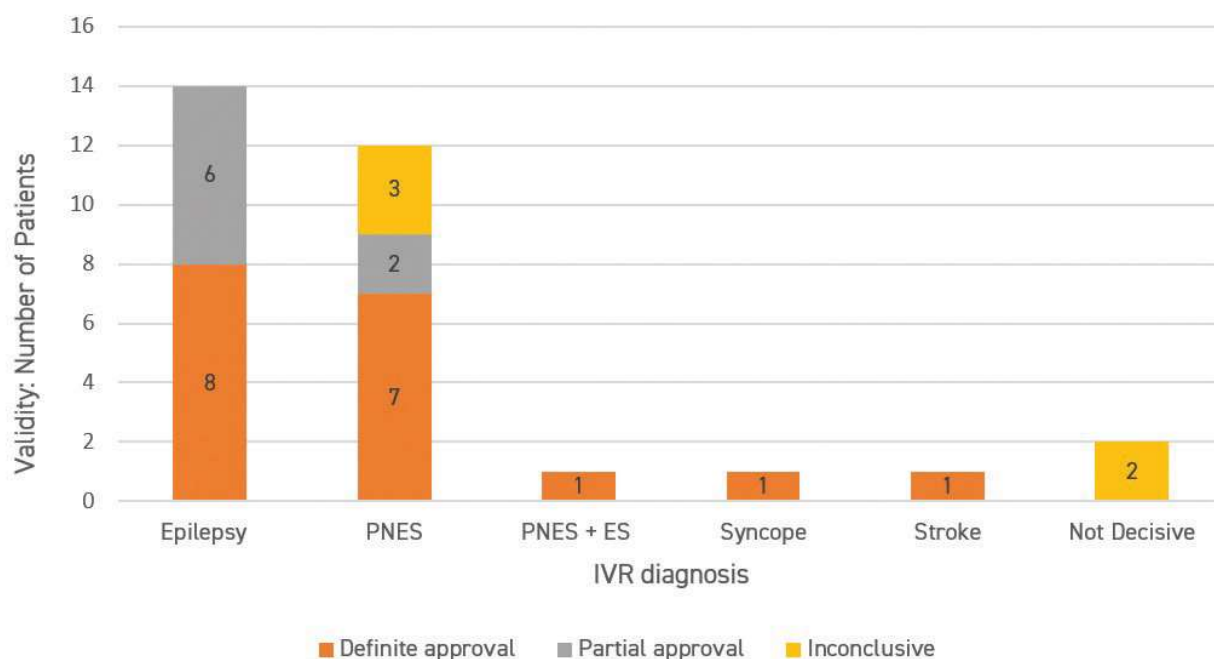
**Table 1.** Summary of IVR utility and validity among the different entities

IVR diagnosis Validity	Epilepsy (14 patients)	PNES (12 patients)	PNES (+ ES1 patient)	Syncope (1 patient)	Stroke (1 patient)	Not decisive (2 patients)
Definite approval	8	7	1	1	1	
Partial approval	6	2				
Inconclusive		3				2

ES = epileptic seizures, IVR = incidental video recordings, PNES = psychogenic non-epileptic seizures

**Figure 1.** Summary of IVR utility and validity among different entities

ES = epileptic seizures, IVR = incidental video recordings, PNES = psychogenic non-epileptic seizures



gram, echocardiogram, Holter electrocardiogram, and tilt test was unremarkable. A surveillance camera in his school documented one event. The patient was standing, then fell suddenly with several myoclonic movements in his arms. He regained consciousness after a few seconds. This video confirmed that the patient presented with recurrent syncope and was advised to strengthen his leg muscle and eat salty food with the resolution of events.

## DISCUSSION

Paroxysmal events, especially events with loss of awareness to the surrounding, pose a clinical challenge. A solid clinical hypothesis is the main cornerstone of proper diagnosis, especially in epilepsy, and all ancillary tests serve as a supplement and should be interpreted cautiously [5]. Epileptiform discharges in a patient with LOC events do not necessarily imply epilepsy, and a positive tilt test does not necessarily imply syncope. Furthermore, in many circumstances, it is hard to build a solid clinical hypothesis based on history taking alone either from the patient or from the surroundings [2].

