Outpatient Smartphone Videos in Epilepsy (OSmartViE): Initial Results

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Abstract

BACKGROUND: Epilepsy is a global disease that is diagnosed based upon clinical grounds often supported by EEG. There are a variety of seizure mimics that can result in a misdiagnosis . New tools beyond routine E & M evaluation in the clinic are necessary to assist with the diagnosis for accurate patient–specific treatment.

RATIONALE: Definitive diagnosis of paroxysmal neurological events can be achieved by the use of video-EEG monitoring (VEM).[1,2] However, barriers for access exist for many who suffer from them. Home videos and hand-held camcorders are promising surrogates.[3,4] The use of smartphones has exploded with sophisticated, portable, video cameras and worldwide availability. We sought to determine the usefulness of outpatient smartphone videos in epilepsy (OSmartViE) and report our preliminary findings of a multi-center prospective study.

METHODS: Eligible patients were prospectively and consecutively evaluated with a routine H&P for the diagnosis of epilepsy. Patient-generated outpatient smart-phone videos (SV) were acquired and reviewed prior to VEM. A forced choice diagnosis of 1) ES, 2) PNEA, or 3) PhysNEE with a corresponding degree of certainty (0-10) that was assigned. Epileptologists and senior general neurology residents without special interest in epilepsy were surveyed for a blinded SV diagnosis. Data sharing was performed via HIPAA-protected data transfer utilizing a web-based software application (CaptureProof®). The H&P, SV, and VEM results were obtained using survey forms and were compared. Sensitivity, specificity, PPV, NPV of the SV for VEM was obtained.

RESULTS: 25 patients [16 F, age 43.33 yrs.; R= 20-80] had H & P, SV and VEM with SV reviewed by 9 epileptologists (Experts) and 7 residents. VEM demonstrated 7/25 (28%) with epilepsy, 15/25 (60%) with PNEA and 3/25 (12%) PhysNEE (tremor, syncope) with 0%, 53% and 67% reflecting convulsive episodes. Correct responses by 7 residents in ES was 26% while 9 epileptologists were correct in 62%. No difference in diagnosis in PNEA (87%, 88%) occurred. SV quality was adequate for interpretation in more than **3/4th (75% v 81%).** Individual responses occurred from technical as opposed to video quality and were limited by lack of whole body view and the duration of an ictal recording. Epileptologists had a greater level of confidence than residents (7.26 v 6.28; p= NS). 3 patients did not have events in the VEM and 1 patient SV was inadequate to make a diagnosis. These 4 patients will not be included in the upcoming paper.

CONCLUSIONS: Secure exchange of SV information is feasible. Most SV had convulsive episodes but 70% were not ES. SV diagnosis had a level of confidence similar to H & P. Epileptologists were better in identifying ES than trainees and more confident in non-epilepsy despite similar accuracy.

Table 1

VEM Diagnosis			
VEM Dx	**No. Pts.**	**%**	**Cum. %**
Epileptic (ES)	7	28.00	28.00
Psychogenic non-epileptic attacks (PNEA)	15	60.00	88.00
Physiologic non-epileptic events (PhysNEE)	3	12.00	100.00

Objective

PRIMARY AIM:
To compare the diagnostic accuracy of patient-provided SV of their habitual paroxysmal event with the standard H & P.

SECONDARY AIM:
1)To identify inter-rater reliability of PV to determine ES and non-epileptic events (NEE) relative to VEM.
2)To determine the additive value of an SV to the H & P in predicting the VEM results in patients with paroxysmal events.

Methods

We prospectively evaluated 25 (24 new) consecutive patients uncontrolled seizures with routine history & physical (H&P) and SV and VEM at Mayo Clinic Florida over 2 years. The treating physician-rendered clinical diagnosis of 1) ES, 2) PNES, or 3) PhysNEE most likely with a degree of certainty (scale: 0-10) was obtained. The diagnosis was confirmed with VEM recording of the habitual event. SVs of a representative event underwent blinded review by 9 other evaluating MDs (plus 7 3rd year general Neurology residents analyzed for diagnosis and level of confidence. Surveys were sequentially completed for all 3 phases (H & P, SV, VEM). SV data collection and sharing was done after training using a HIPPA-protected web-based software method (CaptureProof®). Inclusion criteria: voluntary consent, age 18, completed H & P (before VEM), representative event on SV, and VEM performed, trained to utilize CaptureProof®, and technically viewable SV recording. Exclusion Criteria: younger than 18 years, incomplete H & P, atypical event, inadequate SV, VEM not performed, patient declines participation. Sensitivity, specificity, accuracy, positive predictive value, and negative predictive value were determined for ES, PNEA, and PhysNEEs using SV compared with H & P based upon VEM. Inter-rater reliability tested via Fleiss' Kappa.

Results

- 25 patients [12 Females, mean age 44; range 19-80] had SV scored for ES, PNEA, and PhysNEE by 9 epileptologists and 7 residents .
- VEM had 7/25 (28%) with ES, 15/25 (60%) PNEA and 3/25 (12%) PhysNEE (e.g. syncope); 30%, 70% , and 100% convulsive **(Table 1).**
- H & P identified 21/25 for a VEM diagnosis (84%) after a mean of 3.3 days.
- All SV correctly identified 66% of VEM diagnoses for epileptologists vs. 55% by residents though 5-9 were suboptimal recording (partial view).
- More inter-rater variability was present for SV viewed by residents than epileptologists with k= 0.58 for epileptologists and k= 0.38 for residents.
- Resident responses judging the SV were correct in 26% of ES while epileptologists were correct in 62% of case with no difference in the ability to identify PNEA (87%, 88%); see **Table 2.**
- Epileptologists accepted SV quality more often with 20/25 rating 5 or better (7.5 corrected) and residents 16/25 (6.83 corrected); **see Table 3.**
- The quality of the SV was judged to be adequate for interpretation in nearly 3/4th of SV **(figure)**. Epileptologists had a greater inter-rater reliability than residents (0.6 v 0.4) and higher level of confidence (7.26/10 v 6.28/10) but was not significant.
- There were 45.000 seconds (12.5 hrs.) of SV viewed with a mean of 2.15 minutes vs. 1 hour for H & P (24/25) and 3.3 days of VEM.
- No safety concerns arose with the study.

