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Editorial

Editorial: Outcome of ambulatory video-EEG monitoring in a ˜10,000 patient nationwide cohort

There is currently underutilization of ambulatory techniques in evaluating patients with episodic neurological, in addition to non-neurological conditions [1]. Prior reports comparing routine EEG with ambulatory EEG (aEEG) is often more informative for optimal seizure identification [2,3]. Furthermore, outpatient aEEG monitoring has been shown to be less expensive than inpatient 24-hour video-EEG monitoring (VEM), less restrictive to patients, and allows EEG recording in one's natural environment with exposure to daily seizure triggers [3]. In addition, there is good evidence from early studies that ambulatory EEG is feasible and can yield similar diagnostic information to inpatient EEG [4].

In this issue of *Seizure,* Syed et al. retrospectively analyze a huge database of reports approaching 10,000 ambulatory video-EEG monitoring (aVEM) studies across 28 states from a single independent ambulatory EEG testing facility [5]. Composite results of aVEM were subsequently compared to a cohort undergoing in-patient video-EEG at a National Association of Epilepsy Centers Level IV epilepsy center derived from a 4-bed adult unit and 8-bed pediatric unit. The primary outcome measure was the collective percentage of VEM recordings that captured at least one pushbutton event on video camera or demonstrated epileptiform activity on EEG tracings.

This study of 9221 cases analyzed in-home aVEM (Lifelines Trackit MK3) with 62.5% reaching the primary outcome measure. Of the primary outcome measures in the Syed et al. study, pushbutton events occurred in 75% of aVEM recordings, with 45% (4110 patients) of the aVEM samples with documentation that could be assessed for symptomatology. Of the nearly 5000 aVEM results that captured at least one pushbutton event on video, 98% were reported to be devoid of electrographic ictal changes. 15.1% of push-button negative events demonstrated interictal epileptiform discharges (IEDs) raising the possibility of scalp-negative ictal EEG recording either from brief or spatially-restricted focal seizures. The symptomatology comprised behavioral, autonomic, and emotional events captured on video recording without dissimilarity between adults and children. Overall in 31% of the aVEM patient diaries analyzed, there was absent documentation to describe at least one pushbutton event. This represents an important gap that could be addressed with more detailed education to document symptoms prior to aVEM recording.

Overall, epileptiform discharges were reported in 18.0% of AVEM recordings. The most common localization of epileptiform activity was temporal lobe in adults and generalized in children, in both ambulatory and inpatient cohorts. 96% of aVEM sessions had documentation of a prior routine EEG, but only 13% of these EEGs were reported as demonstrating IEDs. This supports prior results from ambulatory EEG studies demonstrating greater utility in patients with a clinical diagnosis of epilepsy following an initial non-diagnostic routine EEG [7]. Furthermore, this suggests a perceived benefit using long-term EEG monitoring for diagnostic purposes when a routine scalp EEG is normal or non-specific [8].

There are important limitations to consider in the study by Syed et al. when interpreting the results. Because the study results reflect the "first-interpreter" assessment of aVEM reporting, inter-rater reliability was unable to be performed. In a practical sense, many areas outside the United States may not currently acquire video as a standard for performing ambulatory EEG. In addition, push-button activations are oftentimes fraught with false positive results, and potentially involve symptoms that are mistaken as "typical" events. Other ambulatory EEG studies also revealed most push-button activations were "EEG negative" recordings when patients signified a clinical event was present [6]. Thus, the results of push-button events reported in the manuscript by Syed et al. should be interpreted with finite boundaries.

Compared to in-patient video-EEG monitoring, outcome using aVEM was reported to be similar in adults, but lower than that of pediatric patients. In practice, the validity of the results is based upon methodology. Percentiles and continuous variables including Fisher's Exact test and Mann-Whitney were used to generate multiple p-values (Bonferonni corrected). However, a note of caution in interpretation should arise when patients are not independent observations, because p-values generated from standard statistical methods can be misleading [9] as the post-hoc multi-variate logistic regression revealed. Differences between aVEM and in-patient VEM such as EEG reporting vs interpretative review, outpatient vs in-patient selection bias, neurologist vs epileptologist expertise, multi-site vs single site, numerical differences in EEG studies evaluated, and home video vs in-patient video results should be kept in mind by the reader when evaluating group differences. Individual interpretation of routine EEG, and presumably aVEM, by a general neurologist may have reduced accuracy [10]. That said, the authors properly note limitations of the study design and outline the limits in accuracy of reporting, particularly noting when events occurred without an ictal EEG change.

The large cohort study of aVEM reported in *Seizure* provides important information about the utility of aVEM on a large scale. Taken in proper context, aVEM data in the Syed et al. study supports prior ambulatory EEG studies from smaller single-center datasets comprised of at most 500 patients [11] and reinforces the utility of aVEM in non-urgent diagnostic evaluation of patients with seizures as Syed et al. and others suggest [4–8]. Indeed, the study by Syed et al. is an extraordinary achievement that expands on prior work to demonstrate the

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feasibility of analyzing “big data” in an effort to compare types of long-term video-EEG monitoring. The results of this large study provide insight into the process of stratifying aVEM relative to in-patient video-EEG monitoring. However, inpatient video-EEG monitoring has notable differences to aVEM and should remain the accepted gold-standard diagnostic test for evaluating appropriate patients with seizures and spells [3].

In the end, recognizing aVEM as a vital complementary technique intermediate between standard EEG and video-EEG monitoring, performed by experienced interpreters to potentially circumvent high-cost, reduce access, facilitate diagnosis, and alleviate inconvenience associated with inpatient video-EEG monitoring, goes without saying. When aVEM should first be performed before in-patient video-EEG for an individual patient remains an open-ended question. Ultimately each patient referred for evaluation of epilepsy possesses unique characteristics, and diagnostic EEG testing stratification, like treatment decision-making, should be individualized.

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William O. Tatum
Mayo Clinic College of Medicine, Department of Neurology and Neurosurgery, Mayo Clinic, 4500 San Pablo Road, Mangurian Building, 4th Floor, Jacksonville, FL 32224 USA
E-mail address: tatum.william@mayo.edu.