Since a diagnosis of epilepsy can significantly impact a patient's social and occupational life, one should try to reach a confound clinical hypothesis regarding the nature of paroxysmal events.

LTVEM serves as the gold standard for the diagnosis and classification of seizures. Although LTVEM has a high yield, it

has limitations. Only patients with high seizure frequency are eligible for LTVEM. Availability of LTVEM in many regions of the world is low. There is a need to hospitalize the patient [6].

My study shows that IVR have a high yield in the differential diagnosis of LOC. IVR reached a diagnosis in 26–28 of 31 patients (83.8–90.3%). The accuracy of IVR compared to the gold standard test or clinical course was reached in 26/27 patients (95%). In comparison, LTVEM has a reported yield of around 70% [6,7].

Several studies have shown that epileptologists' analysis of videos is as good as LTVEM in differentiating between ES and PNES [8–10].

In a previous study, we showed that first responders had difficulty differentiating between ES and PNES by video footage alone. In that study, epileptologists could differentiate between PNES and ES in 87.5% of cases, first responders had a 44% success rate [11]. Hence, IVR are insufficient to reach a clear and correct diagnosis and should be analyzed only by trained professionals. Moreover, even though IVR have high efficacy, they are achieved in a minority of cases. In our study, only 0.02% of all consultations had recorded usable IVR.

Although IVR can help differentiate between different causes of LOC in this study, IVR served to differentiate mainly between PNES and ES.

Hence, there is still a need for better education of patients, caregivers, and medical personnel to achieve better utilization of this powerful tool.

Most of the IVR were made by personal phones by family, caregivers, or medical personnel. Surveillance cameras recorded a minority of cases. Most of the cases recorded by family phones were cases with high event frequency. In contrast, those recorded by surveillance cameras were, in most cases, first events or low-frequency events. Nevertheless, since understanding the nature of a first event substantially impacts patient management, every effort should be made to determine whether video footage was taken during the event besides obtaining a collateral history.

Moreover, caregivers can have difficulty obtaining video recordings for several reasons. In a study addressing home video recordings, 50% of participants were reluctant to acquire home video due to low seizure frequency, short duration of seizures, and caregivers' lack of time spent with the patient [8].

Another critical issue is the quality of IVR. In our experience, caregivers or family members do not picture the whole body and do not record the event from start to end. It is important to note that in our study, IVR described in medical files were of adequate quality. Hence, we do not know how many IVR were excluded during consultations.

#### LIMITATIONS

This study has several limitations. It is a retrospective study, the sample size is small, and only one evaluator examined IVR. Since the IVR footage itself was not kept, the study was based on the description of the IVR as written in the patient's file. Nevertheless, I believe that the future of making a proper LOC diagnosis is in better IVR recording. Several phone applications can aid in the management of epilepsy patients [12,13]. We believe that there is a need for better education of caregivers and medical personal about the importance of obtaining video recordings of a paroxysmal LOC event. Furthermore, there is a need for a guided application of acquiring video footage of LOC events.

#### CONCLUSIONS

IVR have a substantial yield and are highly accurate in the differential diagnosis of LOC, mainly differentiating between ES and PNES, yet it is utilized in a minority of the patients in real life.

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The best way to predict the future is to invent it.

Alan Kay (born 1940), American computer scientist

#### Capsule

### GM-CSF in glomerulonephritis

Glomerulonephritis is an immune-mediated kidney disease, but the contributions of individual immune cell types is not clear. **Paust** and colleagues characterized pathological immune cells in samples from human patients and mice with the disease. They found that CD4<sup>+</sup> T cells producing granulocyte-macrophage colony-stimulating factor (GM-CSF) caused monocytes to promote disease

by producing matrix metalloproteinase 12 and disrupting the glomerular basement membrane. Targeting GM-CSF to inhibit this axis reduced disease severity in mice, suggesting this cytokine as a potential therapeutic target for patients with glomerulonephritis.

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