Table 2

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

Table 4

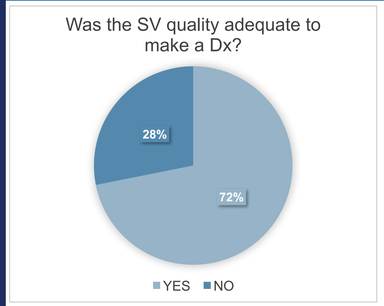
Level	Sensitivity	Specificity	PPV (%)	NPV (%)
All	55.8 (25.5, 64.7)	89.0 (76.1, 95.4)	66.1	83.9
Experts	71.1 (45.2, 88.0)	91.2 (78.3, 96.7)	84.0	89.0
Residents	41.0 (21.0, 64.6)	86.3 (70.8, 94.2)	45.6	78.1
Experts/Good Quality Video	77.4 (39.1, 94.8)	92.0 (82.3, 96.6)	83.9	91.7
Residents/Good Quality Video	36.7 (21.9, 54.5)	84.8 (68.3, 93.6)	50.0	77.4

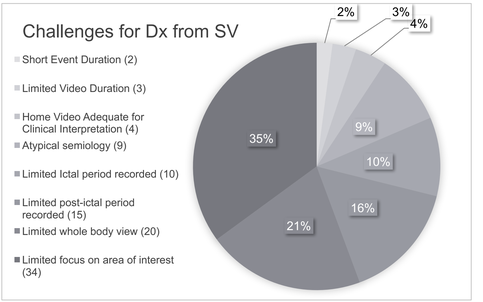
Residents agreement kappa is 0.3777 Experts agreement kappa is 0.5820

Table 3

Patient	% Correct	SV Dx	Adequacy of SV Quality		Length SV	VEM
	Experts	Residents	Experts All Dx	Residents All Dx		# events captured
01 01	100%	100%	8.6	8.33	0:47	2
01 02	71%	43%	7	5.43	2:14	4
01 03	0	0	0.43	0.43	0:10	Multiple
01 04	100%	100%	7.83	6.71	1:25	3
01 05	29%	33%	3	4.17	0:23	2
01 06	100%	33%	6.67	6	0:25	3
01 07	29%	50%	7.5	6.17	3:40	0
01 08	100%	67%	8	7.5	4:01	3
01 09	67%	67%	4	4.5	0:58	3
01 10	50%	67%	3.83	4	4:40	3
01 11	86%	83%	5.57	4	3:47	4
01 12	63%	20%	6.75	6.2	0:28	Multiple
01 13	75%	67%	5.13	2.33	1:07	0
01 14	38%	43%	8	7	4:16	2
01 15	57%	17%	4.29	4.5	3:59	8
01 16	57%	50%	6.29	4.83	0:30	3
01 17	100%	100%	7.71	7.67	5:17	2
01 18	50%	67%	8.13	6.4	3:41	3
01 19	100%	83%	7.43	7	0:21	2
01 20	89%	80%	8.22	9	6:03	2
01 21	100%	100%	5.89	4.67	3:50	4
01 22	22%	17%	5.56	6.5	0:34	20
01 23	25%	14%	6.88	6.43	0:09	0
01 24	63%	33%	7.63	7.67	0:40	2
01 25	75%	33%	6.13	5.33	2:55	1
Median	**71.4%**	**66.7%**	**6.26/7.5c**	**5.71/6.8c**	**2:15 min**	**3.3 days**

Figure





Discussion

VEM is the most specific procedure in the evaluation process of patients with suspected seizures, availability, cost and resource utilization are limited. Smartphones are a ubiquitous part of a global society with cameras capable of high definition. Most diagnoses are made in isolation without sharing of information related to paroxysmal neurological behaviors. Newer techniques are needed given that 20-30% of diagnoses in VEM units are misdiagnosed as epilepsy (1). The reliability of the witness ' history for epilepsy is good though the sensitivity for non-epilepsy is not (2). Home videos are an under-utilized, under-recognized form of tele-medicine (3,4) with diagnostic potential for world-wide impact. We demonstrate the feasibility with a HIPPA secured application. Most patients submitting SV had PNEA. The overall sensitivity is good with experts with a higher level of confidence for diagnosis with a moderate-good IIR compared with VEM correlation. Given the limited resources, access to neurologists, and limitations of H & P (2) , benefit of hand-held video-recorders (3), our initial experience suggests SV are a useful adjunct to standard E & M and best medical practice for patients with seizures. Given reports of similar sensitivity to EEG (4), SV holds promise for patients in regions where availability and transferability are possible and barriers to access and resources are limited (5).

References

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Conclusions

- Secured uploading, exchange, and analysis of SV data is feasible and most SV brought to clinic contained PNEA (convulsive episodes).
- The positive and negative predictive value for a SV was good in expert hand and less predictive for trainees.
- Inter-rater variability in experts was > residents (k= 0.58 vs 0.38).
- SV were reviewed in 2.15 mins as opposed to 60 mins with routine H & P and 1443 minutes (3.3 days) with VEM.
- Supplementing the H & P with a SV provides objective support for a clinical diagnosis of patients with recurrent seizures but does not replace the need for VEM.

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