Outpatient Smartphone Videos in Epilepsy (OSmartViE): Initial Results of Video Quality

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Abstract

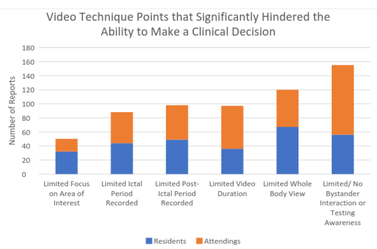
RATIONALE: Mimics of epilepsy such as psychogenic nonepileptic attacks (PNEA) are common.[1] The accuracy of a historical diagnosis for epilepsy is good, but for PNEA only moderate.[2] We present the initial findings from a multi-center prospective trial of smartphone use in epilepsy and address video quality. Home videos have been used as a diagnostic adjunct in epilepsy.[3,4] To address the impact of video quality of smartphones in people with epilepsy (PWE), we sought to evaluate the routine H&P for diagnosis.

METHODS: Patient-generated smart-phone videos (SV) were acquired prior to video-EEG monitoring (VEM). Using the SV, epileptologists and senior neurology residents were forced to choose a diagnosis of 1) ES, 2) PNEA, or 3) physiologic nonepileptic events (PhysNEE). Data sharing was performed via HIPPA-protected data transfer utilizing a web-based software submission (Captureproof®). Video quality was assessed using survey questions that addressed aspects such as lighting, audio and clarity of the SV.

RESULTS: The first 30 patients [20 F, age 44 yrs.; R=21-81]) received VEM with SV review by 10 epileptologists and 8 residents. VEM demonstrated 9/30 (30%) with epilepsy, 18/30 (60%) with PNEA and 3/30 (10%) with PhysNEE. For an epilepsy diagnosis, a 59% sensitivity (SE), but a 90% specificity (SPE) was seen. Overall, based upon the SV, PNEA was identified with a SE of 86% and SPE of 67% for a positive predictive value (PPV) of 80%. SV clarity was adequate with 71% reporting that the overall video quality was suitable to make a prediction. 65% agreed that the duration of video was sufficient. Lighting was deemed too dark 17% of the time. Video clarity was largely adequate, yet 14% of videos were reported as blurry or out of focus. The most commonly reported drawback was limited or no bystander interaction of testing awareness during the recording of the SV.

CONCLUSIONS: Most SV were adequate in clarity, audio, and light according to physician review. SV were mostly limited by limited bystander interaction, lack of whole body view and ictal period recorded. The specificity of an ES diagnosis, in addition to the sensitivity of a PNEA diagnosis makes SV a useful adjunct to routine H & P in clinical practice.

Figure 1



Objective

PRIMARY AIM:
To assess the overall quality of patient-provided SV of their habitual event and determine whether this technique is a useful adjunct to standard H & P.

SECONDARY AIM:
1) To determine the SE, SPE, PPV, negative predictive value (NPV), and accuracy of SV for each diagnosis (PNEA, ES, PhysNEE).
2) To asses SV technical aspects and recorder technique to identify which points significantly hinder the ability to make a diagnosis.

Methods

We prospectively evaluated 30 patients experiencing uncontrolled seizures with routine history & physical (H&P), SV, and VEM at Mayo Clinic Florida over 3 years. The treating physician made a clinical diagnosis of 1) ES, 2)PNEA, or 3) PhysNEE and reported a degree of certainty (scale-0-10). After making a decision based solely on H&P, the diagnosis was then either confirmed or denied by the golden standard of VEEM recording of the habitual event. Outpatient SVs of these events then underwent blinded review by 10 epileptologists and 8 senior general neurology residents, who analyzed the video and deemed whether or not the SVs were adequate to make a diagnosis. They were forced to make a diagnosis of 1)ES, 2)PNEA, or 3) PhysNEE, but were also allowed to chose unknown if the SV was not adequate. At each of the three phases (H&P, SV, VEEM), surveys were completed. In the SV surveys, physicians reported their opinion on quality aspects such as lighting, audio and clarity. Physicians were trained in use of a HIPPA-protected web-based software method (Captureproof®), which was used for data collection and sharing. Patients were included in the study as long as they met the criteria: voluntary consent, age 18, completed H&P prior to VEEM, representative event on technically viewable SV, VEEM recording and Captureproof® program training. Patients were excluded from the study under the criteria: younger than 18 years, incomplete H&P, atypical event, inadequate SV, no VEEM recording, or declining to participate. Using the data collected from the SV surveys, the SE, SPE, ACC, PPV and NPV were determined for each diagnosis (ES, PNEA, PhysNEE) to compare SV with H&P based on the standard diagnosis made with VEEM. The survey responses were also used to assess which technical aspects and techniques of the person recording hindered the ability to make a diagnosis.

