EXPLORING AUTOMATED PUPILLOMETRY IN COMPARISON TO THE WITHDRAWAL ASSESSMENT TOOL-1 FOR THE EVALUATION OF OPIATE ABSTINENCE SYNDROME IN PEDIATRIC CRITICAL CARE PATIENTS

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RESEARCH QUESTION

In pediatric critical care patients tolerant to opiates, is automated pupillometry more sensitive in detecting opiate abstinence syndrome when compared to the gold standard observational scoring system?

BACKGROUND

Opiates are often used in the Pediatric Intensive Care Unit to maintain analgesia and sedation. In doing so, pediatric patients quickly develop tolerance to opiates and must be slowly tapered off to avoid inducing opiate abstinence syndrome. Currently, the gold standard to evaluate for opiate abstinence syndrome is the Withdrawal Assessment Tool-1 (WAT-1), which is a 12-point subjective scale monitoring for symptoms of opiate withdrawal. There are currently no objective tools to evaluate for opiate abstinence syndrome in children. This study attempts to evaluate if automated pupillometry is an accurate and reliable tool to objectively evaluate for opiate abstinence syndrome in pediatric patients who are tolerant to opiates and undergoing an opiate taper. Since opiates are parasympathetic agonists, they stimulate pupillary constriction. Further, it has been shown that pupillary constriction develops tolerance similarly to the analgesic and euphoric tolerance. It is not until the opiate dose is manipulated that patients who are tolerant to opiates will show a change in pupil diameter. Therefore, it is reasonable to assume that automated pupillometry could accurately and reliably evaluate for opiate abstinence syndrome by objectively measuring pupillary changes as the patient tapers off opiates.

METHODS

Opiate-tolerant patients in the pediatric intensive care unit were enrolled in this study. Data was collected twice daily. The WAT-1 scale was collected first, and then automated pupillometry was performed. The right eye was utilized to collect data on the pupillary light response, while the left eye was utilized to collect data on pupillary unrest without a light stimulus. Lastly, total daily opiate dose (TDOD) was calculated and converted to morphine milligram equivalents (MME) for each day on study.

WAT-1 Data Collection Sheet

Subject ID Number:		
Date:		
Time:		

Information from patient record, previous 12 hours:

Any loose/watery stools	No = 0 Yes = 1	
Any vomiting/wretching/gagging	No = 0 Yes = 1	
Temperature >38C (100.4F)	No = 0 Yes = 1	

2-minute pre-stimulus observation

State	Asleep/awake/calm = 0 Awake/distressed = 1	
Tremor	None/mild = 0 Moderate/severe = 1	
Any sweating	No = 0 Yes = 1	
Uncoordinated/repetitive movement	None/mild = 0 Moderate/severe = 1	
Yawning/sneezing	None or 1 = 0 >2 = 1	

1-minute stimulus observation

Startle to touch (glabellar tap)	None/mild = 0 Moderate/severe = 1	
Muscle tone (arm flexion)	Normal = 0 Increased = 1	

Post-stimulus recovery

Time to gain to calm state	<2 min = 0 2-5 min = 1 >5 min = 2	

Total Score (0-12): _____

Day*	Total Daily Opiate Dose (MME)	WAT-1 Score	Pupillary Unrest (AU)	Initial Pupil Diameter (mm)	End Pupil Diameter (mm)	Pupil Latency (sec)	Avg. Pupil Constriction Velocity (mm/sec)	Max Pupil Constriction Velocity (mm/sec)	Pupil Dilation Velocity (mm/sec)	Time to reach 75% (sec)
1a	9.9128	0	5.7	5.5	3.1	0.23	-3.5	-5.61	NA	NA
2a	8.8258	1	7.5	6.6	4	0.2	-3.39	-5.8	1.59	NA
2b	8.8258	0	7.4	6.6	4.2	0.13	-3.03	-4.78	1.61	NA
3a	12	1	5	5.5	2.9	0.2	-4.84	-8.23	2.06	1.77
3b	12	1	5.1	4.5	2.8	0.23	-2.49	-4	1.52	1.24
4a	6.8	0	7.4	6.2	3.6	0.3	-2.68	-5.74	1.63	NA
5a	5.1	0	6.5	3.2	2.5	0.2	-2.02	-2.39	1.59	0.77
6b	3.4	0	6.2	6.5	3.9	0.23	-3.25	-4.54	1.11	NA

Automated pupillometry may be more sensitive in detecting opiate abstinence syndrome when compared to the WAT-1 scoring system.