Figure 2

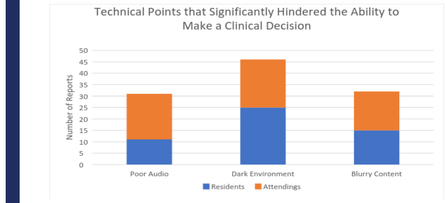


Table 2

Patient	H&P Diagnosis	VEM Diagnosis	Treating Physician	SV Diagnosis Blinded Attendings	Blinded Residents
01 01	PNEA	PNEA	PNEA	PNEA(5)	PNEA (7)
01 02	ES	PNEA	PNEA	PNEA (5), ES (2)	PNEA (1), ES (3), Unknown (2)
01 03	PhysNEE	PhysNEE	PNEA	PNEA (1), Unknown (6)	PNEA (1), Unknown (7)
01 04	PNEA	PNEA	PNEA	PNEA (6)	PNEA (8)
01 05	PhysNEE	PNEA	Unknown	PNEA (2), Unknown (5)	PNEA (2), Unknown (5)
01 06	ES	ES	ES	ES (6)	ES (2), PNEA (3) Unknown (1)
01 07	Unknown	PNEA	ES	ES (4), PNEA (2), Unknown (1)	PNEA (3), ES (3)
01 08	PNEA	PNEA	Unknown	PNEA (7)	PNEA (4), ES (1) Unkown (1)
01 09	PNEA	PNEA	PNEA	PNEA (4), Unknown (4)	PNEA (4), Unknown (2)
01 10	PNEA	PNEA	PhysNEE	PNEA (3), PhysNEE (1), Unknown (4)	PNEA (4), PhysNEE (1) Unknown (1)
01 11	PhysNEE	PhysNEE	PhysNEE	PhysNEE (6), Unknown (1)	PhysNEE (5), Unknown (1)
01 12	ES	PhysNEE	PhysNEE	PhysNEE(6) ES(1), PNEA(1), Unknown(1)	PhysNEE(1), ES(3), Unknown(1)
01 13	ES	ES	ES	ES (6), PNEA (1), Unknown (1)	ES (4), Unknown(2)
01 14	ES	ES	PNEA	ES (3), PNEA (5)	ES (3), PNEA (4)
01 15	ES	ES	PNEA	ES(5), PNEA (2), Unknown (1)	ES (1), PNEA (5)
01 16	PNEA	PNEA	PNEA	PNEA(4), Unknown(3)	PNEA (3), ES (1) Unknown(2)
01 17	PNEA	PNEA	PNEA	PNEA (7)	PNEA (6)
01 18	ES	ES	PhysNEE	ES(4), PhysNEE (1), Unknown(3)	ES (4), PNEA (2)
01 19	PNEA	PNEA	PNEA	PNEA (8)	PNEA (5), Unknown (1)
01 20	PNEA	PNEA	PNEA	PNEA (9), Unknown(1)	PNEA (4), Unknown (1)
01 21	PNEA	PNEA	PNEA	PNEA (9)	PNEA (6)
01 22	ES	ES	Unknown	ES (2), Unknown (7)	ES(1), PNEA (1), PhysNEE (2), Unknown(2)
01 23	ES	ES	ES	ES (3), PNEA (2), Unknown (4)	PNEA (6)
01 24	ES	PNEA	PhysNEE	PNEA (5), ES (1), Unknown (3)	PNEA (2), Unknown (1), ES (1)
01 25	PNEA	PNEA	PhysNEE	PNEA (6), ES (2), PhysNEE (1), Unknown (1)	PNEA (1), Unknown (3)
01 26	Unknown	ES	ES	PNEA (2), ES (4)	PNEA (2)
01 27	PNEA	PNEA	PNEA	PNEA (5)	PNEA (3)
01 28	PNEA	PNEA	PNEA	PNEA (5)	PNEA (3)
01 29	Unknown	PNEA	PNEA	PNEA (1), PhysNEE (3), Unknown (1)	PNEA (1), PhysNEE (2)
01 30	ES	ES	ES	ES (5)	PNEA (1), ES (2)

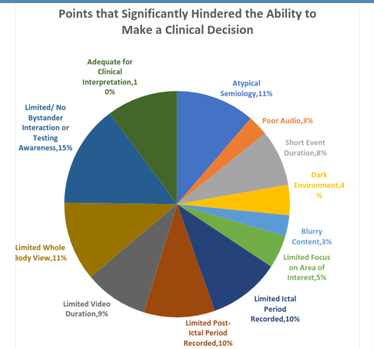
Residents agreement kappa is 0.3777. Attendees agreement kappa is 0.3520