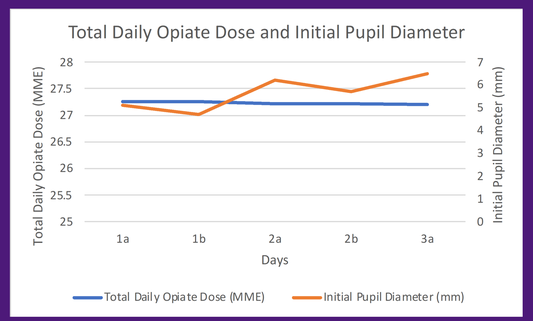

Figure 2. Total Daily Opiate Dose and Initial Pupil Diameter
r_s = -0.94868, *p* (2-tailed) = 0.01385.

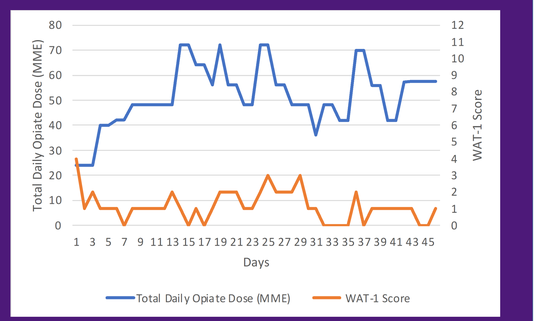

Figure 10. Total Daily Opiate Dose and WAT-1 Score
r_s = 0.09497, p (2-tailed) = 0.5349.

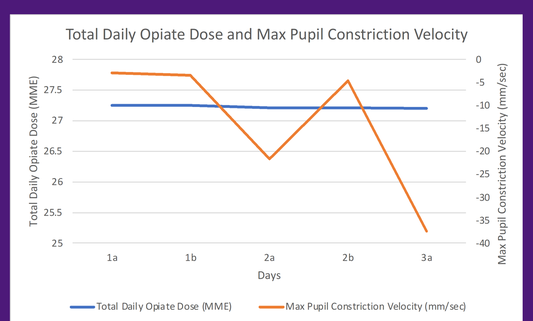

Figure 8. Total Daily Opiate Dose and Max Pupil Constriction Velocity.
r_s = 0.94868, p (2-tailed) = 0.01385.

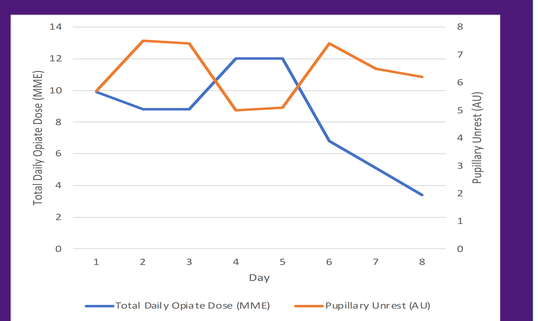

Figure 26. Total Daily Opiate Dose and Pupillary Unrest
r_s = -0.55153, *p* (2-tailed) = 0.15646.
r_s = -0.85084, *p* (2-tailed) = 0.03171 when eliminating last 2 time points

RESULTS

Five patients (0-10 years) were enrolled in the study. Each automated pupillometry (AP) variable was correlated to total daily opiate dose (TDOD) and WAT-1 total score, using Spearman's rho correlation with p-value set to α<0.05.

Subject 1: Removed from study after four days due to inability of device to capture and measure pupil.
Subject 2: TDOD significantly correlated to initial pupil diameter (p=0.01) (figure 2) and maximum constriction velocity (p=0.01) (figure 8).
Subject 3: No statistically significant correlations between AP, WAT-1 score, and TDOD (figure 10).
Subject 4: TDOD significantly correlated to pupillary unrest when eliminating last 2 time points (p=0.03) (figure 26).
Subject 5: No statistically significant correlations between AP, WAT-1 scores, and TDOD.

FUTURE DIRECTIONS

This exploratory study revealed some statistically significant correlations between automated pupillometry and total daily opiate dose, and no statistical significance between automated pupillometry and WAT-1 scores or between WAT-1 scores and total daily opiate dose. Therefore, the current study revealed automated pupillometry may be more sensitive to opiate abstinence syndrome when compared to the gold standard WAT-1 scoring system. However, limitations included small sample size, difficulty of device to capture pupils when surrounded by dark-colored irises, and difficulty of using device on subjects who were agitated while tapering off sedation. Future studies may examine use of ultrasound to measure pupil size.

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