Figure 1

Results

- 30 patients [20 females, mean age 44; range 21-81] had SV analyzed for ES, PNEA, and PhysNEE by 10 epileptologists and 8 residents.
- VEEM had 9/30 (30%) with ES, 18/30 (60%) with PNEA and 3/30 (10%) with PhysNEE
- Physicians deemed the overall video-quality suitable to make a prediction for 71% of the surveys (Figure 1).
- For a PNEA diagnosis, residents yielded 85% SE, 53% SPE, 72% accuracy, 73% PPV and 70% NPV, while epileptologists yielded 87% SE, 79% SPE, 84% ACC, 87% PPV and 79% NPV. All of the physicians combined yielded a PNEA diagnosis with 86% SE, 67% SPE, 79% ACC, 80% PPV and 75% NPV.
- For an ES diagnosis, residents yielded 40% SE, 87% SPE, 71% ACC, 59% PPV and 75%NPV, while epileptologists yielded 75% SE, 92% SPE, 87% ACC, 79% PPV and 90% NPV. All of the physicians combined yielded an ES diagnosis with 59% SE, 90% SPE, 80% ACC, 71% PPV and 83% NPV.
- For a PhysNEE diagnosis, residents yielded 60% SE, 96% SPE, 93% ACC, 55% PPV and 97% NPV, while epileptologists yielded 80% SE, 96% SPE, 95% ACC, 67% PPV and 98% NPV. All of the physicians combined yielded a PhysNEE diagnosis with 72% SE. 96% SPE, 94%, ACC, 62% PPV and 97% NPV.
- For the 71% of all survey responses in which the video quality was deemed adequate to make a diagnosis, the SVs demonstrated 87% SE, 69% SPE, 81% ACC, 83% PPV and 77% NPV for PNEA, 61% SE, 89% SPE, 81% ACC, 71% PPV and 84% NPV for ES, and 72% SE, 97% SPE, 95% ACC, 65% PPV and 98% NPV for PhysNEE (Table 3).
- 65% of survey responses agreed that the SV duration was long enough. 23% reported that there was poor or no audio. 14% reported that the SV was blurry or out of focus. 17% reported that the SV was too dark.
- The most reported points that significantly hindered the ability to make a clinical decision were limited/ no bystander interaction (15%), limited whole body view (11%), and atypical semiology (11%) (Figure 2).
- Dark environment was the mostly commonly reported technical drawback (Figure 3) and limited bystander interaction was the most common flaw for technique of the recorder (Figure 4).
- No safety concerns arose with this study.

Figure 2



Discussion

VEEM is the best all-around method for differential diagnosis of ES, PNEA, and PhysNEE but, availability, cost and resource utilization are limited. Smartphones, however, are widely used in the global society. These devices come equipped with high-definition cameras that have the potential to capture videos of patients' events in order to paint a clear image for the treating physician. Most diagnoses are made in isolation without the accompaniment of a visual aid demonstrating paroxysmal neurological behaviors. Considering that 20-30% of VEEM units falsely diagnose epilepsy, it is evident that newer techniques are necessary.[1] While the witness' verbal history is helpful, it is not sensitive to non-epilepsy diagnoses.[2] In the world of telemedicine, home videos are widely under-utilized and under-recognized as potential diagnostic tools with worldwide impact. [3,4] Using a HIPPA secured application, we demonstrate the feasibility of using SV in adjunct to H&P. The high specificity of ES diagnosis in combination with the high sensitivity of PNEA diagnosis made from SV suggests that SV are a useful adjunct to standard H&P. Although 29% of the responses reported that the video quality was not adequate to make a clinical decision, the most commonly reported limitations are not flaws of the technology, but rather weaknesses in the individual's recording technique (limited bystander interaction, limited whole body view, limited period recorded) or constraints of the patients ictal characteristics (atypical semiology, limited event duration), suggesting that feedback can be provided on how to take a better SV.

Conclusions

- Most SV were adequate in clarity, audio and light according to physician review
- SV were mostly limited by limited bystander interaction, lack of whole body view and ictal period recorded
- The SV were not significantly hindered by technical flaws on the smartphone video capabilities, but rather techniques of the recorder and characteristics of the patients seizures
- SV are highly specific for ES diagnosis and highly sensitive to PNEA diagnosis
- While this technique does not replace the need for VEEM, SV is a useful adjunct to standard H & P.

References

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Table 3

Diagnosis	Sensitivity		Specificity		Accuracy		PPV (%)		NPV (%)	
	Overall	Adequate	Overall	Adequate	Overall	Adequate	Overall	Adequate	Overall	Adequate
PNEA	86	87	67	69	79	81	80	83	75	77
ES	59	61	90	89	80	81	71	71	83	84
PhysNEE	72	72	96	97	94	95	62	65	97	98

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